ENTRO

EASTERN NILE TECHNICAL POWER TRADE INVESTMENT PROGRAM STUDY

AfDB

- INCEPTION REPORT -

to

Eastern Nile Technical Regional Office (ENTRO)

MAIN REPORT

November 2006

EDF – Generation and Engineering Division
73 373
Le Bourget du Lac Cedex
France
Tel: +33-4-79 60 60 60
Fax: +33-4-56 65 20 13
eMail: 79 60 62 35
pierre.brun@edf.fr
http://www.edf.fr

Scott Wilson
Kanthack House, Station Road,
Ashford, Kent TN 23 1 PP
England
Tel: +44 (0) 1233 658200
Fax: +44 (0) 1233 658209
eMail: alan.bates@scottwilson.com
http://www.scottwilson.com

with participation of :

- EPS (Egypt)
- Tropics (Ethiopia)
- YAM (Sudan)

TABLE OF CONTENTS

ABBREVIATIONS AND ACRONYMS

km = kilometre

km² = square kilometre

kW = Kilowatt

MW = Mega Watt

m = metre

m^3/d = cubic metre per day

mm = millimetre

mm^3 = million cubic metres

ADB = African Development Bank

ADF = African Development Fund

CIDA = Canadian International Development Agency

DANIDA = Danish Development Assistance

DFID = Department for International Development (UK)

DIDC = Department for International Development Cooperation (GoF)

DSA = Daily Subsistence Allowance

EEHC : Egyptian Electric Holding Company

EEPCO : Ethiopian Electric Power Corporation

EHVAC = Extra High Voltage Alternating Current

EIA = Environmental Impact Assessment

EIRR = Economic Internal Rate of Return

EN = Eastern Nile

ENCOM = Eastern Nile Council of Ministers

ENSAP = Eastern Nile Subsidiary Action Program

ENSAPT = Eastern Nile Subsidiary Action Program Team

ENTRO = Eastern Nile Technical Regional Office

ENTRO PCU = Eastern Nile Technical Regional Office Project Coordination Unit

EU = European Union

FIRR = Financial Internal Rate of Return

GEP : Generation Expansion Plan

GTZ = German Technical Co-operation

HVDC = High Voltage Direct Current Transmission

ICCON = International Consortium for Cooperation on the Nile

ICS = Interconnected System

IDEN = Integrated Development of the Eastern Nile

JICA = Japanese International Co-operation Agency

JMP : Joint Multipurpose Project

MIWR : Ministry of Irrigation & Water Resources (Sudan)

MWR : Ministry of Water Resources (Ethiopian)

MWRI : Ministry of Water Resources and Irrigation (Egypt)

NBI : Nile Basin Initiative

NELCOM = Nile Equatorial Lake Council of Ministers

NELSAP = Nile Equatorial Lake Subsidiary Action Program

NGO = Non Governmental Organization

NORAD = Norwegian Aid Development

O&M = Operations and Maintenance

PBP = Pay Back Period

PHRD = Policy & Human Resource Development Fund

PIU = Project Implementation Unit

PRSP = Poverty Reduction Strategy Paper

RE = Rural Electrification

SAPP = Southern Africa Power Pool Project

SIDA = Swedish International Development Agency

STS = Senior Technical Specialist

TAF = Technical Assistant Fund

UA = Unit of Account

UNDP = United Nations Development Programme

1. KICK-OFF AND GENERAL STATUS OF PROJECT

The project took off officially with the kick-off meeting held in Addis Ababa on October 20th 2006. During the first project week, the project infrastructure of the Consultant in Addis was established and the Project Office has become operational in the ENTRO PCU offices.

Moreover the anticipated mission held on September in Egypt and Ethiopia and in October in Sudan was very helpful to meet all key representatives in three countries and to finalize agreements and subcontracts with local sub contractors.

For the first module (M1 – Inception mission), significant progress has been achieved during the first project month which is documented in this Report. First preparations were also carried out for two following modules (M2 and M3). The objectives of HPP site visits were reached in Ethiopia (Border and Mandaya sites) as well in Sudan (Dal 1 site).

So far, the Project progress is fully in line with the work and activity schedule.

As envisaged, the Project makes also intensive use of local expertise (involvement of local sub-contractors EPS and TROPICS) and contacts with energy specialists which can also be seen in the list of utilities and key personnel met.

The Inception Report covers the period of Project Month 1, i.e. from October 20th to November 13th 2006, which is also defined as the Inception Mission of Phase 1 of the Project.

With the submission of the Inception Report, the Project proceeds into Module 2 and Module 3 of Phase 1 which are defined as “Market and Power Trade Assessment” and “Energy Sector Profile & Projections”. These modules will be completed with the Workshop N° 2 in Egypt on January 22nd 2007.

2. PRELIMINARY TASKS

2.1 VISITS TO UTILITIES IN COORDINATION WITH ENTRO

2.1.1 AGENDA OF VISITS

2.1.1.1 Acknowledgments

The Consultant, EDF/SW consortium including its own subcontractors (EPS, TROPICS, YAM and SPEEDOTRANS) would like to acknowledge ENTRO team for the warm welcoming and all help and facilitation during the first stage of the Project. In particular the Consultant appreciated the excellent organization of the meetings and the introduction of all key representatives and focal point in the three countries.

2.1.1.2 List of utilities and key personal met

The anticipated mission held in September 2006 and inception mission held in October were the opportunity to meet with key representatives from the three countries (see list below):

Ministry of Electricity - Egypt

- Fouad Taher, Engineering Counselor

EEHC – Egypt

- Dr. Kamel Yassin, Executive Director Planning, Research, Power projects
- Fawzia bou Neima, Board Member for production, Transmission &Distribution Companies Affairs
- Abdel Rahim A. Helmi Hamza, Managing Director Electrical Network Studies

EEPCO - Ethiopia

- Zelalem G/Hiwot, Head Power System Planning Office
- Adede Tesfye
- Tesfaye Batu, Regional interconnection
- Kifle Horo, Generation construction
- Daniel Melatu
- Getye Tesfaye, Transmission, substations O&M
- Atemu Tenibo, Planning,

- Abrawa Abebe, IPP

EPA

- Dr. Yonas Michael, EIA specialist, EPA
- Geremew G/Selassie & Tayech Ourgicho, Editors of Tefetro

Ethiopian Wildlife and Natural History Society

- Kinfe Abebe & Mengistu Wodafrash

Ethiopian Mapping Authority

- Ato Kassaye and Degelo Sendabo

AA University

- Dr Wolde Bewket, , Geography Department
- Dr Abeje Berhanu, Sociology Department
- Dr Bayu Chane, Faculty of Technoloy, Civil Engineering

Ministry of Water Resources - Ethiopia

- Tefera Beyene, ENSAPT leader
- Michael Abebe, Head, Dams & Hydropower Design Department
- Messele Fisseha
- Solomon Tassew, Team Leader, Power Planning & Dam Study & Design

ENTRO

- Mekuria Tafesse, Executive Director
- Dr. Ahmed Khalid, Senior Regional Projects Coordinator
- Dr. Fatma Moustafa, Project Coordinator
- Dr. Hazim Hanafi, Power System Analyst
- Dr. Solomon Abate, Regional Project Coordinator (WSM & IRD)
- Dr. Wubalem Fekade, CBSI LS ENTRO-Based Social Development Officer
- Dr. Babiker Abdalla, Environmentalist
- Jelal Shafi, Power Economist

- Tigabu Adane, Procurement Officer
- Hani Fouad Salama, Head of Finance and Administration

WB

- E.V.Jagannathan, Senior Water Resources Eng.

Ministry of Energy - ERA - Sudan

- Amin Sabri, Secretary General

Ministry of Environment and Physical Development - Sudan

- Therasa Siricio Iro, State Minister.

Ministry of Irrigation & Water Resources - Sudan

- Ibrahim Salih Adam, Vice Chairman Water Resources Technical Organisation
- Mohamed Bahr Eldein Abdalla, Undersecretary
- Dr. Salaheldin Yousif, Chairman Water Resources Technical Organisation

Irrigation Department of Dongola

- Kamal

Ministry of Science and Technology, Agricultural Research and Technology Corporation

- Elfatih Elajib

NEC - Sudan

- Bushra Abdalla Gadalla, Acting General Director
- Musaad Abdalla Mohamed, Generation Director,
- Tageldin Faragalla Dalil, Networks Planning Manager
- Osman Ahmed A / Kariem, Director General Directorate of Planning & Projects

Remote Sensing Authority

- Ms Amna Ahmed Hamid

Ministry of Water Resources and Irrigation

- Dr. Abdel Fattah Metawie, Chairman
- Ibrahim A. El-Desouky, HRI Acting Director
- Mohamed Nasser Ezzat, Advisor

2.1.2 IDENTIFICATION OF STAKEHOLDERS

The Consultant understood that a strong need was the identification of all stakeholders of the Project. This task is not yet completed and the next missions in three countries will allow to establish an exhaustive list.

