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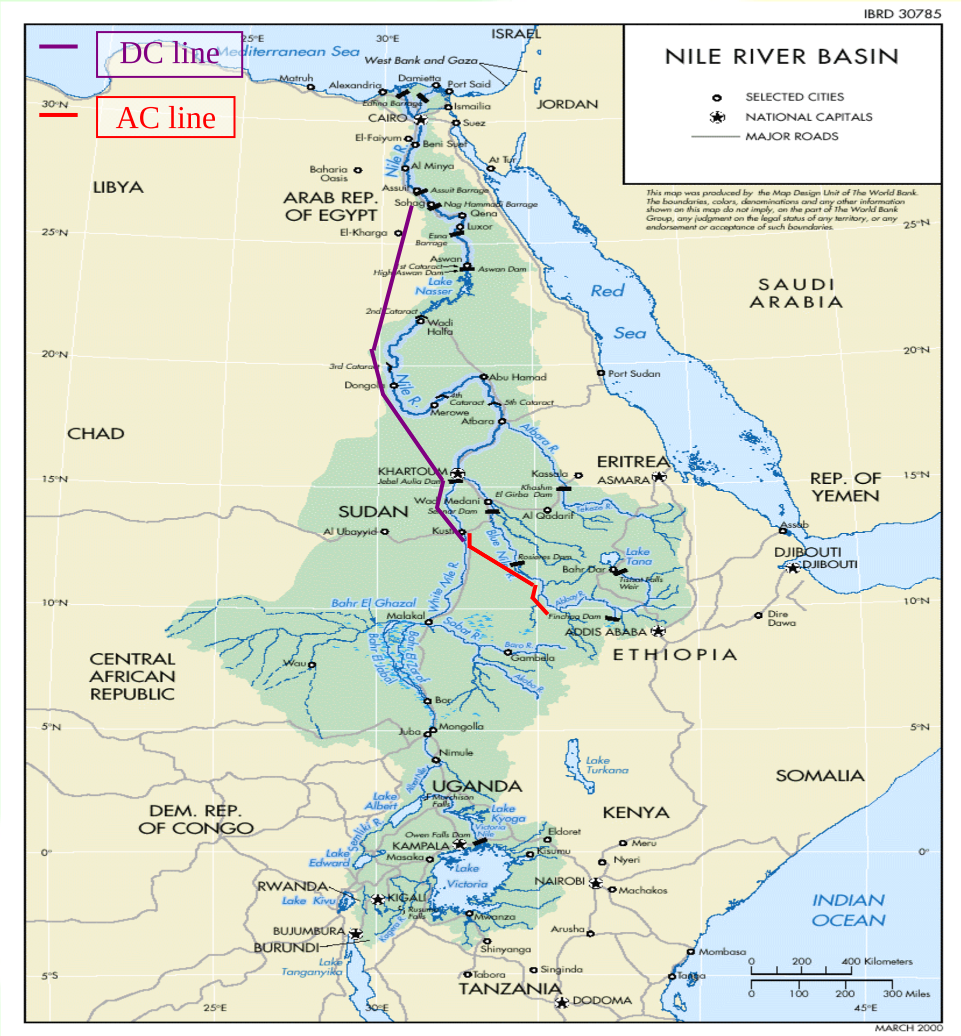
Nile Basin Initiative
Eastern Nile Subsidiary Action Program
Eastern Nile Technical Regional Office

FINAL REPORT

EASTERN NILE POWER TRADE PROJECT

VOLUME 4: LINE ROUTING, ESIA, PHASING, INSTITUTIONAL, FINANCIAL

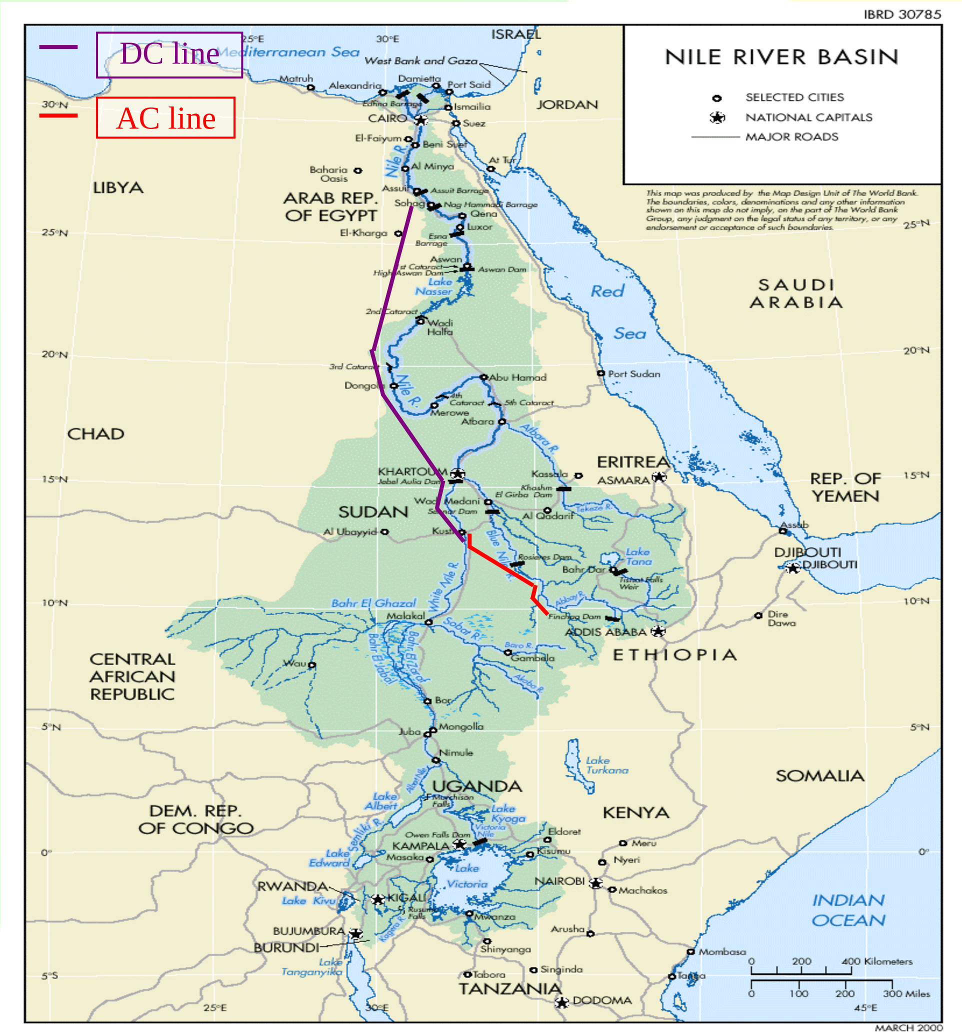


Nile Basin Initiative

Eastern Nile Subsidiary Action Program

Eastern Nile Technical Regional Office

EASTERN NILE POWER TRADE PROGRAM STUDY



EXECUTIVE SUMMARY

Electrical Power Systems
Engineering Company

The Eastern Nile Power Trade Program Study is fully funded by the African Development Bank with the general **objective of promoting regional power trade between Egypt, Ethiopia and Sudan** through creation of an enabling environment, coordinated regional investment planning of power generation and transmission interconnection projects.

The **Eastern Nile Power Trade Program Study** is divided in 2 phases:

- Phase 1: **Cooperative Regional Assessment of Power Trade Opportunities** between Ethiopia, Egypt and Sudan
- Phase 2: **Feasibility Study of the Power Interconnection** between Egypt, Ethiopia and Sudan to export, from Ethiopia, 2 000 MW to Egypt and 1 200 MW to Sudan.

In phase 2, two implementation scenarios have been analyzed :

- Commissioning a 700 MW capacity interconnection Ethiopia-Sudan in 2015 then commissioning the whole Egypt-Ethiopia-Sudan interconnection after Mandaya commissioned in 2020 (with anticipation)
- Commissioning the whole interconnection in 2020 (without anticipation)

The **Phase 1** concluded on the **economic profitability** of the Egypt-Ethiopia-Sudan power interconnection. The project is characterized by good business indicators, as a short payback period and a high benefit to cost ratio under a wide range of hypothesis.

The **Phase 2** concludes on **technical, environmental and financial feasibility**, according the development of a strong institutional framework allowing the building and the operation of this regional interconnection in a progressive way.

<u>Key Contributors</u>

Power Studies : E. Varret, R. Leport, L. Magliano, O. Hurtiger

Line Routing : X. Daudey, X. Campagne

Technical Specifications :
- OHL : X. Daudey
- HVDC : L. Tullus
- AC Stations : L. Popiel
- Control Systems : Ph. Espinasse
- Training : Ph. Espinasse

Institutional Analysis : J. Roux

Financial Analysis :
- M. Muller, NODALIS

Environmental and Social Impact Analysis :
- SCOTT WILSON Ltd, England
- E. Mwelwa, ZESCO

Local Subconsultants for Line Routing and ESIA :
- Egypt : EPS, SPEEDOTRANS
- Ethiopia : TROPICS
- Sudan : YAM CdC

EDF - SW Addis Ababa Ethiopia ENTRO PROJECT

EDF Direction Production Ingénierie Site Cap Ampère 1 Place Pleyel 93282 ST DENIS Cedex FRANCE CIST

Philippe Lebreton, EDF-CIST
Project Manager

Economic results

Investment costs are estimated about **1 860 MSD$_{2006}$** , O&M costs are about **18 MSD$_{2006}$ per year** and revamping costs about **230 MSD$_{2006}$** Social mitigation costs are about **16 MSD$_{2006}$** .

Net present value (NPV) of the project is positive for both demand scenarios: **1 810 MSD$_{2006}$** for medium Ethiopian demand and **2 210 MSD$_{2006}$** for low Ethiopian demand, 10% discount rate, medium fuel price projection. About 160 MUD to 320 MUSD must be added to NPVs from CO_2 savings, if this project is eligible to Clean Development Mechanism.

The **payback period** is reached after **8 full years** of operation for low Ethiopian demand and **7 full years** for medium Ethiopian demand.

The Benefit to Cost Ratio (**BCR**) of the both scenarios are **above 3** for a 10% discount rate, and remains superior to 2 for 8% and 12% discount rates.

Both scenarios have high Economic Internal Rate of Return (EIRR), **respectively 18% and 17%**.

The **sensitivity analysis** executed for a low Ethiopian demand including updated fuel prices projection, shows that the variant with anticipation is even more profitable, with a BCR of 4.9. High fuel prices assumption enhances the interest of the Eastern Nile Regional Power Interconnection project, with a BCR as high as 8.1.

Financial results

With anticipation, assuming a quinquennial tariff mode, a public financing and corporate income tax exoneration, the optimal transmission tariff, ensuring its viability, is **USD$_{2006}$ 7.6 / MWh excluding tax** (equivalent to USD$_{2010}$ 10.6 / MWh)

The variant **without anticipation** is less attractive, requiring a 13% higher average transmission tariff. Under a technical scenario without anticipation, the tariff is **USD$_{2006}$ 8.6 / MWh** excluding tax (equivalent to USD$_{2010}$ 12.0 / MWh).

Transmission tariff is highly sensitive to the proportion of private financing in the financing plan. The average tariff would double under a private financing scheme **USD$_{2006}$ 15.2 /MWh excluding tax** (equivalent to USD$_{2010}$ 21.2 / MWh) compared with the base public financing scheme. The financing strategy will therefore have to focus on raising the large amount of public resources, marketing the project to development aid partners in order to negotiate optimal concessional terms for long-term loans.

Regarding hydrologic risk mitigation, it is recommended to set tariffs for the first 10 years at a level around 5% higher than the equilibrium for the base hydrology scenario, at around USD$_{2006}$ 8.0 / MWh (equivalent to USD$_{2010}$11.1 / MWh).

Regarding sensitivity on financing plan, the financial and tariff modeling shows that the financing strategy will have to take into account both long-term optimization and the capacity for the stakeholders' states to raise fund from public budget.

Regarding loan negotiation with lenders, the strategy will also have to conciliate long-term optimization and the maximum admissible transmission tariff during the debt service period.

The introduction of a 30% corporate income tax has a limited impact under public financing (+ 2% on average tariffs) but a stronger impact under a private financing (+25%) as profit have to be generated, and therefore taxed, to pay out shareholders. Nevertheless, the decision to exempt the Project Company from corporate income tax or not shall depend of an economic "arbitrage" between the additional cost of electricity transmission and the revenue generated by this taxation.

Institutional Recommendations

A global institutional scheme emphasizing the **necessity of a collaborative approach**, mixing multilateral agreements and multilateral institutions, is proposed so as to finance, build, own and operate the Egypt-Sudan-Ethiopian power interconnection.

A suitable model turns out to be a scheme carried out by transnational entity distinct from national Transmission System Operators.

A **convention binding the three EN Countries** is proposed **to set-up a project structure**, in charge of implementing a **Project Company** and of running the **financing project**. The project structure will refine finance, build and operate schemes, in the objective to minimize risks and therefore, costs.

In addition, a multinational **Interconnection Regulator** shall guarantee a continuous control of the development, scrutinizing the compliance with future transparent and non-discriminatory rules.

According a Convention signed in 2009, the financing closure could happen by 2011, making the challenging anticipation scenario possible.

Social and Environmental impacts

This environmental and social impact assessment of the project-affected areas in the three EN Countries reveals no significant issue because the line route has been designed to avoid populated areas. It has also been optimized to avoid sensitive zones such historical & archeological sites, wildlife reserves, large crop areas, existing overhead line crossing.

A **16 MUSD$_{2006}$** environmental and social mitigation measure plan has been estimated to mainly compensate crop and fruit trees in Ethiopia and Sudan and to enforce community gains in Egypt. This budget represents less than **1%** of the total project budget.

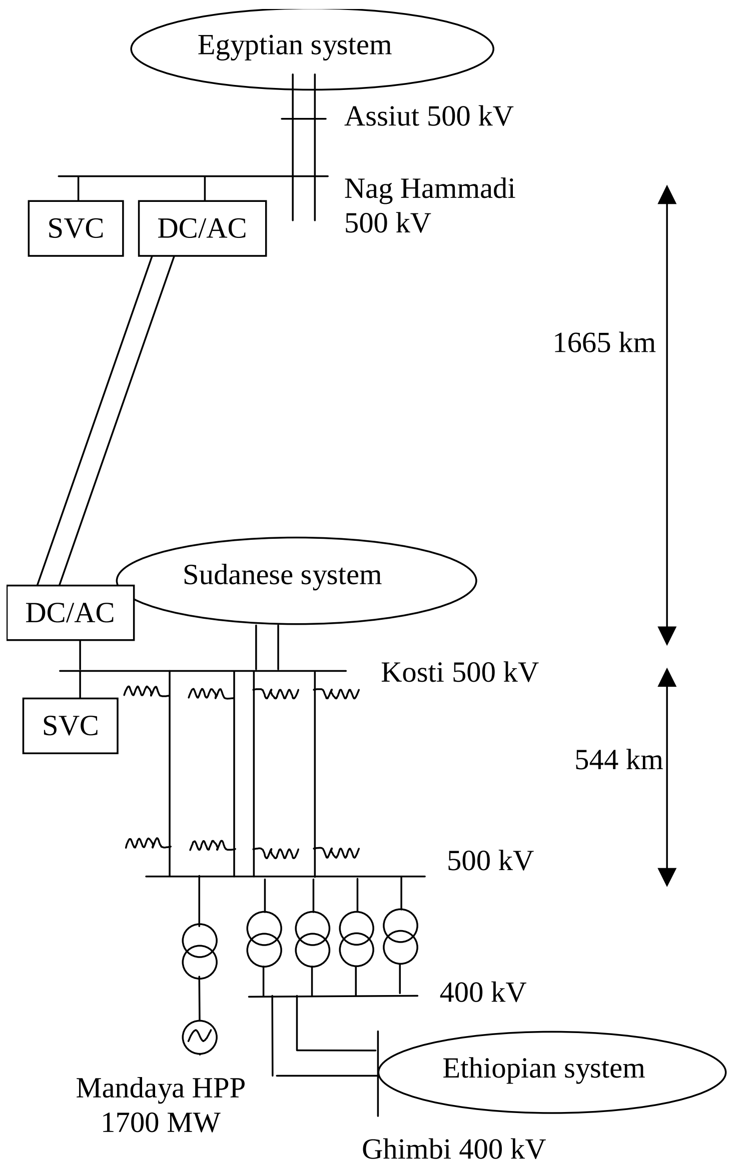
Despite this small ratio, this **Resettlement Action Plan is a key point for the implementation** of the interconnection. The project company shall take a special care and monitor closely that Contractor to fulfill ESIA recommendations and assignments.

Technical Feasibility

EN countries have selected an interconnection scheme consisting in:

- One AC 500 kV link including two 544 km double circuit lines between a 500/400 kV substation at Mandaya in Ethiopia and the AC 500 kV station at Kosti in Sudan
- One DC +/-600 kV link including a 1 665 km bipolar DC line between Kosti and Nag Hammadi in Egypt, a 2 150 MW AC/DC converter station located at each end of the link. One 500 MVAr and one 300 MVAr static var compensators are installed at Kosti and Nag Hammadi.

This interconnection operates in parallel with the Gonder (Ethiopia) and Gedaref (Sudan) 220 kV to be commissioned in the coming year 2009.



Power Studies

To assess the feasibility of this interconnection, different situations were analyzed :

- Peak load situation in 2015
- Peak and intermediate load situation in 2020/2021
- Peak load situation in 2025/2026
- Peak load situation in 2029/2030

The study has demonstrated that **it is possible** to export 3 200 MW from Ethiopia, delivering 1200 MW to Sudan and 2000 MW to Egypt.

The operation of whole interconnected systems **is acceptable**.

DC interconnection optimization study: An economical optimization study for the DC interconnection have lead to select a DC 600 kV scheme.

Operation in parallel of the 220 and 500 kV interconnections: It is advantageous to operate in parallel the 220 and the 500 kV interconnections, for security and economical reasons, with a 250 MVA phase-shift transformer.

DC +/-600 kV, AC 220 kV and 500 kV interconnections: The tripping of one of the poles of the DC interconnection is acceptable. The tripping or a short-circuit on the 220 kV interconnection has a limited impact on the system behavior. In case of short circuit on 500 kV interconnection, for stability reasons the export power to Egypt has been reduced to half. The increase of the short-circuit power and the commissioning of Border lift up this constraint.

Egyptian system : Egyptian system behavior is satisfying with a 300 MVA SVC in Nag Hammadi. The system face safely the tripping of Egypt main steam unit.

Ethiopian system: Ethiopian system behavior is satisfying. In 2020, the Mandaya and Addis Ababa 400 kV backbone is heavily loaded, fulfilling N-1 criteria. The commissioning of Geba 1&2 in 2021 and specifically Border in 2030 will release load constraints. The Ethiopia - Sudan system faces safely the tripping of Ethiopia main unit.

Sudanese system: The behavior of the Sudanese system is satisfying in case of tripping and short-circuit on the neighboring circuits of Kosti. The Ethiopia - Sudan system face safely the tripping of Sudan main unit.

Anticipation of the AC 500 kV interconnection in 2015: The anticipation of Mandaya-Kosti AC interconnection would enable to export the Ethiopian hydro surplus before 2020, and to increase the power export from 200 MW (with the 220 kV AC interconnection) to 700 MW. The energizing of the interconnection is an issue due to harmonic transient over-voltage risks, generated by 400/500 kV Mandaya transformers. This potential issue needs to be studied in a detailed way with the final known characteristics of the network. Several technical and operational alternatives were analyzed, and the black-start with low voltage energizing from a gas turbine plant at Kosti appeared to be the best solution.

Line Routing

AC circuits between Mandaya and Kosti substation face some difficult access and relief characterized by hilly area and flooded zone near Nile.

Kosti substation localization will be decided according with other 500 kV Sudanese project lines to be committed in 2030.

Corridor of ± 600 kV DC Line between Kosti and North Omdurman is located on the West bank of the White Nile River. This line route skirts urban area between Rabak/Kosti-Khartoum, Khartoum agglomeration, future International Khartoum Airport and existing 220 kV lines.

After field investigations, the proposed areas, for ± 600 kV DC Line connection in Sudan and Egypt, are located in free of obstructions places, as highly populated areas, power lines crossing, private agricultural areas and cemeteries.

No major constraint for AC and DC line corridors has been identified after site visits.

Phasing

Arrangement works are divided in ten lots: five for AC and DC overhead lines construction, four for HVDC and SVC substations and one for control center and appropriate supervision.

This **challenging** phasing considers the time for study validation and works construction but does not take into account the bidding processes for construction and consulting services.

AC and DC Technical Specifications

No cutting-edge technologies have been chosen. **Well proven technologies** have been selected for the most part of technical equipments (cables, towers, power stations subsystems, controls systems, transformers, ..). Turn key buys are recommended, one for the both HVDC stations and one for SVC stations.

Operation and Maintenance

A **dedicated control center**, designed to **not depend on the location** and **operated in close cooperation but distinctly** from national transmission operators, handles metering, supervision and controls with local substations and telecommunication links.

Training is a significant part of the development of this project and covers numerous technical and management fields.

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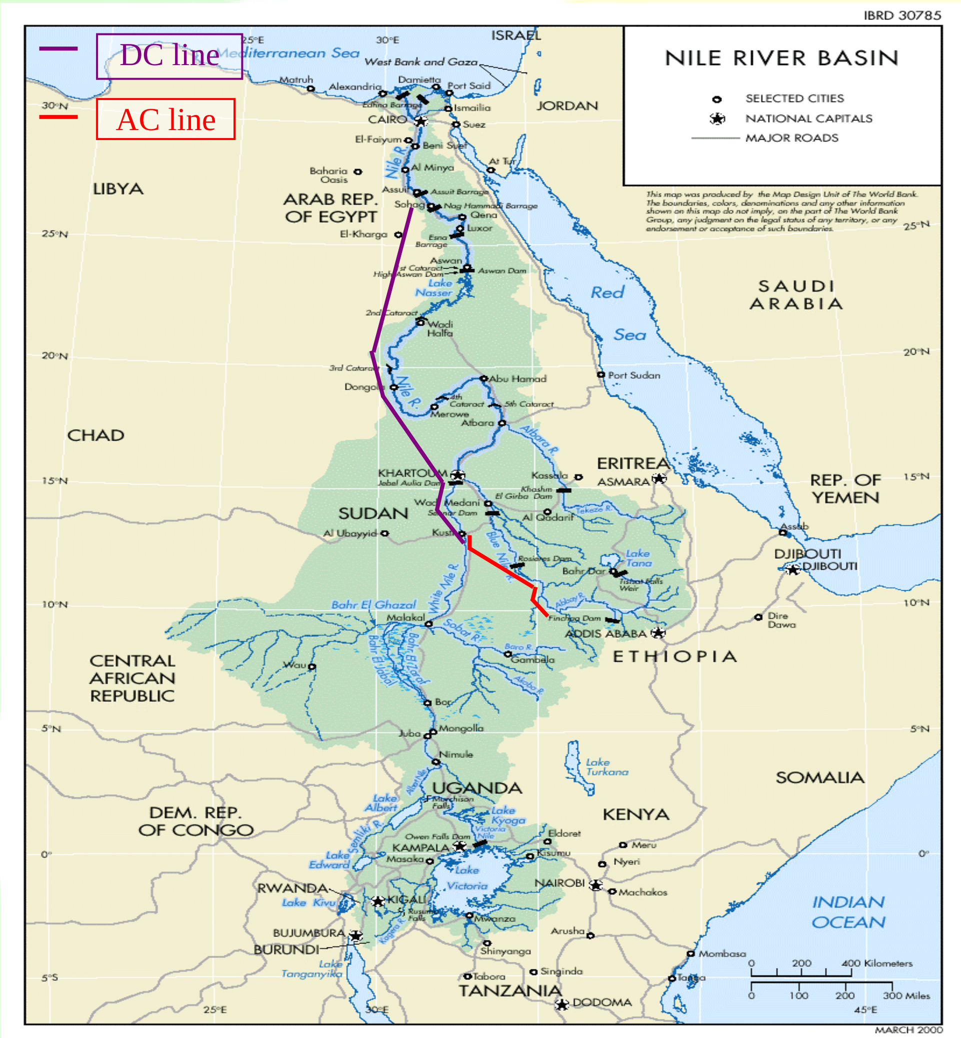

Nile Basin Initiative
Eastern Nile Subsidiary Action Program
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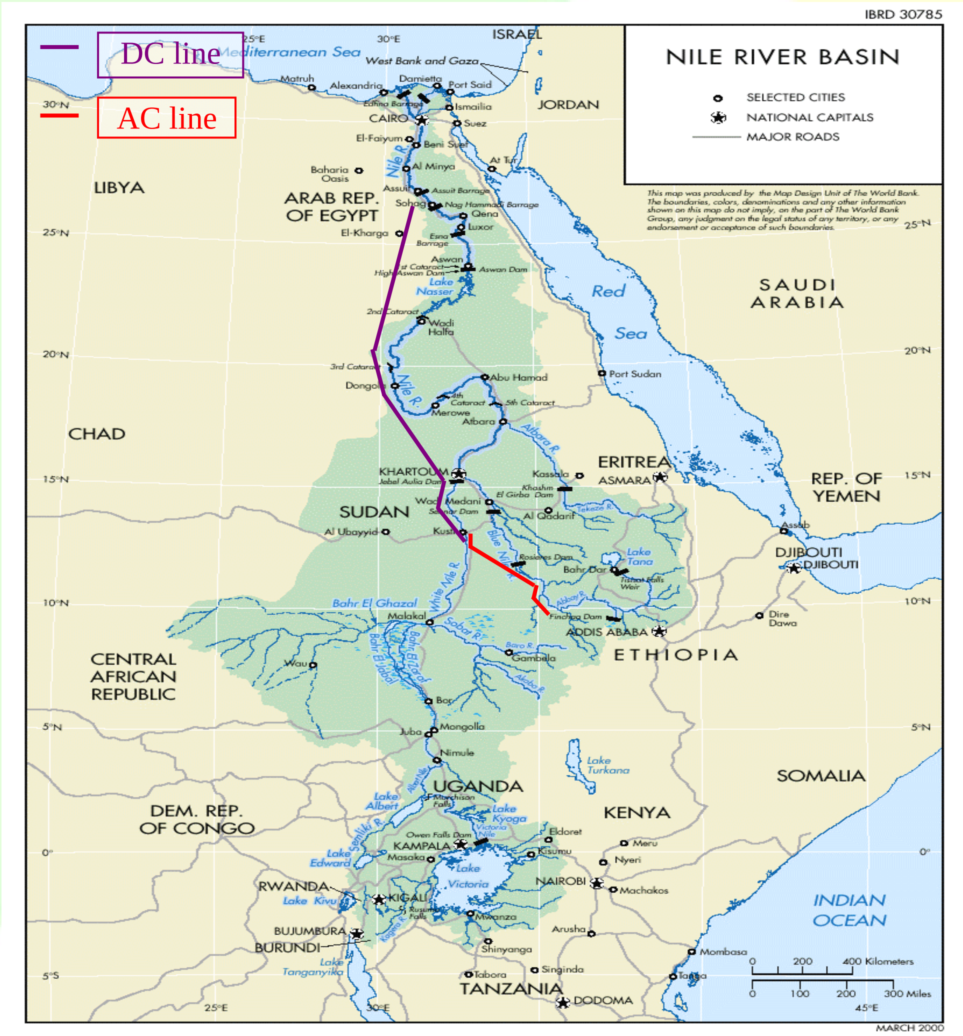
NILE BASIN INITIATIVE
Initiative du Bassin du Nil

EASTERN NILE POWER TRADE PROGRAM STUDY



M2 – LINE ROUTING

EDF
Scott Wilson
EPS Electrical Power Systems Engineering Company

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- **Appendix N°2 : Sudanese Part_YAMS Report (.zip file including 21 files)**
- **Appendix N°3 : Egyptian Part_EPS and SPEEDOTRANS Reports (.zip file including 105 files)**
- **Appendix N°4 : Coordinates of proposed line routing (one Excel File)**
- **Appendix N°5 : Autocad Files of Proposed line routing (two Autocad files)**
- **Appendix N°6 : Surveyor and Google files of Proposed line routing (six files)**

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ABBREVIATIONS AND ACRONYMS

AC	Alternative Current
ACSR	Aluminium Conductor Steel Reinforced
DC	Direct Current
EDF	Electricité de France
EEHC	Egyptian Electricity Holding Company
EHV	Extra High Voltage
ESIA	Environmental and Social Impact Assessment
EN	Eastern Nile
ENPTPS	Eastern Nile Power Trade Program study
ENTRO	Eastern Nile Technical Regional Office
HPP	Hydro Power Plant
HV	High Voltage
HVDC	High Voltage Direct Current
NBI	Nile Basin Initiative
NEC	National Electricity Corporation (Sudan)
OHL	Overhead Line
PI	Point of Inflexion
ROW	Right Of Way
SVC	Static Voltage Compensator
SW	Scott Wilson
TL	Transmission Line

EXECUTIVE SUMMARY

This document provides with the main localization of the lines and substations for the interconnection between Egypt-Ethiopia-Sudan.

1. Preliminary line routing has been issued from desk study and is based on the results of a careful synthesis of the existing maps, including Phase I considerations and Google views.
2. Final proposed line routing has integrated site visit reports from sub-consultancy services and ESIA study findings.

The line route of the interconnection includes :

- A 2x500 kV AC Lines from Mandaya (Ethiopia) to Rabak/Kosti (Sudan)
- A $\pm$ 600 kV DC Line from Rabak/Kosti (Sudan) to Nag Hammadi (Egypt)
- Three power stations located in Mandaya (Ethiopia), in Rabak/Kosti (Sudan), in Nag Hammadi (Egypt)
- Border Dam Connection

The route design has been done in compliance with industry standards and existing public documentation.

The route goes across different areas (mountains, swap areas, river bank, agriculture pot, barren or cultivated lands, desert) and a few obstacles and constraints have been met during the desk study.

The line route is a compromise between the length, the by-pass of urban area and the closeness of existing or committed roads and lines corridor.

Some field visits have been identified to confirm desk study based choices and to make possible realistic adjustments using

- More data collected for a few critical points (Station locations, Nile River crossing mainly).
- Determination of exact position of angle towers.

The main difference between the preliminary and the proposed line routing are :

- **AC Line between Mandaya and Sudanese Substation**: difficult access and relief characterized by hilly area and flooded zone near Nile;
- **Arrival of AC Line and Departure DC Line from Sudanese Substation**: the final position of the substation in Sudan will be in Kosti, near Rabak substation. The final precise localization of Kosti station will be decided according with ENPTPS requirements and others 500 kV Sudanese project lines committed in 2030 on the Sudanese Grid;

- **Corridor of ± 600 kV DC Line between Kosti and North Ondurman** will be on the West bank of the White Nile River. This line routing will skirt urban area between Rabak/Kosti-Khartoum, Khartoum agglomeration and existing 220 kV lines;
- **Arrival of ± 600 kV DC Line on Nag Hammadi**. After field investigations, the proposed area of Nag Hammadi Substation is localized in area without obstructions such as highly populated areas, power lines crossing, private agricultural areas and cemeteries.

The coordinates of line route points are quite precise but not totally definitive and the final and exact position for all points shall be established within the Project Implementation Phase.

1 GENERAL CONSIDERATIONS / METHODOLOGY

The preliminary line routing has been issued from desk study and is based on the results of a careful synthesis of the existing maps, including Phase I considerations and Google views from Mandaya site (Ethiopia), Rabak (Sudan) and Nag Hammadi (Egypt).

The methodology of the line routing study is presented above.

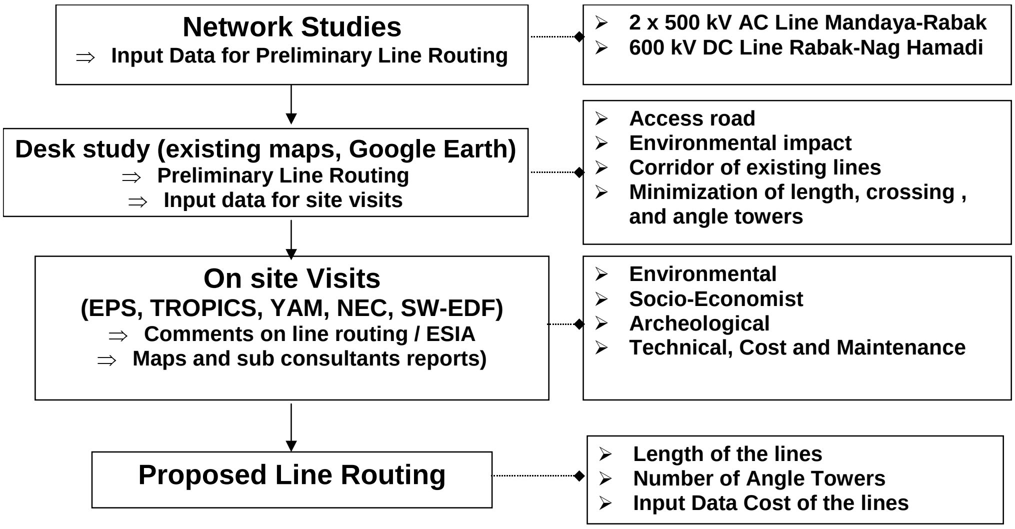


Figure 1: Methodology

The site visits with the sub-consultants support (YAM, TROPICS, EPS and SPEEDOTRANS) will permit to take into consideration the technical, economic and environmental aspects. The field inspection of the line routes will focus on the localization of substations (Rabak/Kosti and Nag Hammadi), the impact on lines corridor and the characterization of angle points. The parameters for the location of respective angle points (PI : point of inflection) follow the rules of :

- Minimization the length of the line route;
- Optimization of the road access from the existing road and evaluation of the environmental impact and avoidance of crossing asphalt roads;
- Minimization of the environmental impact, avoiding as much as possible the urban area, moving a distance away from villages
- Usage as much as possible of the existing corridor of the existing lines;
- Minimization of the crossing of existing and future overhead line in Sudan and Egyptian Grid;
- Minimization of the number of angle towers in order to have the straightest possible line route;
- Avoidance of forests and dense grass cover for the purpose of easy accessibility;
- Moving points nearer to roads for ease of construction, monitoring and maintenance purposes;

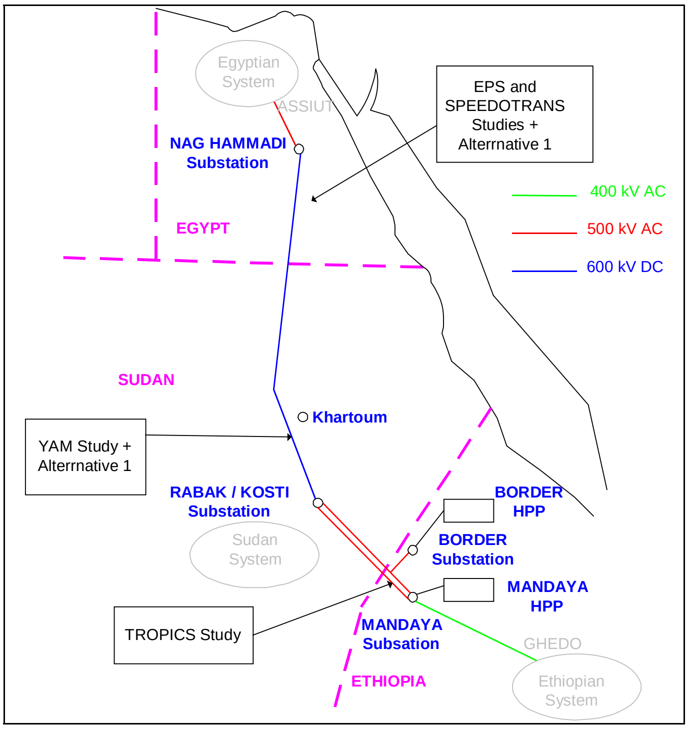


Figure 2: Alternative and sub-consultant studies

The AC line route from Mandaya (Ethiopia) to Rabak/Kosti (Sudan) is divided into 2 parts corresponding to :

- SECTION A _Ethiopia : Mandaya Dam to Ethiopian/Sudan Border
- SECTION B _Sudan : Ethiopian/Sudan Border to Rabak/Kosti

The ± 600 kV DC line route from Rabak/Kosti (Sudan) to Nag Hammadi (Egypt) is divided into 2 parts corresponding to :

- SECTION C_Sudan : Rabak/Kosti to Sudan/Egyptian Border
- SECTION D_Egypt : Sudan Egyptian Border to Nag Hammadi

2 SUDAN AND EGYPTIAN GRID

The proposed line routing for ± 600 kV DC line will be parallel to existing/committed overhead lines in sections of north of Sudan (after North Ondurman) and Egyptian part.

2.1 SUDANESE GRID

On the departure from Kosti to North Ondurman, the ± 600 kV DC line routing will be closer the future 500 kV Kosti – Markheit.

Near Dongola to Egyptian Border, the ± 600 kV DC line will be parallel to 220 kV committed Line Merowe - Wadi Halfa.