2.1.3 NEED FOR COMPLEMENTARY VISITS

The Consultant expects to discuss with ENTRO Executive Manager and ENTRO Project Manager to plan meetings with key relevant representatives during Workshop N° 2 to be sure that all linked projects (such as JMP) will be known by the Consultant team and consequently properly taken into account in the ENTRO Project. The periodic workshops and missions during the overall completion of the Project will be the opportunity to follow up all projects carried out in parallel of the present project.

2.2 OBJECTIVES, CHALLENGES AND RISKS

2.2.1 BACKGROUND

The Nile Basin Initiative (NBI) was established in 1999 as a co-operative framework between the countries of the Nile basin, namely Burundi, Democratic Republic of Congo, Egypt, Eritrea, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda. Various bodies or entities have been established to promote co-operation between the countries in environment, power, water resources, agriculture, socio-economic, training and stakeholder participation. The NBI has acted as an effective mean to improving efficiency in the sharing of the resources of the Nile region. The ENTRO Project is part of the NBI in the facet of power development and trade, naturally interfacing with water resources since much of the region's generation is in the form of hydropower, which can fulfil a dual use of irrigation.

The supply of electric power for the three countries of the study are the responsibility of Egyptian Electric Holding Company (EEHC) in Egypt, Ethiopian Electric Power Corporation (EEPCO) in Ethiopia and The National Electricity Corporation (NEC) in Sudan. The power system of the three countries are not currently interconnected, but Egypt is interconnected with neighbouring countries (Jordan, Libya).

Egypt, Sudan and Ethiopia currently anticipate increasing demand for supply of electricity and each country currently has its own expansion plan to supply that demand through differing sources of generation. Ethiopia's plans are mainly based on the expansion of their hydropower potential since there is an estimated 30,000 MW of capacity yet to be developed. Sudan also has important hydropower potential at some 5,000 MW, but thermal generation through Sudan's oil and gas

reserves is also a possibility for supplying demand. Egypt on the other hand, has fully developed its hydropower potential and its current expansion plans are largely based on thermal generation.

The different generation type and mix between the three countries could be exploited for mutual benefit if the systems were interconnected. Those benefits would be:

- Greater opportunities for displacement of thermal generation by hydroelectric generation;
- Increasing the firm and secondary energy in the interconnected system due to its larger size and more diverse generation composition;
- Opportunities related to investment planning, reducing capital expenditure to fulfill the demand forecast;
- System operation;
- Trading opportunities for Sudan and/or Ethiopia, with Egypt largely as the consumer, providing financially and economically viable development of hydropower capacity; and

As the main consumer, Egypt could benefit from purchasing the increasing electricity supplies from Sudan and Egypt, rather than embarking on the significant capital expenditure of developing its own generating capacity.

2.2.2 OBJECTIVES

The objective of the study is to promote regional power trade through creation of an enabling environment coordinated planning and development of power generation and transmission interconnection projects. The outcome of this study, among others, will include a Power Trade Strategy, a Regional Investment Program and a Memorandum of Understanding to be executed by the countries for implementing the trade strategy and investment program.

Under the framework of the Nile Basin Initiative, the main objectives of the study are:

- To study at the pre-feasibility level three major hydro projects (Border, Dal, Mandaya) which were previously only known at the reconnaissance level.
- To determine the technical and economic feasibility of an interconnection between Egypt, Ethiopia and Sudan.
- To determine a coordinated regional investment plan for generation and interconnection.
- To develop an institutional and regulatory framework that would facilitate and promote power trades between Egypt, Sudan and Ethiopia.

The study will establish a least cost expansion plan for the Eastern Nile region taking into account the interconnection of the power systems of Egypt, Sudan and Ethiopia. The options for interconnection will also be reviewed as part of the expansion plan. The regulatory framework for the trade of power will be analysed to establish the most suitable mechanism. The study must also consider the dis-benefits of the interconnection, such as the social and environmental consequences, and determine suitable mitigation measures to minimise the impact.

2.2.3 CHALLENGES AND RISKS

The challenges and risks identified for the Project completion are summarized in the following table:

Challenges	Associated risks	Preventive action
Volume, un-homogeneity and inconsistency of Data.	Delay in project completion, discrepancies and non reliable comparisons of options (e.g. cost estimates)	Anticipation of data collection and meeting with local partners and counterparts. Data validation with Utilities.
Short duration of the overall project.	Studies not enough detailed and/or delay in studies.	Job completion in day to day collaboration with local counterparts and ENTRO representatives allowing periodic validation.
Multiplicity of stakeholders from three countries with possible antagonist interests.	Delays in acceptance process.	Management action from ENTRO PCU and, when necessary, from Steering Committee.
Accuracy of data collected.	Difficulty to focus on the relevant figures.	Give the right orientation in data analysis to emphasize and identify relevant data.
Constancy of common agreement on major input assumptions for the overall duration of the project.	Delays in acceptance process, changes of figures, trend, assumptions, resulting in new runs of models, and delay	Validation of major hypothesis with all stakeholders involved in the Project at adequate milestone (mainly Workshop N° 2 and 3).
Consultant agreement on the findings of previous studies.	Delay in project completion, necessity of due diligence and revisions.	Validation with all stakeholders involved in the Project at adequate milestone (mainly Workshop N° 2)
Limitation of the number of scenarios to be examined (demand, costs, supply options, etc).	Delay in project completion and needs of additional services due to multiplication of scenarios.	Validation of the relevant scenarios with all stakeholders involved in the Project at adequate milestones (Workshops N° 2, 3, 4).
Agreement on shared criteria for project ranking, especially HPP, between three countries.	Delay in project completion.	Validation with all stakeholders involved in the Project and Steering Committee at adequate milestone (mainly Workshop N° 3).
Carry out HPP prefeasibility studies with (limited) field investigation on sites without accesses in less than 9 months.	Delay in project completion and in particular impossibility to estimate reliable HPP cost at M+5.	Comply with project schedule from early stages (anticipation), using all task force including local partners and simplify the study if necessary.
General political risk in one of the three countries.	Delay in project completion or change of study scope.	Anticipated warning.
Absence of consensus between stakeholders.	Delay in project completion and additional services due to changes in scenarios.	Management action from ENTRO PCU and Steering Committee if necessary.

2.3 PLANNING AND STAFFING

2.3.1 PLANNING

See Appendix 5.2

2.3.2 PROJECT TEAM COMPOSITION

TECHNICAL / MANAGERIAL STAFF

KEY PERSONNEL (International)

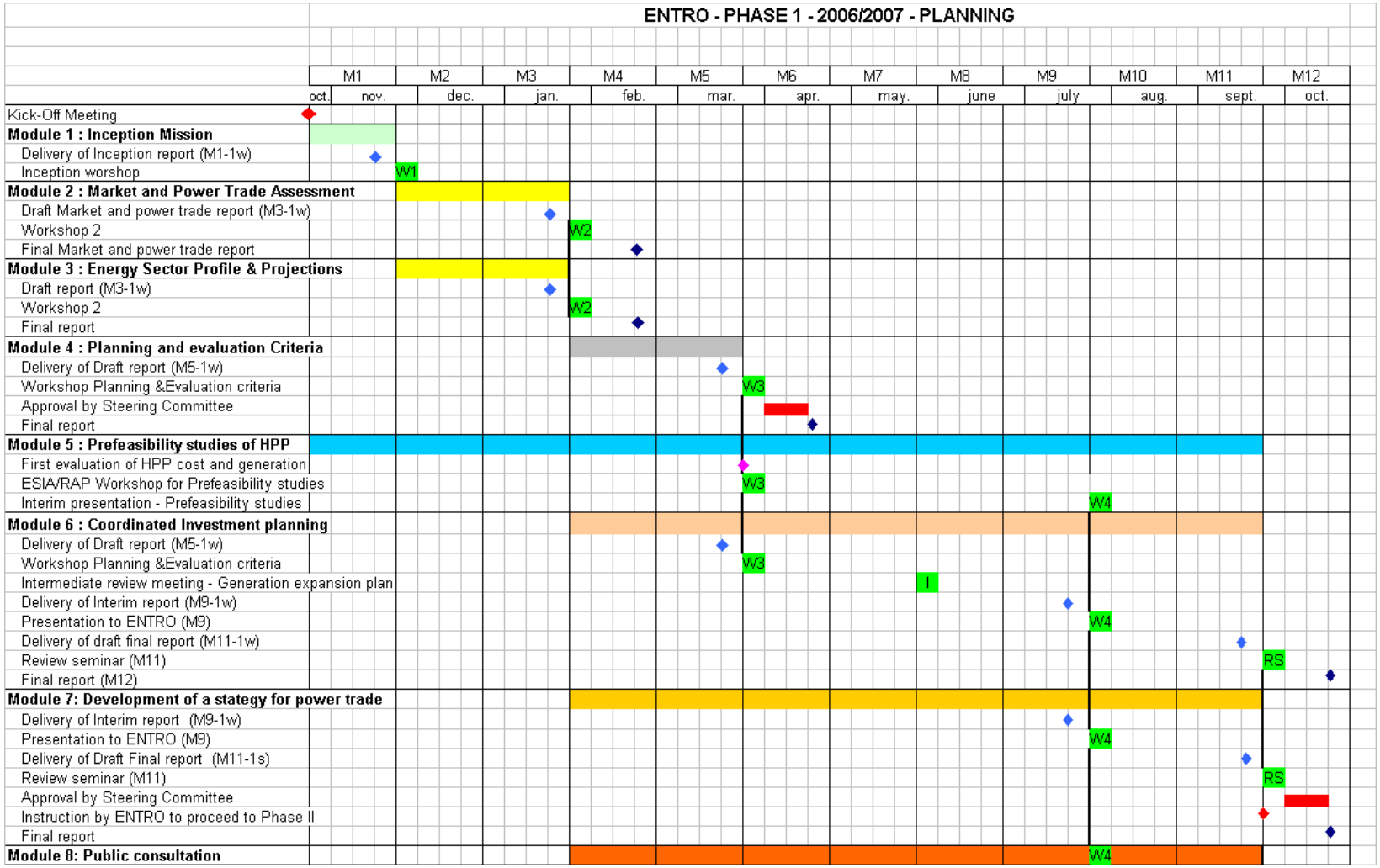
Name	Position
Pierre BRUN	Project Manager
Christian VILADRICH	Deputy Project Manager - Economics and Power Trade Section Team Leader
Alan BATES	Deputy Project Manager - Power Generation Expert - Hydropower Section Team Leader
Robert LEPORT	Deputy Project Manager - Interconnection Section Team Leader
Gérard MALENGE	Utility Economist Expert
Jean-François BALMITGERE	Trading & Cooperation Expert
Alice PEREIRA	Power System Planner
David SURLA	Financial Analyst
Michel CAUBET	Institutional Expert
Patrick JOURDIN	Transmission Engineer Expert
Gwenaelle BONGIOVANI	Static Network Studies
Emmanuel VARRET	Dynamic network Studies
Francis DOS RAMOS	- OHL & Substation Senior Engineer
Christophe GUNTZ	- OHL & Topography Engineer
Hugues PEROL	- Grid Control & Communication Engineer
Andrew WAIN	- Environmental Specialist Section Team Leader
Keith THOMASSON	- Civil Works Senior Engineer
Edda IVAN-SMITH	- Social Specialist
To be named	- Geologist
Hany HASSAN	- Hydrologist
Pierre-Louis ROSSI	- Electromechanics Senior Engineer
Patrick HARTEL	- Large Dam Expert