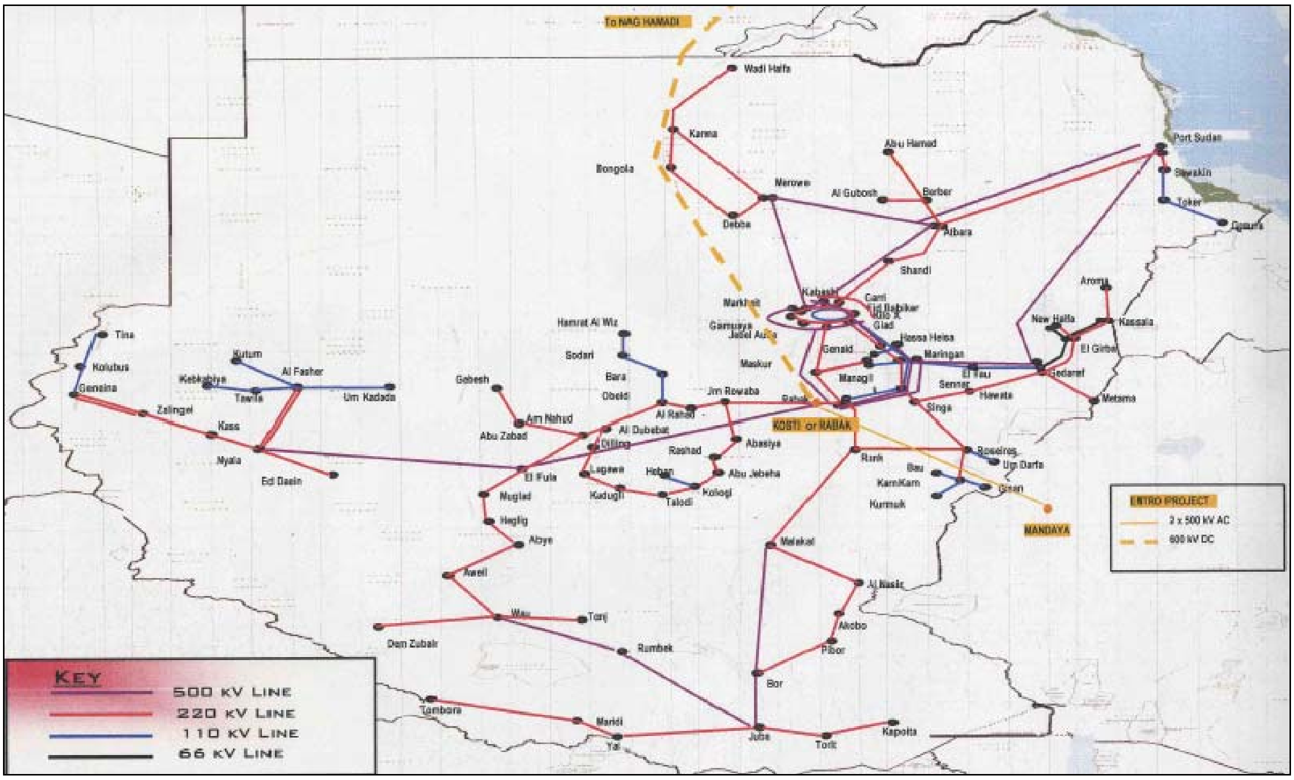


Figure 3: Sudanese Grid

2.2 EGYPTIAN GRID

From Sudan Border to Aswan, the ± 600 kV DC line routing will be parallel to 220 kV existing Line Islah Tokah – Aswan.

From Aswan to Nag Hammadi, the ± 600 kV DC line routing will be parallel to 500 kV Existing Line Aswan- Nag Hammadi.

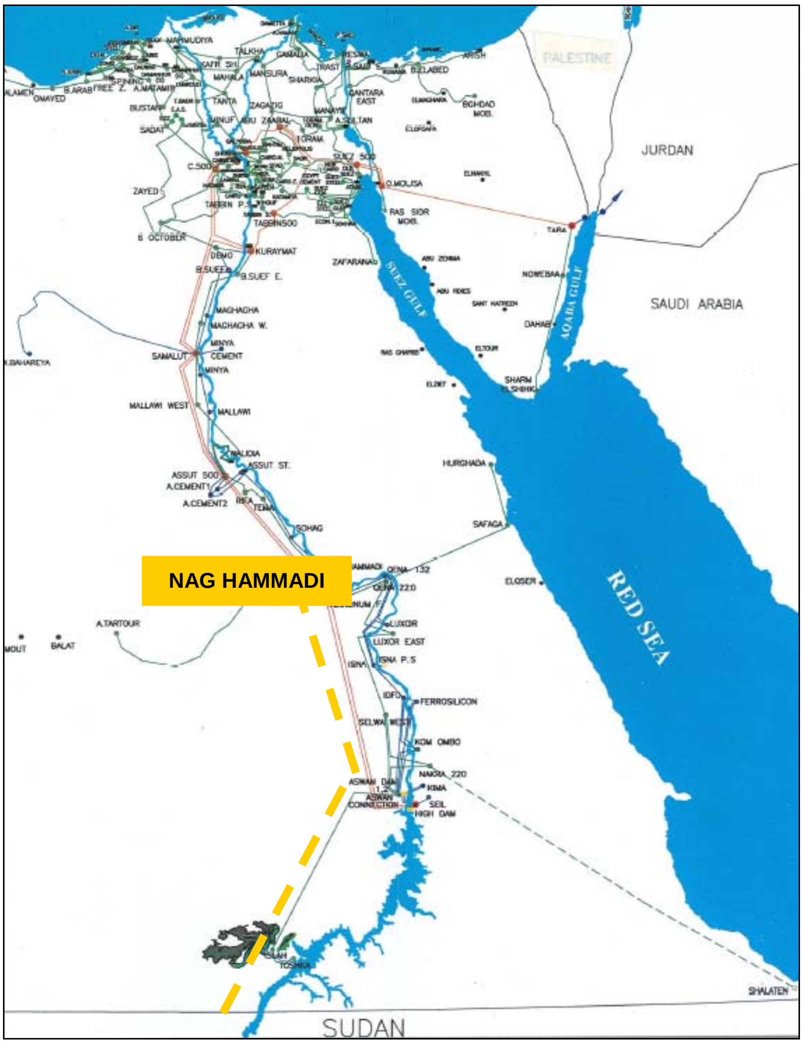


Figure 4: Egyptian Grid

3 RIGHT OF WAY

The Right Of Way (ROW) requested depends on the line configuration:

- **2x 500 kV AC (Four circuits) Overhead Transmission Lines: 2 x 65 = 130 m**

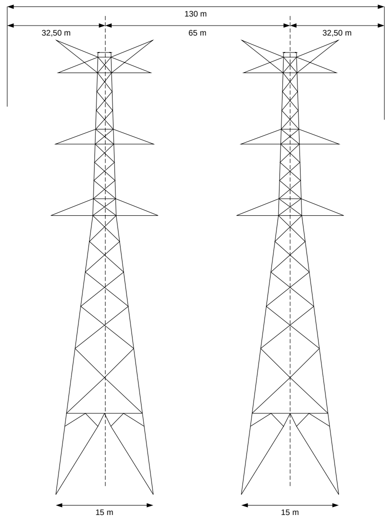


Figure 5: ROW for 2 x 500 kV AC lines

- **High Voltage ± 600 kV DC Transmission Lines: 80 m**

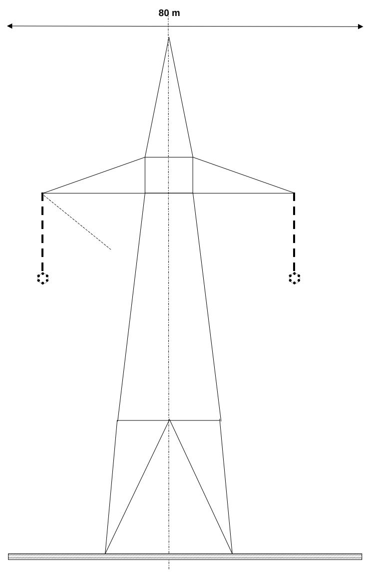


Figure 6: ROW for 600 kV DC lines

For the section where the new transmission lines is parallel with existing or committed lines on different national grids (Sudanese and Egyptian), the minimum distance between 2 lines is 100 m. Furthermore, a large distance of 5km will be taking account between Right Of Way and existing villages.

4 SUBSTATIONS

4.1 MANDAYA SUBSTATION

The future AC Mandaya 500 kV substation will be situated near the Mandaya dam.

The proposed area will be = 0,5 km x 0,4 km.

The final position of the substation will be defined during dam feasibility studies.

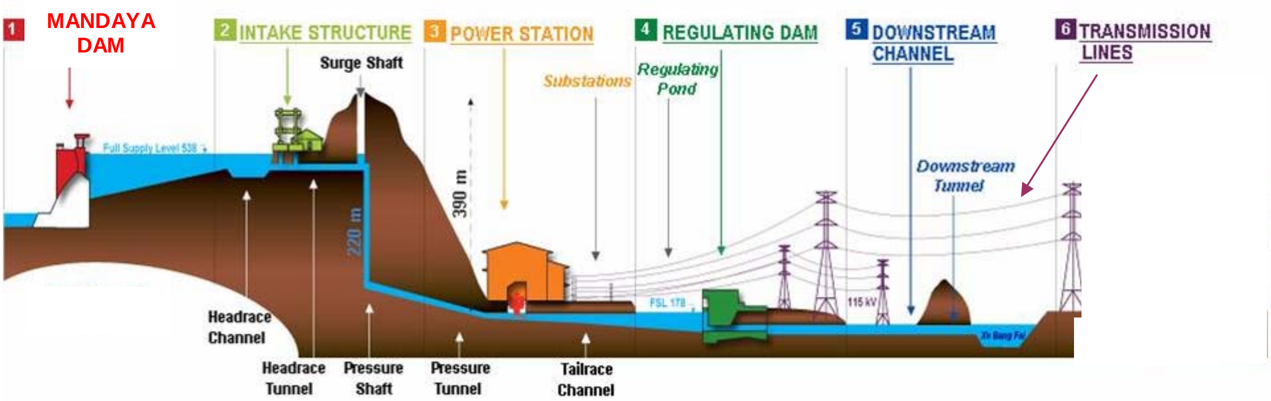


Figure 7 : Mandaya Dam Dower Transmission Platform

4.2 RABAK/KOSTI SUBSTATION

For the ENPTPS purposes, the power substation in Sudan contains :

- Bays for the 2x500 kV lines arriving from Mandaya
- AC/DC conversion and SVC station.
- Bays for the 600 kV DC line to Nag Hammadi

Regarding to the Committed 2030 Sudanese Grid, there will be new 500 kV lines arriving in Rabak area from 1x Markheit, 2 x Meringan, 1x El Fula. The substation will have new bays also for these future 500 kV lines from Sudanese Grid.

Considering the area required for power substation which will host these connection projects and the urban area of existing Rabak substation, it was studied two options:

- Rabak option : extension of the future 220 kV Rabak Substation.
- Kosti option : construction of new substation near the city of Kosti.

The future substation area will be 1km by 1km in order to implement 500 kV bays, 600 kV DC bays, AC/DC conversion and SVC station.

The preliminary option was based on the extension of future 220 kV Rabak Substation. After site visit with NEC/SW and EDF, the alternative Kosti option was studied at the future location of 220 kV Kosti Substation.

The conclusion on the study of the 2 alternatives was that Kosti is the best option for Sudanese Substation.

4.2.1 RABAK OPTION

The future Rabak 220 kV substation is under construction. Three 220 kV lines (Jebel Aulia, Obeid and Rank) are arriving in this new 220 kV Rabak substation, as illustrated in Figure 11 : OHL Routes at Kosti Power Substation.

The Rabak 220 kV substation is surrounded by agriculture area and urbanized zone and it will be difficult to implement the arrivals/departures of 2 x 500 kV AC lines, 600 kV DC Line, 500 kV lines from Sudanese Grid and overhead line for electrode substation.

Furthermore, the 600 kV DC line routing on the East Bank of White Nile will be difficult to implement on the section between Rabak and Khartoum. The main constraint are:

- agriculture area like sugar cane field.
- several crossings of the main road between Rabak and Khartoum
- several crossings of existing 220 kV Jebel Aulia-Rabak.

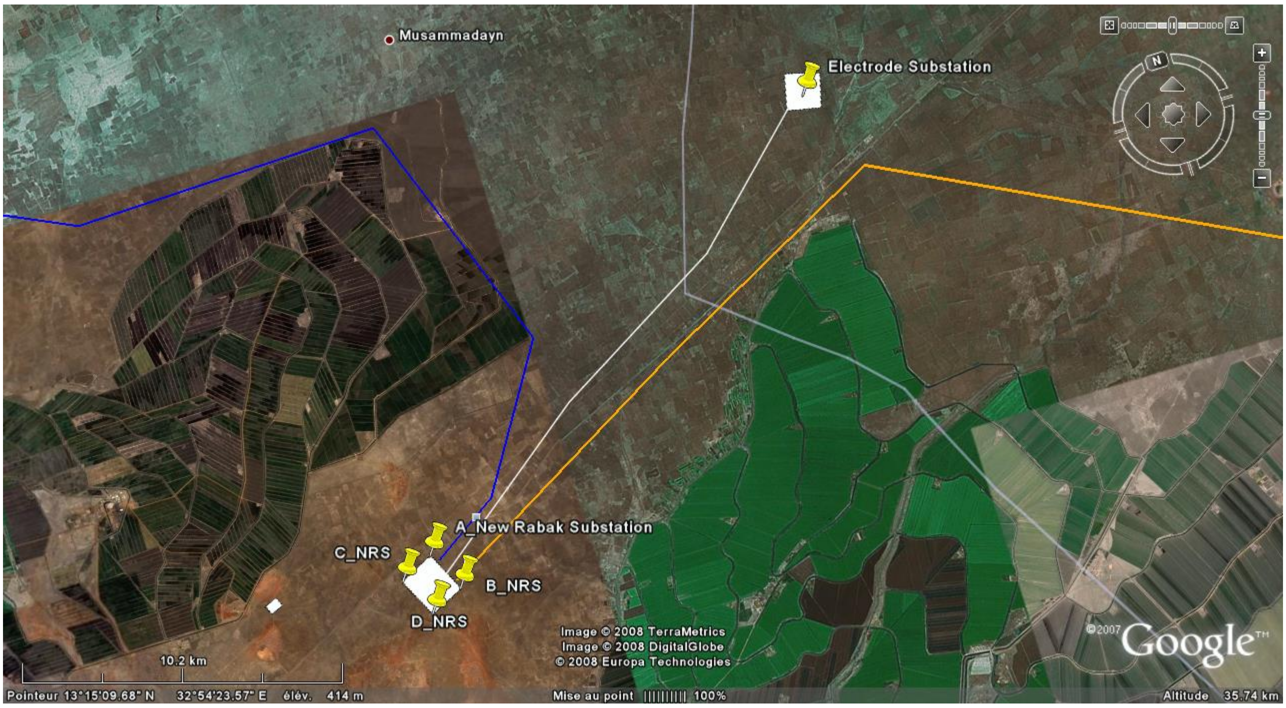


Figure 8 : Rabak Power Substation View

4.2.2 KOSTI OPTION

The other alternative for HVDC/AC substation will be on the west bank of the White Nile River (Figure 9 : Kosti Power Substation Plan View) near Kosti town where there is enough space to implement the arrivals/departures of futures lines (500 kV lines from Sudanese Grid, 600 kV DC line, 500 kV lines from Mandaya, overhead line for electrode substation), 500 kV bays, AC/DC conversion and SVC station.

However the design of Kosti alternative should take account of :

- Construction of asphalt road to access to substation. The cost for 8km of road is estimated at 4 000 k$.
- Special design for substation due to flooded area
- Line-in-line-out connection on the existing 220 kV Rabak-Obeid as illustrated in Figure 11 : OHL Routes at Kosti Power Substation.

An alternative line routing was realized to connect the 2 x 500 kV AC Lines arriving from Sudan-Ethiopian Border to Kosti Substation. The study focused on the White Nile crossing on the north of Kosti/Rabak. Three alternatives were studied for the White Nile Crossing on the site in relation with local population.

Furthermore an alternative of 600 kV DC line routing on the west side of the White Nile River was studied to connect 600 kV DC Line from Kosti to North of Khartoum. The study focuses on avoiding villages, new international airport of Khartoum and uncrossing the 220 kV ring of Khartoum.

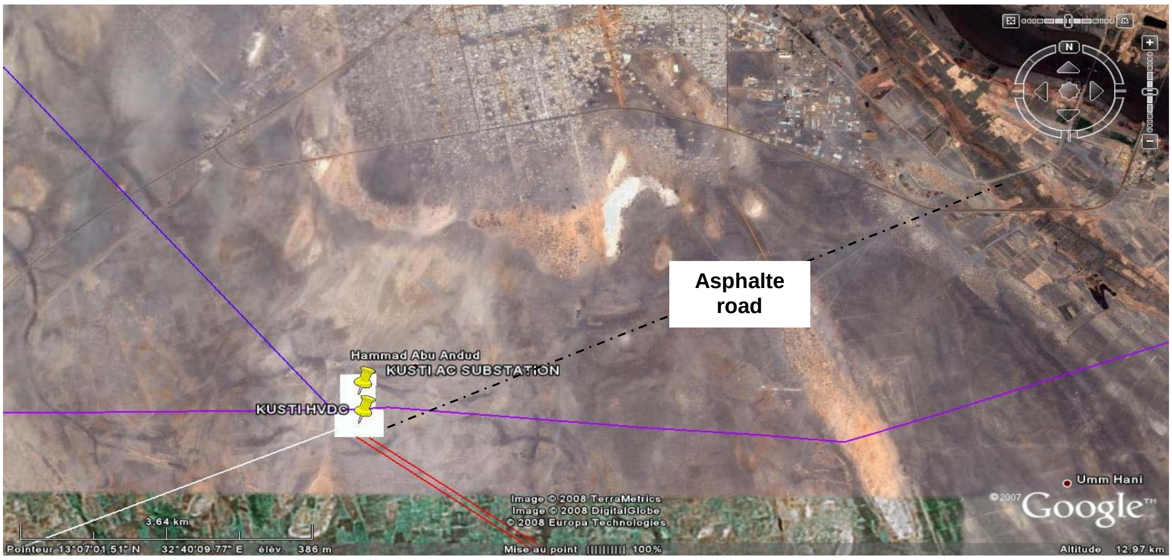


Figure 9 : Kosti Power Substation Plan View

Figure 10 : Kosti Substation

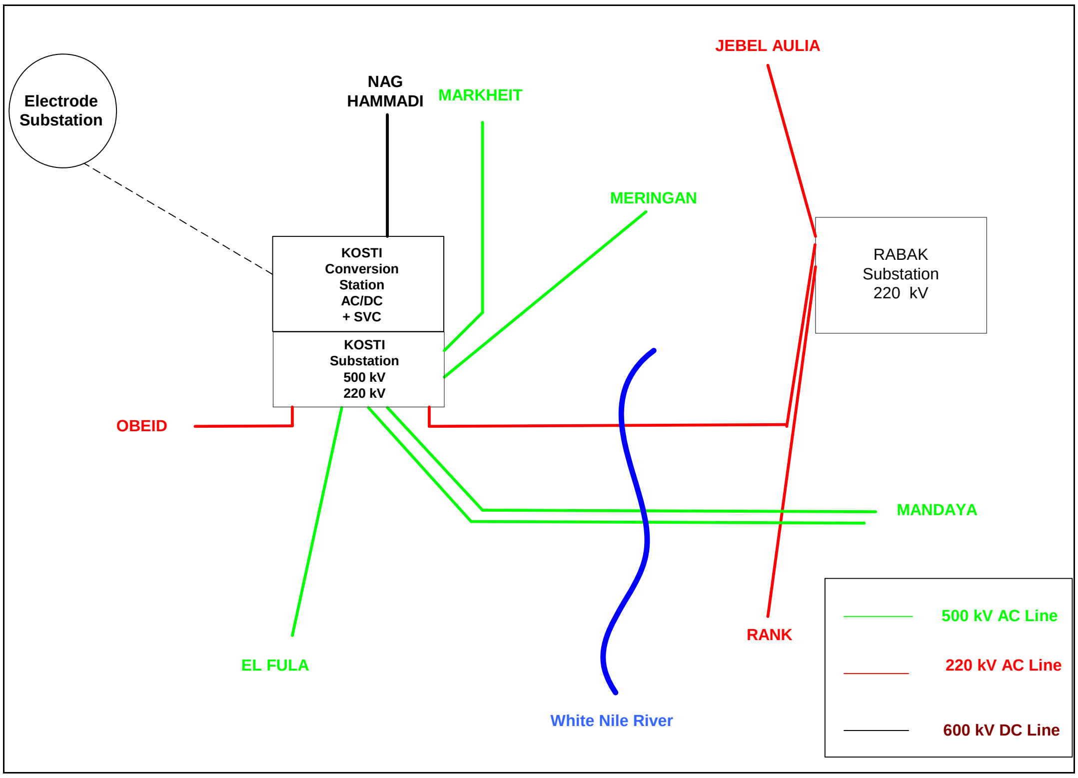


Figure 11 : OHL Routes at Kosti Power Substation

4.3 NAG HAMMADI SUBSTATION

The existing Nag Hammadi Substation is situated on the south of Nag Hammadi agglomeration. The area is not very urbanized.

It is proposed to build the AC/DC conversion station, on the East of the existing substation, behind the existing road. After field investigations, the proposed area of future Nag Hammadi HVDC Substation is localized in area without obstructions such as highly populated areas, power lines crossing, private agricultural areas and cemeteries, as illustrated in Figure 12 : HVDC Station Location at Nag Hammadi.

There will be a short Overhead Line Connection (3 km) between the existing Nag Hammadi substation and the future HVDC station. This connection will be 500 kV AC line, double circuit with three bundle conductors ACSR DOVE per phase and with an estimated transit for 1 circuit of 1960 MW.

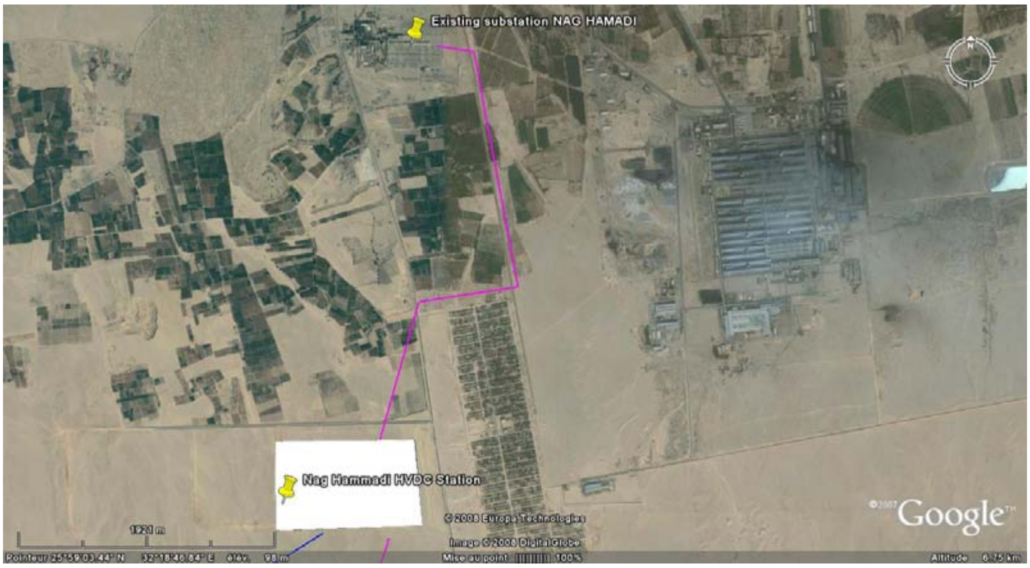


Figure 12 : HVDC Station Location at Nag Hammadi

4.4 ELECTRODE SUBSTATION

For the two HVDC substations in Kosti and Nag Hammadi, there will be a short overhead line between the HVDC substation and electrode substation. The overhead line will have a length between 10 to 20 km. The final localization of electrode substation shall be established within the Project Implementation Phase and depending the soil characteristics.

The electrode substation area will be circular with a diameter of 0,5 km, as illustrated below.

Figure 13 : Electrode Substation

5 White Nile Crossing

There is different alternative to make huge river crossing (800 to 1000 meters) :

- Alternative 1 : Design of 2 extra height tower. The estimated necessary height of the tower is more or less 350 meters.
- Alternative 2 : Design of 2 extra tower inside the Nile crossing. The feasibility study will focus on the special design of foundation depending of the depth of Nile at the crossing.
- Alternative 3 : Insertion of a tower inside small island in the Nile.

For the Nile Crossing, the alternative 3 will seem to be the more interesting in term of cost and technical feasibility. The Concept Design will be similar to the Nile River crossing of the 220 kV Ring Line near White Nile Dam.

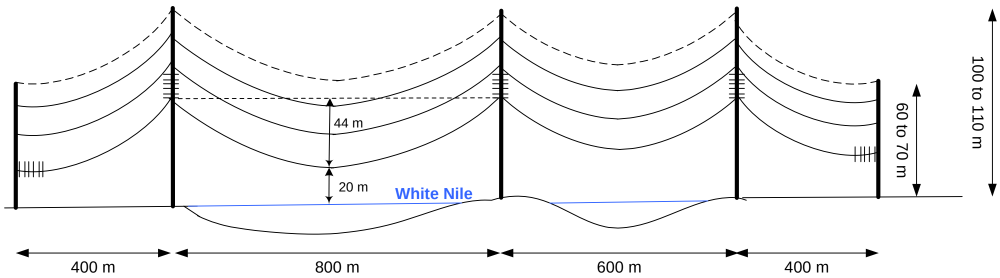


Figure 14 : Concept Design for Nile River Crossing

5.1.1 Rabak Option

For Rabak Option, the Nile Crossing will be for 600 kV DC line and localized near White Nile Dam.

The 600 kV DC line will be near the existing 220 kV Khartoum ring as illustrated Figure 16 : 220 kV Khartoum Ring_ Nile River Crossing View. After the Nile crossing, the line route will go west of Khartoum agglomeration in order to avoid urban areas.

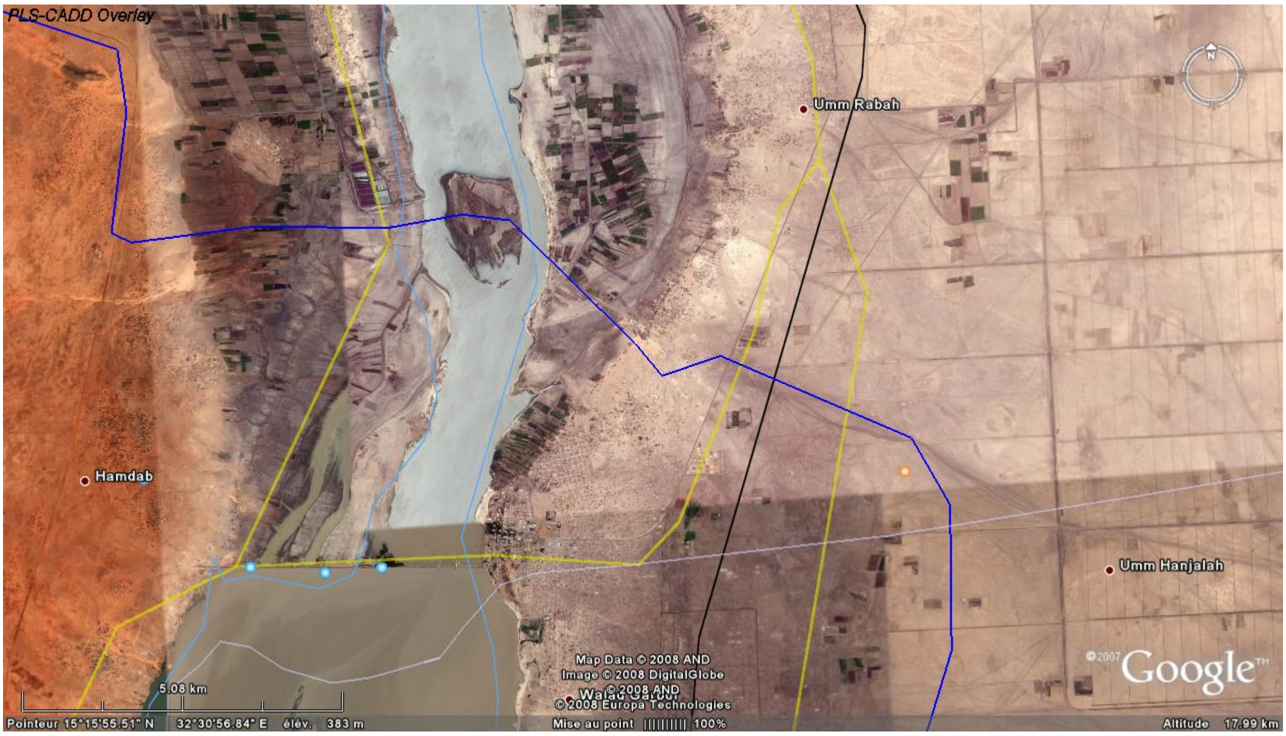


Figure 15 : Section 4_DC Nile River Crossing View

Figure 16 : 220 kV Khartoum Ring_ Nile River Crossing View

5.1.2 KOSTI OPTION

For Kosti Option, the Nile Crossing will be for 2 x 500 kV AC lines and localized at 20-25 km to the north from Kosti/Rabak town in narrowness of Nile river.

After discussion with local people, the location seems to be the more suitable for crossing with minimal environmental impact as illustrated in Figure 17 : Nile River Crossing View for Kosti Option.

Figure 17 : Nile River Crossing View for Kosti Option

The final line routing between the White Nile river crossing and Kosti substation should avoid the agriculture project in the villages area, as illustrated below.

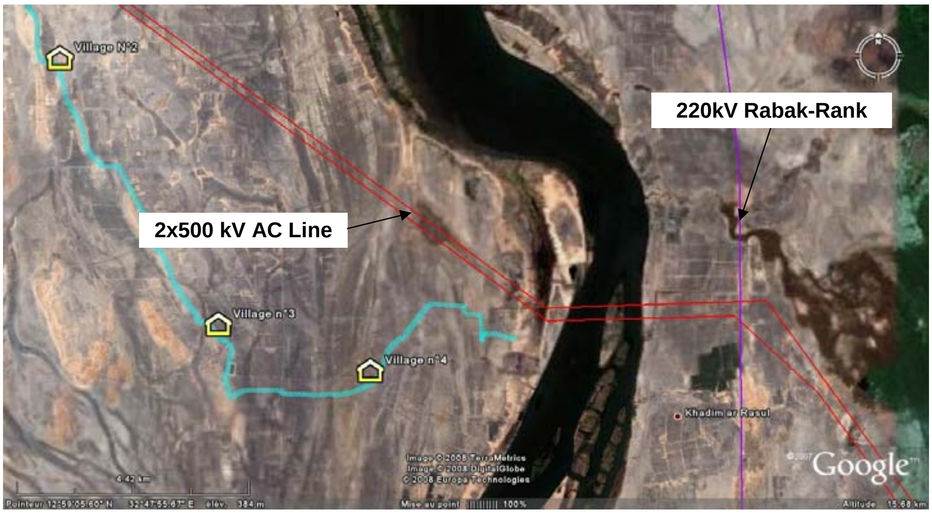


Figure 18 : Nile River Crossing Plan View for Kosti Option

6 DESCRIPTION OF THE LINE ROUTE CORRIDOR

6.1 ETHIOPIAN PART

The field study based on the preliminary line routing was executed by the sub-consultant TROPICS for Ethiopian Part. The main conclusions of the TROPICS report were:

- The recommended option of TROPICS generally follows the same corridor than the preliminary line routing.
- The alignment modifications were based on satisfactory reason/justification (physical, social and environmental) found during the site visit.
- A number of dense villages/ towns were avoided with the re-routing. Potential for future expansion of towns was considered.
- The routing consider to avoid settlement and other facilities out of the impact zone.
- As much as possible straight line was opted. The total length of the proposed line routing was lowered from 168 km to 158 km and the number of Point of Inflexion (Angle Tower) was minimized from 84 to 20.
- Some sections were inaccessible and especially during rainy season.
- Un-avoidable impacts due to the future 2 x 500 kV AC power line will be:
  - Impact on agriculture
  - Land compensation
  - A few settlement of household structure
  - Compensation for 54 households (compared to 204 households in the preliminary line route)

The description on the line routing is presented in Appendix 1 corresponding to TROPICS Report.

6.2 SUDANESE PART

The field study based on the preliminary line routing was executed by the sub-consultants YAM for Sudan Part. Furthermore, the sub-consultant validated the alternative route on the West Bank of White Nile River due to re-localization of Sudan Substation, Kosti instead of Rabak.

Figure 19: West Bank White Nile River Alternative

The main conclusions of the YAM report were:

- The total route is divided into two sections for AC line (Ethiopian/Sudan border to Kosti) and 3 sections for DC line (Kosti to Sudan/Egyptian Bodrer) which are summarized as follows:
  - **Section 1_AC Lines :** Sudan Border to Damazine (120 Km). The proposed route makes two bigger river crossings and a number of crosses on wetlands associated with flooding regime of the Blue Nile. It traverses grassland with sparse trees with subsistence agriculture. In the proposed line routing, some points were modified to be nearer to the access road because there were far form the road, inside the forest and it was difficult to reach them.
  - **Section 2_AC Lines :** Damazine to Kosti (290 Km).It is predominantly through extensive agricultural land with mainly rainfed crops. The area has a number of areas of cultural importance which need to be conserved. In the proposed line routing, some points were modified to be nearer to the access road .
  - **Section 3_DC Line :** Kosti to South Khartoum-North Omdurman (275 Km). The soil type is mainly sandy rocky type with light vegetation. The proposed route remained as it is except for one point which was moved to the west to avoid a big village

- **Section 4_DC Line :** South Khartoum-North Omdurman – Dongola (535 Km). The route is selected to avoid negative impacts on the suburbs and other settlements near Khartoum, the terrain is flat with sandy rocky soils and very light vegetation. Population along the route corridor is low to medium. Accessibility is from the existing roads and tracks. The proposed line routing has been moved to the west side of the asphalt road at distances ranging form 500 - 800m in order to avoid crossing the asphalt road.
- **Section 5_DC Line :** Dongola to Sudan Border (360 Km). Route traverses mainly flat desert terrain with sandy soils and very light vegetation. It avoids major settlements and agricultural activities along the River Nile. Cultural and historical sites may exist along the route. Population is either absent or very low (desert area). The proposed line routing is recommended to be moved to the North to avoid Route Dongola - Halfa - Transmission Route.

- As much as possible straight line was opted. In Sudan, the total length of the proposed line routing (AC and DC lines) was lowered from 1600 km to 1496 km and the number of Point of Inflexion (Angle Tower) was minimized from 332 to 154.
- The proposed line routing will skirt the New International Airport of Khartoum and the existing 220 kV Khartoum Ring
- A lot of Agriculture Project along the different sections were avoided with the recommended line routing. However alternations need to be paid for loss of income due to temporary distances to crop or grazing areas. Furthermore when crossing agricultural areas, the tower should be protected by strong fence to protect against accidental collision by heavy agricultural equipment
- Kosti sub-station is located near potential flood hazard from the White Nile. Proper placing of this station and the construction of potential flood protective measures should receive due attention.
- An improved track should need to be constructed in the section between Kosti and South Khartoum-North Omdurman in order to access for construction and maintenance, especially during the rainy season.
- A right of way of 300m should be cleared in woody areas against fire risk in section Geissan – Damazine – Kosti. The estimated length of concerned line is 40 km.
- No archaeological remains on the proposed line route between Geisan and Omdurman were observed at any point along the whole stretch of the corridor. The proposed points on the west bank of the White Nile are located at spots far away from the river bank..

The description on the line routing is presented in Appendix 2 corresponding to YAM Report.

6.3 EGYPTIAN PART

The field study based on the preliminary line routing was executed by the sub-consultants EPS and SPEEDPOTRANS for Egyptian Part. The main conclusions of the EPS and SPEEDPOTRANS report were:

- Most of line route will be close to the existing main road Wadi Halfa-Aswan and Aswan / ldfu.
- Most of the proposed route are running through desert area.
- No constrains/obstructions along the right of way such as historical zones, military zones. zones of floods at collapses.
- Military zones and historical areas are avoided.
- The line route will be start from Sudan border, then running close to the existing 220 kV T.L Toshky / Aswan dam, then close to the existing 500 kV T.L. Aswan/Nag Hammadi.

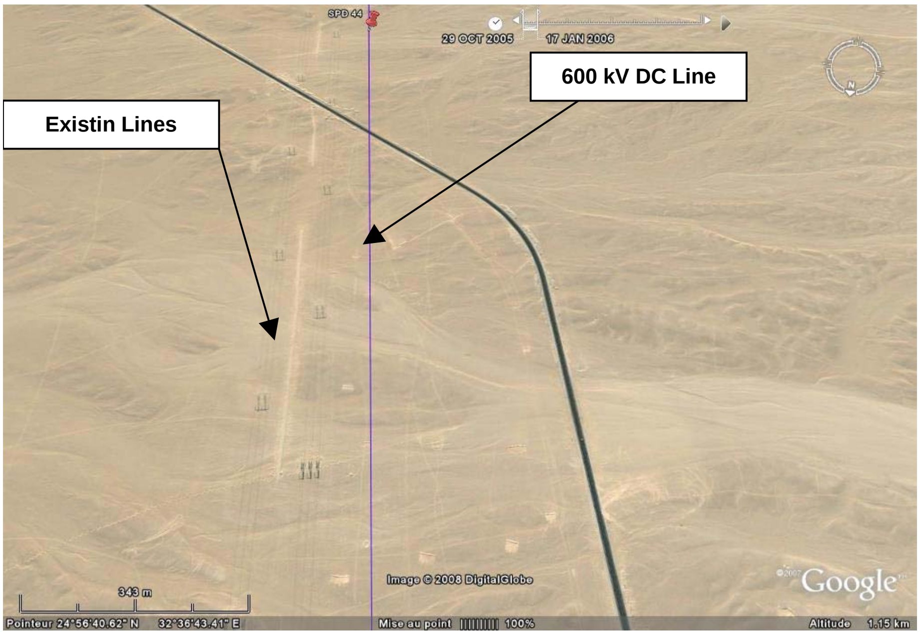


Figure 20: 600 kV DC line routing in Egypt

- The line route will cross a railway line near location of conversion station and also cross Toshka Soillwav.
- The best optimization length of the proposed line routing is approximately 535 km. Two modifications on the preliminary line routing:
    - Arrival on Nag Hammadi Substation : Small length of line route (20 km) passing above mouniain area Jabal Qarn Al-Jir near from Naga Hammadi Substation
    - Optimization on Aswan Area, Toshka Pumping Station

The description on the line routing is presented in Appendix 3 corresponding to EPS and SPEEDPOTRANS Reports.