TECHNICAL / MANAGERIAL STAFF

KEY PERSONNEL (Local)

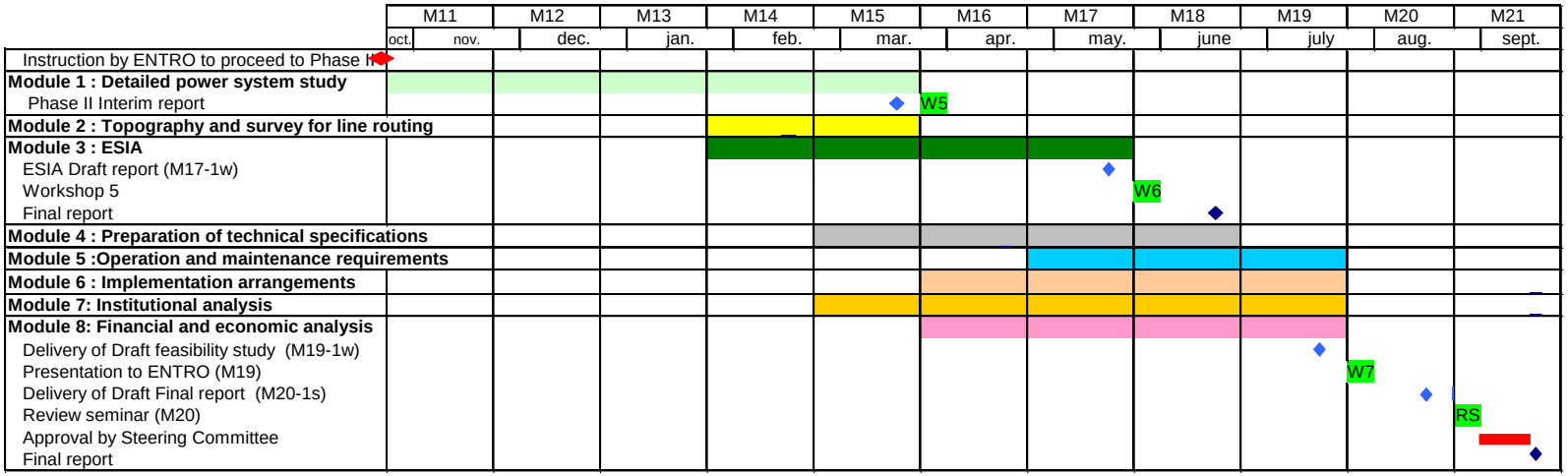
Name	Position
Yahia ABDEL MAGEED	Agriculture Expert, Social, Consultation
Adli ABDEL MAGEED	Local Geologist
Abebe KETEMA	Local Geologist
Sayed AHMED MALIK	Chief Surveyor
John GJNDI BOUTROS	Local Transmission Engineer
Fouad TAHER	Power System Local Expert
Eyob DEFERE DEBREWORK	Power System Local Expert
Wakjira UMETTA	Institutional Local Expert
Azza MAMDOUH KHALIL	Institutional Local Expert
to be named	Environmentalist Local Expert EGYPT
Zeleke CHAFAMO SHASHORE	Environmentalist Local Expert ETHIOPIA
to be named	Environmentalist Local Expert SUDAN

2.3.3 SIMPLIFIED PLANNING FOR PHASE 1



2.3.4 SIMPLIFIED PLANNING FOR PHASE 2

ENTRO - PHASE II - 2007/2008 - PLANNING

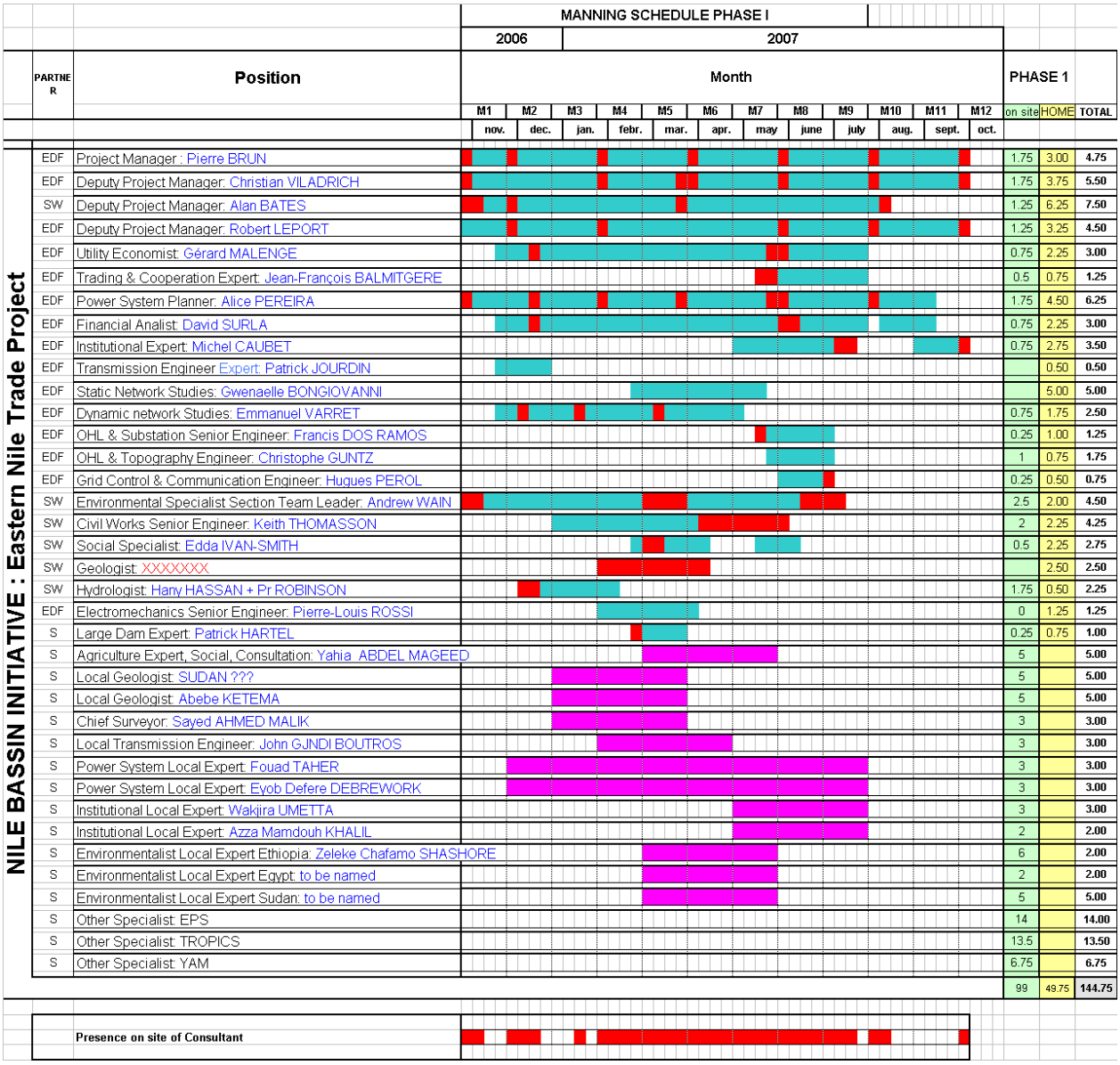


2.3.5 DEADLINES FOR PHASE 1

ENTRO PROJECT - DEADLINES FOR PHASE 1

	DATE
MODULE 1: Inception mission	
Submission of Draft report	13/11/2006
Workshop 1 - Ethiopia	21/11/2006 - 23/11/2006
Submission of Final report	07/12/2006
MODULE 2 AND 3: Market and Power Trade assessment	
Submission of Draft report	15/01/2007
Workshop 2 - Egypt	22/01/2007 - 25/01/2007
Submission of Final report	08/02/2007
MODULE 4: Planning and evaluation criteria	
Submission of Draft report	13/03/2007
Workshop 3 - Sudan	21/03/2007 - 27/03/2007
Approval by Steering Commitee	06/04/2007 - 16/04/2007
Submission of Final report	17/04/2007
MODULE 5: Prefeasibilitystudies of HPPs	
Submission of Draft report	13/03/2007
Workshop 3 - Sudan	21/03/2007 - 27/03/2007
Submission of Interim report	13/07/2007
Workshop 4 - Egypt	20/07/2007-26/07/2006
Submission of Final report	28/09/2007
MODULE 6: Coordinated investment planning	
Submission of Draft report	13/03/2007
Workshop 3 - Sudan	21/03/2007 - 27/03/2007
Intermediate review meeting	28/05/2007-31/05/2007
Submission of Draft report	13/07/2007
Workshop 4 - Egypt	20/07/2007-26/07/2006
Submission of Draft Final report	10/08/2007
Review Seminar	21/09/2007-28/09/2007
Submission of Final report	12/10/2007
MODULE 7: Development of a strategy for Power Trade	
Submission of Draft report	13/07/2007
Workshop 4 - Egypt	20/07/2007-26/07/2006
Review Seminar	21/09/2007-28/09/2007
Submission of Final report	12/10/2007
MODULE 8: Public consultation	
Workshop 4 - Egypt / Ethiopia / Sudan	20/07/2007-26/07/2006
Review Seminar	21/09/2007-28/09/2007
Approval by Steering Commitee	01/10/2007-12/10/2007

2.3.6 STAFFING SCHEDULE



	PARTNER	Position	Month	PHASE 1 on site	PHASE 1 HOME	PHASE 1 TOTAL
			M1 nov. / M2 dec. / M3 jan. / M4 febr. / M5 mar. / M6 apr. / M7 may / M8 june / M9 july / M10 aug. / M11 sept. / M12 oct.			
	EDF	Project Manager : Pierre BRUN		1.75	3.00	**4.75**
	EDF	Deputy Project Manager: Christian VILADRICH		1.75	3.75	**5.50**
	SW	Deputy Project Manager: Alan BATES		1.25	6.25	**7.50**
	EDF	Deputy Project Manager: Robert LEPORT		1.25	3.25	**4.50**
	EDF	Utility Economist: Gérard MALENGE		0.75	2.25	**3.00**
	EDF	Trading & Cooperation Expert: Jean-François BALMITGERE		0.5	0.75	**1.25**
	EDF	Power System Planner: Alice PEREIRA		1.75	4.50	**6.25**
	EDF	Financial Analist: David SURLA		0.75	2.25	**3.00**
	EDF	Institutional Expert: Michel CAUBET		0.75	2.75	**3.50**
	EDF	Transmission Engineer Expert: Patrick JOURDIN			0.50	**0.50**
	EDF	Static Network Studies: Gwenaelle BONGIOVANNI			5.00	**5.00**
	EDF	Dynamic network Studies: Emmanuel VARRET		0.75	1.75	**2.50**
	EDF	OHL & Substation Senior Engineer: Francis DOS RAMOS		0.25	1.00	**1.25**
	EDF	OHL & Topography Engineer: Christophe GUNTZ		1	0.75	**1.75**
	EDF	Grid Control & Communication Engineer: Hugues PEROL		0.25	0.50	**0.75**
	SW	Environmental Specialist Section Team Leader: Andrew WAIN		2.5	2.00	**4.50**
	SW	Civil Works Senior Engineer: Keith THOMASSON		2	2.25	**4.25**
	SW	Social Specialist: Edda IVAN-SMITH		0.5	2.25	**2.75**
	SW	Geologist: XXXXXXX			2.50	**2.50**
	SW	Hydrologist: Hany HASSAN + Pr ROBINSON		1.75	0.50	**2.25**
	EDF	Electromechanics Senior Engineer: Pierre-Louis ROSSI		0	1.25	**1.25**
	S	Large Dam Expert: Patrick HARTEL		0.25	0.75	**1.00**
	S	Agriculture Expert, Social, Consultation: Yahia ABDEL MAGEED		5		**5.00**
	S	Local Geologist: SUDAN ???		5		**5.00**
	S	Local Geologist: Abebe KETEMA		5		**5.00**
	S	Chief Surveyor: Sayed AHMED MALIK		3		**3.00**
	S	Local Transmission Engineer: John GJNDI BOUTROS		3		**3.00**
	S	Power System Local Expert: Fouad TAHER		3		**3.00**
	S	Power System Local Expert: Eyob Defere DEBREWORK		3		**3.00**
	S	Institutional Local Expert: Wakjira UMETTA		3		**3.00**
	S	Institutional Local Expert: Azza Mamdouh KHALIL		2		**2.00**
	S	Environmentalist Local Expert Ethiopia: Zeleke Chafamo SHASHORE		6		**2.00**
	S	Environmentalist Local Expert Egypt: to be named		2		**2.00**
	S	Environmentalist Local Expert Sudan: to be named		5		**5.00**
	S	Other Specialist: EPS		14		**14.00**
	S	Other Specialist: TROPICS		13.5		**13.50**
	S	Other Specialist: YAM		6.75		**6.75**
				99	49.75	**144.75**

2.4 VISIT TO THE THREE HYDRO SITES

2.4.1 RECONNAISSANCE FLIGHT

A reconnaissance flight by Cessna 206 light aircraft was undertaken on 23rd October by Alan Bates – Deputy Project Manager, Andrew Wain – Environment Team Leader and team members from local partners Tropics to carry out initial reconnaissance of the Mandaya and Border dam sites. The flight commenced at 08:00 hrs at the Bole International airport, Addis Ababa and flew along the full length of the Nile River from the confluence with the Muger River (upstream of Karadobi dam site), along the full length of the Mandaya and Border reservoirs to the Border Dam site. Thereafter the flight proceeded to the regional capital of Asosa to refuel. Difficulties were experienced due to local civil aviation procedures and bad weather which delayed the return flight until the following morning 24th October. The return flight was routed along the Didessa River valley which forms a major part of the Mandaya reservoir and thereafter to Addis Ababa. Opportunity was taken during the flight to circle around and photograph both the Mandaya and Border dam sites. A series of photographs was also made of the Nile River at various key locations as well as of all observed settlements. Notes of the flight are provided in Appendix 1.

2.4.2 OBSERVATIONS REGARDING MANDAYA

During the flight over the Mandaya reservoir basin, including both the Nile and Didessa valleys, careful observation was undertaken of both banks of the river to identify roads, tracks, villages, cultivated areas and other features of interest. However, during the entire flight along the full length of the future reservoir not a single road, track, footpath, village or house was seen. Although there may be some usage of the wooded area of the gorge by people resident on the nearby plateau for hunting, collection of native plants etc the first impression is that there will be little or no direct displacement of permanently resident population as a result of reservoir impounding associated with construction of the Mandaya project.

As a result of the inspection of 1:50,000 scale topographic maps of the Mandaya reservoir area and of the observations made during the reconnaissance flight there does not appear to be any reason why the Mandaya reservoir could not be constructed with a much higher dam and full supply level than was considered in previous studies. The Blue Nile River Basin Survey (USBR, 1964) proposed a full supply level for Mandaya of El. 741 m with a reservoir extending some 150 - 200 km upstream to the next identified dam site – Mabil. However, topographic mapping suggests that a reservoir full supply level for Mandaya of up to El. 860 m or thereabouts would be technically feasible, subject to confirmation of suitable geological conditions. In this event, the Mandaya dam would have a height of some 260 metres.