6.4 CONNECTION TO BORDER

From the point T18 (Latitude = 10°36'27.05"N, Longitude = 34°48'36.30"E) on the future 500 kV Mandya – Kosti line, there will be a line in line out connection to Border Dam. The total length of this section is 70 km.

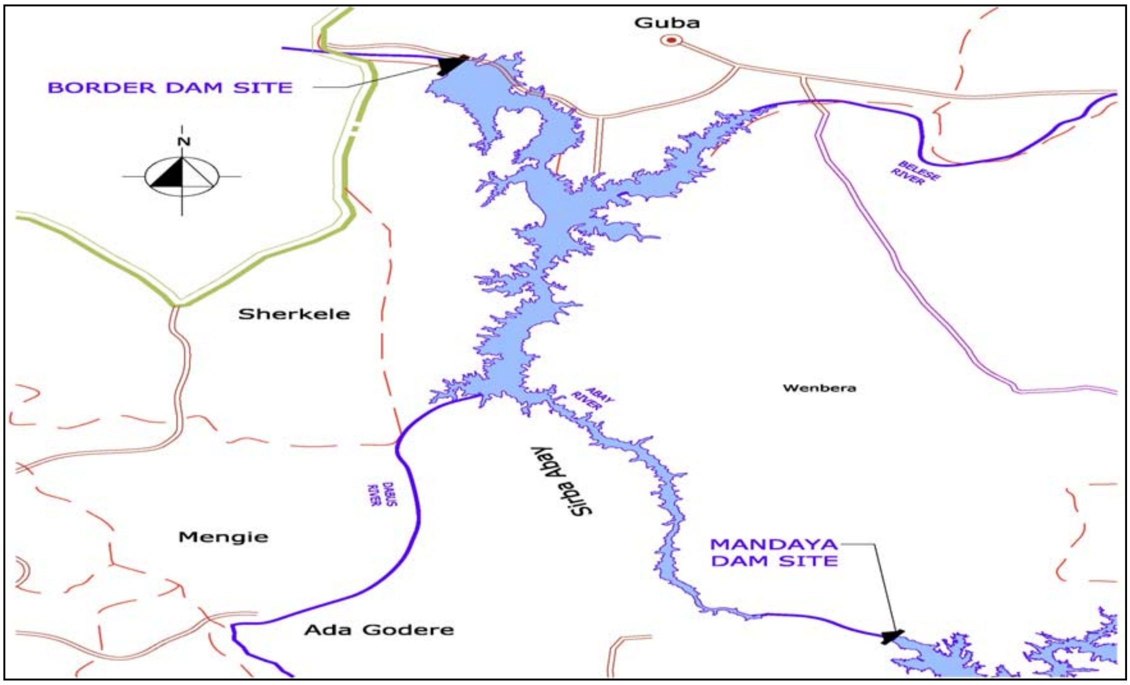


Figure 21: Border Dam Localization

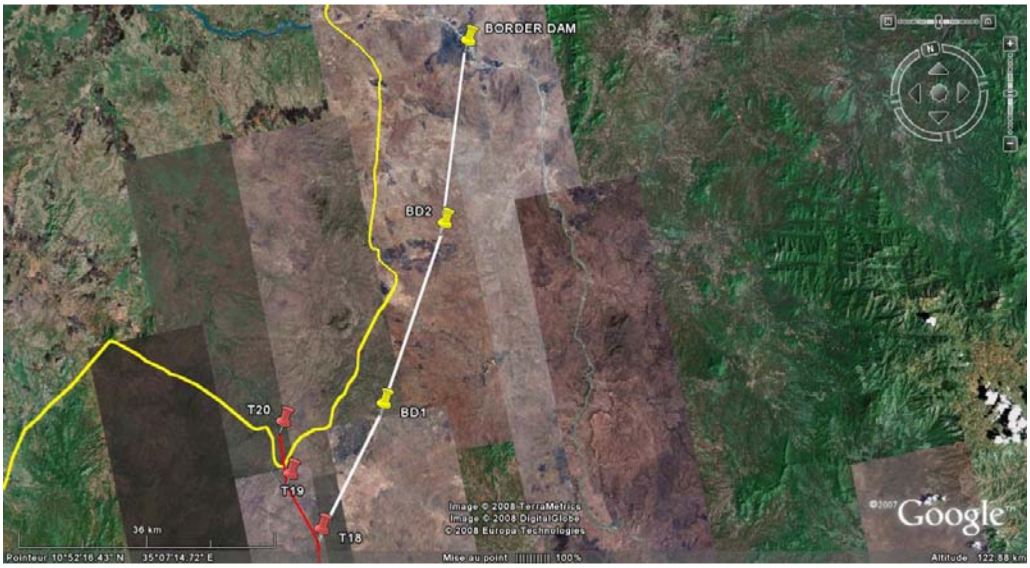


Figure 22: Border Dam Connection

7 CONCLUSION

The recommended line routing was built from the reports recommendations issued from sub-consultants in Ethiopia (TROPICS), Sudan (YAM) and Egypt (EPS and SPEEDOTRANS),

The main difference between the preliminary and proposed line routing for the 2x500 kV AC lines Mandaya – Kosti and the 600 kV DC line Kosti-Nag Hammadi will be :

- Characteristics of the lines (sections length and number of Angle Towers) are issued from site visits considering the following points (physical, biological , socio-economic, relevant environment policy, legal and institutional framework). These constrains will be studied on the site for re-localization of important points (substation, crossing, etc), angle towers (avoid villages, minimize impact environment, new project, etc) and optimisation of the line.

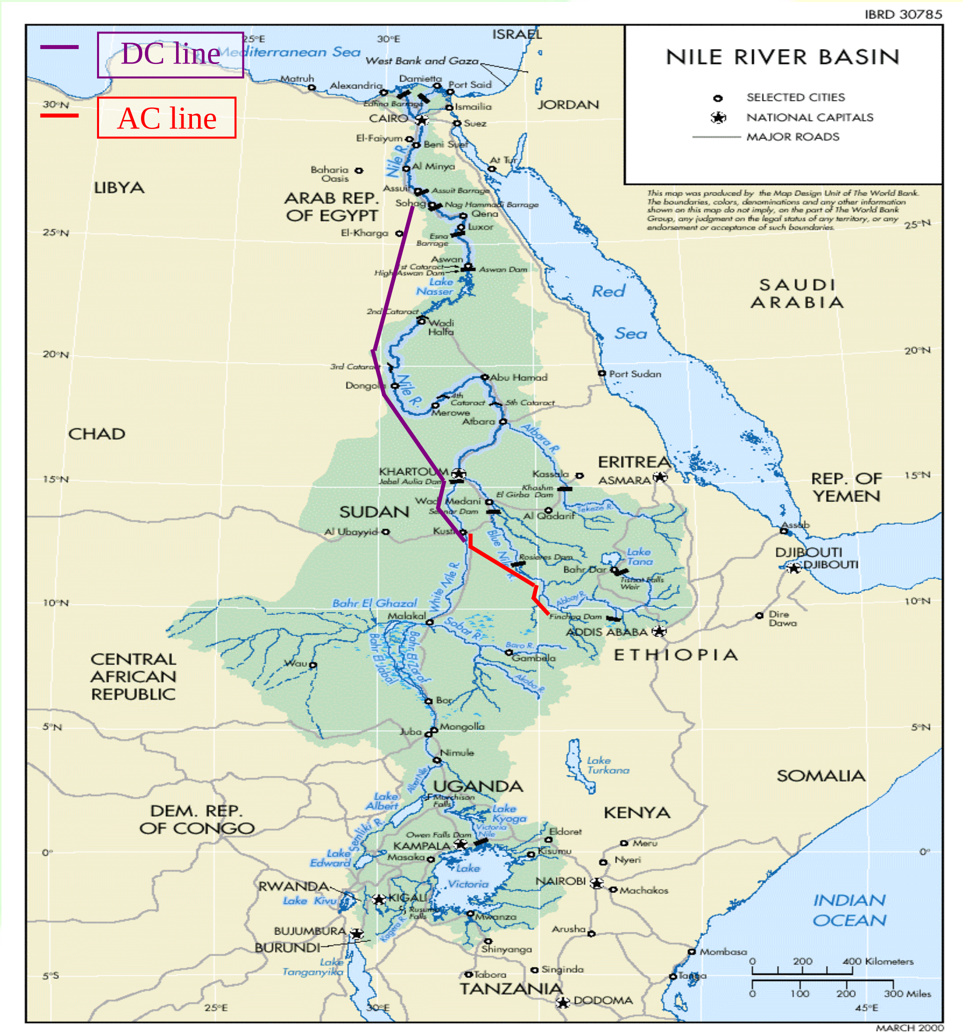
		TOTAL LENGHT		NUMBER OF PI	
COUNTRY	**SECTION**	**Preliminary Line Routing**	**Proposed Line Routing**	**Preliminary Line Routing**	**Proposed Line Routing**
2 x 500 kV AC Lines from Mandaya to Kosti					
Ethiopia Section A	Mandaya Dam To Sudan Border	168 km	158 km	84	20
Sudan Section B	Sudan Border To Rabak/Kosti	430 km	386 km	65	57
	TOTAL	**598 km**	**544 km (- 9 %)**	**147**	**77 (- 48 %)**
1 x 600 kV DC Line from Kosti to Nag Hammadi					
Sudan Section C	**Rabak/Kosti** To Sudan Border	1170 km	1130 km	267	69
Egypt Section D	Sudan Border To **Nag Hammadi**	550 km	535 km	61	46
	TOTAL	**1720 km**	**1665 km (-3.2 %)**	**328**	**115 (-65 %)**

Table 1: Recommended line routing characteristics

- Localization for Sudanese substation : The Kosti localization will be better than Rabak for Sudanese substation. The area is indeed more adapted for ENPTPS purposes and new arrivals of 500 kV lines from Sudanese grid. Furthermore, the crossing of White Nile river will be more easier at 20 km from the towns of Kosti and Rabak. The section will be easy to implement on the West bank instead of Est bank.
- The ESIA Study will be focused on this proposed line routing.

Nile Basin Initiative
Eastern Nile Subsidiary Action Program
Eastern Nile Technical Regional Office

EASTERN NILE POWER TRADE PROGRAM STUDY



M3 – ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT (ESIA)

EPS Electrical Power Systems Engineering Company

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ABBREVIATIONS AND ACRONYMS

AC	Alternative Current
ADB/AfDB	African Development Bank
AIDS	Acquired immune deficiency syndrome
AMSL	Above Mean Sea Level
ART	Anti-Retroviral Therapy
BGNRS	Benishangul Gumuz National Regional State
BP	Bank Procedure
CAP	Compliance Action Plan
CAPMAS	Central Agency for People Mobilisation and Statistics
CBR	Crude Birth Rate
CPA	Comprehensive Peace Agreement
CRA	Cooperative Regional Assessment
CSA	Control Statistics Agency
CSO	Civil Society Organization
CV	Coefficient of Variation
DC	Direct Current
EA	Environmental Assessment
EDF	Electricité de France
EEAA	Egyptian Environmental Affairs Agency
EEHC	Egyptian Electricity Holding Company
EEIS	Egyptian Environmental Information System
EEPA	Ethiopian Environmental Protection Authority
EEPCO	Ethiopian Electric Power Corporation
EHP	Environmental Health Department
EHV	Extra High Voltage
EIA	Environmental and Impact Assessment
EMP	Environmental Management Plan
EMU	Environmental Monitoring Unit
EN	Eastern Nile
ENCOM	Eastern Nile Council of Ministers

ENPTPS	Eastern Nile Power Trade Program Study
ENTRO	Eastern Nile Technical Regional Office
ENSAP	Eastern Nile Subsidiary Action Program
EPA	Environmental Protection Act
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
GAB	Gulf Arabic Belt
GDP	Gross Domestic Products
GFR	General Fertility Rate
GMA	Global Acute Malnutrition
GPS	Global Positioning System
HCENR	Higher Council of Environment and Natural Resources
HPP	Hydro Power Plant
HV	High Voltage
HVAC	High Voltage Alternative Current
HVDC	High Voltage Direct Current
INC	Interim National Constitution
ITN	Insecticide-treated mosquito Nets
LV	Low Voltage
MALR	Ministry of Agriculture and Land Reclamation
MDGS	Millennium Development Goals
MHUNC	Ministry of Housing, Utilities and New Communities
MOHP	Ministry of Health and Population
MOWR	Ministry of Water Resources
MWRI	Ministry of Water Resources and Irrigation
MNBI	Nile Basin Initiative
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NGO	Non-Governmental Organization
NOPWASD	National Organization for Potable Water and Sanitary Drainage
NWRC	National Water Research Centre
NWRP	National Water Resources Plan
OHTL	Over Head Transmission Line

OP	Operational Policy
PAP	Project Affected Person
PFS	Pre - Feasibility Study
PMTCTS	Prevention of Mother To Child Transmission
ROW	Right of Way
SAM	Severe Malnutrition
SARS	Sudan Archaeological Research Society
SVC	Static Voltage Compensator
TFR	Total Fertility Rate
TOR	Terms of Reference
TPP	Thermal Power plant
UNCCD	United Nations Convention to Combat Desertification
URTI	Upper Respiratory Tract Infections
VCT	Voluntary Counseling and Testing
WCPA	World Commission on Protected Areas

1 INTRODUCTION

1.1 PROJECT BACKGROUND

The Nile River system is shared by 10 riparian countries: Burundi, Democratic Republic of the Congo, Egypt, Ethiopia, Eritrea, Kenya, Rwanda, Sudan, Tanzania and Uganda. Under the Nile Basin Initiative, all countries agreed and established a basin-wide framework to fight poverty and promote economic development in the region. Action oriented sub-basin programs (NELSAP, ENSAP) were formulated that are intended to shift focus from planning to action on the ground through investment in development projects. For this purpose, ENCOM was established and Ethiopia, Egypt and Sudan have jointly adopted a strategy to develop, utilize and manage water resources of the Eastern Nile Basin in an integrated, equitable and sustainable manner. In doing so, they are guided by a shared vision "*to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources*" (EDF and Scott Wilson, November 2007).

Over the past 30 years, various sub-groups of the Nile countries have engaged in cooperative activities. However, the inclusion of all countries in a joint dialogue opens up new opportunities for realizing win-win solutions. It also holds the promise for potential greater regional integration, both economic and political, with benefits far exceeding those derived from the Nile River itself. The Nile Basin Initiative (NBI) comprises a Council of Ministers of Water Affairs of the Nile Basin (Nile-COM), a Technical Advisory Committee (Nile-TAC), and a Secretariat (Nile-SEC) located in Entebbe, Uganda (EDF and Scott Wilson, November 2007).

It is with this background that the Eastern Nile Technical Regional Office (ENTRO) was established and commissioned the Eastern Nile Power Trade Program (ENPTP) Study. The general objective of this study is: "*To promote regional power trade between Egypt, Ethiopia and Sudan through creation of an enabling environment coordinated regional investment planning of power generation and transmission interconnection projects*" (EDF et al, 2008).

The ENPTP Study has been carried out in close contact and co-operation with the three countries' Utilities: Egypt Electrical Holding Company (EEHC), Ethiopian Electric Power Corporation (EEPCo) and the Sudanese National Electricity Company (NEC). In addition, other relevant institutions, in particular the Nile Basin Initiative, the Ministry of Water Resources and Irrigation of Egypt, the Ministry of Water Resources of Ethiopia, the Ministry of Irrigation & Water Resources of Sudan have been involved in the study (EDF et al, 2008).

The study has been fully funded by the African Development Bank (ADB). ENPTP Study has been divided into two phases:

- Phase I: Cooperative Regional Assessment of Power Trade Opportunities between Ethiopia, Egypt and Sudan and;

- Phase II: Feasibility Study of the Power Interconnection between Egypt, Ethiopia and Sudan. of Électricité de France (EDF) and Scott Wilson Ltd (Scott Wilson),

The Phase I study has been carried out by a consortium ics Consulting Engineers (Ethiopia), Electrical Power Systems Engineering Company (Egypt) and Yams (Sudan).

The successful completion of Phase I of ENTRO study in November 2007 demonstrated that it was very profitable for the three countries that Ethiopia exports power to Egypt and Sudan. The recommended export capacity option determined in Phase I is:

- Capacity between Ethiopia and Sudan : 1200 MW; and
- Capacity between Ethiopia and Egypt : 2000 MW.

The power is to primarily be generated by the 2000 MW Mandaya Hydropower Project located in Ethiopia, and the uplift in energy at hydropower facilities in Sudan resulting from Mandaya's regulation of the river, and raising of dry flows (EDF and Scott Wilson, November 2007).

The decision to proceed to Phase II (Feasibility Study on the recommended option) was therefore taken by ENTRO in December 2007, on the basis of the findings of Phase I.

The Phase II feasibility study has therefore been executed for an interconnection scheme of 1 200 MW capacity from Ethiopia to Sudan and of 2000 MW capacity from Ethiopia to Egypt, through the following transmission system:

- One 500/400 kV substation located on Mandaya HPP site, Ethiopia, equipped with four 500/400 kV 510 MVA transformers;
- One AC/DC 500kV substation located in Kosti, Sudan, connected to Mandaya substation through two double 500kV AC circuits and Static Compensator (SVC); and
- One DC/AC 500kV substation located in Nag Hamadi, Egypt, connected to Kosti substation through one bipolar DC line (1650km).
- Two double circuit 500 kV AC lines, running between Mandaya HPP, Ethiopia, and Kosti, Sudan, 500 kV substations.
- 600 kV DC bipolar line between Kosti, Sudan, and Nag Hammadi, Egypt.

Construction of the interconnection scheme is expected to commence in 2013 and commissioning of components of the scheme is expected from the year 2015 until 2020 for the whole scheme to be commissioned. This is in the accelerated or anticipated scenario. In the scenario without acceleration or anticipation, commencement would be 2015 and commissioning of the whole scheme by 2020.

The Phase II Feasibility Study has been split up into the following modules:

- M 1: Detailed power system studies
- M 2: Topography and survey for line routing
- M 3: Environmental & Social Impact Assessment
- M 4: Preparation of Technical Specifications
- M 5: Operation & Maintenance requirements

- M 6: Implementation Arrangements
- M 7: Institutional analysis
- M 8: Financial and economics analysis
- M 9: Training

1.2 Scope Of Work

Scott Wilson Ltd has been commissioned to undertake module M3, ESIA of the Eastern Nile Power Trade Study Phase II, Regional Power Interconnection Feasibility Study. This reports forms module M3: the Environmental and Social Impact Assessment (ESIA) of the Phase II interconnection scheme.

The Environmental and Social Assessment of the Mandaya Hydropower Project has been evaluated in Phase I of the study and is not part of the scope of works for this ESIA (EDF and Scott Wilson, November 2007).

Scott Wilson is an international environmental and engineering consultancy with over 80 offices worldwide, providing integrated professional services in the transportation, property, environment and natural resource sectors.

Scott Wilson has been assisted in the ESIA by Tropics Consultant Engineers (Ethiopia), EPS (Egypt) and Yams (Sudan). A listing of the people involved in completing the EIS is contained in Appendix A.

The ESIA has been undertaken to relevant Ethiopian, Sudanese and Egyptian Legislation and Standards, as well as African Development Bank Guidelines (see Section 3).

Further details on the methodology adopted for the ESIA and legislation relevant to the EIS are included in Sections 2 and 3 respectively.

1.3 Contents And Organisation Of The Report

This ESIA provides an initial appraisal of the environmental and social impacts of the Phase II interconnection scheme. The structure of the report is organised as follows:

- Following the Executive Summary, the background to the project and scope of work, are presented in Section 0.
- Section 1 presents the introduction to the study and the report.
- Section 2 presents the methodology adopted for undertaking the ESIA and the study areas.
- Section 3 summarises relevant environmental policy, legal and institutional frameworks in Ethiopia, Sudan and Egypt. It proceeds to introduce the African Development Bank's

environmental policy and the World Bank safeguard policies that are considered for the project.

- Section 4 provides a description of the project as studied at feasibility level in parallel with this report.
- Section 5 considers project alternatives.
- Section 6 presents the conditions of existing physical environment of the project-affected areas in Ethiopia, Sudan and Egypt.
- Section 7 presents the conditions of the existing biological environmental of the project-affected areas in Ethiopia, Sudan and Egypt.
- Section 8 presents the conditions of the existing social and economic environment of the project-affected areas in Ethiopia, Sudan and Egypt.
- Section 9 describes the project's principal potential impacts and mitigations during the construction and operational phases.
- Section 10. presents an environmental and social management plan for the project and describes the institutional strengthening which is expected for managing and monitoring the project in the three countries.
- Section 11 presents a consolidated environmental monitoring plan for the project covering three countries.
- Section 12 presents a list of interagency / Public None Governmental Organisations involved in the project area who were consulted during the study.
- Section 13 presents an indicative summary of costs of environmental mitigation and enhancement measures, management and monitoring.
- Section 14 presents conclusions drawn from screening the project in a global and regional context and lists the conclusions reached about further actions required to move the project forward.
- Section 15 presents a list of references and reference materials used in the report.

2 METHODOLOGY

2.1 INTRODUCTION

It was noted in the Strategic Environmental and Social Assessment Report (Phase I, November 2007) and mentioned by SW at the review meeting on Phase I at Bahr Dar (December 2007) that the Phase II ESIA study and report of the interconnection would be premature. This is because socio-economic conditions (including compensation) may be expected to change before the interconnection is implemented (currently unknown construction date) and the assessment will be out-of-date. Banks are generally insisting that ESIA reports should not be more than 18 months out-of-date before implementation. Thus, it may be expected that ENTRO and national environmental agencies may need to update this ESIA study at a later date.

The future ESIA study will then be supported by detailed resettlement planning (house by house), detailed soil sampling, detailed tower locations, detailed compensation estimates, and the current uncertainties about numerous social conditions and institutional arrangements between the situation now, in 2008, and the proposed 2013 to 2015 construction date will be reduced as more detailed survey information on the route will be available.

Nevertheless, this ESIA follows the Terms of Reference provided in Annex 1 of the Initial Environmental Impact Assessment (IEA) of Mandaya Hydropower Project (ENTRO November 2007), provides an assessment of environmental and socio-economic conditions along the interconnection routes, and provides cost estimates of mitigation measures, which will provide a valuable overall assessment and be capable of revision and up-dating in future.

2.2 APPROACH AND METHODOLOGY ADOPTED FOR THE STUDY

The approach and methodology for this ESIA follows the established pattern for power line projects, as follows:

- Review of Documents. An extensive review of relevant documents has been undertaken, including environmental protection regulations and guidelines, policy papers, census reports, Abbay Master Plan reports and maps, Woody Biomass study reports and maps, Cooperative Regional Assessment (CRA) watershed management reports and many other technical publications. Documents and information were collected from ENTRO, federal and regional offices and elsewhere.

- Collection and review of maps and images. The scale of topographical mapping prepared by the Ethiopian Mapping Authority is at 1:50,000 and available for the whole of the ROW in Ethiopia, while Google earth images were used for ROW study and determination of the proposed route in Egypt and Sudan. Photographs from the consultant's aerial survey in October 2006 over some of the ROW and satellite images obtained via the Internet have been consulted. For the purpose of assessing land use, vegetation cover, infrastructure and other socio-economic activities in identified areas that would be inundated or otherwise directly impacted, use has been made of the extensive Abbay Master Plan study reports and maps, and those of regional sector offices.

- Field survey and public participation. The consulting team conducted its first on-site investigations in July 2008 and followed up with more surveys between August and September 2008. Visits were made to Sudan in October Fieldwork included, terrestrial habitat survey, focal group discussions with local communities and discussions and collection of data from relevant regional government and sector offices and in woredas in Ethiopia, States in Sudan and Governorates in Egypt. Focus group discussions were held with local people and organizations, including farmers, elders, public service workers, teachers, health care workers and other relevant stakeholders. Discussions with representatives of regional administration offices focused on demographic data, land management and agricultural activities, local compensation guidelines, and infrastructure.

- Reporting. Collation of all the information gathered and assessment of environmental and social impacts in a final report

2.3 WORK PROGRAMME FOR ESIA

The program for the environmental and social impact assessment has been closely linked to the program of technical studies. A key starting point for the planning of the ESIA was the endorsement of the recommendation for the configuration of the project with transmission interconnectors from Mandaya site in Ethiopia comprising a 500 kV HVAC link to Sudan and HVDC interconnector to Egypt. This was outlined in the inception report (ENTRO, April 2008). The work Program for the ESIA comprised appointment of sub consultants, input to the route selection, fieldwork and final reporting. These program steps are outlined below.

Appointment of Local Sub-consultants

The general scope of work for the various local sub-consultants was identified and finalized following the confirmation of the selected option. Arrangements with the sub-consultants in each country were finalized through various discussions. The scope of work for the sub-Consultants is shown in Appendix B.

Route selection

The proposed routes were initially examined using available mapping (1:50,000 and 1:10,000 scale in Ethiopia), satellite images and Google earth images of other parts of the routes for which detailed mapping was not available. The preliminary route selection selected using the above techniques and coordinates were given to the local consultants for field verification to come up with the preferred or proposed route.

Areas along the transmission routes with high population density were identified for particular attention in later fieldwork. Other environmental factors which might influence route selection were also be identified such as agricultural (irrigated) areas, and areas prone to flooding, the number of powerline road crossings, proximity of important infrastructure, etc and these were verified on the ground in most cases.

Particular attention has been given to cultural historical sites and property along the line route including ancient temples, burial sites, fortifications etc and where appropriate the line route has been adjusted to avoid such features.

Fieldwork

The fieldwork activities were coordinated with the work of the technical teams undertaking line route and soil surveys.

Fieldwork included observations relating to the ecological setting of the various sections of the transmission line routes together with identification and consultation with local communities along the route who would be affected by the construction and operation of the line.

Where the line routing in the northern part of Sudan and Southern Egypt traverses unpopulated desert terrain with minimal vegetation, cover the assessment has been carried out primarily using remote sensing techniques. However the desert terrain sections where archaeological and historical heritage is of significance, specific archaeological surveys were undertaken.

Social assessment fieldwork has been concentrated in areas with greater population. Local consultants in each country with the assistance of Scott Wilson conducted surveys and stakeholder consultations and produced reports (for SW) on their sections of the interconnection.

Reporting

As per the TOR, the work and reporting paid attention to the policy, legal and administrative framework, including description of national utility compensation policy and grievance procedures. The existing physical, biological and socio-economic environment along/adjacent to proposed Rights of Way (ROW) have been described with particular attention being given to project impacts on:

- land requirements in ROW,
- land acquisition,
- relocation of people,
- reduction of visual impact,
- corona effects,
- electrical and magnetic field effects,
- ecology.

The Social Impact Assessment covers:

- Population size, age, gender, literacy, health (including HIV/AIDS/malaria), education, fertility and mortality rates

- Characteristics of poor people and vulnerable groups, employability, economic activities, access to education and health facilities and to productive factors and assets disaggregated by gender.
- Types of development programs and projects targeting women
- Societal framework, including local and administrative structures and government's priority in terms of development in project areas; implementation of donor-funded projects cutting across sectors in the project area.
- Assessment of positive and negative impacts and recommendation of mitigation measures, including institutional strengthening.
- Cost estimates of enhancement and mitigation measures, including compensation and institutional strengthening, management and monitoring.

3 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

This chapter presents relevant environmental policies, legislative and administrative frameworks at regional, national and international level, for Ethiopia, Sudan and Egypt. Focus has been given to regional level organisations that are responsible for preparation of environmental policy, technical guidelines, review and close follow-up of implementation of environmental safeguard measures.

It also includes an overview of relevant International Legislation, with summaries of the African Development Bank's environmental policy and the World Bank's safeguard policies that will or may be triggered by the project.

3.1 ETHIOPIA

3.1.1 THE CONSTITUTION

The Constitution of the Federal Democratic Republic of Ethiopia, which entered into force on August 21st 1995, forms the fundamental basis for enactment of specific legislative instruments governing environmental matters at the national level. Articles 43, 44 and 92 of the Constitution specifically deal with the right to development, environmental rights and environmental objectives respectively. Thus:

In a section that deals with the right to development:

- Article 43 (1) gives broad right to the peoples of Ethiopia to improved living standards and to sustainable development.
- Article 43 (2) acknowledges the rights of the people to be consulted with respect to policies and projects affecting their community.
- Article 43 (3) requires all international agreements and relations by the State to protect and ensure Ethiopia's right to sustainable development.

In a section that deals with environmental rights Article 44 guarantees the right to a clean and healthy environment.

In a section that deals with environmental objectives, Article 92 sets out the Federal policy principles and significant environmental objectives. More specifically Article 92:

- Affirms the commitment of the Government to endeavour to ensure that all Ethiopians live in a clean and healthy environment.
- Warns that the design and implementation of development programs and projects should not to damage or destroy the environment.
- Guarantees the right of people to full consultation and their expression of views in the planning and implementation of environmental policies on projects that affect them directly. Imposes the duty on Government and citizens to protect the environment.

3.1.1.1 Land ownership and holding right

Article 40 (3) vests the right to ownership of rural and urban land, as well as of all natural resources, in the government and in the peoples of Ethiopia. It recognizes land as a common property of the Nations, Nationalities of and peoples of Ethiopia and prohibits sale or any other exchange of land.

Article 40 (4) guarantees the right of farmers to obtain land without payment and protection against eviction from their possession.

Article 40 (5) guarantees the right of pastoralists to free land for grazing and cultivation as well as the right not to be displaced from their own lands.

In recognition of the value of human input on land Article 40 (7) states that “Every Ethiopian shall have the full right to the immovable property he builds and to the permanent improvements he brings about on the land by his labour or capital. This right shall include the right to alienate, to bequeath, and where the right to use expires to remove his property, transfer his title, or claim compensation for it.”

In recognition of the right to acquire property for the purpose of overriding national interest Article 40 (7) empowers the Government to expropriate private property for public purposes subject to payment in advance of compensation commensurate to the value of the property.”

In a section that deals with economic, social and cultural rights Article 41 (9) sets out the State responsibilities to protect and preserve historical and cultural legacies.

3.1.2 ENVIRONMENTAL POLICY

The Environmental Policy of the Federal Democratic Republic of Ethiopia was approved by the Council of Ministers in April 1997. Its overall policy goal may be summarised in terms of the improvement and enhancement of the health and quality of life of all Ethiopians, and the promotion of sustainable social and economic development through the adoption of sound environmental management principles. The policy is integrated with the overall long-term strategy of the country - agricultural led industrialization and other key national policies. It sets out its specific objectives and key guiding principles, contains sectoral and cross-sectoral policies and provisions necessary for the appropriate implementation of the Policy itself.

With respect to environmental impact assessment (EIA) the Policy sets out specific policies, key elements of which may be summarized hereunder:

The need to address social, socio-economic, political and cultural impacts, in addition to physical and biological impacts, and to integrate public consultation within the EIA procedures.

Incorporation of impact containment measures into the design process of public and private sector development projects and inclusion into EIA of mitigation measures and accident contingency plans.

Development of detailed technical sectoral guidelines for EIA and environmental auditing.

Establishment of an interlinked legal and institutional framework for the EIA process to ensure that development projects are subjected to environmental impact assessment, audit and approval in a coordinated manner.

Development of EIA and environmental auditing capacity within the Environmental Protection Authority, sectoral ministries and agencies as well as regions.

The Policy has been developed as a national instrument enhancing the objectives of the Constitution and setting out clear-cut directions with respect to environmental concerns particularly in terms of regulatory measures adopted as well as in the process of design, implementation and operation of development projects. Its recognition of the significance of addressing cross-sectoral environmental issues in the context of a national approach to environmental assessment and management integrates the efforts of a wide range of institutions across the country. It provides a sound and rational basis for addressing the country's environmental problems in a coordinated manner.

3.1.3 SECTORAL POLICIES

As measures to effectively deal with environmental problems several sectoral policies have been issued. These include:

- National Population Policy issued in April 1993.
- National Policy on Women issued in March 1993.
- National Agricultural Resource Policy and Strategy issued in 1993.
- Energy Policy issued in 1994.
- Water Resource Management Policy in 1999.
- Policy on Biodiversity Conservation and Research issued in April 1998.
- Rural Development Policy and Strategy issued in 2002.
- Sustainable Development and Poverty Reduction program issued in 2002.

The broad guiding principles under the Federal Constitution and the more instructive directions set out under the Environmental Policy of Ethiopia have been further expanded and refined by three environmental framework legislations designed to enable implementation of the Federal policies on environment. These legislations are instrumental to translating the broad objectives of the policies into practice, as they provide for specific rules of substance and procedures having the force of law across the country. The legislations are described in Section 2.2.

3.1.4 NATIONAL AND REGIONAL CONSERVATION STRATEGIES

Ethiopia has formulated a National Conservation Strategy, which takes a holistic view of the natural, cultural and human resources and seeks to integrate into a coherent framework, plans, policies and investment related to environmental sustainability. Within this framework, region-specific conservation strategies have been formulated and these have been taken into consideration for this ESIA where these are available. For example, the Amhara Region has in place its own Regional Conservation Strategy (Amhara National Regional State, 1999) but Benishangul Gumuz has not yet produced a strategy for its region.

3.1.5 LEGISLATION ON EXPROPRIATION OF LAND AND COMPENSATION

The Federal Legislation on Expropriation of Land for Public Purposes & Compensation (Proclamation No. 455/2005) in effect repealed the outdated provisions of the Ethiopian Civil Code of 1960 regulating land acquisition and compensation for the purpose of public projects. This new legislation established detail procedures setting the time limits within which land could be acquired after a request is received from a proponent, principles for assessment of compensation for properties on the land as well as for displacement compensation. It also empowered the Woreda administration to establish valuation committees to value private properties. In the case of public-owned infrastructures to be removed from the right-of-way the owners of the structures would assess the value of the properties to be removed. Additionally the legislation provided for appeals on valuation decisions but such action would not delay transfer of possession of land to the proponent or contractor appointed by the proponent.

The Proclamation has removed the barriers for planned land acquisition, substantially raised the amount of compensation payable to expropriated owners of properties and displaced people. In addition to financial compensation in an amount sufficient to reinstate the displaced people to the economic position prior to displacement, the relevant Regional administration is required to give replacement land to any person who has lost land in favour of a public project. An assessment of compensation does not include the value of the land itself since land is a public property not subject to sale in Ethiopia.

The responsibility of a proponent of a proposed project under Ethiopian law does not extend beyond the payment of compensation for properties and displacement. In other words the displaced people need to seek resettlement options in the framework of land administration systems of the relevant rural or urban land administration.

3.1.6 LEGISLATION ON PRESERVATION OF CULTURAL HERITAGE

The Research and Conservation of Cultural Heritage Proclamation No. 209/2000 of Ethiopia defines cultural heritage broadly as “anything tangible or intangible which is the product of creativity and labour of man in the pre-history and history times, that describes and witnesses to the evolution of nature and which has a major value in its scientific, historical, cultural, artistic and handcraft content.”

Prior approval of the Authority for Research and Conservation of Cultural Heritage is required to remove from its original site, an immovable cultural heritage (Art. 21/1). Whenever a registered movable cultural heritage is encountered during the execution of the project it is possible to remove such property by notifying the Authority in advance (Art. 21/2).

Any person who destroys or damages cultural heritage intentionally shall be punished with gregarious imprisonment not less than 10 years and not exceeding 20 years (Art. 45/2).

3.1.7 THE NATIONAL PROCLAMATION ON WATER RESOURCE MANAGEMENT

The Water Resources Management and Administration in the country should be based on the Ethiopian Water Resource Management Policy, and the Water Resources Laws of the country as indicated in Proclamation No 197/2000. The Ministry of Water Resources (MoWR) is entrusted with broad powers of “planning, management, utilization administration and protection of water resources”. This includes promoting the implementation of medium and large multipurpose dam projects.

According to the Proc. No.197/2000, the duties of the MoWR's are inventory of water resources, allocation of water resources, establishing standards for design and construction of waterworks (including hydropower dams), issuing guidelines and directives for the prevention of pollution of water resources as well as for water quality and health standards, establishing water users' associations, and settlement of disputes.

3.1.8 ENVIRONMENTAL IMPACT ASSESSMENT PROCLAMATION

This Proclamation (No 299/2002) aims primarily at making environmental impact assessment (EIA) mandatory for categories of projects specified under a directive issued by the Environmental Protection Authority (see 3.3.1) whether such projects belong to public or private bodies. The Authority issued several directives subjecting categories of projects to environmental impact assessment. The Proclamation describes a policy, strategy, program, law or an international agreement as “public instrument” and directs the Authority to issue guidelines distinctively classifying certain categories of public instruments as likely to entail significant environmental impact. The Proclamation requires, among others:

- Specified categories of projects to be subjected to EIA and receive an authorization from the Authority or the relevant regional environmental agency prior to commencing implementation of the project.

- Licensing agencies to ensure that the requisite authorization has been duly received prior to issuing an investment permit, a trade or operating license or a work permit to a business organization.

- The Authority or the relevant Regional environmental agencies may exempt from environmental impact assessment projects with insignificant environmental impact.

- A licensing agency may suspend or cancel a licence that has already been issued where the Authority or the relevant regional environmental agency suspends or cancels environmental authorization.

Procedures that need to be followed in the process of environmental impact assessment are described in the Proclamation. Thus a project initiator (Proponent):

- Must undertake a timely environmental impact assessment, identifying the likely adverse impacts, incorporate the means of their prevention, and submit the environmental impact study report accompanied by the necessary documents to the Authority or the relevant regional environmental agency.

- Must ensure that an environmental impact assessment is conducted and an environmental impact study report prepared by an expert who meets the requirements set forth by the directive issued by the Authority.
- Must submit an environmental impact study report to the Authority or the relevant Regional environmental agency for review.