The reservoir associated with construction of Mandaya dam with a full supply level of El. 860 m would extend almost the entire length of the Nile valley to the Karadobi site. This would command the hydropower potential of the valley with two dams (Mandaya, Karadobi) rather than three (Mandaya, Mabil, Karadobi). The higher dam at Mandaya so created would provide a substantial increase in reservoir volume compared to having two lower dams at Mandaya and Mabil thus providing valuable long-term protection against impacts of sediment deposition.

The flight over the Mandaya site revealed that the plateau located on both banks of the river at the dam site appears to offer suitable locations for construction of an airstrip which will be of value during the construction of the project.

The reconnaissance flight confirmed previous information that there are no roads with 50 km of the Mandaya site. Accordingly, access to the Mandaya site for topographic survey, site investigation and environmental studies will need to be effected by helicopter. The plateau areas on both banks of the river at the dam site are clear of trees and appear to present suitable sites for landing a helicopter. Little evidence of rock exposures could be seen from the aircraft due to tree cover.

2.4.3 OBSERVATIONS REGARDING BORDER

During the flight along the Nile from the Mandaya dam site to the Border dam site a number of fairly large villages of up to 30 or more houses were observed close to the river, particularly on the Eastern bank of the river. This is in contrast to the 1:50,000 scale mapping which shows some 10 villages all located on the West bank of the river. It is apparent from the reconnaissance flight that population numbers within the reservoir basin are significant and as a first estimate it would appear that numbers are likely to be in the range of 2000 – 5000 persons. Cultivation associated with these villages appeared mainly to comprise "slash and burn" clearings on higher ground away from the river rather than recession agriculture on the river banks.

The massive rock outcrops in the river channel which are reported in the Land and Water Resources of the Blue Nile River report (USBR, 1964) could be clearly seen from the air as well as the extensive outcrops at higher levels on the abutments.

2.4.4 VISIT TO BORDER

A site visit by road was made to the Border dam site over the period 25th October to 29th October by members of both the hydropower engineering and environmental teams. The Border site is extremely remote and lies some 800 km by road from Addis Ababa. The route initially followed the main road from Addis Ababa to Debre Markos crossing the Nile River at the Kessie Bridge. The opportunity was taken to inspect the key gauging station at the bridge including the staff gauge and cableway facilities.

From Debre Markos the main road to Bahir Dar was followed as far as Kosso Ber where an unsurfaced local road was taken westwards to Chagni. The Kosso Ber – Chagni road was in very poor condition in places with severe rutting from heavy vehicles. Conditions were worsened by recent rain rendering the road slippery and making progress extremely slow. The team stayed overnight at Chagni before continuing the following day to the town of Mankush (Guba), which is located some 60 km from the dam site, arriving at noon. The unsurfaced road from Chagni to Mankush (Guba) was in fair to poor condition. In some places reconstruction was underway.

During the afternoon the environmental and social team called on the local administrative officials before visiting the Yarenja refugee village which lies within the Border reservoir impoundment area.

The engineering team attempted to visit the Border dam site using a 4-wheel drive vehicle but were unable to reach within 14 km of the site due to the poor condition of three steel "Bailey" bridges which were found not to have any decking timber in place. The stream at the first bridge site could not be forded as the river-bed was too soft to sustain the weight of a vehicle, following recent rain. As it was too late in the day to walk the 14 km distance to the site, the team returned to Guba. Various options were then considered to allow the site visit to proceed the following day. Following discussions with local transport operators in Guba, a large truck was hired for the following morning and this was able to cross the three bridges by driving on the steel bridge girders.

Some 5 km from the site progress was again halted due to a severely damaged concrete “Irish bridge” crossing which could not be safely crossed with the truck. From this point the team proceeded on foot through heavy unseasonal rain and reached the dam site approximately 1 hour later.

The river channel of the Nile at the dam site comprises massive exposures of granite with quartz intrusions with several deep and sharply defined narrow channels through which the river passes at low flows. The river level at the time of the visit was some 10 – 15 m below the maximum level reached during the recent wet season. Large exposures of granite bedrock were observed on the abutments. Various photographs were taken to record the observed conditions and in particular the extent of rock outcrops visible in the river channel. Quality of the images was affected by the heavy rain which impeded visibility.

The team departed from the Border dam site at approximately 11:00 hours on 28th October and returned to stay overnight at Chagni. Following overnight rain the road from Guba to Chagni and Kosso Ber was extremely slippery and had to be traversed with great care. The team proceeded to Addis Ababa arriving in the evening of 29th October.

As a result of the observations of the site during the visit, and in particular of the extensive outcrops of rock, both in the river bed and on the abutments, it was concluded that drilling of two investigation drillholes at the site would provide very little additional information. Accordingly, it is proposed that the investigations at the Border site are confined to seismic refraction profiling to establish the depth of the interface between the surface soils and the underlying rock in those areas which have soil cover. This would retain a greater proportion of the available funds for more detailed investigation at the Mandaya site.

2.4.5 VISIT TO DAL1

The site visit to the Dal-1 dam site in Sudan took place over the 4 day period 2nd November to 5th November 2006.

The team participating in the visit comprised Alan Bates, Deputy Project Manager, Andrew Wain – Team Leader – Environmental and Social, Dr Babikar Ibrahim – ENTRO, Eng. Idris – NEC, Kamal – Ministry of Irrigation and Water Resources, Mohammed Hieba – Local Representative EDF.

The team set off from Khartoum at 07:00 hours on 2nd November with two Toyota Land Cruiser four-wheel drive vehicles, each equipped with additional spare wheels. The route to Dongola followed a direct route across the desert to Abu Dom some 350 km NNW of Khartoum before following a route some 1 – 2 km west of and parallel to the Nile. The majority of the route to Abu Dom was of good quality tarmac surface although there were some long stretches of up to 30 km where the road was under reconstruction and diversions on rough tracks were necessary.

On the route to the project area it was possible to observe various features of the transmission system associated with the 1250 MW Merowe hydropower project (presently under construction) including the two double circuit 500 kV transmission lines and substations which will provide the interconnection between the project and Khartoum, the transmission line from Merowe to Dongola and the distribution network serving Dongola and nearby villages.

Near Abu Dom a visit was made to one of the resettlement areas for population displaced by impounding of Merowe reservoir. The team was able to visit one of the houses (owned by the driver of one of the vehicles used).

Various aspects of the resettlement programme were examined including the irrigation areas where each household was allocated 6 Feddan of irrigated land (with irrigation infrastructure provided) and also the additional land area where households received an allocation of a further 3 Feddan for each 1 Feddan that was previously owned, which could be developed at the initiative of the individual. It was noted that although excellent provision had been made for irrigated farms for the displaced households, only a small part of the land had been brought under cultivation with many land areas lying idle. The reasons for this are probably manifold but appear to include drift of population to Khartoum and other centres.

A surfaced road between Abu Dom and Dongola is currently under construction and diversions on rough tracks comprised over 50% of the 200 km distance to Dongola. The road follows a route some 1 –2 km away from the Nile river and as a consequence bypasses the settlements which are located closer to the Nile river. The party arrived in Dongola at approximately 17:00 hrs and crossed the Nile by vehicle ferry after having obtained travel permits for the foreign Consultants from the local administration. Thereafter the team proceeded on the East bank of the Nile to the settlement of Bayuda where accommodation was kindly provided by family members of Mr Mohammed Hieba.

The following day the team proceeded northwards along the Nile valley along an unmade track which was generally in very poor condition. The track passed through a number of quite large settlements comprising several hundred dwellings (eg. Argo, Kerma, Delgo) and smaller villages (30 – 50 houses) which at times were almost continuous with only minor gaps between settlements. Extensive cultivation was evident including both date palms near to the river and mixed cropping and livestock grazing on the flood plains away from the river. A wide strip of cultivated land away from the Nile in the vicinity of the village of Kerma was particularly notable. This area was reported by local inhabitants to flood reliably and thus provided an extensive and productive naturally irrigated farming area.

The team arrived at the Kagbar site at approximately 17:00 hours after traveling a distance of some 180 km on rough tracks. After an inspection of the site the team proceeded to Abri for the second overnight stop. On the morning of 4th November the team set off for the Dal-1 site, reaching the Dal site at approximately 11:00 hrs. Observations were made of the foundation material for the dam as the bedrock at the site which is known as the Dal Cataract was exposed over a substantial area of the river banks and the abutments. A local ferry was used to cross the river to Dal village on the West bank of the Nile where opportunity was taken to interview members of one of the local households. The team departed from Dal at 15:00 hours returning to Bayuda at 21:00.

On the following day, 5th November, the team crossed back to the West bank of the Nile river by means of a vehicle ferry crossing at Argo and drove along the West bank of the Nile to Dongola. At Dongola a brief visit was made to the offices of the regional administrative officials before departing for the return journey to Khartoum. En route to Khartoum a visit was made to the Agricultural Research Station established as part of the RAP for the Merowe project. The Director of the research station provided an excellent summary of the work of his unit since establishment in early 2005, including trials of various crops and different fertilization regimes and extension and training services provided to farmers relocated from Merowe. The team returned to Khartoum arriving at 23:00 hrs after a total journey totalling some 1650 km over the four days.

3. DATA COLLECTION

3.1 METHODOLOGY

The data collection is a key phase of the project. The quality and reliability of the data will determine of the quality of results provided by the Study. Some parts of the studies (e.g. generation and transmission master plan, load flow analysis, etc, in Module M6) being time intensive and totally dependant on input data, the validation of the data will be a prerequisite.

In anticipation with the official kick-off of the project, the Consultant provided ENTRO in July with a questionnaire describing the list of data and previous studies necessary for the Study. This list was organized along the following items :

- reports and previous studies relevant to the present study,
- hydrological data,
- data and reports related to electrical demand,
- technical-economical data related to the existing generation mix,
- technical-economical data related to the power supply candidates,
- technical-economical data related to the transmission system,
- data and reports related to the institutional aspects.

Considering the huge amount of data, its diversity, the multiplicity of sources and time of update, the following information are traced in an EXCEL file for each data or report (see appendix 2):

- availability of the data: should the data be unavailable, a value will be proposed by the Consultant based on its international experience,
- origin of data : date and source of information (Utility, Ministry, etc),
- support of data : electronic, paper, etc,
- comments : any comments on the quality of the data.

Finally, after completion of the data collection, the data base will be submitted to ENTRO for approval. This validation will be prerequisite for the beginning of M4 and M6 modules.

At the end of the project, the electronic data and the inventory of key documents will be made available to ENTRO on an external Hard Disk (60 Mo capacity with USB2 interface).

3.2 CURRENT STATUS OF THE DATA COLLECTION PROCESS

On the base of the questionnaire provided by the Consultant on July 17th, 2000, ENTRO PCU team compiled a significant amount of data and reports that was delivered to the Consultant after the kick-off meeting in Addis Ababa on October 20 th, 2006.

A first review of this set of data and reports during the Kick-off mission allowed the Consultant to focus the work of the Local Partners (EPS and Tropics) on the collection of the missing data and reports from the different utilities and relevant Ministries in Egypt and Ethiopia.

A tripartite agreement is in the process of being ratified between ENTRO, the Ministry of Water Resources of the Republic Democratic of Ethiopia (MWR) and the Consultant. Within the terms of this agreement , the MWR shall :

- provide the consultant with all available reports, studies, maps and other relevant and related documents,

- review draft reports and send the comments to ENTRO and the consultant.

The first meeting between EEPCO and Tropics in Ethiopia was on November 3rd, 2006.

Three weeks after the kick-off meeting, about 30% of the required data have been collected, which is a fair ratio considering the large amount of data. The authorization to get the data (after signature of tripartite agreement), the establishment of contacts with the relevant responsible in the different utilities or Ministries and the full involvement of local partners should allow to gather the pending data in the coming weeks.

The data collection is now progressing at a quicker pace.

3.3 REPORTS AND DATA COLLECTED

The appendix 2 presents an overview of the data already collected for the different countries and the same appendix presents the detailed list of data already collected for the generation mix.

The synthesis is given in the hereafter paragraphs for the three countries. The consistency and completion of the data base will be definitively assessed with the first runs of the different simulation tools (hydro flow, generation and network simulation). This is the reason why some additional data collection is planned in each following modules (M2, M3, etc).

3.3.1 EGYPT

Reports and previous studies :

No report or previous study has been collected up to the date of redaction of the present document.

Of special mention for present study is "Opportunities for power trade in the Nile Basin – Final Scoping study – ESMAP – January 2004" realized by the World Bank within the Energy Sector Management Program.

Data related to the generation mix :

The data compiled by ENTRO PCU were provided in EXCEL file form. The source of data is unknown.

The efficiency curve and hydrological historical inflow series of the existing and future hydro plants is to be gathered from EEHC and/or the MWR.

Data related to the transmission system :

The data compiled by ENTRO PCU were complemented by data gathered by EPS in Egypt by the beginning of November.

Most of the static data for the existing network in 2002 are available (zero sequence are missing). The data for 2005 seem to come from planning study. There is no 2006 information/validation on the existing network.

Concerning dynamic data, there is no information about alternators characteristics, the regulation (voltage or governor), defence plan, protection scheme (clearing time).

The same data are provided for 2010 and 2015. The generation is given up to 2022.

Data related to institutional aspects :

Only limited information have been gathered. Text of law and contract of power exchange are in the process of being collected.

3.3.2 ETHIOPIA

Reports and previous studies :

A number of reports have been collected : updated Ethiopian Master Plan, feasibility studies of Hydro Plant Projects (Beles, Karadobi, ...).

More reports on HPP are in the process of being gathered.

The number of candidates HPP is significant : 12 feasibility or pre-feasibility reports have been identified.

Data related to the generation mix :

The data compiled by ENTRO PCU were provided in EXCEL file form.

Very limited information is available for thermal generation (represents less than 5% on the installed capacity). Tropics is having a meeting with EEPCO Generation Operation Departmenet on November 13th to get these data.

The efficiency curve and hydrological historical inflow series of the existing and future hydro plants is to be gathered from EEPCO and/or the MWR.

Data related to the transmission system :

There is hardly no data on the existing network. The list of planned elements is detailed in the Master Plan update (June 06) up to 2015, but the detailed technical characteristics are missing. The load is detailed in energy (type of client, volume) and the global peak forecast is given up to 2030 (in the Sudan-Ethiopia Interconnection), but the load per substation is not available, and there is no indication concerning the reactive consumption. There is no link between the annual energy and the synchronous peak and off peak demand per substation.

There is no information for the period 2015 up to 2030, except the load forecast.

Concerning dynamic data, there is no information about alternators characteristics, the regulation (voltage or governor), defence plan, protection scheme (clearing time).

Data related to institutional aspects :

Only limited information have been gathered.

3.3.3 SUDAN

Reports and previous studies :

The reports on the Sudan Master Plan and demand forecast is not yet available.

The only HPP feasibility study collected is Sheireq one.

Data related to the generation mix :

The data compiled by ENTRO PCU were provided in EXCEL file form.

A lot of data from 2003 are available for thermal and hydro generation. These data need to be reviewed with NEC for possible update and validation.

The efficiency curve and hydrological historical inflow series of the existing and future hydro plants will be gathered from RASPO model describing the Nile hydro basin in Sudan.

Data related to the transmission system :

Most of the static data for the existing network in 2002 are available, except the load (building and electricity sector database). There is no 2006 information on the existing network, and especially on Merowe power plant and connection expected soon (mid 2007).

Concerning dynamic data, alternators characteristics and voltage regulation have been provided, coming from an extraction from PPSE software. The manufacturer value are not known. The governor model, defence plan, protection scheme (clearing time) are not provided.

The only data provided for 2005 to 2030 is the peak forecast for the global system. The detailed value par substation is not available.

Data related to institutional aspects :

Only limited information have been gathered.

3.4 SPECIFIC DATA COLLECTION FOR HYDROPOWER PRE-FEASIBILITY STUDIES

3.4.1 DATA GATHERED BY ENTRO

Hydropower Pre-feasibility Studies

The principal data collection for the hydropower feasibility studies comprises:

- Copies of reports of recent relevant studies involving the Nile River basin
- Copies of data relating to the electricity systems in Ethiopia and Sudan
- Topographic mapping at scale of 1:50,000, where available
- Hydrological data
- Geotechnical data.

In advance of the commencement of the study by the Consultants, ENTRO arranged for data to be collected from the power and water authorities in each of the three countries. This data included in particular information on the existing power systems in each country. Copies were collected by ENTRO of the pre-feasibility study report of the Karadobi hydropower project and the Ethiopia – Sudan Interconnection study. Facilities were also made available for use of the ENTRO library in which copies are held of a wide range of documents relating to the Nile Basin. The availability of this information has contributed to a smooth start to the activities and allowed good progress to be made on parallel activities such as the site visits.

In addition to the above, ENTRO has facilitated data collection from the library of the Ministry of Water Resources in Addis Ababa. Copies of relevant reports have been borrowed from the Ministry library for study and copying of relevant sections where appropriate. The reports referred to have included the Land and Water Resources of the Blue Nile (USBR, 1964), and Abbay River Basin Master Plan Study (BCEOM, 1999). Copies of 1:50,000 scale maps and aerial photographs covering the Border site contained in the Beles River Basin Study have also been referred to.

3.4.2 DATA GATHERED BY CONSULTANT

Topographic Mapping

Copies of 1:50,000 scale mapping of the Nile basin in Ethiopia, with 20 m contour interval were purchased by the Consultant from the Ethiopian Mapping Authority (EMA) for use during the engineering and environmental studies. Sufficient numbers of copies of maps were obtained to provide reference copies for use both in the ENTRO PCU office, offices of the Consultant in the United Kingdom, offices of the local sub-Consultant in Addis Ababa and for use by technical and environmental teams in the field. The published 1:50,000 scale maps derived from aerial photography available from EMA do not cover the area of the Border site and the Nile river for some 50 km upstream although orthophoto maps prepared from satellite imagery are available and have been obtained from EMA for this area.