The Proclamation directs the Authority and the relevant Regional environmental agency how to deal with an environmental impact study report they receive. Thus, after evaluating the report by taking into account any public comment and expert opinion the Authority or the relevant Regional environmental agency must do one of the following:

- Approve the project without condition and issue authorization if it is satisfied that the project may not cause negative impact.
- Approve the project and issue authorization with condition that must be met in order to reduce adverse impacts to insignificant impacts, or
- Refuse implementation of the project if the negative impact cannot be satisfactorily avoided.

In the event of a project having likely trans-national impact within Ethiopia the regional environmental agency would not assess an environmental impact study itself, but refer the report to the National Authority. The Proclamation has no provision regulating environmental impact assessment of projects crossing the borders of Ethiopia.

3.1.9 ENVIRONMENTAL POLLUTION CONTROL PROCLAMATION

The Proclamation on Environmental Pollution Control No 300/2002 primarily aims to ensure the right of citizens to a healthy environment and to impose obligations to protect the environment of the country. In this connection the Proclamation provides a basis from which the relevant environmental standards applicable to Ethiopia can be developed and sanctions violation of these standards as criminally punishable offences.

In order to ensure implementation of environmental standards and related requirements, inspectors of the Authority or of the relevant Regional environmental agency are empowered by the Proclamation to enter, without prior notice or court order, any land or premises at any time, which seems to them appropriate. Such a wide discretionary power of inspectors explains the serious concern and commitment of Ethiopia to the protection of the environment from pollution.

3.1.10 INSTITUTIONAL ARRANGEMENT FOR ENVIRONMENTAL PROTECTION

Of paramount significance in terms of institutional framework for environmental protection is the Environmental Protection Organs Establishment Proclamation No. 295/2002, which entered into force on October 31st 2002. This Proclamation establishes the institutional arms (such as the Environmental Protection authority, see Section 2.3.1) of the Federal Government to ensure the realisation of the objectives of the Constitution and of the Environmental Policy of Ethiopia with respect to environmentally sustainable management of economic and social development of the country, both at Federal and Regional level.

The Proclamation directs every relevant sectoral agency of the Federal Government to set up an environment unit as part of its organizational structure and also for each Regional State to establish a Regional autonomous environmental agency. Apart from assigning specifically defined responsibilities to the Environmental Protection Authority the Proclamation links the efforts of Regional states with that of the Authority by instructing the Regional states to prepare and submit reports on the respective state of the environment and sustainable development and submit them to the Authority.

The significance attached to the Authority is reflected in its composition which is made up of a Council comprising members drawn from the Prime Ministry, Federal Government, Regional States, Ethiopian Chamber of Commerce, Confederation of Trade Unions and local NGOs involved in environmental protection and the Director General of the Authority. The Council is entrusted with the responsibilities of reviewing environmental policies, strategies, laws, providing advice on the implementation of environmental policies, and evaluating the guidelines and environmental standards prepared by the Authority. This guarantees that the Council has approved all guidelines and environmental standards issued by the Authority.

3.1.11 INTERNATIONAL AGREEMENTS

Ethiopia has ratified the following international conventions and protocols pertaining to the environment and which are of relevance to the Project:

United Nations Framework Convention on Climate Change, 1992.

Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal adopted on 22 March 1989.

Bamako Convention on the Ban of the Import Into Africa and the Control of Trans-boundary Movement and Management of Hazardous Wastes within Africa, adopted 30 January 1991.

Convention on Biological Diversity, 5 June 1992.

United Nations Convention to Combat Desertification (UNCCD), adopted 1997.

Convention on the Protection of World Cultural and Natural Heritage ratified 1997.

Convention on the Means of Prohibiting and Preventing the Elicit, Import, Export and Transfer of Ownership of Cultural property, ratified 2003.

3.1.12 INSTITUTIONAL ARRANGEMENT AND RELEVANT GUIDELINES

The institutions responsible to ensure implementation of environmental public instruments at Federal and Regional levels are key role players whilst sectoral institutions engaged in development activities reinforce the efforts of the key institutions as partners to the key institution. The key institutions devote their time fully to environmental matters, as they were established for that purpose while sectoral institutions were established for other purposes with limited environmental responsibilities. The latter enhance the objectives of environmental institutions by complying with the environmental objectives of the country in the course of preparing and implementing their own projects.

3.1.12.1 Ethiopian Environmental Protection Authority

The key institution at Federal level is the Ethiopian Environmental Protection Authority (EPA), which was established on October 31 2002 by Proclamation No. 295/2002. It is the Federal institutional arm entrusted with the widest responsibilities on environmental protection. The Authority reports directly to the Prime Minister and is responsible for:

- Preparation of environmental policies and laws and to ensure that these are implemented.
- Preparation of directives and implementation of systems necessary for the evaluation of the impact of projects on the environment.
- Preparation of environmental protection standards and implementation of directives concerning soil, water and air.
- Preparation of recommendations regarding measures needed to protect the environment.
- Enhancement of environmental awareness programs.
- The conduct of studies on desertification and the coordination of efforts to combat it.
- Implementation of international treaties concerning the environment to which Ethiopia is a signatory.
- Provision of advice and technical support to the regions on environmental matters.

The Proclamation gives the EPA a mandate to involve itself with all environmental issues and projects that have a Federal, interregional and international scope. Most of the powers of the EPA relate to coordination and monitoring aspects.

3.1.12.2 Regional Environmental Agencies

Proclamation N° 295/2002 requires each Regional state to establish its own independent environmental agency with the responsibilities to coordinate and follow-up the Regional effort to ensure public participation in the decision making process, to play an active role in coordinating the formulation, implementation, review and revision of Regional conservation strategies as well as to foster environmental monitoring, protection and regulation.

Accordingly BGNRS established Environmental Protection Land Administration and Use Authority in 2004 which is equipped with duties and responsibility towards conservation and protection the environment. Major activities of the authority focused on environmental awareness creation, participating in delineation of area for investment purpose. According to the authority official, the major limitation includes the lack of structural set up at woreda level, lack of qualified professionals, absence of necessary environmental survey and other equipments and low level of awareness to environmental consideration in planning and implementation of development projects in the region. Despite the implementation of various medium and large scale projects in the past few years, the office received EIAs of limited projects only. The authority is working closely with the national EPA especially with respect to capacity building of staffs through the provision of short term training. A new structural set up is under finalization; two major departments are formed Land Use and Administration Department and Environmental Protection Department under which Biodiversity, EIA and Environmental Education teams found. The new structure provides opportunity to assign environmental expert in extensive investment zones.

3.1.12.3 Sectoral Environmental Units

Each Federal and Regional organization of the government that deals with environmental matters is required by Proclamation No. 295/2002 to set up its own unit with the responsibilities to coordinate and follow-up in order to ensure that its activities are in harmony with national efforts to protect the environment. Several institutions at national level have established their in-house environmental unit.

3.1.12.3.1 The EEPCO Environmental Monitoring Unit

As part of the establishment of environmental units within sectoral ministries, an Environmental Monitoring Unit (EMU) was established in the Ethiopian Electric Power Corporation (EEPCO) staffed by an environmentalist, sociologists and a forester.

The EMU is responsible for carrying out Initial Environmental Examinations, coordinates the tender process for environmental consultants on behalf of EEPCO, monitors environmental and socio-economic including resettlement activities in the power sector, undertakes environmental review and represents EEPCO in all the matters that are related to the Environmental study of a project.

3.1.13 ENVIRONMENTAL GUIDELINES

As a step forward in developing the environmental policies and legislations the Environmental Protection Authority issued a procedural guideline which defines specific examinations to which a proposed project needs to be subjected in the process of environmental impact assessment. The procedural guideline currently in effect is one that was issued in November 2003 and sets forth the various stages of evaluation that a project proposal needs to pass through. These stages are pre-screening consultation, screening, scoping, environmental impact study, reviewing and decision-making. Pre-screening consultation is not an actual stage in the EA process but a point where the proponent and the relevant environmental organ establish contact and hold consultation on how best to proceed with the EA. The environmental organ may also conduct environmental audit or surveillance of a project to ensure compliance with the environmental quality criteria or other provisions stated in the environmental impact assessment.

The procedural guideline requires a proponent to submit an initial environmental examination report to enable the relevant environmental agency to decide the application of a further level of assessment depending on the outcome of a screening report. At this level of examination the decision may be either of the following: no EA required, preliminary assessment is applied to or full scale EA applies where the project is found to be one that may have significant impacts.

The Ethiopian Environmental Protection Authority has issued other guidelines for environmental and social impact assessment of projects in different sectors. These include:

- Guidelines for Dams and Reservoirs, 2004.
- Guidelines on Irrigation, 2004.
- Guidelines for Mineral and Petroleum Operation Projects, 2003.
- Guidelines on Road and Railway, 2004.
- Guidelines on Hydropower Production, Transportation and Distribution.
- Guideline on ambient water quality of domestic, agricultural and industrial wastes.

These guidelines provide a comprehensive statement of the type of adverse impact that may occur and set out clearly the aspects, which need to be addressed in an initial environmental examination and in an environmental and social impact assessment. The guidelines are clear and understandable in their application, and more importantly provide a sound basis for examination and assessment of projects in the sectors for which they were designed. The source of references and further reading accompanying each guideline point out the extent of professional research conducted to develop the guidelines and encourages further reading in selected areas covered by the guidelines Project background.

3.2 SUDAN

The Section presents a description of the policy, legal and administrative framework for environmental and social aspects.

3.2.1 INTERIM NATIONAL CONSTITUTION AND COMPREHENSIVE PEACE AGREEMENT

Matters related to Environmental Pollution and Ecology are fully recognized by both the Interim National Constitution (INC) and the Comprehensive Peace Agreement (CPA). The Environmental and social justice stipulations enjoy the protection of these two documents and the section on Environment and Natural Resources includes:

- Guarantees the right of the people to clean and diverse environment, and citizens are imposed to preserve and promote diversity;
- Policies and actions which may adversely affect the existence of animals or vegetation are prohibited; and
- The state is required to promote sustainable utilization of natural resources through legislations.

Moreover, the executive and legislative powers are stipulated for each of the National and State levels. These cover land, natural resources, Climate, national heritage, water management, economic policies and planning, treaties and traditional and customary laws. A separate schedule deals with resolution of disputes. Moreover, the INC allows for new legislation to be in acted, while revision or repeal of some of the existing laws might be considered to conform with the provisions of the constitution.

The INC gives the Federal Government the right to expropriate land for development purposes and to compensate owners. Natural Resource Management Protection of cultural heritage and respect of traditional and customary regulations are considered in a number of articles. Land issues under federal and state powers are specified. These powers relate to urban development, planning, housing, electricity generation, water resources and land tenure.

3.2.2 SUDAN ENVIRONMENTAL PROTECTION ACT, 2001

The Sudan Higher Council of Environment and Natural Resources (HCENR) drafted a new framework law for environment as a step for coordinating all matters concerning this issue. The Sudan Environmental Protection Act (EPA) was enacted in 2001.

3.2.3 OTHER ENVIRONMENT RELATED LAWS

Environmental Protection Act of 2001.

Environment Health Act 1975.

Public Health Act 1975.

Industrial relation Act, 1976.

Electricity Act 2001.

Land Acquisition Ordinance 1930.

Unregistered Land Act 1970.

Wildlife Protection and National Parks Act 1986.

Forestry Act 1989.

Forests and Renewable Natural Resources Act 2002.

3.2.4 LEGISLATIONS ON LAND ACQUISITION AND COMPENSATION

Land settlement and registration ordinance 1925.

Land acquisition Act 1930.

Unregistered land 1970.

Civil transaction Act 1984.

Urban planning and land disposal Act 1994.

Central forest Act 1932.

3.2.5 LEGISLATIONS ON PRESERVATION OF CULTURAL HERITAGE

Antiquities Ordinance of 1905, 1952.

Antiquities Protection Act 1999.

These constitute the principal national legislations dealing with protection and conservation of Sudan's Archaeological Heritage.

3.2.6 INSTITUTIONAL ARRANGEMENTS FOR ENVIRONMENTAL PROTECTION

Higher council for Environment and Natural Resources.

State Council for Environment and Natural Resources.

Wildlife conservation.

Antiquities and Museums National Corporation

National Electricity Corporation.

Civil Societies (Active NGO's).

3.2.7 INTERNATIONAL CONVENTIONS

Conservation of Migratory Species and Wild Animals, 1979.

Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973.

Climate Change convention 1992.

Biodiversity Convention 1992.

The Rio Declaration.

Agenda 21.

Conventions on Wetlands (Ramsar Convention).

Convention to Combat Desertification and Drought.

3.3 EGYPT

This section presents relevant environmental policies, legislative and administrative frameworks at regional, national and international level, for Ethiopia, Sudan and Egypt. Focus has been given to regional level organisations that are responsible for preparation of environmental policy, technical guidelines, review and close follow-up of implementation of environmental safeguard measures.

3.3.1 LAW ON THE ENVIRONMENT

The law on the Environment (No4/1994) and its executive statutes, which came into force in February 1995, provides formal EIA regulations in Egypt. These statutes specify a list of categories of projects to be subject to EIA. This list comprises of the following categories:

- Black (a full EIA required);

- Grey (a “scoped” EIA focusing on specific aspects of the project and environment);
- White (excluded from EIA if they are unlikely to have a significant impact).

The statutes also give provisions for environmental monitoring, licensing of EIA experts, and sectoral environmental guidelines for ten sectors (including electricity and energy) of the economy.

3.3.2 INSTITUTIONS WITH RESPONSIBILITIES FOR WATER QUALITY

The institutions involved with water quality management in Egypt are generally line-management ministries with responsibilities in areas that are related to, but not necessarily coincident with environmental protection. The Ministry of Health and the Ministry of Industry have many other functions, many of which conflict with water quality management. Egypt lacks such a relatively strong central coordinating or managing body, although the Egyptian Environmental Affairs Agency (EEAA) has some of the appropriate rules (coordination, studies and evaluation). The following outlines institutions with major roles in water quality management.

3.3.3 MINISTRY OF WATER RESOURCES AND IRRIGATION (MWRI)

The MWRI is formulating the national water policy to face the problem of water scarcity and water quality deterioration. The overall policy’s objective is to utilize the available conventional and non-conventional water resources to meet the socio-economic and environmental needs of the country. Under law No. 12 of 1984, MWRI retains the overall responsibility for the management of all water resources, including available surface water resources of the Nile system, irrigation water, drainage water and groundwater.

The MWRI is the central institution for water quality management. The main instrument for water quality management is Law 48. The MWRI is responsible to provide suitable water to all users but emphasis is put on irrigation. It has been given authority to issue licenses for domestic and industrial discharges. The responsibility to monitor compliance to these licenses through the analyses of discharges has been delegated to MOHP.

The National Water Research Centre (NWRC) supports the MWRI in its management. Within the NWRC, three institutes are focusing on the Nile, the irrigation and drainage canals and groundwater (NRI, DRI, RIGW). NWRC maintains a national water quality monitoring network and contracts portions of the monitoring activity to these institutes. NWRC also operates a database where all MWRI water quality data is consolidated. NWRC also operates a modern, well equipped water quality laboratory.

3.3.4 EGYPTIAN ENVIRONMENTAL AFFAIRS AGENCY (EEAA)

The central organization for environmental protection is the EEAA. This agency has an advisory task to the Prime Minister and has prepared the National Environmental Action Plan of Egypt 2002/17 (2002). The Minister of State for Environment heads the agency. According to Law 4, it has the enforcing authority with respect to environmental pollution except for fresh water resources. Through Law 48, the MWRI remains the enforcing authority for inland waterways.

Sectoral ministries and the Egyptian Environmental Affairs Agency (EEAA) issue terms of reference for black and grey projects. The EEAA also reviews and evaluates environmental documents and then forwards its recommendation to the competent administrative authority.

The EEAA is establishing an Egyptian environmental information system (EEIS) to give shape to its role as coordinator of environmental monitoring. Moreover, staff is being prepared to enforce environmental impact assessment (EIA). Major industries have been visited in view of their non-compliance with respect to wastewater treatment. Compliance Action Plans (CAP's) are being agreed upon to obtain a grace period for compliance. Additionally EEAA is monitoring waste from Nile ships and is responsible for coastal water monitoring. In cooperation with the MWRI, an action plan was implemented to reduce industrial pollution of the Nile.

3.3.5 MINISTRY OF HEALTH AND POPULATION (MOHP)

The MOHP is the main organization charged with safeguarding drinking water quality and is responsible for public health in general. Within the framework of Law 48/1982, this Ministry is involved in standard setting and compliance monitoring of wastewater discharges. The Environmental Health Department (EHD) is responsible for monitoring with respect to potable water resources (Nile River and canals). The MOHP samples and analyses all intakes and treated outflows of drinking water treatment plants. Also water from drinking water production wells is monitored. In case of non-compliance of drinking water quality, especially with respect to bacterial contamination, MOHP takes action.

Within the framework of Law 48 MOHP samples and analyses drain waters to be mixed with irrigation waters, industrial and domestic wastewater treatment plant effluents and wastes discharged from river vessels. In case of non-compliance of discharges, the MWRI generally takes action upon notification from the MOHP.

3.3.6 MINISTRY OF HOUSING, UTILITIES AND NEW COMMUNITIES (MHUNC)

Within the Ministry of Housing, Utilities and New Communities, the National Organization for Potable Water and Sanitary Drainage (NOPWASD) has the responsibility for planning, design and construction of municipal drinking water purification plants, distribution systems, sewage collection systems, and municipal wastewater treatment plants. Once the facilities have been installed, NOPWASD organizes training and then transfers the responsibilities for operation and maintenance to the regional or local authorities.

3.3.7 MINISTRY OF AGRICULTURE AND LAND RECLAMATION (MALR)

MALR develops policies related to cropping patterns and farm production. Moreover they are in charge of water distribution at field level and reclamation of new agricultural land. With respect to water quality management issues, their policies on the use and subsidy reduction of fertilizers and pesticides are important. In addition, MALR is responsible for fisheries and fish farms (aquaculture).

The Soil, Water and Environment Research Institute is part of the MALR and is responsible for research on many subjects such as water and soil quality studies on pollution, bioconversion of agricultural wastes, reuse of sewage wastewater for irrigation, saline and saline-alkaline soils, fertilizer and pesticide use and effects.

3.3.8 EGYPTIAN ELECTRICITY HOLDING COMPANY (EEHC)

The Egyptian Electricity Holding Company (EEHC), previously known as the Egyptian Electricit0079 Authority before it was transformed into a joint stock holding company in 2000, forms part of the Egyptian Ministry of Electricity and Energy and is responsible for controlling the generation and transmission of electrical power for the entire country of Egypt.

3.3.9 EGYPT'S AGRICULTURAL POLICY UP TO 2017

A Land Master Plan of Egypt was prepared in 1986. It concluded that the construction of AHD not only made the intensification of agriculture feasible in the old lands but also extended it to new “reclaimed” areas. Some 650 000 fedddans out of 805 000 feddans of land reclaimed during 1960-70 was made possible due to the increased supply of water from AHD. The total land that could be reclaimed is subject to water availability. The arable area per person declined by 75% from 0.51 feddan/person to 0.13 feddan/person during 1887-1990 (Abu Zeid and Rady 1991).

The strategy for agricultural development up to 2017 has a number of aims.

To increase the annual rate growth in the agricultural production from 3.4% to 3.8% during the remaining period of the Fourth 5-Year Plan, and to 4.1% annually up to 2017. This goal is attainable only through vertical and horizontal expansion of plant and animal production, which will have a positive bearing on job creation, income to producers and the overall standard of living of the rural population.

To reclaim no less than 150,000 feddans annually, within the Master Plan of Egypt's Land and water resources which assesses the reclaimable and cultivable lands in the Delta, Southern Valley, East Owaynat, the area of and round Lake Nasser and East and West of Suez Canal by the year 2017 at about 3.4 million feddans. The inhabited area would reach 25% of the total area of Egypt.

To increase the agricultural production horizontally and vertically through the efficient allocation and use of soil and water resources. Maintenance and development of the natural resource base is an integral part of Egypt's sustainable agricultural development program.

To form a national strategic stock of the basis food commodities by focusing on the efficient use of the available resources and redirecting investments to such areas that help fulfil the increasing food needs of the population. This shall be accompanied with rationalization of food consumption levels, reduction of post-harvest losses.

3.3.10 WATER POLICY

The Ministry of Water Resources and Irrigation (MWRI) has prepared a National Water Policy till the year 2017 including three main themes:

- Optimal use of available water resources;

- Development of water resources; and
- Protection of water quality and pollution abatement.

At present, Egypt is addressing the issue of limited water quantity by managing the demand side. MWRI formulated a water master plan in 1981. This plan is currently updated. The process of updating the water master plan aims to allocate available water resources according to various needs and demands that are feasible from the economic perspective. It also aims to gain social acceptance and political support. The Water Master Plan is updated through the National Water Resources Plan (NWRP) project.

The NWRP has been operated since 1998 and jointly funded between MWRI and the Netherlands Government. This project is directed towards developing a National Water Resources Plan that describes how Egypt will safeguard its water resources both quantity and quality and how it will optimize the use these resources in response to the socio-economic and environmental conditions.

According to Article (19) of Law No. 4 of Egypt in 1994 regarding environmental protection and Article (10) of the executive regulations by the competent administrative authority or the authorization of Almatha environmental impact assessment of the business required licensing in accordance with the components and designs and specifications issued by foundations and EEAA with the competent administrative authority. Due to the passage of the electrical link inside the Egyptian border from Wadi Halfa to the Naga Hammadi longitudinal distance of about 600 km 2, breaking the three provinces are the province and city of Luxor, Aswan and Qena in the western desert region, since it shows that these lines impact on the environment and also by the line Residents next to these lines was a study of environmental monitoring by the Line as well as social and economic situation of the resident population of these areas.

Table 1 : Major Environmental Laws of Egypt

Law no.	Issued on	Subject:
4	1994	Protection of the environment
48	1982	For the protection of the River Nile and water ways
53	1966	Agriculture
79	1961	Naval disaster and naval ship wreckages
102	1983	Nature protectorates
117	1983	Ensure adequate protection of the relics
10	1990	Assigned the Egyptian General Authority for the area to work with him to deal with other ministries needs local governorate to coordinate action to expropriation and re-placement.

3.4 INTERNATIONAL LEGISLATION

This section includes an overview of relevant International Legislation, with summaries of the African Development Bank's environmental policy and the World Bank's safeguard policies that will or may be triggered by the project.

3.4.1 AFRICAN DEVELOPMENT BANK'S ENVIRONMENTAL POLICY

The African Development Bank's (AfDB) environmental policy was approved in 1990 and its environmental assessment guideline followed in 1992. The Bank has continually updated its environmental policy and its social and environmental study guidelines. AfDB's updated policy on environment was issued 2004, incorporating and redefining environmentally sustainable development. The Bank's development plan seeks to ensure that environmental management tools like strategic impact assessment and project level environmental and social assessment will be used systematically to monitor environmental performance and encourage community involvement. With regard to sustainable energy development, the Bank has identified the need to refocus its instruments and policy to deliver sustainable, reliable and environmentally friendly energy resource development. The proposed project under study is in line with the Bank's policy in relation to sustainable and environmentally friendly energy resource development.

In line with the updated policy, two relevant guidelines, namely the Strategic Impact Assessment Guideline and the Integrated Environmental and Social Assessment Guideline that were produced in 2004, were used for guiding the present pre-feasibility study and preparation of TOR for a future feasibility study. Based on the nature, scale and identified impacts the project can be categorized as Category 1. According to the AfDB, Category 1 projects that proceed to full feasibility study and implementation require a full Environmental and Social Impact Assessment (ESIA), including the preparation of an Environmental and Social Management Plan (ESMP). The ESIA examines the project's potential beneficial and adverse impacts in detail and recommends any measures needed to prevent, minimise, mitigate or compensate for adverse impacts and to enhance environmental and social project benefits. The Bank provides special attention to public participation in the environmental study process through conducting meaningful consultations with relevant stakeholders, including potential beneficiaries, affected groups, Civil Society Organisations (CSOs) and local authorities, about the project's environmental and social aspects and take their views into account.

3.4.2 WORLD BANK'S SAFEGUARD POLICIES

The World Bank has developed a series of safeguard policies to help promote socially and environmentally sustainable approaches to development as well as to ensure that Bank operations do not harm people and the environment. These safeguard policies include the Bank's policy on Environmental Assessment (EA) and those policies that fall within the scope of EA. These have been considered in relation to the project and their applicability is summarised as follows:

- Safeguard policies on Environmental Assessment, International Waterways, Involuntary Resettlement, Natural Habitats, Physical Cultural Resources and Forestry apply to the project.

- Safeguard policies on Indigenous Peoples, Pest Management and Disputed Areas may be applicable to the project.

For future funding purposes, it is intended that this report should reflect the current policies, requirements and guidelines of the World Bank (the safeguard policies are outlined below). By examining these in relation to the project in this environmental assessment report, it is also intended to build up confidence and trust in all stakeholders that these important issues will be addressed in detail in future phases of study.

3.4.3 ENVIRONMENTAL ASSESSMENT (OP 4.01)

Environmental Assessment is one of the environmental, social, and legal safeguard policies of the World Bank. Environmental Assessment is used in the World Bank to identify, avoid, and mitigate the potential negative environmental impacts associated with Bank lending operations. This policy is considered to be the umbrella policy for the Bank's environmental 'safeguard policies'.

The Operational Policy (OP) and Bank Procedure (BP) 4.01 on Environmental Assessment (EA) published in January 1999, applies to the project. The project is determined as Category ‘A’, requiring a full EIA.

Annexes of the OP define the required structure of the EIA report and the structure of the Environmental Management Plan (EMP) with which the future EIA report must comply.

OP 4.01 states that for Category ‘A’ projects that are highly risky or contentious or that involve serious and multidimensional environmental concerns, the developer should normally engage an advisory panel of independent, internationally recognized environmental specialists to advise on all aspects of the project relevant to the EA.

In relation to public consultation, OP 4.01 requires a two-stage process:

- Shortly after environmental screening and before the terms of reference for the full EIA are finalised, and

- Once a draft EIA report is prepared.

In addition, the borrower is required to consult with stakeholder groups throughout project implementation as necessary to address EIA-related issues that affect them.

3.4.4 INVOLUNTARY RESETTLEMENT (OP 4.12)

This policy applies to the project because involuntary resettlement will be required.

Any requirement for involuntary resettlement is considered to be one of the most important environmental impacts of a proposed project, and Bank guidance on resettlement and compensation is now very comprehensive and specific, particularly in relation to the identification, participation and support of project-affected persons (PAPs). The policy objectives stated in OP 4.12 are as follows:

- Involuntary resettlement should be avoided where feasible, or minimized, exploring all viable alternative project designs;

- Where it is not feasible to avoid resettlement, resettlement activities should be conceived and executed as sustainable development programs, providing sufficient investment resources to enable the persons displaced by the project to share in project benefits. Displaced persons should be meaningfully consulted and should have opportunities to participate in planning and implementing resettlement programs;

- Displaced persons should be assisted in their efforts to improve their livelihoods and standards of living or at least to restore them, in real terms, to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.

The "Involuntary Resettlement Sourcebook: Planning and Implementation in Development Projects", comprising some 468 pages published in 2004, is the authoritative document which clarifies many policy and technical issues that confront resettlement policymakers and practitioners. It provides guidance on resettlement design, implementation, and monitoring, recognizing that construction of road and dam infrastructure (considered a pre-requisite for sustained socioeconomic growth in ENTRO's power trade projects) requires acquisition of land and, therefore, physical relocation and economic displacement of people.

3.4.5 NATURAL HABITAT (OP 4.04)

This policy may be triggered by the project. It states that wherever feasible, Bank-financed projects are sited on lands already converted (excluding any lands that in the Bank's opinion were converted in anticipation of the project). The Bank does not support projects involving the significant conversion of natural habitats unless there are no feasible alternatives for the project and its siting, and comprehensive analysis demonstrates that overall benefits from the project substantially outweigh the environmental costs. If the environmental assessment indicates that a project would significantly convert or degrade natural habitats, the project should include mitigation measures acceptable to the Bank. Such mitigation measures include, as appropriate, minimizing habitat loss (e.g., strategic habitat retention and post-development restoration) and establishing and maintaining an ecologically similar protected area. The Bank accepts other forms of mitigation measures only when they are technically justified.

The Bank encourages borrowers to incorporate into their development and environmental strategies, analyses of any major natural habitat issues, including the identification of important natural habitat sites, the ecological functions they perform, the degree of threat to the sites, priorities for conservation, and associated recurrent-funding.

The Bank defines critical habitats as existing protected areas and areas officially proposed by governments as protected areas (e.g., reserves that meet the criteria of IUCN classifications), areas initially recognized as protected by traditional local communities (e.g., sacred groves), and sites that maintain conditions vital for the viability of these protected areas (as determined by the environmental assessment process);or sites identified on supplementary lists prepared by the Bank or other authoritative sources. Such sites may include areas recognized by traditional local communities (e.g. sacred groves); areas with known high suitability for biodiversity conservation; and sites that are critical for rare, vulnerable, migratory, or endangered species. Listings are based on systematic evaluations of such factors as species richness; the degree of endemism, rarity, and vulnerability of component species; representativeness; and integrity of ecosystem processes.

If an EIA indicates that a project would significantly convert or degrade natural habitats, the project must include mitigation measures acceptable to the Bank. Such mitigation measures may include, as appropriate, minimizing habitat loss (e.g., strategic habitat retention and post-development restoration) and the establishment and maintenance of an ecologically similar protected area. The Bank accepts other forms of mitigation measures only when they are technically justified.

The Bank takes into account the borrower's ability to implement the appropriate conservation and mitigation measures. If there are potential institutional capacity problems, the project must include components that develop the capacity of national and local institutions for effective environmental planning and management.

3.4.6 PHYSICAL CULTURAL RESOURCES (OP/BP 4.11)

This policy may be triggered by the project. Cultural resources are important as sources of valuable historical and scientific information, as assets for economic and social development, and as integral parts of a people's cultural identity and practices. The loss of such resources is irreversible, but fortunately, it is often avoidable. The objective of OP/BP 4.11 on Physical Cultural Resources is to avoid, or mitigate, adverse impacts on cultural resources from development projects that the World Bank finances.

The United Nations term "cultural property" includes sites having archaeological (prehistoric), palaeological, historical, religious, and unique natural values. Cultural property, therefore, encompasses both remains left by previous human inhabitants (including middens, shrines, and battlegrounds), and unique natural environmental features such as canyons and waterfalls. The World Bank requires that, before proceeding with a project that may risk damaging cultural property (e.g., any project that includes large scale excavations, movement of earth, superficial environmental changes or demolition), the cultural property aspects of the project site must be determined. If there is any question of cultural property in the area, a reconnaissance survey should be undertaken in the field by specialists.

3.4.7 FORESTS (OP 4.36)

This policy may be triggered by the project. Whilst this policy is principally related to World Bank activities in the forestry sector, it includes policies on the conservation of forest biodiversity, the sustainable management of forest areas, and the participation of local people particularly in the management of the surrounding forests. The policy emphasizes that the management, conservation, and sustainable development of forest ecosystems and their associated resources are essential for lasting poverty reduction and sustainable development.

The policy states that:

- The Bank does not finance projects that, in its opinion, would involve significant conversion or degradation of critical forest areas or related critical natural habitats;

- If a project involves the significant conversion or degradation of natural forests or related natural habitats that the Bank determines are not critical, and the Bank determines that there are no feasible alternatives to the project and its siting, and comprehensive analysis demonstrates that the overall benefits from the project substantially outweigh the environmental costs, the Bank may finance the project provided that it incorporates appropriate mitigation measures.

This policy overlaps with that on Natural Habitat (OP 4.04) to a great extent. In the projects case, if woodland issues are not considered covered by Natural Habitat (OP 4.04), it would cover roads, and transmission lines through woodlands.

3.4.8 INDIGENOUS PEOPLES (OP 4.20)

This Operational Policy provides policy guidance to ensure that indigenous people benefit from development projects, and to avoid or mitigate potentially adverse effects on indigenous people caused by Bank-assisted activities. Special action is required where Bank investments affect indigenous peoples, tribes, ethnic minorities, or other groups whose social and economic status restricts their capacity to assert their interests and rights in land and other productive resources. The Bank defines "indigenous peoples," "indigenous ethnic minorities," "tribal groups," and "scheduled tribes" as social groups with a social and cultural identity distinct from the dominant society that makes them vulnerable to being disadvantaged in the development process.

3.4.9 PEST MANAGEMENT (OP 4.09)

Rural development and health sector projects have to avoid using harmful pesticides. A preferred solution is to use Integrated Pest Management techniques and encourage their use in the whole of the sectors concerned.

If pesticides are considered necessary at full EIA stage, either for crop protection at resettlement sites or in the fight against water-related vector-borne diseases, a Bank-funded project should include a Pest Management Plan (PMP), prepared by the borrower, either as a stand-alone document or as part of the Environmental Assessment. Currently, this policy is not expected to be triggered by the project.

3.4.10 PROJECTS IN DISPUTED AREAS (OP 7.60)

The project area is not in a disputed area and the Bank's policy on disputed areas will not be triggered by the project.

3.4.11 INTERNATIONAL CONVENTIONS

Relevant international conventions are summarised table below.

Table 2 : Relevant International Conventions

Name of Convention/Agreement	Date of Ratification
Convention concerning the protection of the world cultural and natural heritage	07/02/1974
Convention concerning prevention and control of occupational hazards caused by carcinogenic substances and agents	25/03/1982
Convention concerning the protection of workers against occupational hazards in the working environment due to air pollution, noise and vibration	04/05/1988
Vienna convention for the protection of the ozone layer	09/05/1988
Montreal Protocol on substances that deplete the ozone layer	02/08/1988
Convention on wetlands of international importance especially as water fowl habitat (RAMSAR)	09/09/1988
(London) Amendment to the Montreal protocol on substances that deplete the ozone layer	13/01/1993
Convention on biological diversity	02/06/1994
(Copenhagen) Amendment to the Montreal protocol on substances that deplete the ozone layer	28/06/1994
United Nations framework convention on climate change	05/12/1994
United Nations convention to combat desertification in those countries experiencing serious drought and / or desertification. Particularly in Africa	07/07/1995
Kyoto Protocol	1997

4 PROJECT DESCRIPTION

This section has been prepared with reference to the Eastern Nile Power Trade Program Study, Phase II: Regional Power Interconnection Feasibility Study – Inception Report, EDF et al, April 2008. The different Feasibility study modules have also provided useful input into this section. The key feasibility study modules that have been used to describe this project are: M4 – Main project equipment; M3 – Operation and Maintenance specifications and M6 – Phasing and arrangement of the project implementation (EDF et al., November 2008). The description provided in this section provides the technical conclusions provided at the time of compilation, changes may be expected as more analysis is provided to the project feasibility study.

4.1 BACKGROUND

The Eastern Nile Subsidiary Action Program (ENSAP) is an investment program by the Governments of Egypt, Ethiopia and the Sudan under the umbrella of the Nile Basin Initiative (NBI). It is led by the Eastern Nile Council of Ministers (ENCOM), comprised of the Water Ministers in the three Eastern Nile countries, and an ENSAP Team (ENSAPT) formed of three technical country teams. The objective of ENSAP is to achieve joint action on the ground to promote poverty alleviation, economic growth and reversal of environmental degradation.

The Eastern Nile Technical Regional Office (ENTRO) was established by an ENCOM decision in 2001, started operation in June 2002 in Addis Ababa, Ethiopia, and was restructured in 2004/2005. ENTRO manages and coordinates the preparation of ENSAP projects, capacity builds and strengthens institutions and provides secretariat support to ENCOM/ENSAPT.

One of the programs being managed by ENTRO is the Eastern Nile Power Trade Program Study (ENTPS), which is fully funded by the African Development Bank, and has the general objective:

“To promote regional power trade between Egypt, Ethiopia and Sudan through creation of an enabling environment, coordinated regional investment planning of power generation and transmission interconnection projects” (Phase II, Inception Report, April 2008).

The study has been carried out in close contact and co-operation with the three countries’ Utilities: Egypt Electrical Holding Company (EEHC), Ethiopian Electric Power Corporation (EEPCo) and the Sudanese National Electricity Company (NEC). In addition, other relevant institutions, in particular the Nile Basin Initiative, the Ministry of Water Resources and Irrigation of Egypt, the Ministry of Water Resources of Ethiopia, the Ministry of Irrigation & Water Resources of Sudan have been involved in the project.

The Eastern Nile Power Trade Program Study was divided into 2 phases:

- Phase I: Cooperative Regional Assessment of Power Trade Opportunities between Egypt, Ethiopia and Sudan, and;

- Phase II: Feasibility Study of the Power Interconnection between Egypt, Ethiopia and Sudan.

The successful completion of Phase I of the ENTPS in November 2007 demonstrated that it would be very profitable for the three countries if Ethiopia exports power to Egypt and Sudan from the proposed Mandaya Hydropower Plant (HPP). The recommended export capacity option determined in Phase I was:

- Capacity between Ethiopia and Sudan : 1,200 MW;
- Capacity between Ethiopia and Egypt : 2,000 MW

The decision to proceed to Phase II was therefore taken by ENTRO in December 2007, on the basis of the findings of Phase I.

Feasibility and ESIA studies of the Mandaya HPP were undertaken as part of Phase I of the ENTPS and assessment of the Mandaya HPP is therefore excluded from the Phase II study.

4.2 PROJECT COMPONENTS

The Phase II feasibility study is to examine an interconnection scheme for Ethiopia to export 3,200 MW to Sudan, including 2,000 MW for Egypt as follows (see figure):

- 1,200 MW capacity from (Mandaya HPP) Ethiopia to (Kosti) Sudan; and
- 2,000 MW capacity from (Mandaya HPP) Ethiopia to (Nag Hammadi) Egypt.

The Project being assessed in this ESIA, comprises the following transmission system:

- Three substations and converter stations:
- One 500/400 kV substation located on Mandaya HPP site, Ethiopia, equipped with four 500/400 kV 510 MVA transformers;
- One HVDC(AC/DC) 500kV substation located in Kosti, Sudan, connected to Mandaya substation through two double 500kV AC circuits (544 km) and Static Compensator (SVC); and
- One HVDC(DC/AC) 500kV substation located in Nag Hamadi, Egypt, connected to Kosti substation through one bipolar DC line (1665km).
- Transmission lines:
- Two double circuit 500 kV AC lines, running between Mandaya HPP, Ethiopia, and Kosti, Sudan, 500 kV substations, for a distance of 544 km;
- 600 kV DC bipolar line between Kosti, Sudan, and Nag Hammadi, Egypt. The total length of the line is about 1,665 km.

The overall line will be a total length of 2,209 km. The project components are summarised and described in more detail in tables below.

Country	Component	Land Take	Length	Location
Substation and converter stations				
Ethiopia	500/400kV Substation			Mandaya
Sudan	AC/DC 2 x 1075 Converter Station			Kosti
Egypt	DC/AC 2 x 1010 MW converter station			Nag Hammadi
Power lines				
Ethiopia	500kV AC line – Section 1	1,257.6 ha	158 km	Mandaya Substation to Sudan/Ethiopia Border
Sudan	500kV AC line – Section 2	1,120 ha	126 km	Sudan/Ethiopia Border to Damazin
	600kV AC line – Section 3	2,320 ha	260 km	Damzin to Kosti Converter Station
	600kV DC line – Section 4 - 6	10,216 ha	1,130 km	Kosti Converter Station to Dongola and Egypt/Sudan Border
Egypt	600kV DC line – Section 7	4,280 ha	535 km	Egypt Sudan Border to Nag Hammadi
Total		**19,193.6 ha**	**2,209 km**	

Table 3 : Summary of Project Components

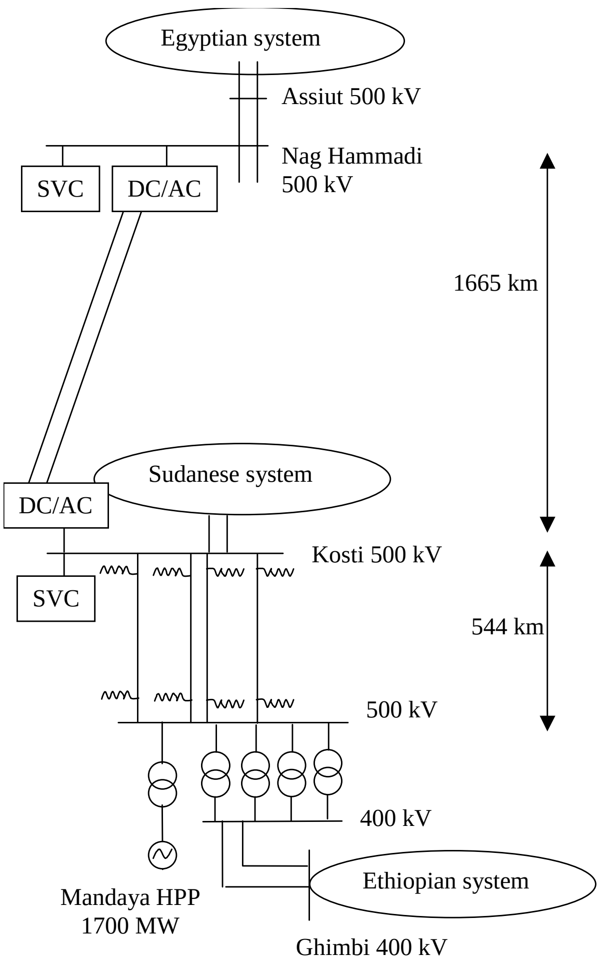


Figure 1 : Proposed power transmission system

4.3 SUBSTATION AND CONVERTER STATIONS

The network will have the following stations: one main AC Substation at Mandaya HPP, Ethiopia; one HVDC(AC/DC) Converter station at Kosti, Sudan; one HVDC(DC/AC) Converter station at Nag Hammadi, Egypt and; two ground electrode stations to be located near Kosti and near Nag Hammadi.

4.3.1 500/400 KV SUBSTATION - MANDAYA, ETHIOPIA

The powerline will start from the Mandaya 500/400kV Substation. This substation will need to be developed with four 500/400 kV 510 MVA transformers. Mandaya HPP will be connected on a 500kV busbar.The total area to be taken up by the substation will be approximately 30 hectares. Refer to near the proposed Hydropower station on the Blue Nile in Northern Ethiopia. The substation will be equipped Figure 2.

Figure 2 : Existing substation at Rabak, a similar substation will be constructed at Mandaya HPP

4.3.2 HVDC CONVERTER STATIONS

The transmission network will have the first HVDC Converter station at Kosti in Sudan, this will be close to the proposed Kosti Substation. The HVDC station at Kosti will require an area of approximately 100 hectares in the flood plain which is predominantly agricultural land and open grassland. The Converter station will be connected to the AC substation by a 220kV AC overhead line. From Kosti, there will be a 600 kV DC bipolar powerline which will terminate at another HVDC Converter station at Nag Hammadi in Egypt, this will also require approximately 100 hectares of land. The layout of the two Converter stations will be similar to the outline presented in Figure.

Figure 3 : Lay out of a HVDC (AC/DC) Converter Station

Associated to the two converter stations will be two Ground Electrode stations near Kosti and near Nag Hammadi (each ground electrode station ranging from 10 to 20 km from the converter station). High conductivity soil layers are required down to several hundred meters to reduce the electrical fields in the area. It can be roughly estimated to 80 ha circle (1 km diameter). Lay out of the ground electrode station is as presented in Figure 4.

Figure 4: Land electrode site layout

4.4 POWERLINES

The project consists of:

- the two main AC 500kV Over Head Transmission Lines, which run between the 400/500kV Mandaya substation (Ethiopia) and 500kV/600 kV Kosti substation (Sudan);
- the main DC ± 600kV Over Head Transmission Line Transmission line between the 500/600kV Kosti substation (Sudan) and 500kV/600 kV Nag Hammadi substation (Egypt).

4.4.1 SECTIONS 1 - 2: 500KV AC OVERHEAD LINE, MANDAYA SUBSTATION, ETHIOPIA – KOSTI CONVERTER STATION, SUDAN (544 KM)

The Mandaya HPP (Ethiopia) will be connected to the Sudan network (via Kosti Substation) through two AC 500kV Transmission lines with double circuit. This Main transmission line, will start from the gantry of the 500kV substation located in nearby the power plant (Mandaya Substation) to the Kosti Substation (Sudan). Table below gives the technical details about the AC line and figure gives the structure of the Overhead Transmission Line (OHTL) tower.

The route will have two 500 kV tower structures each requiring a right of way (RoW) of 65 m each, therefore the total RoW size requirement will be 130 m. The total route distance of 544 km is divided into two sections.

This route with a right of way of 130 m will have two powerlines each carrying 500 kV double circuits lines. The two lines will have one Blue Nile crossing near Mandaya HPP, a crossing of about 200 m river width. The next major river crossing would be on the white Nile at a river section close to Rabak with a river width of about 900 m.

Table 4 : General Specifications for the 500 kV AC Transmission Lines

DESCRIPTION	**500 kV OHTL** **Mandaya – Kosti**
Total Length	158 km (Ethiopia) + 386 km (Sudan)
Type	2 lines with Double circuit
Number of Towers	1177
Suspension towers	1100
Anchor towers	77
Number of Gantries	one at the substation yard
Insulators	IEC Class (160 kN,210 kN).
Type	Composite
Pollution class	16 mm/kV (Ethiopia) 31 mm/kV (Sudan)
Conductors	ACSR DOVE
Number / Phase	4 bundles / Phase
Earth Wires	ACSR and OPGW
Minimum Ground Clearance	11 m
Maximum tower footing resistance	10 Ohms

Source: EDF et al, 2008 (Module M4 – Main equipment)

ENTRO Project
500 kV AC line _ Tower
Mandaya (Ethiopia) _ Rabak (Sudan)

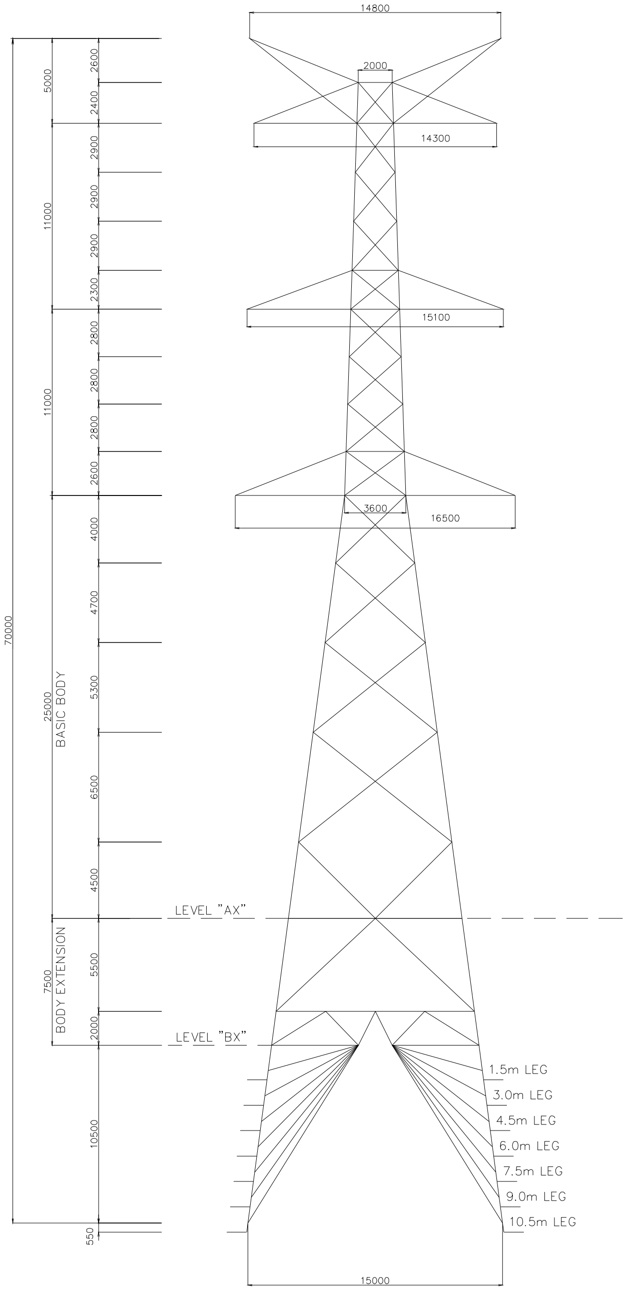


Figure 5 : Tower structure of the 500 HVAC double circuit Transmission Line from Mandaya to Kosti

Section 1 - Ethiopia: Mandaya Substation to Sudan Border (158km)

The 500kV AC powerline will traverse through the following six administrative woredas (administrative areas) in the Benishangul Gumuz National Regional State (BGNRS) in Ethiopia:

- Agalo Miti;
- Wonbera;
- Sirba Abbay;
- Oda Gudere;
- Menge; and
- Sherkole woreda.

The power transmission section that falls within the first two woredas (Agalo Miti and Wonbera) is less than 2 km in length. The Mandaya Power Station is located in the Wonbera woreda across the Abbay River and Section 1 of the 500 kV AC power transmission line immediately crosses the River over a narrow section into the Sirba Abbay woreda. The route mainly traverses an area which is sparsely populated with subsistence agriculture. The terrain is mainly undisturbed pristine vegetation with hills to low mountains near Mandaya and plain and medium hills near the Sudan Border (Tropics, 2008). The route from Mandaya to the Sudan Border is shown in Figure.

This section of the route will have the following major features:

- The total length of the line is 158 km extending from the Mandaya Power Station to the last bend located near the town of Gizen on the Sudanese border.
- The line corridor Right of Way (ROW) width is 130 m.

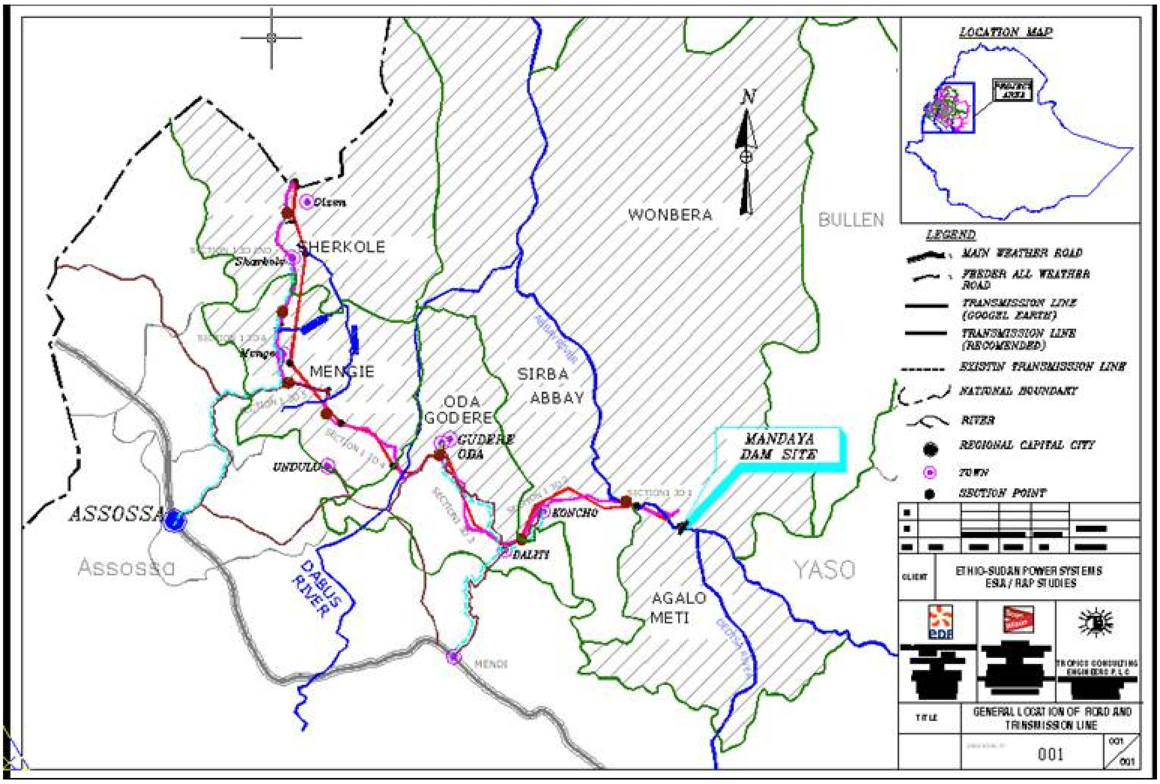


Figure 6 : Location map of the route from Mandaya to Sudan/Ethiopian Border

Section 2 - Sudan: Ethiopia/Sudan Border to Damazin (126 km)

This section of the proposed route makes two big river crossings, the first near the Sudan Border at Fabudo and the second at Murmurs. The route also crosses a number of wetlands associated with the flooding regime of the Blue Nile. Overall the route mainly traverses grassland with sparse trees to open shrubland with predominantly vertisol soil. The terrain comprises mainly flat plains to low hills with subsistence agriculture and has a low population based in small rural villages.

Section 3 - Sudan: Damazin to Kosti Route Section (260 km)

This section of the route is predominantly through extensive agricultural land, with rain-fed crops, supported by predominantly vertisol soils. Overall, this area of Sudan also has a number of areas of cultural importance which, if in the footprint of the project, will need to be avoided or conserved (see Section 8.3.9 – archaeology and cultural heritage). The area has low to medium population density mainly based in rural villages.

4.4.2 SECTIONS 4 – 7: 600KV DC BIPOLAR OVERHEAD TRANSMISSION LINE, KOSTI, SUDAN – NAG HAMADI, EGYPT (1,665 KM)

The AC Line will terminate at the AC/DC Converter Station, which will be located at Kosti. The location of the Converter Station is still to be confirmed and the size of land will be determined.

From Kosti to Nag Hamadi will be an overhead 600kV DC transmission line. The size of the right of way to be taken up will not be more than 80 meters. The 1,665 km Kosti – Nag Hamadi is divided into 4 sections and the sections 4 to 7 are described accordingly. Next table gives a general description of the 600 kV line technical aspects and figure shows the DC line tower structure.

Table 5 : General specification of the ± 600 kV DC Over Head Transmission Line

DESCRIPTION	**± 600 kV DC OHTL** **Rabak - Nag Hammadi**
Total Length	1130 km (Sudan) + 535 km (Egypt)
Type	One bipole with 6 sub-conductors per pole
Number of Towers	2340
Suspension towers	2225
Anchor towers	115
Number of Gantries	one at the substation yard
Insulators	IEC Class (160 kN,210 kN)
Type	Composite
Pollution class	31 mm/kV
Conductors	ACSR CURLEW
Number / Phase	6 bundles / Pole
Earth Wires	ACSR and OPGW
Minimum Ground Clearance	13 m
Maximum tower footing resistance	10 Ohms

Source: EDF, November 2008, M4 – Main Equipment

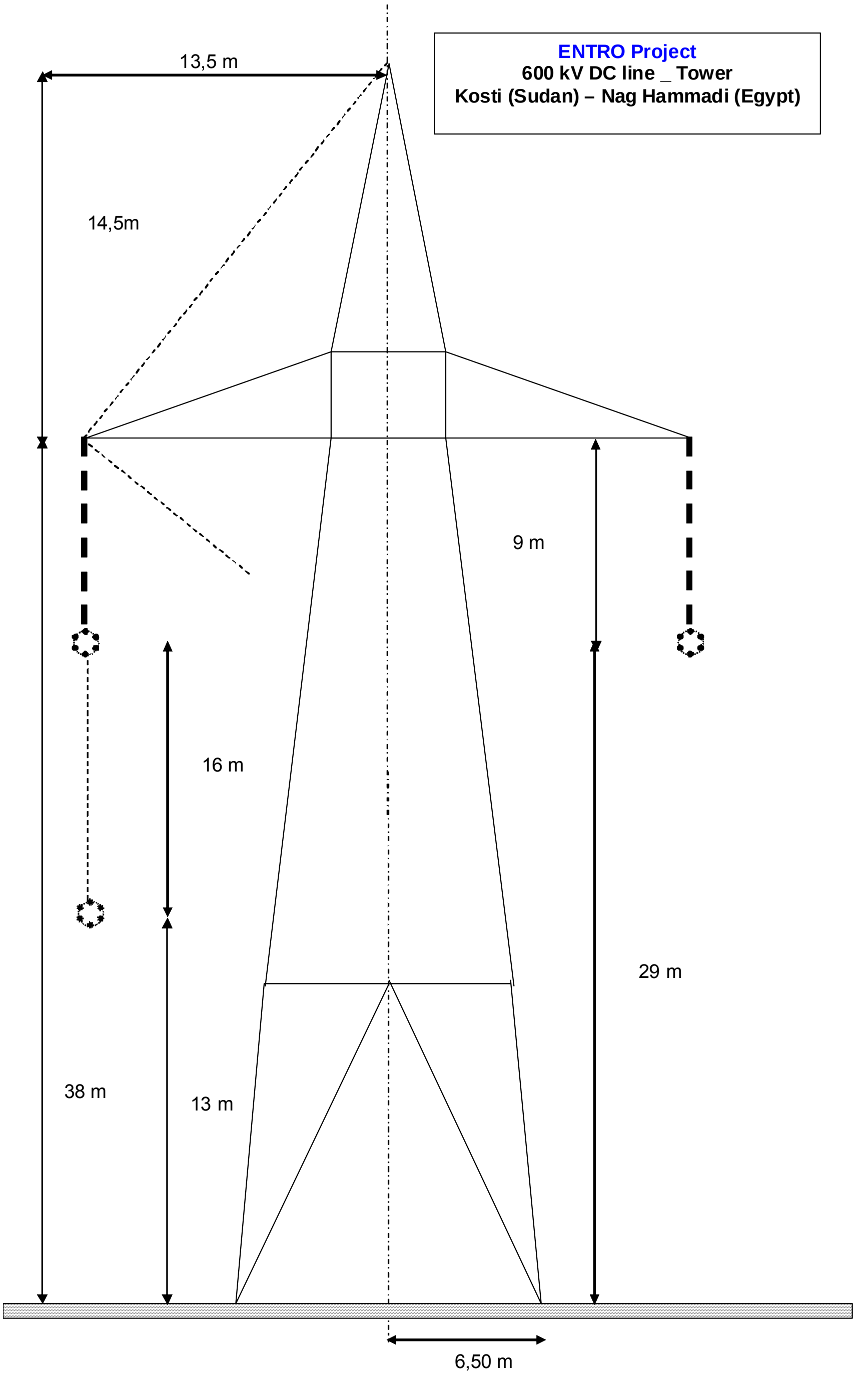


Figure 7 : 600kV DC Tower Structure

The total length of the 600 kV route will be 1,665 km, which is described according to the following four sections:

- Section 4 - Sudan: Kosti to North Khartoum;
- Section 5 – Sudan: North Khartoum - Dongola DC Line;
- Section 6 – Sudan: Dongola to the Sudan Border ;
- Section 7 – Egypt: Sudan/Egypt Border to Nag Hammadi, Egypt

Section 4 - Sudan: Kosti to North of Khartoum DC (390 km)

The 390 km route of DC line from Kosti to North of Khartoum passes on the left bank of the White Nile in mainly flood plain area. The soil type is mainly black cotton soils, vetisols tending to sandy loams towards the edge of the flood plain. There is no all weather road in this section and therefore a good access road would have to be constructed to facilitate construction works and maintenance during operations especially in the distance between Kosti and Ed Dueim (a distance of about 150km).

Section 5 - Sudan: North Khartoum - Dongola DC Line (383 km)

This section of the route has been selected to avoid the suburbs and other settlements near Khartoum, wherever practicable. The terrain is flat with sandy to rocky soil types and very light vegetation. The population along the route corridor is of a low to medium density. Accessibility to the route is mainly from the existing roads and tracks.

Section 6 - Sudan: Dongola to the Sudan Border (357 km)

This section of the route traverses mainly flat desert terrain with sandy soils and limited vegetation cover. The desert conditions mean that overall this area is sparsely populated.

The route has been selected to avoid major settlements and agricultural activities along the River Nile. Accessibility is through the old tracks along the road from Egypt. Cultural and historical sites may exist along the route and care should be taken to ensure these sites are preserved. The population along the route is very low population due to the desert conditions

Section 7 – Egypt: Sudan/Egypt Border to Nag Hammadi, Egypt (535km)

This section of the route traverses desert terrain with sandy to rocky soils having very light vegetation. Most of the route corridor is flat but it becomes mountainous towards Nag Hammadi. The majority of the route corridor is unpopulated although there is medium to high population in the area around Nag Hammadi. The visual impact is minimized as the planned route utilises an existing overhead line corridor, however the visual impact would be higher in the area near Nag Hammadi. The route avoids the major settlements and irrigated agricultural activities along the Nile River. Along the route may also be sites of cultural and heritage significance, effort should be made to conserve such sites. Figure shows the route of the power line in Egypt.

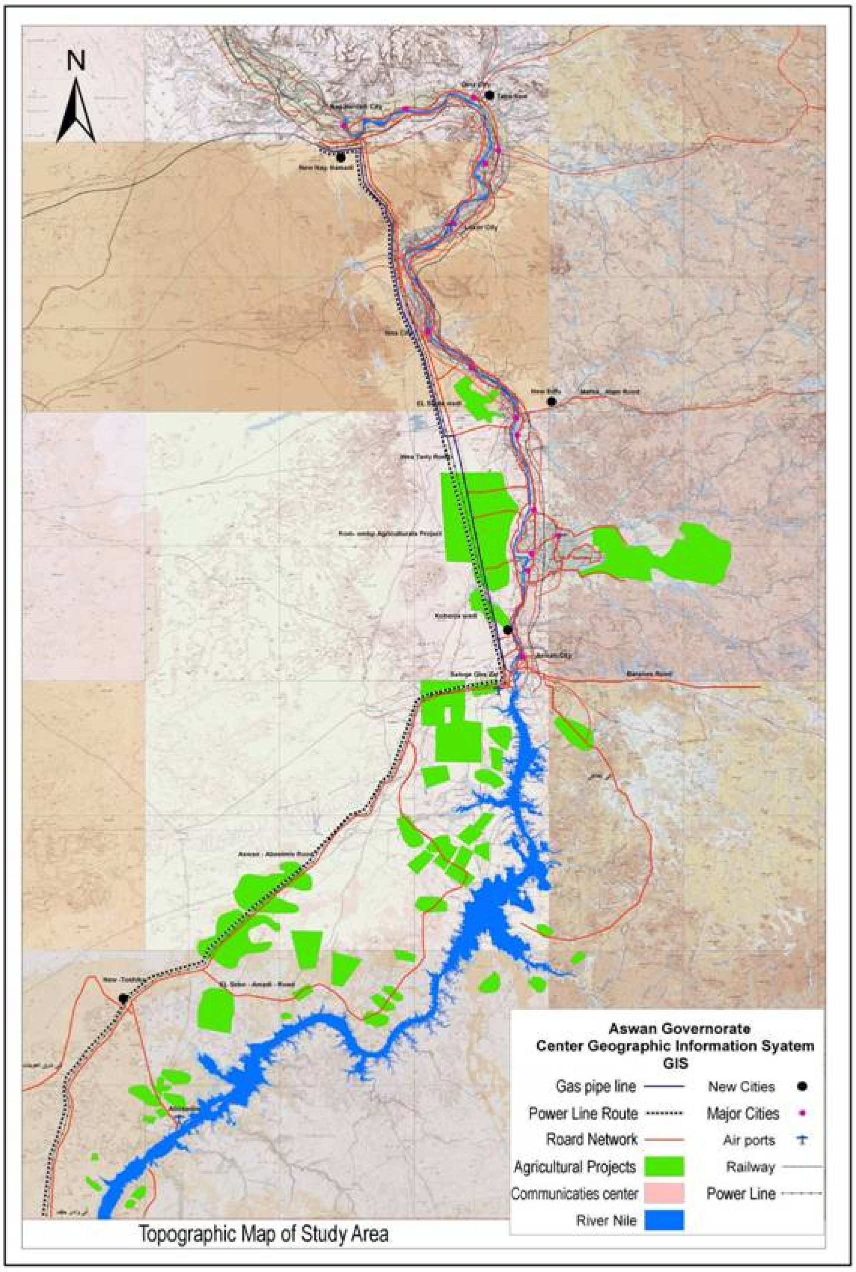


Figure 8 : Location for the route from Sudan/Egypt Border to Nag Hammadi

4.5 CONSTRUCTION

An implementation arrangement is proposed which depends on cost estimates and estimated time to execute the works, engineering, procurement, control and management activities for line and station building. (As proposed in Module M6 – phasing and arrangement of implementation). The construction works for the Ethiopia/Sudan/Egypt interconnection are divided in nine lots:

five lots for Over Head Lines AC/DC construction; and

four lots for AC/DC substations.

For this project, implementation is proposed based on the following assumptions:

- there will be different contractors depending the specified works (OHL or Substation).
- there will be one contractor per country for the OHL construction.
- for HVDC and Electrode stations in Nag Hammadi and Kosti, theses works are in the same lot in order to have the same company to ensure compatibility for DC equipment in both stations.
- in Nag Hammadi, the construction of 500 kV substation and the connection of HVDC station to existing Nag Hammadi substation is effected in the same lot of the HVDC station construction .

The phasing for the implementation and commissioning of the various project components is proposed in two scenarios, the scenario with anticipation (acceleration of implementation of some components of the project) and the scenario without anticipation (without acceleration and all components starting at the same time). The difference between the two scenarios is a period of five years as outlined in next table

Table 6 : Phases of project implementation and commissioning

Lot	Project Component	Year of Commissioning	
		Scenario with Anticipation	Scenario without Anticipation
Lot 1	Construction of Kosti Static Voltage Compensator (2 years)	2020	2020
Lot 2	Construction of Kosti HVDC and electrode station (3 years)	2020	2020
	Construction of Nag Hammadi HVDC and electrode station	2020	2020
	Connection to Nag Hammadi 500kV substation	2020	2020
Lot 3	Construction of Mandaya 500/400 kV substation (3 years)	2015	2020
	Mandaya HPP to Mandaya 500 kV substation connection	2020	2020
Lot 4	construction, installation and commissioning of the AC/DC 500kV KOSTI substation in Sudan (2 years)	2015	2020
Lot 5	Construction, testing and commissioning of 2 lines 500 kV double circuit AC overhead line (approximately 158 km) between Mandaya substation (Ethiopia) and Sudan-Ethiopian Border (3 years)	2015	2020
Lot 6	construction, testing and commissioning a of 2 lines 500 kV double circuit AC overhead line (approximately 430 km) between Sudan-Ethiopian Border and Kosti substation (Sudan) (4 years)	2015 (1st line) 2017 (2nd line)	2020
Lot 7	construction, testing and commissioning a ± 600 kV bipole DC overhead line (approximately 590 km) between Kosti substation (Sudan) and Bohad village (4 years)	2020	2020
Lot 8	construction, testing and commissioning a ± 600 kV bipole DC overhead line (approximately 590 km) between Bohad village (Sudan) and Sudanese / Egyptian Border (4 years)	2020	2020
Lot 9	construction, testing and commissioning a ± 600 kV bipole DC overhead line (approximately 550 km) between Sudanese/Egyptian Border and Nag Hammadi HVDC substation (Egypt) (4 years)	2020	2020

Source: EDF, November 2008, M6 – Phasing and arrangement

4.5.1 SUBSTATION AND CONVERTER STATIONS

This part of the project will be handled under contract Lots 1 to 4. The components will take a period of 2 to 3 years from construction to commissioning. The Construction of the AC Mandaya substation under the scenario with anticipation will commence much earlier and expected to be commissioned in 2015. The Commissioning time for the scenario without anticipation is expected to be 2020. One contractor is expected to be commissioned to construct the two HVDC Stations to ensure compatibility of the system.

4.5.2 TRANSMISSION LINES

The total construction period is expected to be a maximum of four years.

Permanent roads will be located within the ROW and will have a width of 5m. Where the route corridor passes in areas where there are existing roads, these shall be used, however where the route passes far from the existing roads, new access routes will be constructed to facilitate both construction and maintenance.

The length of the access roads to be constructed will be determined after detailed survey, however areas with poor existing roads especially in flood plains (route between Kosti and Ed Dueim), all weather access routes will have to be constructed.

Priority for employment will be given to communities where the towers will be located.

Clearance between line conductors and ground will be maintained in accordance with the regulation set by the relevant institutions i.e. Ethiopian Electricity Agency (EEA), Sudan Electricity Corporation and Ethiopian Electricity Company.

4.5.2.1 Surveying and Pegging

This activity will be undertaken by the contractors, the detailed surveying will be done and specific locations of towers will be determined and pegged. The next activity will be ROW clearing where the route corridor passes through wooded areas, however where the route passes through grasslands, ROW clearing will be minimal. This activity will be closely followed by the ROW acquisition and determination and assessment of compensation where necessary. Before commencement of construction, compensation and the ROW for the whole route corridor would have been completed.

4.5.2.2 Access Routes

In some sections, the route corridor passes areas that are far from the existing access route, therefore new routes would have to be opened up to facilitate construction activities. This shall be done using earth moving plant and and machinery. In flood plain areas, the access route construction shall be more intensive to ensure the route are accessible by vehicles throughout the year.

4.5.2.3 Tower Construction and Foundations

Construction of high power towers and double circuit transmission (500 KV AC) will be conducted near the Ethiopian border, which extends from Mandaya Power Station to Sudan border. The towers materials will be composed of steel, Aluminium conductors etc… The towers will be erected on concrete foundation and each towers assumed will occupy about 100 m^2 area hence will be lost permanently. The major construction activity involves erection of these towers and stringing of the transmission power line.

4.5.2.4 Equipment Requirements

Construction works shall involve the use of various types of equipment, however the main equipment to be used that may have impact of the environment will include: earth moving equipment for site preparation and clearing and access road construction; and heavy trucks for transportation of construction materials and equipment.

4.6 Operations and Maintenance

The Operation and Maintenance of the AC substations and HVDC Converter Stations which will be required for the regional interconnection project between Ethiopia, Sudan and Egypt. There will be three substations and these are:

- AC 400kV- 500kV Mandaya substation located in Ethiopia;
- HVDC (AC/DC) 500kV Kosti substation in Sudan connected to Mandaya substation through two double 500kV AC circuits (544km); and
- HVDC (DC/AC) 500kV Nag Hammadi converter station connected to Kosti substation through one 600 kV bipolar DC line (1665km).

The transmission system will be operated and maintained by the Operator, and could be supported through the provision of outsourced contracts with local or international companies skilled in operation and maintenance (O&M).

During operations, there are two types of maintenance that will be required:

(a) Preventive maintenance carried out at predetermined intervals intended to reduce the probability of failure or the degradation of the functioning of an item. This can includes activities such as: periodic visual checking of the insulator, oil level in cable sealing ends, counter and earth wire.

(b) Corrective (curative) maintenance carried out after fault recognition and is intended to put an item into a state in which it can perform a required function. Activities such as change of active part of the circuit breaker after an internal fault would be classified as corrective maintenance.

For the Transmission system, the main aspects of operation and maintenance would be directed as follows.

Mandaya Substation

The Mandaya substation is composed of 2 main components of the substation, one 420kV substation connected to the Ethiopian transmission network, the other one 500kV substation dedicated to the international connection with Sudan.

The operators need to be familiar with O&M procedures of both type of equipment, specially the safety procedures conditioned by the insulation distance in 420kV or 500kV.

Kosti Substation

The Kosti substation is composed of 3 main components of the substation, one AC-500kV substation connected to the Ethiopian transmission network, one for the 500kV Static Voltage Compensator substation and one for the AC/DC converter substation dedicated to the international connection with Egypt.

There is need to be familiar with the three types of technologies or at least to foresee dedicated training for suitably personnel on O&M for SVC and AC/DC converter.

Nag Hammadi Substation

The Nag Hammadi DC/AC Converter Station will be connected to Kosti Converter station through one 600 kV bipolar DC line.

4.6.1 MAIN TASKS OF THE O & M FOR THE AC SUBSTATION AND DC CONVERTER STATIONS

The Operator will be in charge of operating an AC Substation, in compliance with the requirements set in the Operating Agreements (OA) which are used by the other regional Operators (from Egypt or Sudan and Ethiopia).

The DC equipment is designed for minimum maintenance requirements which ensure both routine (planned) and corrective (unplanned) outages are kept to the shortest possible times. The objective of the maintenance program is to ensure that the Converter stations are kept in good working order such that they are able to meet the performance requirements throughout their life.

The main missions assigned to the Operator, will be as follows:

(a) To review the O&M manuals and to develop and update the Standing Instructions and Procedures related to the operation and the maintenance of the whole facility.

(b) To operate and maintain the whole Project facility including 500 kV substations and transmission lines, in order to procure the highest availability and performance of equipment in compliance with the O&M Manuals and Standing Instructions and Procedures.

(c) To prepare and manage the maintenance outages for which external resources could be contracted from time to time.

(d) To ensure the safety of people, works and equipment.

(e) To establish and manage a procurement process of consumable, spares, support and services contracts.

(f) To recruit, train and keep well-trained personnel with competencies necessary to carry out the current permanent activities.

(g) To transfer O&M knowledge to the staff.

4.6.2 PRE-OPERATION PERIOD

Before the commissioning period of the substation, the Operator shall address issues of the utmost importance to ensure a successful operation as follows:

(a) Prepare itself to its missions described above by setting-up an operational staff and organization.

(b) Prepare the staff recruited by providing suitable training.

(c) Review the O&M Manuals and Design Manuals from an operability and maintainability point of view, as well as the safety procedures and instructions.

(d) Prepare and issue the Standing Instructions and Procedures for the operation and maintenance of the Facility relating to: operation, maintenance, safety and first aid, performance monitoring, security, incident reporting, fire fighting and prevention, emergency plans, administration, environmental compliance.

(e) Prepare and enter into contracts for the various maintenance services.

(f) Specify, procure, implement and test the billing system associated to the international Transmission lines (500 kV OHTL between Mandaya and Kosti substation).

(g) Report on O&M implementation.

4.6.3 OPERATING PERIOD

During the operating period, the core activities will be those directly related to the Operation and Maintenance of the whole facility, in compliance with the Operating Agreements (EPA) contracted with the other utilities. The facilities will be handed over to the respective utilities for operation through the EPA. The following will comprise the core activities in operating the facility.

(a) Operate, monitor and inspect the Facility.

(b) Maintain records and reports of the operation of the Facility.

(c) Prepare, co-ordinate and negotiate planned outage programs with other utilities involved by the Project.

(d) Comply with all Standing Instructions and Procedures related to the operation of the whole facility.

In addition to the above, for maintenance, core activities will comprise the following:

(a) Plan and perform routine, periodic and occasional visual inspection of the Facility including tests of the equipment.

(b) Plan and perform routine, scheduled and corrective maintenance of the Facility.

(c) Maintain records and reports of all maintenance works.

(d) Maintain and keep the Computerised Maintenance Management System updated.

(e) Plan, organize and manage any subcontracted maintenance work;

(f) Prepare the Operator's proposed Annual Maintenance Plan, with services to be subcontracted included.

(g) Comply with all Standing Instructions and Procedures related to the maintenance of the whole facility.

To ensure the facility operates effectively, the following non-core activities will be carried out as part of the O & M:

(a) Ensure site Security.

(b) Road and ground maintenance.