Mapping of the Border dam site area at 1:50,000 scale is available as Sheets 40 and 44 of the mapping produced for the Beles River Basin Survey (Pietrangelli, 1990). However, the contour interval of this mapping is not consistent with EMA mapping, being 25 m and 50 m generally and up to 100 m in hilly areas.

Mapping at a scale of 1:250,000 of the Dal-1 dam site in Sudan, including the reach of the river as far upstream as Dongola has been obtained from Mierag Space Technology Company of Khartoum. This mapping appears to date from the 1930's and does not have reliable contour information. Efforts were made to obtain maps at a scale of 1:100,000 with 10 m contour interval which exist for some parts of Sudan but the coverage may not extend to the Dal area.

Mapping of the Kagbar site within the Dal to Dongola reach of the Nile was carried out as part of a feasibility study by the Hydroproject Institute of Moscow. However only the Executive Summary of the report has been located and seen by the Consultants to date. Copies of the remaining 4 volumes including drawings (which it is hoped will include copies of mapping) have yet to be located.

Geotechnical Data

Little site-specific geotechnical data has been obtained for the project sites. National geological mapping has been obtained from the appropriate agencies together with published papers on seismicity in the project areas.

The USBR (1964) study has provided useful and reasonably detailed descriptions of the Mandaya and Border sites in Ethiopia including photographs.

Various reports provide cost estimates for the development of the Dal–1 site in Sudan. However, in contrast to the Mandaya and Border sites, little useful geotechnical information has been obtained from previous reports regarding the Dal-1 site. The Long Term Power System Planning Study prepared for the National Electricity Corporation by Acres (1993) provides drawings and cost estimates for both the Dal-1 and Kagbar sites but on closer inspection the drawings do not contain any contour information, geological information is very general and it is apparent that the sites were not visited during the study. The more recent Long Term Power System Planning Study (PB Power, 2003-2006) presented updated cost estimates for the Dal-1 and Kagbar projects but once again the work comprised a desk study only and did not include a visit to the sites or any fieldwork.

3.4.3 ACCURACY, RELIABILITY AND QUALITY OF DATA

Mapping

There appear to be some discrepancies in the levels shown on the Beles River Basin Study maps (Sheets 40 and 44) compared to previously reported levels, such as those quoted in the report Land and Water Resources of the Blue Nile Basin (USBR, 1964) and the orthophoto maps purchased from by EMA. The USBR study included a major survey exercise to link the survey grids of Sudan and Ethiopia by means of primary triangulation and levelling. The USBR report indicates tailwater level at the Border site of El. 495 m whereas the contours on the Beles mapping suggest a level of around 575 m. These differences are potentially of great importance since they relate directly to the generating head at the Border site and to the height of the dam. It is noted that there is good correspondence between the 1:50,000 orthophoto maps and the USBR level data leading to the preliminary conclusion that the Beles mapping is erroneous. It is hoped that the mapping commissioned by the Consultants and field survey of the valley cross-section at the site will resolve these differences.

Mapping of the Dal site in Sudan obtained to date is not adequate for the purposes of the pre-feasibility study. The only reference to topographic data which has been discovered during the inception mission relates to a single surveyed cross-section of the Nile river near the Dal site which was one of a series of cross-sections surveyed at 5 km intervals (thought to have been surveyed in the 1950's) covering the reach of the Nile from Wadi Halfa to Khartoum. The cross-section 155 km upstream of Wadi Halfa is apparently close to the Dal site and was used in the Nile Waters Study (Coyne and Bellier, 1978) as the basis for conceptual design and cost estimation.

More recent conceptual designs and cost estimates for the Dal site carried out as part of long-term power development studies (Acres, 1993 and PB Power, 2003-2006) appear to have used the same information as no record could be found of any more recent field work or surveys.

3.4.4 NEEDS FOR COMPLEMENTARY DATA

Hydrology Data

Additional data needs to be collected during the forthcoming weeks, particularly in respect of river flow data for the Nile River in Ethiopia. This will be undertaken by the Scott Wilson hydrologist, Hany Hassan, who will visit Ethiopia and Sudan during November.

Geological Data

Geological information is required for each of the proposed project sites. Where available information will be sought from relevant agencies. However, it is anticipated that little site-specific data will be available. Extensive rock exposures at the Dal site in Sudan and Border site in Ethiopia are such that drilling is not considered necessary at pre-feasibility level.

A programme of site investigation of the Mandaya and Border dam sites will be required to provide information to provide sufficient geological data for preliminary design and costing of the projects taking account of the height of the proposed dams at each site.

3.4.5 METHODOLOGY TO FILL THE GAPS

Mapping of Hydropower Sites

In order to improve the quality of mapping available for the study, a contract has been awarded by the Consultant to BKS Surveys of Coleraine, Northern Ireland, UK for preparation of 1:10,000 scale mapping. This mapping will cover of the Border site and reservoir area up to elevation 600 m. and of the Mandaya site and reservoir area up to an elevation of 750 m. The mapping will be derived using SPOT satellite images and is anticipated to be completed within 8 – 10 weeks after commencement of the study. This mapping will be used as the basis for the engineering and environmental studies of the Border and Mandaya sites.

The topography at the Dal and Kagbar sites in Sudan is complex with an incised channel between rocky islands and very shallow slopes away from the river. As the height of structures under consideration are relatively low compared to Mandaya and Border, and the numbers of population potentially affected is large there would be considerable benefit in having detailed mapping with contour interval of 2 – 2.5 metres which would allow the reservoir boundaries, inundated areas and affected population to be determined with greater confidence. This level of mapping would normally be carried out only at feasibility level and is outside the scope of the present contract. However, as the impacts of dam options at Dal are very significant for the local population we recommend that consideration is given to commissioning mapping of this area as a reimbursable expense.

Quotations have been sought from BKS in UK for detailed mapping of the Dal site from aerial photographs at scale of 1:40,000 which were carried out by BKS in 1985. Details of the cost of this mapping are not yet available but will be presented at the Inception Workshop.

A quotation for mapping has been obtained from Mierag Space Technologies Company of Khartoum for mapping to be prepared from satellite imagery. The cost of the mapping with a contour interval of 2.5 m would be USD 335,000, made up as follows:

Item	**Cost (USD)**
High resolution images (5000 km^2)	150,000
Field Survey	120,000
Image processing and feature extraction	40,000
Contour line generation	25,000
Total	335,000

Site investigation at dam sites

In order to provide geotechnical information regarding the Border and Mandaya dam sites, a Tender Document has been prepared and issued to selected local contractors for site investigation works. The tender document was finalized on 30th October following the site visit to the Border site. Completed bids are due for submission on 18th November in advance of the Inception Workshop. It is anticipated that the Contract for the site investigation will be awarded by January 2007 (but preferably sooner) following approval by ENTRO and ADB. Commencement of the site investigation works is anticipated not later than February 2007 and is anticipated to take approximately 8 weeks.

3.5 COMPLETION OF THE DATA COLLECTION

As previously stated, the data base is complete to 30% at the date of redaction of the present document.

The list of missing data has been identified for each country (see appendix 2).

The Local Partners are working closely with the different Utilities and Ministries in order to gather these data and reports, and get validation of data.

In parallel, the Consultant begun the analysis and review of the available data in the perspective of the work to be done in Modules M2 and M3.

4. OVERVIEW OF THE NEXT STEPS

The next steps of study are detailed hereafter : the Module M5, under process will be continued and the Modules M2 and M3 will be carried out:

4.1 MODULE 2 : MARKET AND POWER TRADE ASSESMENT

Module 2 deals with the assessment of the existing situation in the three countries. Its will be organize in four parts:

- Review of the electricity sector.
- Assessment of existing generation mix (TPP, HPP, geothermal, etc).
- Assessment of existing power trade.
- Assessment of existing transmission system.

4.1.1 REVIEW OF THE ELECTRICITY SECTOR

This review will cover the following items :

- Energy Sector Background Information.
- Energy Resource Potential and Balances.
- Economic, Financial and Institutional Setting.
- Dynamics of interactions between the energy sector, the economy, and the environment.
- Energy sector sustainability.
- Status of Private Sector Participation in the Energy Sector.
- Energy Efficiency.
- Crosscutting issues (population, gender, poverty, governance, etc).

4.1.2 ASSESSMENT OF THE EXISTING GENERATION MIX

The purpose of this task is to establish the power generation capacity of the existing power generation facilities and their evolution over the study period.

This task will be carried out on the basis of existing studies and close co-operation with experts and counterpart staff.

The three different following sub tasks will be implemented:

- Additional data collection and analysis of existing data / studies concerning the present and future situation of the existing power generation mix.
- Establishment of a reference data set describing the existing power generation facilities and their future development.

4.1.3 ASSESSMENT OF EXISTING POWER TRADE

- Identification of the possible existing power trades.
- Type of contract, capacity, price of energy and services.

4.1.4 ASSESSMENT OF THE EXISTING TRANSMISSION NETWORK

This task will review the existing transmission network in the three countries, focussing on the possible constraints created to the integration of the three power systems.

The Consultant will study data collected during the Inception mission, and will perform if necessary complementary data collection to collect specific elements for the transmission networks and the Control centers.

4.2 MODULE 3 : ENERGY SECTOR PROFILE & PROJECTIONS

Module 3 deals with the future evolution of the demand and identification of supply and interconnection options. The findings of this Module will constitute the base on which the regional investment plan will be determinate. This Module will be organized in seven parts:

- Review and update of previous demand forecast.
- Potential trade opportunities.
- Review of the existing Generation Expansion Plan.
- Identification of generation supply options.
- Review of existing transmission master plan.
- Identification of interconnexion options.
- First evaluation of economic profitability of exports from Sudan-Ethiopia.

4.2.1 REVIEW AND UPDATE OF DEMAND FORECAST

- Review of the past evolution of demand (energy and annual peak demand, by economic sectors, correlation with the GDP growth rate, demographic evolution, etc).
- Identification of demand characteristics (load factor, daily and seasonal variations and demand diversities).
- Review of the existing consumptions patterns and tariff.
- Review of the more recent demand forecast available.
- Update of the demand forecast.

4.2.2 POTENTIAL TRADE OPPORTUNITIES

The purpose in this task is to identify the potential of power trades between, on one side, the area composed of Egypt, Ethiopia and Sudan, and on the other side, the neighbouring countries (Libya, Jordan, Djibouti, Kenya, etc).

Obviously, the potential evolution of power trades between Egypt, Ethiopia and Sudan, which is the core of the present study, will be the result of Module M6 (Investment Regional Planning).

4.2.3 REVIEW OF EXISTING GENERATION EXPANSION PLAN

- Analysis of the existing Generation Expansion Plan.
- Analysis of the evolution of the resulting supply / demand balance.

4.2.4 IDENTIFICATION OF GENERATION SUPPLY OPTIONS

- Identification of the generation supply options (or candidates).
- TPP candidates characteristics :
  - Technology / type of fuel / capacity.
  - Technical characteristics (heat rate, emissions, forced an planned outage rate, …).
  - Economical characteristics (investment and O&M cost, life duration).
- HPP candidates characteristics :
  - Technical-economical characteristics.
  - Inflows series.
  - Multi-purpose uses and socio-environmental constraints.
- Other type of power candidates (geothermal, wind, solar, etc).

4.2.5 REVIEW OF EXISTING TRANSMISSION MASTER PLAN

- Analysis of the existing Transmission Master Plan

4.2.6 IDENTIFICATION OF INTERCONNEXION OPTIONS

- Identification of the relevant technologies (AD, DC, etc).
- Identification of the possible interconnection points.
- Identification of typical nominal costs (investment cost per km of line, converter station cost, etc).

4.2.7 FIRST EVALUATION OF ECONOMIC PROFITABILITY OF EXPORTS FROM SUDAN-ETHIOPIA

On the basis of the data gathered in Module 3, it will be possible to give some first gross indications of the profitability of export of hydro power from Sudan / Ethiopia area to Egypt.

This analysis will be made by comparison of the two following costs :

- levelized cost of hydro generation for a typical large HPP and levelized cost of interconnection,

- levelized cost of power TPP candidate in Egypt for semi-base generation.

4.3 MODULE 5 : PRE-FAISABILITY STUDIES OF THREE HYDRO PROJECTS

An initial review and assessment has been made of the three hydropower sites (Border, Mandaya and Dal-1) in order to provide guidance for the future direction of the project. In carrying out the initial assessment the Consultants have made estimates based on field observation of technical, environmental and social factors, but excluding cost data. A schedule of meetings on environmental issues during the Inception Mission is provided in Appendix 2.

4.3.1 MANDAYA

The Mandaya site is the most upstream of the hydropower sites under consideration. The topography at the site is well suited to development of a major dam. The USBR (1964) study recommended a dam some 150 metres in height (FSL 741 m) with a reservoir extending upstream to the next identified site at Mabil. The Mandaya site is capable of accommodating a dam of up to 260 metres in height (FSL 860 m) or thereabouts, obviating the need for the Mabil project and with the reservoir extending upstream close to the Karadobi site. The reservoir area and volumes have yet to be established by digitising and measurement from the 1:50,000 maps or from new mapping. However, it is clear that the reservoir will provide a high degree of regulation of inflows and flood mitigation as well as having a sufficiently large volume to ensure a long period of life prior to significant storage losses due to sediment deposition.

The installed capacity of the Mandaya project is preliminarily estimated as some 2400 – 2800 MW with potential energy generation estimated as some 16,000 to 18,000 GWh/year. The firm and average energy output and installed capacity will be studied in detail in the forthcoming reservoir modelling task.

From observations during the reconnaissance flight it would appear that there are few permanently resident population within the reservoir area.

4.3.2 BORDER

The Border site is the most downstream of the hydropower sites under consideration within Ethiopia. The topography at the site is well suited to development of a dam of moderate height of some 80 m. The USBR (1964) study recommended a dam some 80 metres in height (FSL 575 m) with a reservoir extending upstream close to the Mandaya site. This development appears near-optimal for the site since higher levels would appear to require extensive saddle dams to contain the reservoir.

The installed capacity would be of the order of 800 MW and annual energy generation would be of the order of 7000 – 8000 GWh/yr.

A number of villages are present along the Nile river valley and would need to be resettled to nearby areas along the reservoir perimeter.

4.3.3 DAL

Two options have been considered in the past for development of the Dal-Kagbar-Dongola reach of the Nile. These comprise:

- a high dam option at Dal with full supply level of El. 218 m which would flood upstream as far as Dongola or

- a cascade of two lower reservoirs at Dal and Kagbar which would operate as run-of-river projects.

Various full supply levels have been considered for Kagbar. In feasibility studies carried by Hydroproject Institut of Moscow in 1997 a first stage development with FSL of 209 m was proposed with installed capacity of 108 MW.

A second stage of development would raise the FSL by 4 metres to El. 213 m. Other studies (Acres, 1993 and PB Power, 2003-2006) have proposed an FSL of El. 218 m, similar to the high Dal option and with an installed capacity of 300 MW. Local objections resulted in the planned development of Kagbar being deferred.

Long term power development plan studies by Acres (1993) and PB Power (2003-2006) both recommended the High Dal option rather than the Low Dal plus Kagbar alternative based on the lower engineering costs for the single project rather than cascade development. However, both of these studies were based on desk-top analysis alone, without field visits to the project area and did not take account of environmental and social costs.

The Hydroproject Institute report drew attention to the potential impact of sediment on the Kagbar development with an estimate that 80% of the reservoir storage would be lost within the first 7 – 8 years of operation. With the construction of Merowe taking place upstream it is anticipated that this will no longer be the case and that following impounding of Merowe in 2008, the majority of sediment will be deposited within the Merowe reservoir and future that sediment concentrations at Dal and Kagbar will be much lower than current levels although some sediment can still be expected to arise from degradation of the river bed downstream of Merowe.

It is clear from the site visit that development of a high dam at Dal would lead to significant population displacement and social upheaval. In addition it would appear that the Dal reservoir would be extensive but relatively shallow potentially leading to excessive losses due to evaporation. Having regard to both of these factors it is considered that the most appropriate development of the Dal reach would comprise two low head run-of-river projects at Dal and Kagbar.

4.3.4 SUMMARY

A preliminary comparison of dams is provided in the following Table:

Dam	Dam Height (m)	Installed Capacity MW	Annual Energy Generation GWh/yr	Population Displaced by Reservoir
Mandaya	Up to 260	2,400 – 2,800	16,000 – 18,000	0 – 1,000
Border	80	700 – 800	6,000 – 7,000	2,000 – 5,000
High Dal	45	700 – 800	4,000 - 5,000	10,000 – 20,000
Low Dal + Kagbar	25 + 20	340 + 108/300	3,000 – 4,000	5,000 – 10,000

If the above-mentioned recommendation with respect to development of the Dal-Kagbar-Dongola reach of the Nile in Sudan is accepted, it appears that the Dal and Kagbar projects are probably too small to justify adoption as the first stage of an interconnected regional system linking Egypt, Ethiopia and Sudan.

However, both Dal and Kagbar can be interconnected at relatively low cost to the existing Sudan transmission network at Dongola once the new transmission lines associated with the Merowe project are completed.

Accordingly, within the context of a regional energy trading initiative it is recommended that the study should focus on one of the Ethiopian projects as a first development for regional energy supply and trading. The Dal and Kagbar projects could be developed separately as national projects within Sudan or could form part of a second stage of a regional development programme.

Either the Border site or Mandaya are capable of providing substantial energy supplies to the region. The Border site would have a much-reduced regulatory effect on Nile flows compared to Mandaya and would also require significant population re-location. Nevertheless, the studies will continue to be advanced in accordance with the Terms of Reference both at Dal/Kagbar and Border sites reflecting their potential for development in the later stages of a regional programme.

It is emphasised that the above figures are subject to review and update as the study proceeds and more accurate information becomes available. However, the Table allows a preliminary ranking of options to be made to assist in the further planning of the study activities.