4.6.4 TRANSMISSION LINES RIGHT OF WAY MAINTENANCE

The transmission system will have two types of transmission lines and these will be: the two double circuit 500 kV AC lines and; the one bipole 600 kV DC line. The two AC lines will have a 130 m ROW while the HVDC line will have a ROW of 80 m.

The main Operation and maintenance activities related to right of way maintenance especially for the route corridors in vegetated areas include the following:

- Periodic monitoring required to ensure new settlements are not constructed within the ROW (the constructed access roads may lead to establishment of settlements);
- Periodic (at least once a year) vegetation clearance to maintain clearance between line and ground (to ensure an adequate fire break between vegetation and the transmission line; local people shall employed to clear the ROW);
- Standing trees/vegetation to left and right of the power line route should be periodically (at least once a year) cleared to prevent flashover from a conductor; and
- Maintenance of the access road in the ROW; at least once a year is expected.

The above activities will however be kept to the minimum when power line route corridor is through desert and grassland areas. Figure gives the requirement for right of way vegetation clearing.

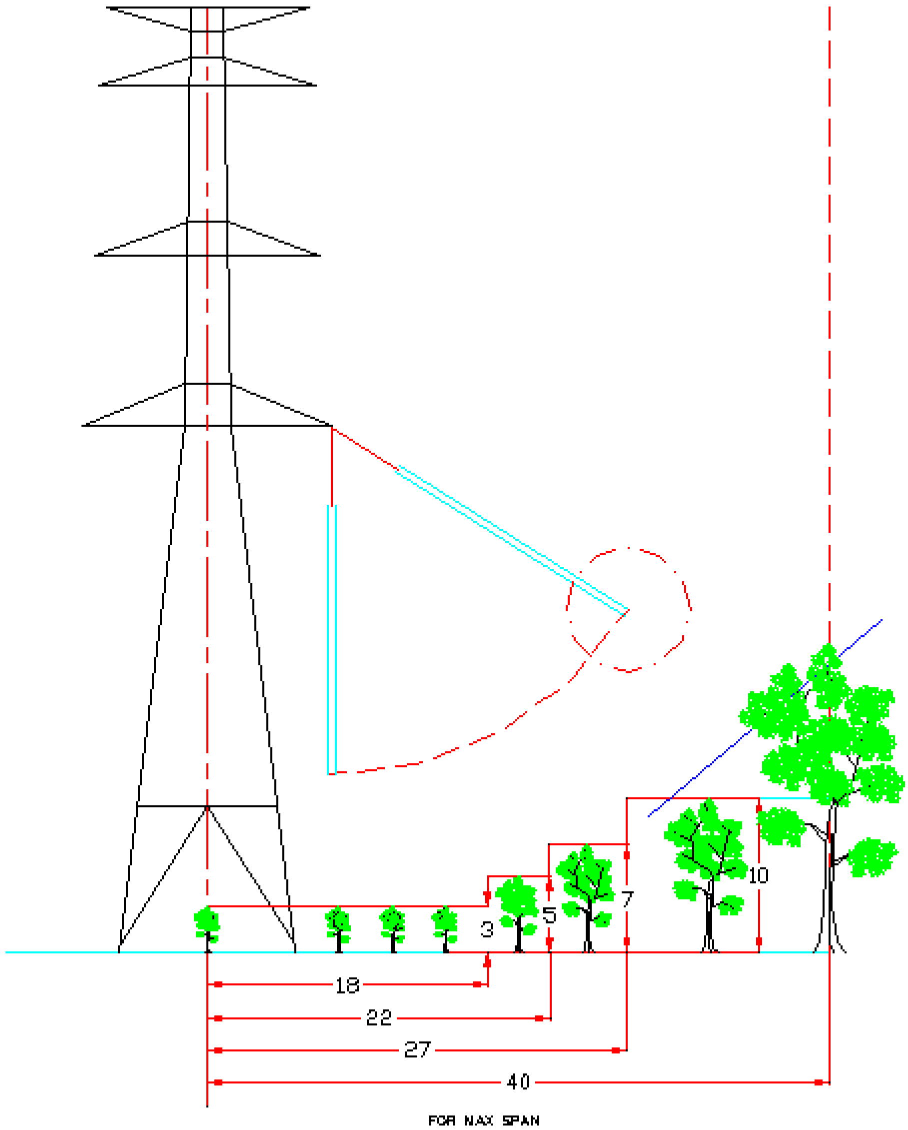


Figure 9 : Clearance of corridor under the Over Head Transmission Line in wooded areas

5 ANALYSIS OF ALTERNATIVES

5.1 INTRODUCTION

Alternatives have been considered, from the outset of planning, and during the Pre-Feasibility (Phase I) and Feasibility phases (Phase II) of the Study. The objective of considering alternatives was to find the optimum operating conditions for the Project. The ESIA process provided the opportunity for these environmental and social implications to be fed into the Project decision-making process and design. The final Project selected (the Base Case), as presented in Chapter 4, is considered to be at the time of writing this report, the most viable in terms of economic, environmental and social considerations.

This Section outlines the alternatives that have been considered for the Project and assesses their environmental and social implications. The process of considering alternatives adopted by the Project team began in the Pre-Feasibility Study (PFS) phase when a number of strategic options relating to the location of hydropower components and line routing were considered. Once the preferred project configuration was chosen, different options within the framework of the preferred Base Case were evaluated and will continue to be refined through future studies. As such this Section is divided into two key parts:

- Pre-Feasibility Assessment; and
- Alternatives Considered within the framework of the preferred project option.

This Section also provides an evaluation of the “Zero” Project Option1.

5.2 PRE-FEASIBILITY ASSESSMENT

5.2.1 POWER GENERATION ALTERNATIVES

During Phase I a strategic assessment was undertaken of key alternatives for the development of the Project. This extensive study focussed, primarily, on options for hydropower generation along the Abbay River as well as other hydropower options along the Blue Nile and other power generation mixes.

Module 6 of Phase I of the Power Trade Investment Study evaluated the benefits for the region provided by an interconnection of the three power systems according to various level of integration of these systems. It accounted for :

- Determination of least-cost generation expansion plan for the three isolated systems;
- Determination of least-cost generation expansion plan for the coordinated system;
- Determination of the least-cost interconnection option in terms of technology; and
- Transmission system analysis.

[1] Zero Project Option is the “no project” or “without project” option (World Bank OP 4.01), which in accordance with international best practice should be assessed within the alternatives section of the EIS.

One of the aspects of these studies has been derivation of the economic costs of generation. These are shown schematically in figure where the costs of new thermal and new hydropower generation candidates are compared for one of the cases considered for year 2030.

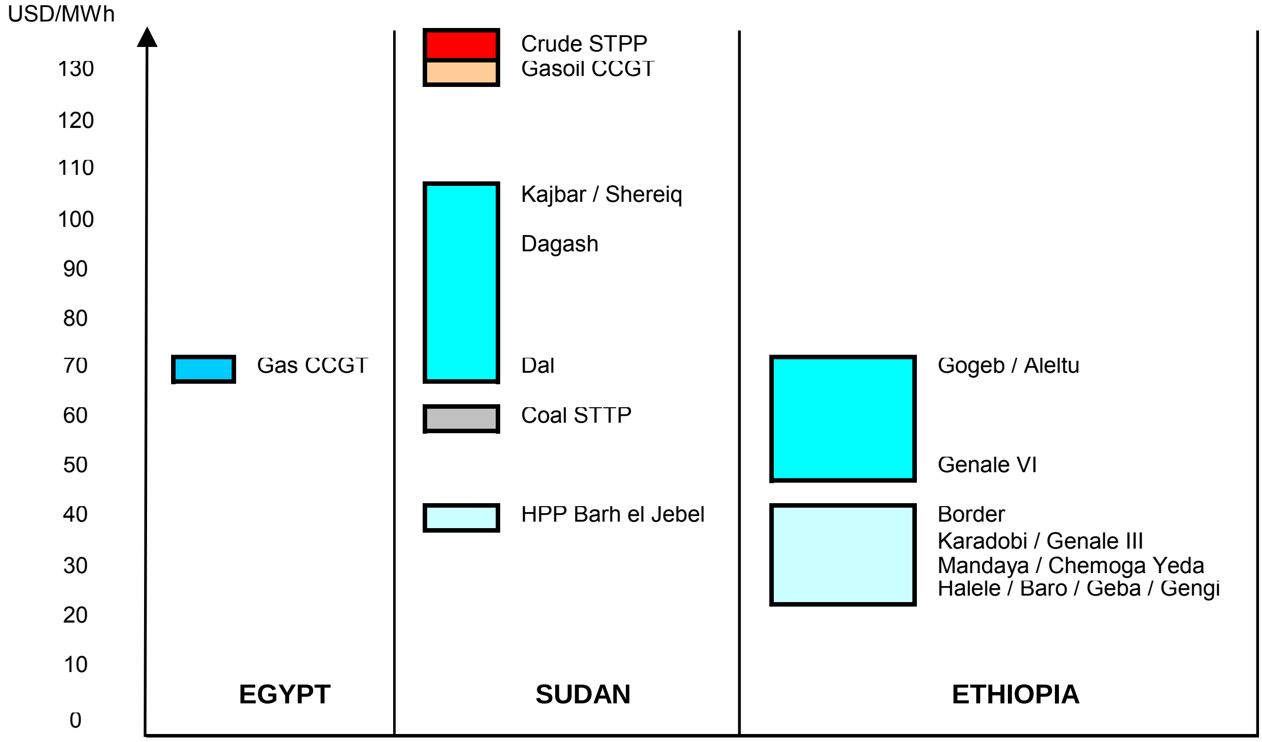


Figure 10 : Comparison of economic generation costs in the different generation mixes (6 000 hours/ year) - Year 2030 - Medium fuel price scenario (60 USD/bbl) - 10% discount rate

The cost effectiveness of projects is summarised as follows:

- The lower cost generation projects are composed of a group of Ethiopian hydropower projects (Mandaya, Karadobi, Border, Halele, Geba, etc). Their economic costs range from 25 to 40 USD/MWh;
- The next lowest cost project, close to 40 USD/MWh, is Bahr el Jebel hydropower project in the south of Sudan;
- Then close to 60 USD/MWh are Combined Cycle Gas Turbine (CCGT) in Egypt, coal-fired Steam Turbine Power Plant (STPP) in Sudan (but the number of coal-fired STTP is Sudan is limited by transmission capacity), and a group of hydropower projects in Ethiopia;
- Then from 70 to 110 USD/MWh are the hydropower projects on the Main Nile river in Sudan, which include Dal;

- Finally, the most expensive units are gas oil-fired CCGT and crude oil-fired STPP is Sudan.

Accordingly, considering the cost and availability of power surplus, the bulk of power export will come from cost effective hydropower projects in Ethiopia (all cost effective hydropower in Sudan being absorbed by Sudan's internal demand).

Power export to Sudan would lead to the greater economic savings, because of greater cost differential between saved and imported energy, as well as lower transmission cost.

For more details, please refer to the full analysis of power generation costs given in Phase I Module 6 Coordinated Investment Planning report, Volume 2.

A strategic Environmental and Social Assessment was undertaken in Phase 1 of the study to provide an initial analysis of the key environmental and social impacts of the alternatives considered (ENTRO, November 2007). This analysis indicated that with regard to land area inundated and people displaced the Karadobi, Mandaya and Border HPP appeared favourable. With regard to air quality, particularly CO_2 emissions from construction and operation of the HPP options compared to that produced to create the same amount of energy through burning fossil fuels. It was estimated that there was a saving in the order of at least 100:1 in favour of HPP at Mandaya with similar ratios for the other HPP options. Other options like Nuclear and solar energy were not evaluated.

5.2.2 TRANSMISSION ALTERNATIVES

During Phase 1, network studies were launched to investigate different solutions to interconnect the three countries and propose the least cost interconnection alternative that would be able to transmit the expected power exchanges and satisfy the technical requirements and the planning criteria.

The amount of transmitted power and the distance between the countries were the main parameters considered in evaluating the type of interconnection link. With about 3,200 MW exported from Ethiopia over a distance of about 550 km to Sudan and about 2200 km to Egypt, DC technology appeared as the best suitable solution. But with the presence of the Sudanese system, that allows controlling the voltage along the interconnection path, AC alternatives are technically possible and could also be competitive solutions to interconnect the three systems and transmit consequent power.

The study examined the connection of Mandaya HPP to the Ethiopian system with the interconnection with Egypt and Sudan being in operation. The different AC and DC interconnection alternatives were examined and the impact of the power exchange on the three systems was investigated. For AC alternatives, the power exchange devoted to Egypt flowed through the Sudanese system. Consequently, the impact of this exchange on Sudan was investigated. Transmission losses over the interconnection were determined.

The investment cost and the transmission cost of each alternative were calculated. The transmission cost, expressed in \$/MWh, included the investment cost, the cost of losses and the operation and maintenance cost.

A number of different connection points were also investigated and the preferred project chosen based on the minimum length of the interconnection line avoiding as much as possible constraints on the transmission system of the three countries. Reducing the length of the line allows reducing the investment cost of the interconnection and the amount of losses and leads obtaining the least cost alternative.

In Ethiopia, Mandaya HPP 400 kV substation was the interconnection point for AC and DC alternatives.

In Sudan, for AC alternatives, Hasaheisa, Meringan and Rabak 500 kV substations, the main load centres close to the border with Ethiopia, were considered as interconnection points to receive power from Ethiopia. Merowe HPP and Port Sudan TPP 500 kV power stations, in the north of the country, were interconnections points to send power to Egypt.

For DC alternatives, Hasaheisa, the huge load centre close to the border, was the interconnection point selected to receive the tapping DC/AC converter.

In Egypt, for AC alternatives, Nag Hammadi, Sohag and Assiut 500 kV were the interconnection points. Beyond Assiut in the North, AC alternatives would not be technically feasible.

For DC alternatives, Nag Hammadi, Sohag, Assiut, Cairo 500 and Suez 500 kV substations were interconnection points. High Dam HPP 500 kV substation, close to the border with Sudan, cannot be extended and cannot receive the interconnection link.

The project being discussed in this feasibility study was chosen as the preferred alternative, for this a preliminary route was chosen which was to be subjected to route study and analysis to come up with the preferred proposed route. Table below therefore provides the general line routing aspects of length and number of angle towers. (refer to Module 2 of this feasibility study).

Table 7 : Comparison between the Preliminary Line Route and the Preferred Proposed Line Route

COUNTRY	SECTION	Total Length		Number of Angle Towers	
		Preliminary Line Route	Preferred Line route	Preliminary Line Route	Preferred Line Route
2 x 500 kV AC Lines from Mandaya to Kosti					
Ethiopia	Mandaya to Sudan/Ethiopia Border	168 km	158 km	84	20
Sudan	Sudan/Ethiopia Border to Rabak/Kosti	430 km	386 km	65	57
TOTAL		598 km	544 km (9% less)	147	77 (48% less)
1 x 600 kV DC Line from Kosti to Nag Hammadi					
SUDAN	Rabak/Kosti to Sudan/Egypt Border	1,170 km	1,130 km	267	69
EGYPT	Sudan/Egypt Border to Nag Hammadi	550 km	535 km	61	46
TOTAL		1,720 km	1,665 km (3.2% less)	328	115 (65% less)

5.3 ALTERNATIVES WITHIN THE PROJECT BASE CASE

5.3.1 TRANSMISSION LINE ROUTES - ETHIOPIA

Following phase 1 of the study a first preliminary line routing option between the Mandaya HPP and the Sudanese border near the town of Gizen was established based on the criteria outlined above (least cost, minimum distance, etc). This was based on a desk study that utilised a careful synthesis of the existing maps, including Phase I considerations and Google Earth views from the Mandaya site to the Sudanese border. This preliminary route was expected to have approximately 84 angle towers and an estimated total length of 168 km. This preliminary route was further refined during Phase 2 of the study (Module M2 - topography and survey for line routing) the field component, which was undertaken between 12 and 24 July 2008.

Throughout Phase 2 of the study, alternatives were evaluated based information obtained from key informants during the site visits and environmental & socio economic considerations forwarded by the respective professionals. The overall aims of route refinement were to:

- minimise/avoid adverse impacts;
- minimise the length of the line route;
- utilise existing road facilities as much as possible; and
- minimise the number of angle towers in order to have the straightest possible line route.

In doing so, the refinement is expected to have about 20 angle towers and an estimated total length of 158 km.

A summary of the key differences between the preliminary route and the refined route are outlined in table below.

Table 8 : Ethiopia Section – Route Analysis

Characteristics	Preliminary Route	Preferred Proposed Route
Permanent road access length	30km of permanent road access. Traverses along (100m) existing roads & trails	50km of permanent road access. Crosses most of the existing roads, goes parallel (2-5km) along existing road.
Crossings	Main crossing - Abbay River (300 m width)	Main crossing - Abbay River (250m width)
Vegetation	Moderate to low value woodland – no protected areas crossed	Moderate to low value woodland – no protected areas crossed

Characteristics	Preliminary Route	Preferred Proposed Route
Settlements	Traverses a number of settlement centres; may led to relocation of about 569 people	Traverse only scattered rural settlements; may led to relocation of about 241 people
Public Infrastructure	Expected to affect some schools, clinics, etc.	No infrastructure is affected
Cultural Heritage & Historical Sites	Affects Graveyard Site	No cultural site is affected
No of Bend towers	84	20
Length estimated	168 km	158 km

As described above alternatives were considered throughout the course of Phase 2 evaluating every section of the route in order reduce and minimise adverse impacts and improving the construction and operational criteria of the transmission line, i.e. increasing the transmission alignment along permanent roads to aid construction and maintenance activities. The refined route has distinct advantages in terms of cost, environmental and social impacts and as such is currently the preferred option.

5.3.2 TRANSMISSION LINE ROUTES – SUDAN

The preliminary line routing constituted the basis for the Current re-routing Survey. The on-site reconnaissance revealed that the majority of the points were reasonably positioned. However, minor and major changes for the re-routing alignment were recommended on grounds of justifications based on physical, social and/or environmental aspects.

The main reasons for movement and re-routing included:

- Avoidance of existing and proposed transmission lines
- Avoidance of crossing asphalt roads
- Moving a distance away from villages
- Moving points nearer to roads for ease of construction, monitoring and maintenance purposes
- Avoidance of forests and dense grass cover for the purpose of easy accessibility

Refer to next table for specific details recommended route, route length, and the reasons for the proposed changes.

The proposed preferred route, though in the same environment and general route corridor, has minimal environmental and social impacts compared to the preliminary route. The preferred route therefore provided the best alternative.

Table 9 : Sudan Section Route analysis

Section	Length of Route (km)		Reason for change
	Preliminary Route	Preferred Proposed Route	
Ethiopia Border to Damazen	130.95	121.78	Some points in the preliminary route were an impractical distance from the road, being located deep inside the forest which is difficult to reach and may have meant opening up access route through the forest. Points therefore were moved to be nearer to the road
Damazen to Kosti	254.40	258.32	The change was proposed in order to locate the route points closer to the road
Kosti to North Khartoum	391.22	390.40	The preliminary route remained the same except for the point K6 which was moved to the west to avoid a large village
North Khartoum to Dongola	384.85	383.04	The Route has been moved to the west side of the asphalt road at distances ranging form 500 - 800m some points in the preliminary route. Some points were to the east of the road which may have meant crossing the main road. The proposed route will remain on the west side and will avoid crossing the asphalt road
Dongola to Sudan/Egypt border	356.69	356.62	The proposed Route was moved to the north to avoid crossing the Dongola - Halfa - Transmission Route.
Total Length	1518.11	1510.16	There is an approx. 8km reduction in length on revised proposed route

5.3.3 TRANSMISSION LINE ROUTES – EGYPT

The preferred route corridor is not very different from the preliminary route, but the re-alignment and adjustments have avoided negative impacts which makes the route to be the preferred alternative. Refer to table below for details of the proposed changes to the preliminary route.

Table 10 : Egyptian Section – Route Analysis

Sections where changes are proposed	Justification for the changes
Survey points 266-281 In Aswan Governorate	No changes were proposed in the route from the Sudan Border to South of Aswan as the route passes through the desert area, does not affect communities or settlements, does not affect historical sites, oases, wadis, protected areas, mines or factories
Survey points 281-282 (27) and points 27 – 1 (297) in the Aswan Governorate	The preliminary route was changed due to the fact that it was crossing and interfering with the existing facilities such as the toshka switch yard, the new canal, the 66 kV line and the 220 kV line. The proposed change to the route between survey point 281 to point 282 to new survey point No 27 realigns the propose preferred route to be parallel to the existing 220 kV line.
Survey points 27 – 1 to 298 in the Aswan Governorate	The preliminary route was re-aligned so that it can be parallel to the existing 220 kV and will be futher distance from cement factory (at point No. 9), the line will be 2 km away from the factory and shall not cross any settlements
Survey points 298 – 308 in the Aswan Governorate	The preliminary route was considered to be the preferred route as the line route is parallel to existing 220 kV and is 7 km away from the Aswan air port.
Survey points 309 – 317 in the Qena Governorate	The preliminary route has been re-aligned so that the line route will be parallel to the existing 500 kV, shall not cross any settlements and shall be far from the sewage plant at Esna by 500m. (The preliminary route was crossing the sewage plant).

5.4 WITHOUT PROJECT

In line with best practice for ESIA the alternative of "Without Project" has also been considered. The "Without Project" or "Zero" option would mean that the Project would not take place and the Eastern Nile Power Trade Project would not happen.

The fundamental benefit of the Project is the potential gain for the local, regional and national economies and specifically for the potential employees of the Project. It is against the economic background that the "Without Project" option can be assessed.

Should the Project not go ahead, the environment would remain in its current state and the negative impacts listed in the ESIA would not take place. However, the impacts are mitigated and the environmental impacts can be managed in the short and long term, and are deemed to be acceptable.

Without the Project the following positive and direct benefits would be lost:

- Sustainable Electrical power for 3 countries for a long period of time.
- Direct employment opportunities and the associated economic multiplier effect for the local communities;
- The positive impact on the regional and national economies through taxes and royalties that increase national wealth with a trickle down effect leading to improved services.

5.5 THE PREFERRED POWER TRANSMISSION LINE ROUTE

From the above analysis of the route alternatives, the preferred proposed route as outlined before has therefore been adopted on which to base the feasibility study which is presented in this report.

6 PHYSICAL ENVIRONMENT

This section has been prepared with reference to the Eastern Nile Power Trade Program Study, Phase II: Regional Power Interconnection Feasibility Study – Inception Report, EDF et al, April 2008, Tropics, 2008; EPS, 2008 and YAM, 2008. This section describes the physical baseline environment along the entire route corridor as obtained from the literature review and field data collection.

6.1 BACKGROUND

The route corridor is described in detail in section 4, Project description, of the report. The physical environment is described according to the route sections shown in next Table.

Table 11 : Power line route specifications

No.	Country	Section of the Route	Total Length (Km)
2 X 500 kV AC Power Lines – 130m ROW required			
1	Ethiopia	Mandaya Dam to Sudan Border	158
2	Sudan	Sudan Border to Rabak / Kosti	366
1 X 600 kV DC Power Line – 80m ROW required			
3	Sudan	Rabak / Kosti to Sudan Border	1130
4	Egypt	Sudan Border to Nag Hammadi	535

Source: EDF et al, November 2008, Module 2

6.2 ETHIOPIAN SECTION

6.2.1 CLIMATE

6.2.1.1 Rainfall

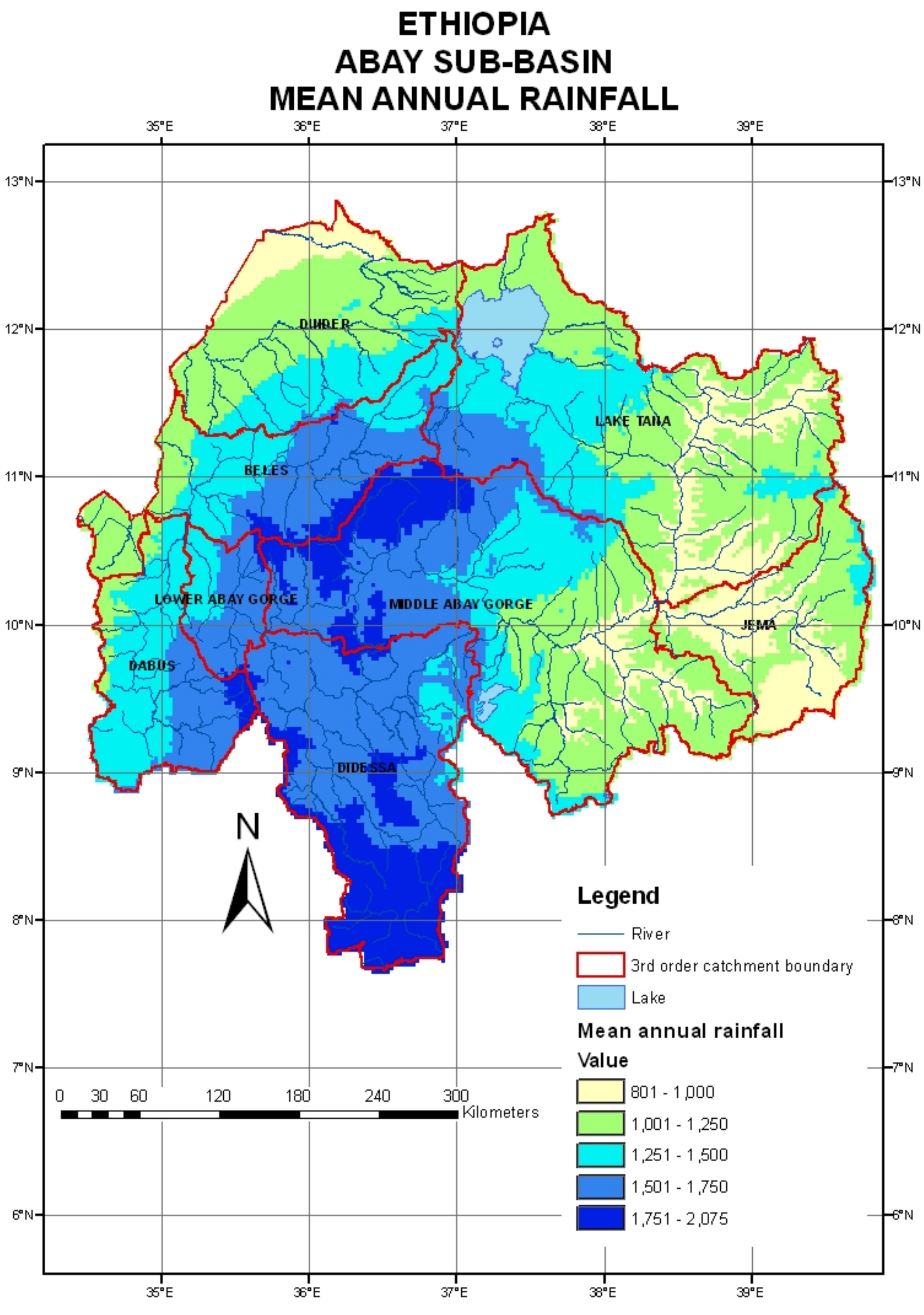
Rainfall in the project area has mono modal pattern which is characteristic of western Ethiopia including the Benishangul Region (BGNRS). The wet season is long and usually extends from April/May to October/November. The field investigation was conducted in the middle of the rainy season which makes movement both walking and driving difficult. On the other hand, the wet condition enabled an easy identification of vegetation through visible leaves & fruit. Rainfall generally decreases from the start of the line route around Mandaya to the end of the Ethiopian section at the Ethiopia / Sudan border. Average annual rain fall is estimated to be 1,200 mm in the project area.

Figure indicates mean annual rainfall of the Abbay sub basin based on the Country report (Tecsult et al., June 2006).

The only metrological station which is found in the vicinity of the line route is at Koncho, which provides an indication of the rainfall conditions near to Mandaya. The station is located at the entrance of Koncho rural town and is shown in next Figure.

6.2.1.2 Temperature

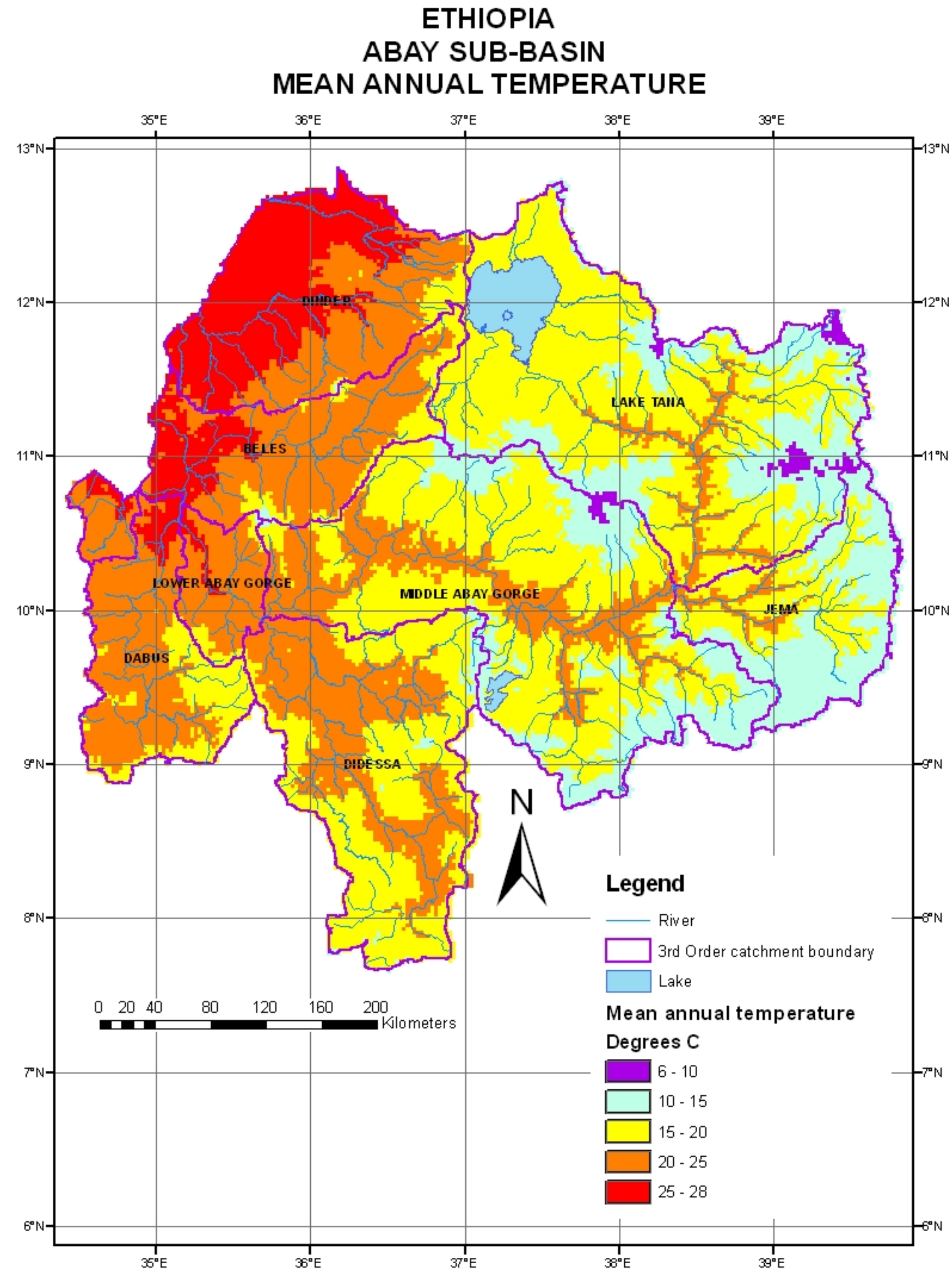
The project area is located in a relatively hot part of the Abbay basin in the Ethiopia territory and has a mean annual temperature between 25 and 28^{o}C. As indicated by local informants and previous knowledge of the area, the temperature condition in the dry months of February and March, which exceeds 40^{o}C in Sirba area that could influence construction activities. The period is also known with occurrence of natural and human induced fire. The temperature condition in the project area is shown in figure based of the CRA report 2006.



Source: Ethiopia Country Paper, Hydrosult et, 2006

Figure 11 : Abbay Basin: Mean Annual Rainfall in the Abbay Sub Basin

Figure 12 : Metrological Station at Koncho Town



Source: Ethiopia Country Paper, Hydrosult et, 2006

Figure 13 : Abbay basin: Mean Annual Temperature

6.2.2 WATER RESOURCES

The power line route crosses the Abbay River right after coming out of the Mandaya Power Station. The other major river that will be crossed by the line route in Ethiopia is Dabus River which is a major tributary, next to Beles River, of Abbay River in the downstream area. These major rivers have no crossing, however as observed during the time of the field investigation construction of road and crossing bridge is under progress. The line route will cross a number of small river tributaries which are main water source to human & livestock population. Furthermore, these water sources are used for small scale gold mining (traditional gold panning to washout gravel and soil matters in the process of searching fine gold particles.)

6.2.3 LAND USE AND LAND COVER

Natural mixed woodland is the dominant land cover that can be observed throughout the power transmission route. As the name suggests, most of the tree species are deciduous and remain without leaves during the dry season. The field survey was conducted in the middle of the rain season hence deep greenery of the trees and the undergrowth observed. The density of woodland is higher in mountainous areas and where settlements are absent.

Crop production along the power transmission line route and the surrounding area is limited. The main section with relatively intensive crop cultivation is the Koncho and Daleti area. This section lies between 44 km to 55 km from Mandaya. Sparse cultivation plots are also observed in Gizen, Shegole and Menge areas. The main crops grown include sorghum, maize and sesame. Furthermore, various vegetables and shrub food plants such as “Kenkes” are grown, especially around settlements and provide part of the staple diet. The people also depend on wild fruits as source of food and main natural plants with wild fruits include Ficus sycomors, Tamarindus inica, Ximenia Americana, Oxytenanthera abyssinica, Commifora Africana, Ziziphus spina-christ, Carisa edulis, Syzygium guincense, Adansonia digitata, Cordia Africana.

Extent of the different land use and land cover in the ROW was made based on site observation. Table below provides the rough estimate and has been used to evaluate impacts due to the project implementation.

Table 12 : Estimate of land use cover in the Project Right of Way, Ethiopia

	Option I		Option II	
Type of land use	**Area (m^2)**	**% in the ROW**	**Area (m^2)**	**% in the ROW**
woodland	9908811	45	12043872	59
Open grass land	747067	3	576221	3
crop cultivation	5221858	24	5075511	25
Settlements	3571807	16	1752175	9
Other infrastructures	2424777	11	858221	4
Total	21874320	100	20306000	100

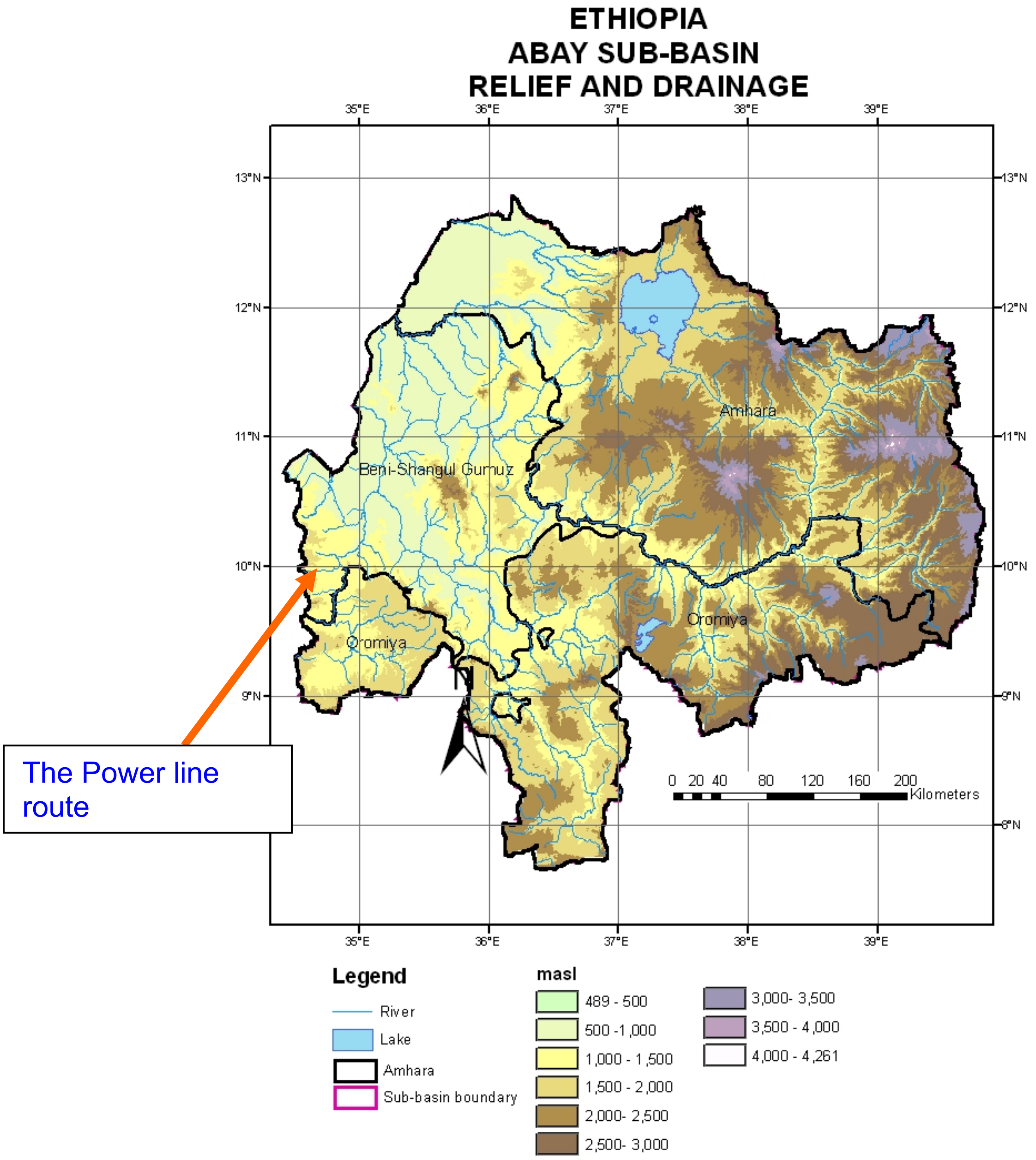
Source: Observations during field survey, July 2008

6.2.4 TOPOGRAPHY

The topography along the power transmission route and surrounding area has been obtained through site investigation, use of 1: 50,000 scale topographic maps, previous study documents and knowledge of the route locality. The Mandaya Power Station is located about 2km downstream of the dam location and the topography is undulating to flat land (approximately 640 masl). It is located outside the Abbay River flood influence area yet there could be potential flood hazard from small tributary rivers that originate from the Wonbera highland area (3,000 masl).

Right after the station, the route crosses the Abbay River which consists of flood prone side banks. Upstream of Mandaya dam the Abbay River flows in a deep narrow gorge. It starts stretching after the Mandaya dam site and the width of the river varies from few hundred meters near the substation to km in the Sudan plain area. The lowest altitude of the route is found in Abbay River crossing section which is about 620m.a.s.l. The line route then traverses undulating, rolling and hilly topography and the maximum altitude in the route section could reach 1200 masl. The power line route generally avoids traversing in mountainous terrain with high altitude which are located in the surrounding area. Settlements and crop cultivation were hardly observed as most of the mountainous areas have dense natural vegetation cover.

The general relief and drainage condition in the Abbay River sub basin is shown in Figure.



Source: Ethiopia Country Paper, Hydrosult et, 2006

Figure 14 : Relief map of the study area

6.2.5 SOILS & GEOLOGY

The soils and geology of the power line route and surrounding area was captured using field observation, professional judgment and review of previous working materials as indicated in the reference list and cited in the following section.

6.2.5.1 Geology

The geology of the area, starting from Mandya dam site, along the route to the Ethiopian-Sudan border are Diorite, Granodiorite, syntectonic granites, Birbir group and Adigrat formation. Adigrat sandstone is a Variegated quartzose sandstone of fluvial or littoral origin. It consists typically of yellowish to pink, fine to medium grained, non calcareous, well sorted, cross-bedded quartz sandstone. It becomes calcareous in places at the top, with the development of thin beds of limestone. The Adigrat sandstone formation is mainly observed in the route sections that extend from 33 to 900 km from the Mandaya power station. Syntectonic granites consist of Granites formed during the major episodes of folding and metamorphism that form large massifs aligned parallel to the trend of the surrounding rocks. It is commonly pink or yellowish grey and is some times porphyritic containing large crystals in a finer grained matrix. Granites are encountered north of Daleti town at the contact between the Diorit. According to the second edition of the Geological map of Ethiopia (1996) Birbir group consists of Meta basalt, meta andesite, greenshchist, phylite, meta conglomerate, quartz and marble. Marble and gold minerals potential are known in different part of the Benshangul region. Gold is mainly extracted through traditional means where as modern mining of marble has been practiced around Daleti area for the past decades. The Birbir group and Granodiorite are encountered mostly along the power line route.

The potential of marble in different part of the region is indicated in the BGNRS investment office bulletin. Estimates in various areas in the vicinity of the Project, include 2,803,394 m^3 around Daleti; 24,511,410 tonnes in Bullen; 17,110,000 tonnes in Burada; 46,540,000 tonnes in Mora and 4,980,000 tonnes in Ekonto area. Gold is the main and widely occurring metallic mineral and traditional gold panning is considered as one important economic activity in the region.

Figure shows the distribution of the various geology types along the power route and surrounding area.

6.2.5.2 Soils

The major soil types in the power line routing and surrounding area are Haplic nitosols, rhodic nitosols, Haplic Acrisols and Haplic Alisols and Euteric leptisol. The main soil forming factors such as climate, topography, organisms, parent material and time give rise to the thickness, amount of organic matter in soil and mineral assemblage. Nitisols are derived from basalts/tuffs and granites/associated felsic materials. The soils are reddish brown in colour, clay to clay loam in texture, well drained and very deep. It also has good permeability, a favourable structure, and high water holding capacity. Haplic nitosol soil type covers large area along the power route line. It covers large area of the Benshangul Gumuz regional state as well. It is also observed at the lower river valleys of Dabus and Abbay rivers close to the border of Ethiopia with Sudan. The Rhodic nitosols are found along the narrow strip parallel to the route and their coverage is not as wide as Haplic Nitosols.

There is very little presence of Hapic Alisol noted from approximately 16 km to 400 km (Section II – IV) along the power line route. These soils are reddish brown in colour and have deep profiles, usually exceeding 100 cm. Alisols are mainly derived from basalts, granites and granodiorites and possess favourable drainage, structure and workability.

Euteric leptisol is the shallowest of all the soil and found in the last section of the route close to Ethiopia –Sudan border. They are shallow soils with limited profile development and are usually prone to drought. Apart from offering limited grazing resources they have little sustainable agricultural potential. The susceptibility of these soils to erosion is one of the reasons which preclude their sustained use. The Leptosols are developed on relatively young surfaces and were probably only moderately deep to deep by origin. The last section of the route comprises Acrisols which are mature soils that have developed on old land surfaces characterized by seasonally wet and dry humid tropical climates. They exhibit strongly weathered profiles and may be affected by aluminum toxicity and high phosphorus fixation. Figure shows distribution of the various soil types along the power route and surrounding area.

Soil erosion hazard

Soil erosion hazard is dependent on topographic feature, slope gradient, vegetation cover, rainfall and soil type condition of the area. Deforestation, over cultivation, overgrazing and overpopulation are known to initiate and aggravate soil erosion which ultimately results in land degradation.

Soil erosion rate in the power transmission route and surrounding area could be considered low. The work conducted during the Abbay Master Plan Study (BECOM 1999) and the recently CRA study by ENTRO (Tecsult et al., June 2006) showed low erosion hazard in the lower section of the basin including the project locality. The CRA assesses the extent of soil degradation in terms of erosion and produced a report that describes percent of weredas with moderate to sever erosion hazard. The power line route traverses through four woredas and all of them were found out in the least severity class (0-11%). Figure shows soil erosion hazard by woreda.

The Phase II ESIA site visit and investigation conducted in July and August 2008 found few soil erosion features along the line route and surrounding area. This is due to factors observed such as dense/sparse woodland with shrub and grass undergrowth, low population density (less than 10 people per km square), limited agriculture practice on plain and undulating land. In recent years. However various development initiatives that were conducted without the due consideration to the environment resulted in deforestation and increased soil erosion in different part of the region as read out in reports obtained from regional offices. Discussion and consultation with the natural resource experts in the BGNRS also depicted increased soil erosion risk in the recent years. Implementation of the power transmission consists of vegetation clearing for temporary and permanent access roads, pit excavation and other activities that may initiate erosion. The situation could be worst in areas with higher slope gradient hence the necessary precaution and mitigation required to prevent erosion.

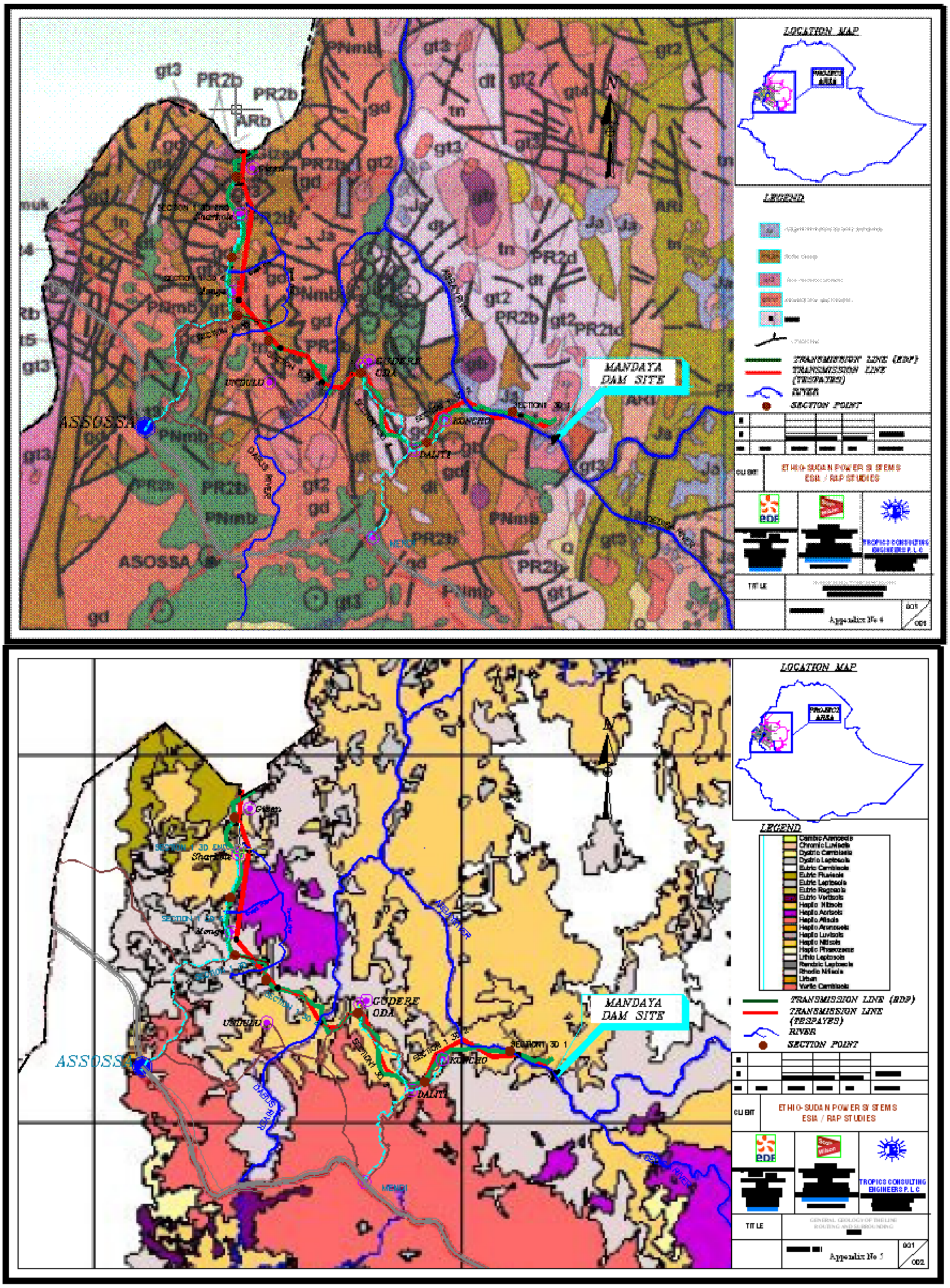
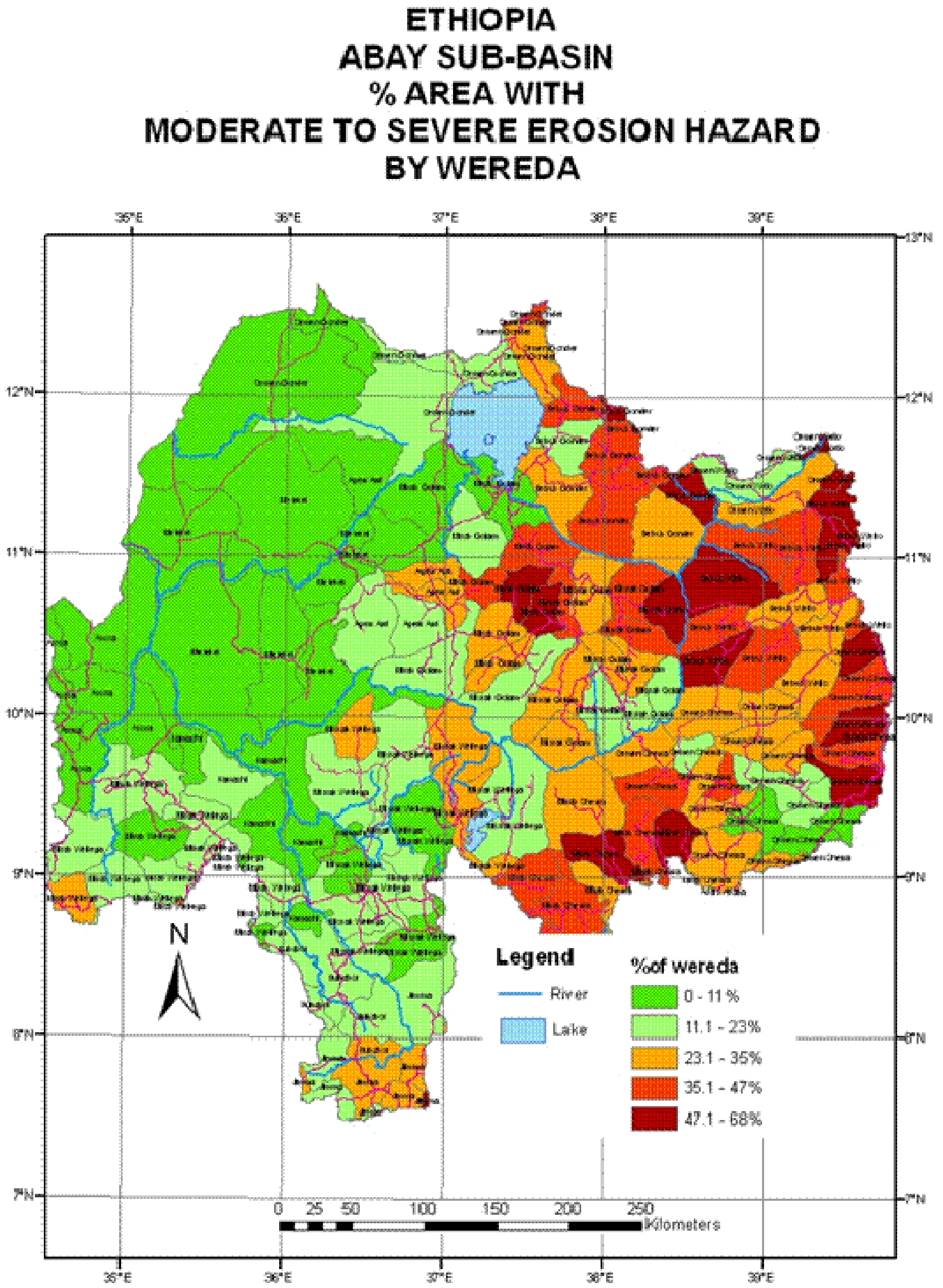


Figure 15 : Geology of the Study area



(Source: Tecsult et al., June 2006)

Figure 16 : Soil Erosion hazard map

6.3 SUDAN SECTION

In discussing the physical environment of the Sudan Section, the discussion on the route corridor will make reference to two sections: A) Ethiopian/Sudan Border to Rabak / Kosti Section and B) Rabak / Kosti to Sudan/Egyptian Border.

The Ethiopian/Sudan Border to Rabak / Kosti section traverses areas within Sudan for a distance of 366 Km. This route corridor covers an area with high rainfall of over 1,000 mm with mixed forest with grassland and gives way to flood plain conditions as the route corridor traverses the most fertile and extensive agricultural areas between the Blue and White Nile rivers.

The Rabak / Kosti to Sudan/Egyptian Border section of the route corridor has a total distance of 1,130 Km, traversing an area of flood plain conditions from Rabak / Kosti to desert conditions from North Khartoum.

6.3.1 CLIMATE

6.3.1.1 Rainfall

The climate of Sudan is wholly tropical and varies from complete desert north of Latitude 18N through regions of semi-desert with rainfall of varying intensity and duration, passing southwards into a continental equatorial type of climate with a considerable dry season (Barbour, 1961). Rainfall is seasonal and for much of the country it is related to the position of the inter-tropical convergence zone. The country has a dry season from November to April, and rainy period from May to October. In recent years precipitation has been less and unreliable.

In the Ethiopian/Sudan Border to Rabak / Kosti Section, the highest rainfall is found in the southeast at the Ethiopian border where the mean annual rainfall exceeds 1,000 mm/yr. Over much of the southern part of the route, rainfall varies between 750 and 1,000 mm/yr. In the area near Rabak and Kosti, the rainfall decreases northwards from 750 to 250 mm near Khartoum. The rainfall variability increases from south to north.

In the Rabak / Kosti to Sudan/Egyptian Border section, the annual rainfall isohyets generally run southwest to northeast, ranging from less than 25 mm in the north to 400 mm (UNDP/World Bank, 1988). Rain falls mainly between July and September in a single season. Two broad rainfall belts are recognized:

- from < 25 mm near the border with Egypt to 150 mm near Khartoum, rains are erratic with a coefficient of variation (CV) as high as 100 percent; and
- from 150 mm near Khartoum to 400 mm near Kosti, rains are variable with CV's as high as 30 percent.

6.3.1.2 Temperature

Daily minimum and maximum temperatures in January are 14°C and 33°C and those in May are 24° and 44°C respectively. The mean annual temperature in the area near Rabak and Kosti is 28°C falling to 25°C at the border with Ethiopia.

Temperatures are high with a mean daily winter temperature of 16° C in the north and 29° C in the south of the country. During the summer the highest mean daily summer temperature at Atbara on the desert edge is 43° C, while at Wadi Halfa in the desert temperatures of 52° C are common. At Khartoum 47° C is frequently experienced in the months preceding the rainy season (Whiteman, 1971).

6.3.2 WATER RESOURCES

6.3.2.1 Surface Water Resources

The average annual flow of the White Nile at Khartoum is approximately 26km^3. The Main Nile from the confluence of the Blue and White Niles flows 1,500 km from Khartoum to Lake Nubia (Nasser). The river flows through a series of cataracts with a total drop of 250 m. The seasonal flow pattern exhibits the combined characteristics of the two main tributaries with the seasonal pattern of the Blue Nile superimposed on the regular pattern of the White Nile. Figure presents an overview of surface water resources of Sudan

There are a number of ephemeral streams (wadis and khors) that flow during the rain season. The more important of these include the Gash on the east bank and the El Milk on the west bank.

The average annual suspended sediment entering Lake Nubia (Nasser) is estimated to be 120 million tons of which 72 % is from the Blue Nile, 25 % from the Atbara and only 3 % from the White Nile.

6.3.2.2 Groundwater Resources

Four categories of ground water basins have been recognized in Sudan as a whole (Tecsult International et al., 2006) based on the geological formations:

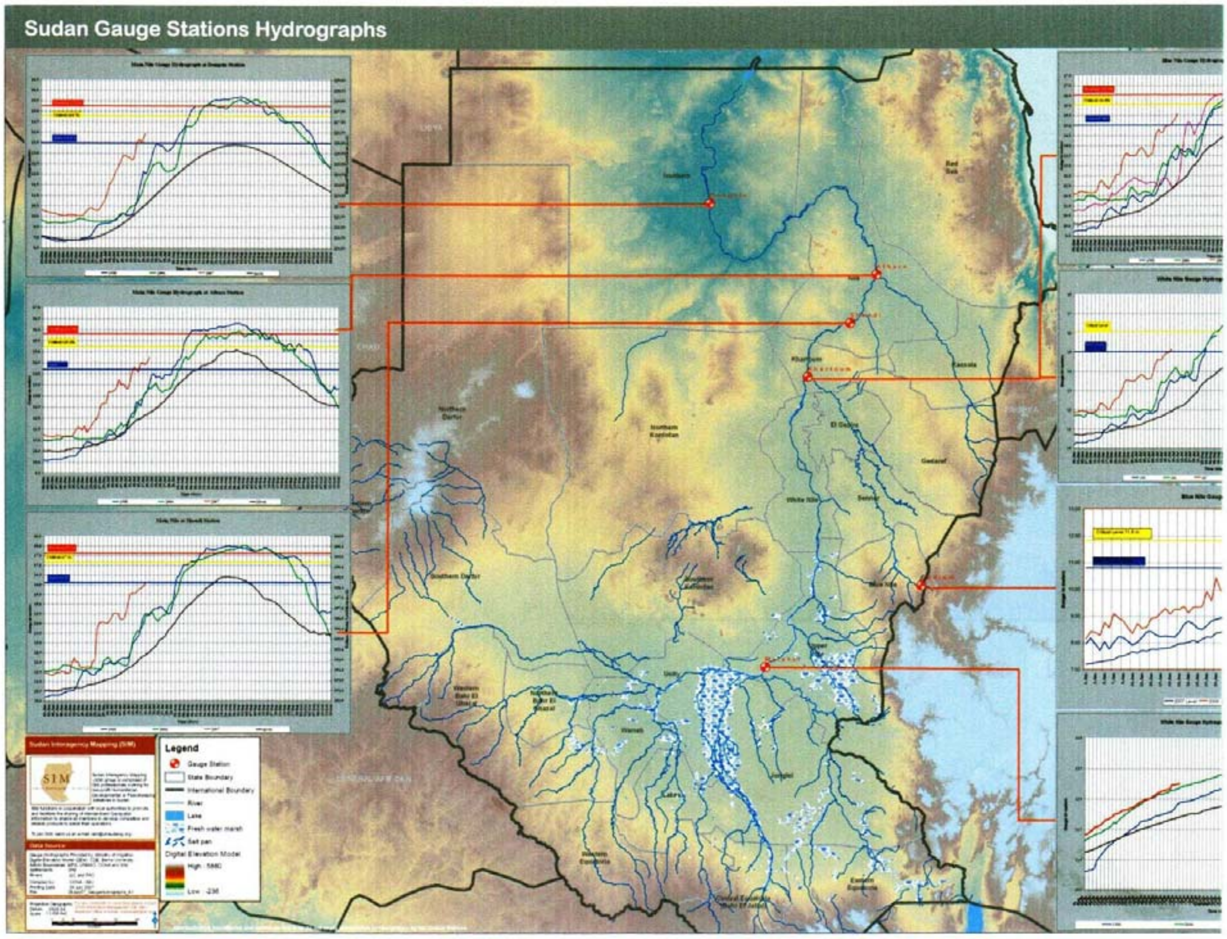
- fractured/weathered basement complex aquifers;
- Nubian sandstone basins;
- Detrital Quaternary-Tertiary Basins; and
- Recent Alluvium Basins.

Basement complex rocks only have a limited ground water yield but are especially important in the rainfed farming areas where reliable water supplies are a major constraint to agricultural development.

The Nubian sedimentary formation forms the most extensive and largest ground water basin in Sudan. Although recharge from rainfall is limited an annual amount of 1,074 million m^3 is received from the Nile River system. The quality is good to excellent with salinity values rarely exceeding 600mg per litre.

The Quaternary-Tertiary aquifers are located in a steep sided rifted basin in the Blue Nile Rift in Sennar State. The total annual recharge is estimated at 160million m3. Water quality is variable with local highly salinized zones.

The alluvial basins are located along most seasonal streams and are recharged from rainfall and season flows. Water quality is generally good. Along the Gash and other streams shallow hand dug wells are used to irrigate small plots of vegetables.



Source: Tecsult et al., September 2006

Figure 17 : Water resources of Sudan

6.3.3 LAND USE AND LAND COVER

Figure gives the land cover of Sudan. The discussion below gives descriptions related to the route corridor of the power line.

6.3.3.1 Landcover and Vegetation

Figure shows the vegetation cover of Sudan, the route corridor traverses across the country for the south east to the north of the country, therefore the route corridor has the whole cross-section of the land cover in Sudan from woody areas to bare desert areas. From the analysis of a 10 km transect using the GIS facility, it shows that the land cover and land use pattern around the transmission line follows a general pattern within the transect from Gizen to Dongola is as follows:

- Bare areas 401,170 ha
- Agriculture 295,673 ha
- Rangelands 467,806 ha
- Woody areas 38,827 ha

The line transect from Dongola up to Omdurman in dominated by bare areas with few scattered grazing areas. Rangelands with few agriculture activities are encountered in the area between Omdurman – Kosti. The area from Rabak to Damazine is predominantly occupied by traditional and mechanized agriculture in association with rangelands and forests stands of *A..Seyal* and *A.Senegal* in admixture with grass cover. The transect from Damazine to Geissan is dominated by woody-grass cover in association with rangelands and agricultural activities. Multiple land use activities incorporate agro-sylvo-pastoral land tenure system.

Fire hazards & vegetation burnings are frequently encountered along and in the vicinity of the route. The volume of feed for these fires is not big in the northern and central parts of the route. However, the small section from Damazine to Geissan is characterized with heavy grass cover and dense forests which increase the potentiality of serious burnings. Precautionary measures are necessary and the possibility of tree and grass clearance and establishment of fire lines along the right of way should be seriously considered.

The patterns of natural vegetation cover is closely related to the mean annual rainfall of the specific areas and regions. This pattern is observed to be altered where overgrazing, deforestation, burning and cultivation is intensive. Therefore some sections of the route corridor's, landcover is influenced heavily by human activities. The landcover on the route sections through the flood plain environment (Damazen to Ed Dueim) is heavily influenced by intensive agricultural activities

6.3.3.2 Acacia Thornland alternating with Grassland

Between the 360mm and 570mm isohyets on the heavy clays grassland merges into *A. mellifera* thornland. Other tree species include *A. nubica, C. decidua, Cadaba glandulosa, C. rotundifolia and Boscia senegalensis.* The last three species often persist after A. mellifera has been cleared. Much of this vegetation is being cleared for small-scale sedentary and large-scale semi mechanised agriculture.

Grass species include *Cymbopogan nervantus*, *Sorghum purpereo-sericeum*, *Hypparhenia ruffa*, *Tetropogan cenchriformis* and *Cenchrus cilliaris*. Sufficient grass dry matter is produced to provide material for annual burning.

6.3.3.3 Acacia seyal-Balanites Savanna

From the Ethiopian border to El Jebelein (above 570mm rainfall isohyet), there is increasing dominance by *A. seyal* in association with *Balanites aegyptiaca*. *A. senegal* is retained for gum arabic harvesting whilst *A. seyal* is used for charcoal production. *B. aegyptiaca* becomes increasing prevalent because it is fire resistant, does not produce good charcoal and is hard to cut.

The grasses tend to occur in pure stands of *Hyparrhenia anthistirriodes* or *Cymbopogon nervatus* with *Sorghum spp*. in the higher rainfall areas. These grasses become largely unpalatable to livestock during the dry season. There is abundant material for annual fires.

6.3.3.4 Semi-desert grassland shrubland

The area from ED-Duem to Jebel Aulia and up to Omdurman is covered by scanty Semi-desert scrub and grass land. Acacia tortillas are the dominant tree species growing on sandy loam soils. The area is thinly populated along the proposed route between points K_7 and $_{K6}$. Few scattered small hills and wadis are encountered. South of Ed-Duem and up to Kosti the semi-desert vegetation gets a bit richer and changes into thorn Savannah and scrub of *A.tortillis*, A. *chrenbergiana, L. pyrotechnica* and *P. turgidum* with small pockets of *ziziphus spina-christi* and *A-nilotica* on depressions and wadis. The route traverses areas of low cover grassland with sparse shrubs and trees; the population density is low and scattered in single or groups of small villages.

6.3.3.5 Desert dunes without perennial drainage

The route from North Khartoum (Omdurman) to Dongola passes through flat desert terrain with sandy soils and very light vegetation. It traverses areas which are sparsely populated with subsistence agriculture along narrow strips on the Nile banks. Ephemiral grasses with few scattered trees of acacia species are rarely encountered, especially at depressions and water courses. Generally, the surroundings of the route are characterized by flat terrain with sandy looming soils and vast areas devoid of vegetation cover.

6.3.3.6 Absolute desert

This refers to the area from Dongola to the Egyptian Border. This area represents absolute desert characterised by sandy dunes and bare mountains and hills. The only area with vegetation is along the Nile where alluvial soils occur and irrigation agriculture is undertaken.

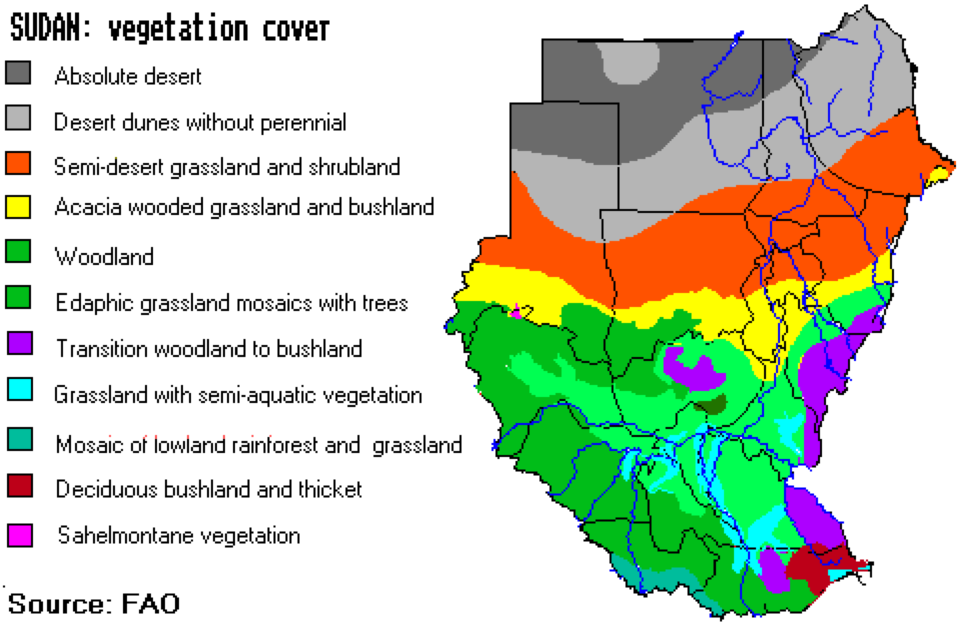


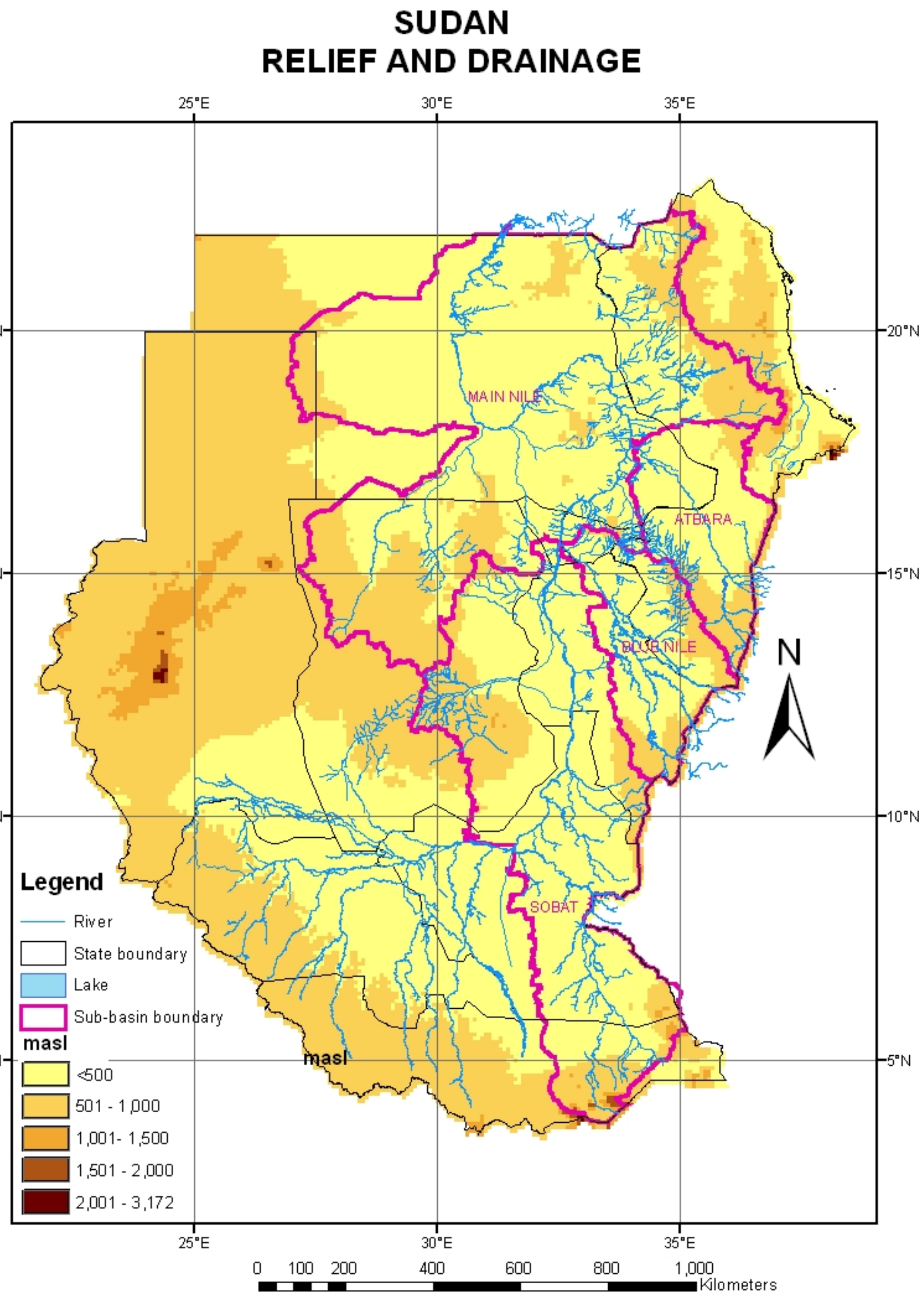
Figure 18 : Land Cover Map of Sudan

(Source: YAM, November, 2008)

6.3.4 TOPOGRAPHY

The Study area is mainly underlain by the Gezira Quaternary and Recent alluvial sediments carried by the Blue Nile, which rest unconformeably on the Nubian Sandstones (Ismail Elboushi & Yassin Salam, 1983) There are three main members: Upper Clay, Lower Sandy and the Mungata sandy Clay.

The Nubian Sandstones outcrop in the north near Khartoum where it consists of conglomerates, sandstones and mudstones. Topography of Sudan can be seen from the relief map presented in Figure.



(Source: Shuttle Radar Terrain Mission (SRTM 90) digital terrain model)

Figure 19 : Sudan: Relief and Drainage.

6.3.5 GEOLOGY

According to Whiteman (1971); Vail (1990) and Grass (2002) the Sudan is made up of the following major geological units: Basement Complex, comprising highly folded and metamorphosed ortho– and para-gneisses and schists intruded by syn-tectonic batholithic granitoids and gabbroic masses.

Post-tectonic central igneous complexes of variable composition and age, some of which are in the form of well developed ring complexes. Extensive phanerozoic sedimentary cover of relatively undeformed deposits. Cenozoic mid-plate basaltic volcanism which occur as discrete volcanic centres and plateau basaltic flows associated with the Ethiopian Rift Valley magmatism.

The rock types that characterize the route section are the Basement Complex rocks which include: Gneisses, migmatites, marble and granitic rocks. These rocks are dissected mostly by NW-SE fault lines.

The geology in the Rabak / Kosti to Sudan Border section is dominated by Nubian type sediments of the Nubian Super-group. The sediments unconformably overlie the Basement Complex rocks that crop out near chainage K4. Sandstones, clay stones and conglomerates are the dominant facies of the Super-group. Ferruginous crusts interbedded with sandstones and siltstones are frequently found in the route area. Beds can rarely be followed over long distances and rapid lateral facies variations are typical of these sediments. The sediments are believed to be of Cretaceous to Tertiary age (Prasad et al., 1986).

The topography, in this route section, apart from the sand dunes (Qoz sand) is generally flat plain cut by Wadis and Khors that drain into the White Nile. These sand dunes are about 2 m to 5 m high from ground level.

The main underlying geological formations within the Main Nile Sub-basin include the older Basement Complex rocks, the Nubian Sandstones, Tertiary unconsolidated sediments and recent superficial wind blown sands. The Basement Complex comprises gneisses, schists, marbles and intrusive granites and basic rocks. The Nubian Sandstones overly unconformably the Basement Complex rocks and comprise mainly sandstones, siltstones and conglomerates. This formation forms the main groundwater basins in Sudan.

The topography along the line routing in the section from North Khartoum to the Sudan / Ethiopia border, this section is flat to undulating with some localized small hills and sand dunes (Qoz sand) and moving sand sheets particularly at chainage K48 (Qoz Abu Dulu and at chainage 001S (Baja sand sheets). Between chainage004S and chainage 002S the route will traverse along clayey sandy silty soils (upper Nile terrace). The route will cross a number of seasonal water courses (Wadis and Khors) that drain into the Nile River. At Multaga and from chainage DD6 up to Dongola the route will pass through some localized gravelly ridges of residual soil as well as rocky ridges. Dongola sub-station is located on a residual soil which is underlain by sandstones.

Basaltic rocks were encountered as isolated small hills west of Khartoum at Jebel Toriya within the route area and east of chainage 018 south-east of Multaga.

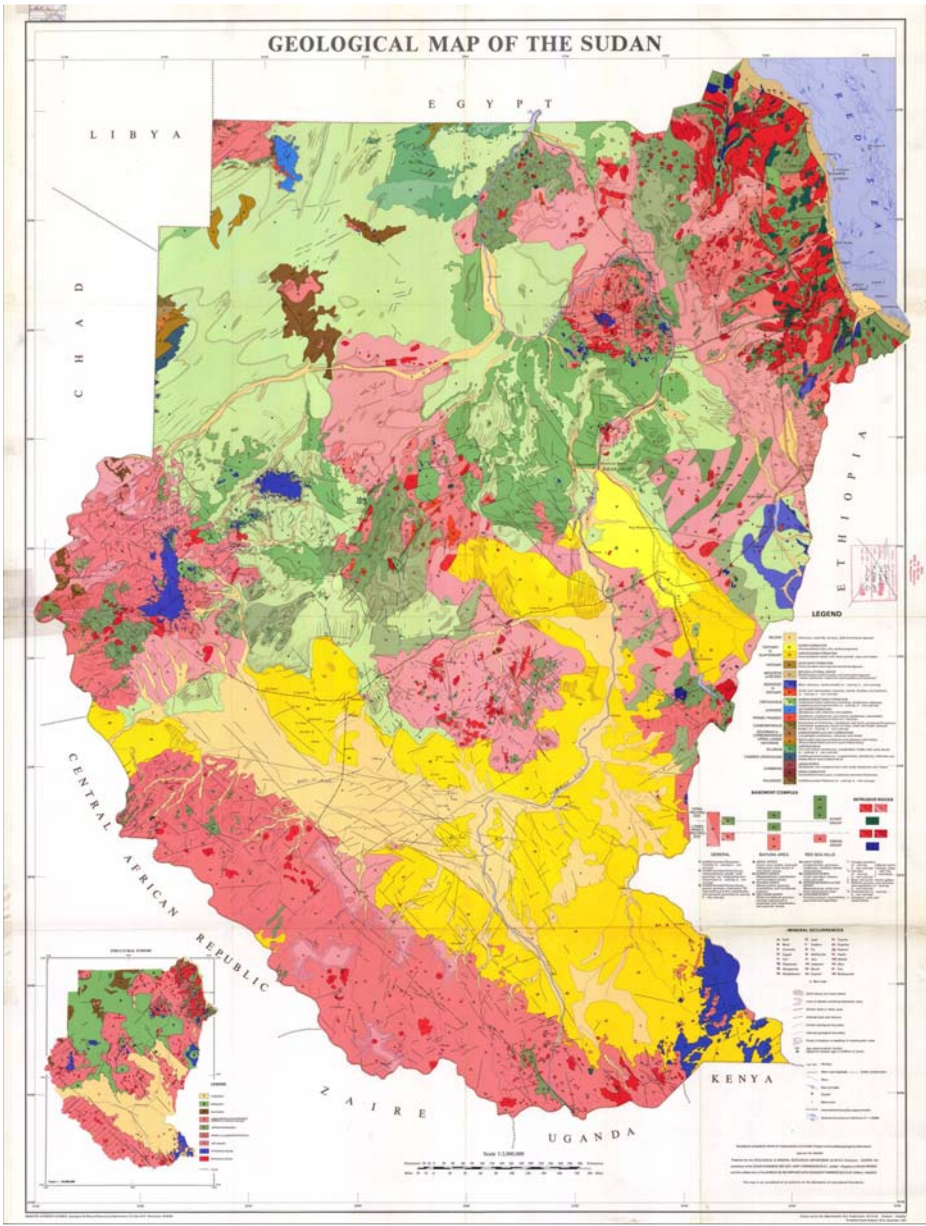


Figure 20 : Geology of the Study area

Source: Geological and Mineral Resources Department, 1981

Figure 21 : Basement complex outcrops at the upper route section (Queissan area).

Figure 22 : Outcrop of Basement complex rocks (microsyenite) at chainage km4

Figure 23 : Dune sand (Qoz Abu Dulu) at chainage 001S of Khartoum - Dongola section

Figure 24 : A hill of Nubian sediments at chainage km7 (road distance sign)

6.3.6 SOILS

Soils in the route corridor can be commonly classified into four groups: (i) thin desert soils consisting of loose sand over bare rock in the north, (ii) fixed or shifting aeolean sands in the north and central parts, (ii) clay soil derived from old and recent alluvium over large areas of th e central and eastern parts.

For the most part of the upper section (Geissan area) the route traverses along hilly area and gravelly sandy silty soils (colluvium). The Recent deposits include the Nile alluvium, sand dunes and the black clays of the flood plains. The route will cross a number of seasonal water courses locally known as Wadis and Khors e.g. Khor Tumad near the Ethiopian boarder. In the middle and upper parts of the section these Wadis and Khors drain into the Blue Nile.

Active gully erosion characterizes the higher parts of the section. However, the lower part, towards Rabak, the topography looks flat with less Wadis and Khors that drain into the White Nile.

The routing will cross the White Nile where Kosti sub-station is proposed. The Kosti sub-station is located in the flood plain which presents a potential flood hazard from the White Nile. The substation should therefore be carefully positioned with flood protection measures taken into account during the design process.

The main soil types are black cotton soil (Gezeira clay) which is known of being impervious and expansive. It overlies the Basement rocks and covers most of the route area, particularly between chainage (road distance sign) 111 and KM 1 (Nile crossing at Rabak).

In the Rabak/Kosti to Sudan Egypt border, especially in the northeast on the hills and ridges of the Basement Complex rocks are shallow, stony and light textured Regosols, Leptosols and Phaeozems of low fertility. These soils are highly erodible. Across the northern part of the section, Arenosols are widespread and are derived from unconsolidated sediments and textures are very sandy. Soils are deep but excessively well drained. These soils are extremely susceptible to wind erosion. Where rock is near the surface these grade into shallow and stony Leptosols. Along the Nile River is a narrow band of Vertisols and Fluvisols.

The main soil types encountered in this route section on Rabak / Kosti to Sudan / Ethiopian Border are colluvial soils (mainly gravelly sandy silty soils) formed, before were transported, by the disintegration and decomposition of some Jebels (hills) of the Nubian sediments. Furthermore, sand dunes (Qoze sand) and sand sheets are present particularly between chainage (road distance sign) Km4 and Kosti. However, the sand dunes are stable because of the vegetation cover. Moreover, alluvial soils occur as higher terraces of the White Nile. In many cases the alluvial soils are overlain by the dune sands.

The main soil types encountered in this section (Kosti to Sudan Border) include residual soil, dune sand and alluvial soil. Residual soil has been formed by the disintegration and decomposition of some hills of the Nubian sediments. Windblown sand was seen in form of dune sand (Qoz sand) and moving sand sheets particularly at chainage 48 (Qoz Abu Dulu) and at chainage D015 (Baja sand sheets). Alluvial soil represent the higher terraces of the Nile between chainages 0045 and 002. Residual soil is formed of gravels of siliceous nature with some sand and fines. The dune and sheet sands are siliceous and fine graine in texture. Alluvial soil is formed of Nile silt.

Figure 25 : Excavated pit (Hafeir) used as water reservoir in the impervious Gezeira clay near road distance sign (chainage) 128

Figure 26 : Cultivated dune (Qoz) and sheet sands between chainage km4 and Kosti

Figure 27 : Residual soil near Multaga at chainage 05 of the Khartoum – dongola upper section

6.4 EGYPT SECTION

The route corridor in Egypt covers a total distance of 535 km mainly through desert terrain from the Sudan Border to Nag Hammadi. The route corridor traverses the Aswan and Qena Governorates of Egypt, therefore the discussions of the baseline information will focus on these two Governorates. Table below gives a description of the route corridor in terms of physical features (the survey co-ordinate points relate to points provided by EDF during the route survey for the Phase 2 Feasibility Study).

Table 13 : Route Corridor and the Related Governorates

Route Section Angle Points	Description of the route
Survey coordinate points 266-281 in Aswan Governorate	Desert area traversed by the route corridor from south of Aswan to the border of Sudan.
Survey coordinate points 281-282 (27) 27 – 1 (297) in Aswan Governorate	Desert area and the proposed route shall be parallel to the existing 220 kV line.
Survey coordinate points 27 – 1 (298) in Aswan Governorate	Desert area, the line route shall be parallel to the existing 220 kV
Survey coordinate points 298 – 308 in Aswan Governorate	Desert area, the line route shall be parallel to existing 220 kV and shall be far from Aswan air port by 7 km.
Survey coordinte points 309 – 317 in Qena Governorate	Desert area, the line route shall parallel to the existing 500 kV
Survey coordinate points 317-325 in Qena Governorate	Mountainous desert area
Survey coordinates points 325 – 327 in Qena Governorate	Land under preparation for agricultural use near Nag Hammadi. finalisation and changes expected for Substation connection to the existing Nag Hammadi substation

6.4.1 CLIMATE

The climate in the route corridor is hot and dry in the summer and moderate in the winter. Mean summer temperature is 31.9^{o}C and the mean winter temperature is 17.1^{o}C. The hottest period is during July and August, whilst the coolest period is December to January. Rainfall is scarce, generally not exceeding 1 mm a year. The area may receive 3 millimetres in some years, but several years may pass without any rain at all. Rain in the eastern desert may occasionally cause flash flooding in the wadis on the east bank of Lake Nasser and into the River Nile. Next table presents the average monthly climatic parameters for the route corridor.

Table 14 : Average Monthly climatic data

PARAMETERS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
Average Air Temperature Degrees C	13.6	15.5	20.2	25.7	29.9	32.1	32.3	31.9	29.8	25.6	19.8	15.1
Maximum Air Temperature Degrees C	22.6	24.9	29.5	35.4	39.3	41.5	41.1	40.5	39.0	34.8	29.1	24.0
Minimum Air Temperature Degrees C	5.9	6.9	11.5	16.5	20.7	23.0	23.9	23.6	21.5	17.3	11.7	7.6
Relative Humidity (%)	58	48	40	32	29	28	31	33	37	42	52	58
Wind speed (@2m agl ms-1)	1.3	1.4	1.4	1.5	1.4	1.5	1.4	1.3	1.2	1.1	1.1	1.1
Solar Radiation (C/cm2/day	374	461	544	613	640	690	685	652	573	491	410	361
Rainfall (mm)	0	1.0	4.0	0	0	0	0	0	0	0	0	0

Source: Yam, 2008

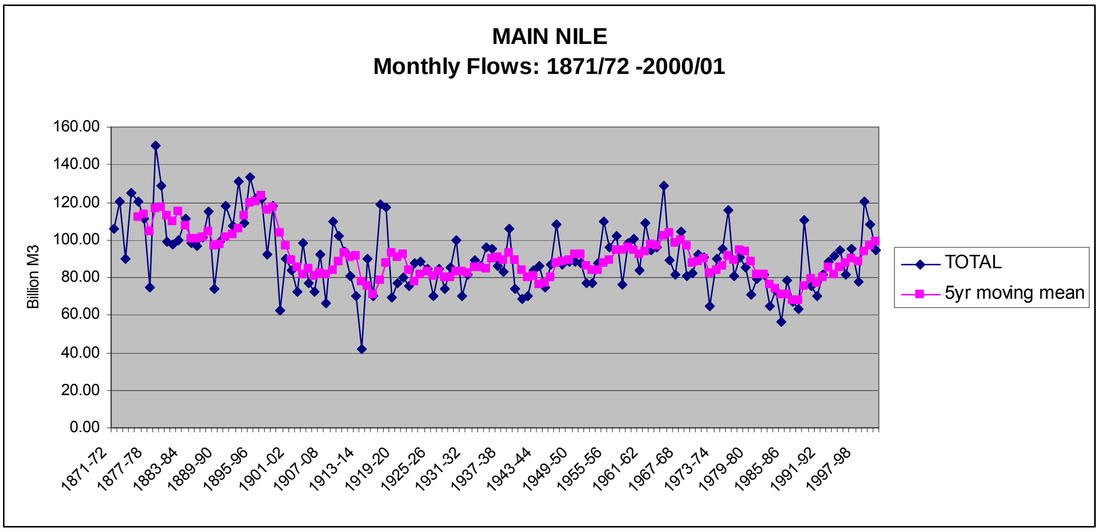
6.4.2 WATER RESOURCES

6.4.2.1 Surface Water

In the areas adjacent to the proposed route corridor, the main source of surface water is the Nile. The seasonal flow pattern exhibits the combined characteristics of the two main tributaries with the seasonal pattern of the Blue Nile superimposed on the regular pattern of the White Nile.

The total annual flow at the border with Sudan has historically been taken (before any significant abstraction) as 84 km^3 (1905-1959) (Tecsult et al., September 2006). However, there is considerable year to year, as well as periodic variations as can be seen below.

It has been noticed that there are circles of wet and dry periods in the river discharge. From 1871 to 1896 saw a period of high flows. Between 1901 and 1975 annual discharges averaged around $87km^3$. The decade from 1976 to 1987 saw a series of very low flows – average annual flow about $76km^3$, since when flows have increased again which indicates a wet period. Refer to figure for long term Nile River discharge.



Source: Tecsult et al., July 2006

Figure 28 : Main Nile: Monthly Discharges and 5 year moving mean.1871/72 -2000/01

An important feature in the Governorate is Lake Nasser, which is approximately 500 km long, of which 350 km is within the Egyptian territory while the remaining 150 km is within the Sudanese. Lake Nasser is one of the largest artificial lakes in the world. The lake was created in 1969 between the First and Second Cataract of the Nile as a consequence of the construction of the Aswan High Dam. The Lake is of vital importance as it represents Egypt's main reservoir of fresh water.

The average annual suspended sediment entering Lake Nasser is estimated to be 120million tons of which 72 % is from the Blue Nile, 25 % from the Atbara and only 3 % from the White Nile.

Egypt's water resource base mainly consists of:

- Egypt's quota from the Nile.
- Underground water.
- Effective rainfall and torrent water.
- Non traditional water resources which include:
- Intermediate reuse of agricultural drainage water and treated wastewater;
- Desalinated water.

The total water resources available to Egypt is estimated at 73.8 billion cubic meters per annum including the natural and non-traditional resources. Next table shows the distribution of water resources among various sectors. The agricultural sector consumes about 81% of total water available.

A major feature of the strategy for agricultural development in Egypt is to benefit from a variety of improvements in the efficiency of the Nile system in order to increase the productivity per unit of water.

Table 15 : Distribution of Water Use by Sector (Billion cubic meters/annum)

Sector	Consumptive Use(Billion m^3/annum	%
Agriculture	50.8	81.1
Industrial & Municipal Uses	8.8	14.1
Electricity	2.0	3.2
Navigation and Winter Closure	1.0	1.6
Total	62.6	100

6.4.2.2 Nile River

The Nile is the major source of water in Egypt. Egyptian is almost entirely dependent on irrigation. Consequently, agricultural development is closely linked to the Nile River and its management. The Nile Waters Agreement between Egypt and Sudan in 1959 gave Egypt 55.5 billion cubic meters, almost more than 90% of the country's developed water resources.

6.4.2.3 Groundwater

In the area along the route corridor in Egypt, there are mainly three major reservoirs of groundwater, the situation also applies to the whole country, these are:

- Valley and Delta Reservoirs;
- The Nubian Sandy aquifer in the Eastern and the Western desert, around the High Dam's lake and in Sinai; and
- Calcareous rocky aquifer scattered nationwide.

The Nile basin reservoir is highly efficient in storing water. Approximately 4.0 billion cubic meters, of the total 7.5 billion cubic meters are drawn annually from this reservoir to provide the surrounding towns and villages with potable water.

6.4.2.4 Non-traditional Water Resources

Approximately 4.5 billion cubic meters/annum are reused in irrigation. There is a potential for intermediate reuse of about 5 billion cubic meters annually, out of 12 billion cubic meters being drained into the sea to maintain the salt balance of the Delta soils and the underground water. Treated wastewater reuse is currently estimated at 1.5 billion cubic meters annually.

Desalination projects are planned at the coastal areas to meet the demand of the tourist projects under construction.

6.4.3 RELIEF AND DRAINAGE

Higher relief is found on the eastern side of the basin. In the southwest the watershed of low relief with the Toshka Depression lying to the west, the proposed route corridor traverses the area to the west of the Nile valley. In the northeast the watershed has much higher relief. A number of wadis with catchments of some considerable size are found in the east.

The valley along the Nile is basically green farmland. The area west of the Nile valley is flat and sandy desert with a few small, uninhabited oases. East of the Nile valley the landscape is hilly and rather mountainous desert. A number of wadis are present.

The route corridor pass trough the western side of the valley where Qena and Luxor governorates. The topography of Qena – Luxor indicates that the main physical features of the area may be divided into three main physiographic units: Nile valley; Neogene and Quaternary sediments and The upper Cretaceous and Lower Tertiary.

6.4.3.1 Nile Valley

The Nile Valley separates the Eastern Desert and the Western Desert and has two main components, the river channel itself and the flood plain. The Nile Valley is bounded on both sides by norm faults and is in effect a rift valley with the River Nile occupying the deepest part of the valley. The complex geologic history of faulting and tectonic activity was so responsible for the formation of the Qena bend, or the giant meander-like deviation in the River’s course from its predominantly north-south direction. The modern course of the river is characterised by a meandering topography and inter-channel islands. Very few of these islands existed prior to construction of the Aswan High Dam and they now cover large areas above the annual high water level. These are cultivated and many of them are still enlarging. The majority of islands have formed since the construction of the high dam and vary in size from 200 m^2 to over 1,500 m^2. The modern flood plain is represented by the fertile silt layers of agricultural land on both the eastern and western banks of the Nile. The land is at an elevation of between 3m and 6m above the mean level of the Nile.

The width of the flood plain varies from less than 2 km in the south to over 20 km in the north. The vast majority of people have settled in the Nile Valley. Low terraces and small hills lie alongside the cultivated area of the valley; these terraces and hills are covered in Neogene and Quaternary sediments.

6.4.3.2 Desert

Desert represents the larger proportion of Qena Governorate (more than 85%), and falls within one of the world’s driest deserts. The Nile divides the desert into two distinct regions, the Western Desert and the Eastern Desert. Except for areas along or near the Nile Valley, the deserts are virtually unpopulated and represent large expanses of natural, largely unspoiled wilderness. The edges of the Nile Valley represent a transition area between the desert and fluvial habitats of the Valley. Formerly this zone was fairly broad, made of a patchwork of various habitats and feral lands. Today, along most the entire length of the Valley, land reclamation is taking place and extending agriculture into the desert margins and adjacent wadis, making the transition from arable to desert habitats very sharp. The ridges and plateaus on either side of the Valley generally act as natural barriers to further expansion. Two primary microhabitats may be distinguished in the deserts: mountains and wadis, and plains. No oases or substantial sandy areas or dunes are known.

The mountain and wadi habitat is largely confined to the territory east of the Nile. In this habitat the scant vegetation is restricted to the major wadis and their main tributaries. The few ridges that overlook the Nile Valley on both sides provide refuge for some species that utilise the resources of the Valley and then retreat to the relative security of the neighbouring desert. Several bats, birds of prey and larger carnivorous mammals follow this strategy, for which these ridges are an important part of their habitat. Open gravel and sand desert occupy large parts of the Governorate. This, however, is the least productive of its habitats. West of the Nile the habitat is largely of this type, with almost non-existent vegetation.

Western Desert

A gravel covered plain of variable width fringes the Nile Valley from the west and rises gradually to reach a ridge, forming the eastern edge of the plateau of the Western Desert. This plateau, reaching up 450 m altitude, is covered with sharp limestone surface, dissected by numerous deep wadis, which drain towards the Nile.

A transect was made through the limestone ridge fringing the western side of the Nile Valley during the spring visit. Several large and medium-sized wadis cut deep through this ridge, which reaches an elevation of most 500 m.

These wadis take the form of impressive winding canyons, with towering cliffs. Deeply cut canyons provide ample shade within and a fair amount of vegetation grows in this relatively sheltered environment.

6.4.4 GEOLOGY AND LANDSCAPE

The main underlying geological formations within the Lake Nasser Basin include the older Basement Complex rocks, the Nubian Sandstones, Tertiary unconsolidated sediments and recent superficial wind blown sands. The Basement Complex comprises gneisses, schists, marbles and intrusive granites and basic rocks. The Nubian Sandstones overly the Basement Complex rocks and comprise mainly sandstones, siltstones and conglomerates. The Recent deposits include the Nile alluvium, sand dunes and the black clays of the flood plains.

The Governorate of Qena- Luxor is located in the Nile Valley area of Upper Egypt and occupies a portion of a sub-regional sedimentary basin known as the Assiut Basin. The sedimentary basin has a depth of over 3 km above the basement rocks. The basin is a portion of the western structure of the Arabian-Nubian Massif and the regional dip is in a western direction. In the Assiut Basin, carbonate rocks belonging to the Eocene and Upper Cretaceous period dominate the top portion of the sedimentary section. The lower section is mainly composed of clastic rocks belonging to the Mesozoic and to the Paleozoic - the Nubian sandstone complex. The sedimentary section is locally overlain by Neogene clays from the Pliocene and Quaternary fluviatile deposits of sand, gravels and silty clays. The discontinuous uplifting of the sedimentary and the underlying basement rocks caused several cracks and fissures to the west of the uplifting. The basin is affected by tensile stresses that are responsible for the formation of a complex fault system.

Figure 29 : Bare rocky hills in the study area

In the Qena - Luxor area, the stratigraphy of the surface and near-surface sedimentary succession is differentiated into the following units (from the surface) :

6.4.4.1 Pliocene Unit (Paleonile deposits)

Dominated by clays with some inter-bedded sands, mainly in the sub-surface, overlies the eroded surface of the Eocene carbonates and acts as an aquaclude for the overlying Quaternary aquifer.

6.4.4.2 Eocene Unit

The Eocene Unit is made up of karstified chalky and dolomitic limestone and marls with flint bands and nodules, having an exposed thickness exceeding 200 m. Generally exposed more in the western direction. The sedimentary section has athickness of about 2000 m and is underlain by basement rocks. The section is dominated by carbonate beds in the upper portion and by sandstone and shale beds in the lower portion. Unconsolidated Quaternary deposits dominate the surface. The limestone is fissured and acts as another aquifer; however, it has not been well assessed and is consequently not well exploited.

6.4.4.3 Palaeocene-Late Cretaceous Unit

Dominated by shales with thin interbeds of chalk and phosphate, and generally acts as an aquaclude separating the Eocene fissured carbonate aquifer from the Nubian aquifer bow (the Upper Cretaceous fissured carbonate aquifers are missing in the south of the Governorate). This unit has a thickness of about 400 m.

6.4.4.4 Upper Cretaceous-Paleozoic

Sandstone with shale interbeds having an exposed thickness of about 300 m. In the sub-surface the thickness may reach 1000m. Locally exploited via small scale quarrying.

6.4.4.5 Pre-Cambrian

Pre-Cambrian is composed of highly fractured igneous and metamorphic rocks with a very limited distribution at the surface, however very widespread at depth.

6.4.5 GEOMORPHOLOGY

The Study area comprises two main geomorphological units: the alluvial plain and the structural plateaux.

6.4.5.1 Alluvial Plains

The alluvial plains may be divided into the young alluvial plains and the old alluvial plains. The young alluvial plains occupy much of the present flood plain of the Nile and are underlain by a silty clay layer. The surface of this plain is generally flat and slopes very gently in a northerly direction with a ground elevation of about 80 m Above Mean Sea Level (AMSL). The present river channel of the Nile is incised into the silty clay layers, generally to the eastern side of the valley.

Erosion of Nile banks and deposition of eroded material has become a major problem on the Nile in recent years. Increased human intervention in the river channel and the flood plain includes constructing bank protection measures and other structures such as new road bridges and has lead to the instability of the river channel with some areas actively eroding and others becoming areas of deposition. The construction of the Aswan High Dam and barrages along the course of the Nile has greatly influenced the stability of the channel. The old alluvial plain occupies the outer portions of the valley and extends to the foot slopes of the surrounding escarpments. The surface of the plain is underlain by mixed sand and gravels and is developed into successive terraces rising more than 25 m above the present level of the flood plain. The complex drainage channels or wadis dissect these terraces. The surface is undulating and occasionally covered by shifting sands.

6.4.5.2 Structural Plateaux

The plateaux constitute a portion of the extensive calcareous plateaux on the western side of the Red Sea hills. The Nile valley or trough incises through these plateaux with a difference in relief of over 100 m. The surface of these plateaux is rough and is underlain by weather resistant limestone forming a typical hamada or rocky desert. The plateaux terminate with fault-controlled escarpments, which may rise abruptly or gently from the alluvial plains. The surface of the plateaux is dissected by dry drainage lines, which were active rivers during the wet climatic of the late Tertiary and so during the pluvial phases of the Quaternary. The alluvial fans developed by such drainage network are essentially hidden under the present floodplain.

6.4.6 SOIL

Shale and clay deposits are important primary deposits used for several purposes including cement, brick, and ceramics industries. Shales and clays occur in marine Cretaceous and continental Quaternary deposits and often intercalate with sandstone and limestone. Isna and Dakhla shales are very important and widely distributed in Qena. Quaternary shales are distributed at the entrance of Wadi Qena and south of Qena-Safaga road. A large brick factory at El Maharousa, about 20 km south of Qena City exploits large quantities of Isna shale.

6.4.6.1 Aggregates (Sands and Gravels)

Sands and gravels are widely distributed in Qena and are heavily exploited for use in the construction industry. Aggregates extracted in Qena are commonly exported to the Red Sea Governorate for use in the construction industry, particularly relating to the rapidly expanding tourism sector.

The demand for aggregates, especially gravel, has caused significant environmental problems relating to extraction and may also lead to local changes in hydrogeology, which may impact water supplies.

Sand and gravel quarries are widely distributed in the Qena area and occupy part of the old alluvial plain of the Nile Valley. A total of 59 quarries are officially registered in Qena Governorate and are regulated by the Law 86/1956. The Governorate department of quarries and mining controls permitting.

6.4.7 LAND USE / LAND COVER

The landcover around the route corridor is mainly bare rock and sand. The distribution of the sand is an important factor in determining the potential sources of drifting sand. Generally the most extensive areas of sand are to the west with most bare rock to the east. The prevailing winds are from the northwest which explain the direction of the drifting sands. The only vegetated area is the area is along the Nile river which has alluvial soils mainly used for irrigated agriculture.

The total area of Qena-luxor is approximately 10,265 km^2 of which over 85% is uninhabited desert. Approximately 10% area is agricultural land with the remaining area being occupied by urban areas, villages, roads, the River Nile and drainage canals and drains.

By use of LANDSAT imagery, an analysis of the land use for Qena-Luxor boundaries was undertaken giving five main land use types. Next table shows the land use types of Qena – Luxor. It was found that nearly all vegetated areas in Qena are agricultural in nature.

Table 16 : Land use in Qena-Luxor Governorate

Description of Land	Total Area Km^2	Total Area (%)
Desert areas, rocky outcrops& barren land	13,225	88.6
Vegetated areas	1,121	7.5
Urban areas, industrial areas rural housing, roads, rail	59	0.4
Water: River Nile, canals, drains flooded areas	130	0.9
Unclassified/Mixed: scrub sandy areas, etc	388	2.6
Total	14,933	100

Source: landsat 7 analysis

6.4.7.1 Land Reclamation

Egypt has a national strategy to try to reclaim desert areas and transform them into productive agricultural lands. Prior to 1998 approximately 42,600 Feddans were reclaimed in Qena Governorate of which about 75% are located on sandy soils and the 25% on saline soils. According to the national strategy for land reclamation a further 218,500 Feddans of land will be reclaimed from desert areas and other marginal lands in Qena Governorate. Figure shows a newly desert reclaimed land near Nag Hammadi which is the location of the proposed Nag Hammadi substation.

Figure 30 : Desert reclaimed land for agriculture near Nag Hammadi

7 BIOLOGICAL ENVIRONMENT

This section has been prepared with reference to the Eastern Nile Power Trade Program Study, Phase II: Regional Power. The description Interconnection Feasibility Study – Inception Report, EDF et al, April 2008, Tropics, 2008; EPS, 2008 and YAM, 2008provided in this section provides the biological environment which presents the biological baseline environment along the route corridor as submitted from the literature review, field observation and data collection.

7.1 BACKGROUND

The route corridor is described in detail in Section 4, Project description, of the report. The biological environment will be described according to the route sections described in table below.

Table 17 : Power line route specifications

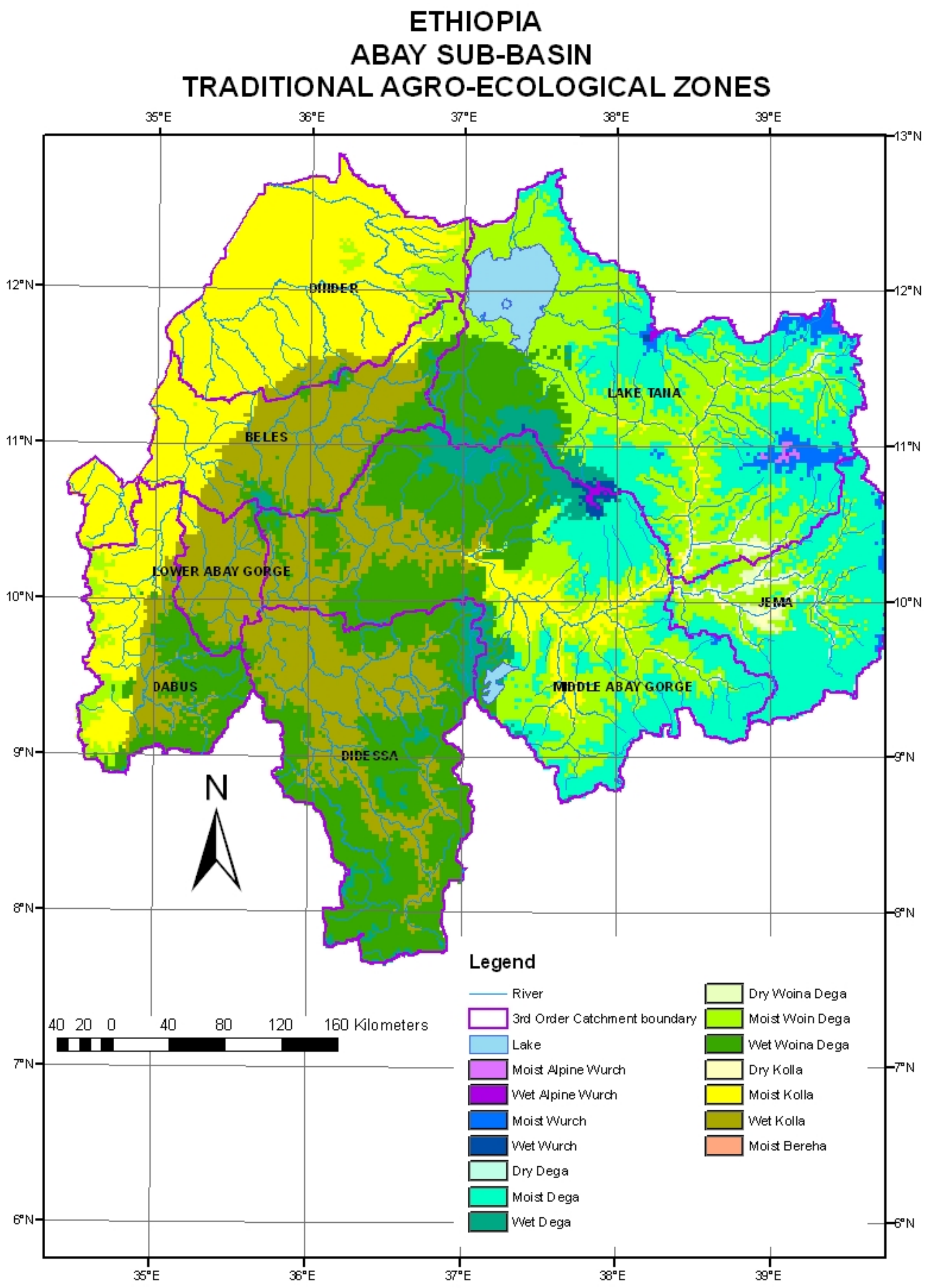
No.	Country	Section of the Route	Total Length (Km)
2 X 500 kV AC Power Lines – 130m ROW required			
1	Ethiopia	Mandaya Dam to Sudan Border	158
2	Sudan	Sudan Border to Rabak / Kosti	366
1 X 600 kV DC Power Line – 80m ROW required			
3	Sudan	Rabak / Kosti to Sudan Border	1, 130
4	Egypt	Sudan Border to Nag Hammadi	535

Source: EDF, 2008

7.2 ETHIOPIAN SECTION

7.2.1 AGRO ECOLOGICAL ZONES

The power transmission line routing traverses through two agro ecological zones; namely moist and wet kola based on the work of Cooperative Regional Assessment (CRA) (Tecsult et al, June 2006) agro ecological classification in the Abbay Basin. Information on traditional agro ecological zones was also obtained from Benishangul (BGNRS) which was based on woody biomass inventory and strategic planning project; moist lower kola & moist upper kola agro ecology classes were identified in the project area according to the study. Figure shows Agro ecological zone in the Abbay basin based on CRA study report (date).



Source: Ethiopia Country Paper, Hydrosult et al, 2006

Figure 31 : Traditional Agro-ecological Zone

7.2.2 PROTECTED AREA

The country in general and the Benishangul Region in particular are endowed with diverse flora and fauna and some of which are endemic to the country. This diversity is the result of diversified climatic, soil and elevation condition. Next table provides the Ethiopia biodiversity under different plant and animal category. Relevant proclamation and regulation and corresponding responsible institution has been established towards conservation and protection of important ecosystems in the country. Accordingly, there are 12 Parks, four wildlife sanctuary and seven wildlife reserves that are known as nationally protected area. Many of the important plant and animal species are found in these protected areas. Majority of these areas are not managed properly, only two of the National Parks (Seimen & Awash NP) were gazeeted and preparation and implementation of their management plan is not yet realized.

None of the nationally important areas are located in the project influence area. The nearest possible important area is the Dabus Valley controlled hunting area, which is located downstream of Mandaya dam site. Based on information found in the Mandaya Dam ESIA study document, the Dabus Valley controlled hunting area has been registered by Ethiopia with the World Commission on Protected Areas (WCPA) which maintains a world database of protected areas. Dabus is registered as Site Code 13752 (Tropics, 2008).

Table 18 : Biodiversity in Ethiopia

Category	Species in Ethiopia Approximate number No.	Proportion of species endemic in Ethiopia %
Higher plants	6,500 – 7,000	12
Mammals	277	31
Birds	862	17
Reptiles	210	9
Amphibians	63	24
Fish	150	4

Source: Tefetro, EPA Magazine, August 2004

7.2.3 TERRESTRIAL VEGETATION AND HABITAT

An environmental survey has been conducted of the project area in July and August 2008. The survey provided opportunity to observe leaves, flower, and fruit of the natural vegetation which assists on site identification of species. The technical hand book, Useful Trees and Shrubs for Ethiopia by Azene Bekele was also used for identification of species. The terrestrial vegetation type & habitat in the power line route and surrounding area include shrub/grassland, mixed woodland, riverine communities and lowland bamboo forest.

The status of the natural vegetation is not yet critically affected by human activities. This is mainly because of very low population density, limited agricultural practice and infrastructure facilities. During the field visit clearance, of natural vegetation cover was observed in some localities as crop production is getting momentum in the region. Increased levels of deforestation is also indicated by the regional environment office due to various investment projects that will ultimately disturb the natural vegetation.

7.2.3.1 Mixed Combertum - Terminalia woodland

The majority of the power line route corridor will traverse through mixed deciduous woodland vegetation cover. Density of the woodland tree species varies from place to place and tends to be low in places with human settlement and agriculture practice. The tree height ranges from 5 m to 12 m, which is usually underlined with a shrub and grass layer. The main shrub & grass species observed include *Grewia mollis, Maytenus sengelensis, Pliostigma thoningii, Gadenia ternifolia, Fluggeaea virosa, Pennisetum polystachion, P. schweinfurthii* and *Sorghum arundinaceum*.

The main tree species observed include Anogeissus leiocarpa, Boswellia papyrifera, Combretum collinum, Combretum hartmannianum, Cussonia ostinii, Entada abyssinica, Erythrina abyssinica, Pterocarpus lucens, Strychnos innocula, Oxythenantera abyssinica, Terminalia collinum, Sterospermum kunthianum and Acacia polyachantha. The site investigation and discussion with local experts at woreda and region level, during the site visit, confirmed low density of Boswellia papyrifera which is known with high economic value. During the field visit, sparse Incense tree cover of Boswellia species was observed in the last section near Gizen area, between Bilgidilu and Menge town and also in the first section near Abbay River. The power line route corridor doesn't traverse through incense cover utilized by cooperatives. This is mainly due to the sparse cover of the incense species in the project area which doesn't attract for commercial production. Based on information obtained at woreda and regional level, commercial harvest of incense by cooperatives is practiced in Kumruk and Guba area where dense cover of A.senegal (Gum Arabica) is present. These areas are far away outside the power transmission corridor.

Natural and human fires influence the woodland cover in the project area. The situation may also impact on the conductors of suspended power transmission cables. Fire are started by communities in BGNRS for various purposes, such as clearance at the start or for the expansion of crop land, stimulation of new fresh growth, to control insects, wildlife hunting, prevention of settlement huts from fire through initiating back firing. Overall, fire could be considered as the most important factor influencing terrestrial vegetation in the project area.

Figure 32 : *Combertum terminalia* woodland, Daleti to Bilgidilu town

Figure 33 : *Adansonia digitata*, relatively common in the sections near the Ethiopia Sudan Border

7.2.3.2 Lowland bamboo (Oxytenanthera abyssinica)

BGNRS has a large area of low land bamboo and the distribution varies from place to place along the route corridor The most extensive dense cover of bamboo was observed in Bamassi area (some 20 km South of Assosa) and some 40 km from NE of Assosa along the road to Menge; note that both localities are out of the project influence area. The power transmission route around Koncho, Daleti and Biligidilu will cross isolated patches of bamboo at localized section. Refer to figure showing a stand of bamboo.

As noted in the Mandaya environment study report (EDF and Scott Wilson, November 2007), the lowland bamboo forest is a vegetation of unique importance not only to Ethiopia, but it represents a significant proportion of the whole bamboo vegetation present in the African continent. Lowland bamboo has got diversified benefit to the rural population in BGNRS. The major uses of the resource include fuel wood, construction, fencing, fodder for animals, bamboo bud or shoots for human feed, as a raw material for making various house utensils.

Studies also indicated potential for establishment of bamboo based cottage industries to process and/or export raw materials or semi processed bamboo products to generate income. In relation private investment by the name “Land and Sea” established to process and export bamboo products. The factory has already been established in Assosa & the operation will be started in few months time, as mentioned by officials from the investment office. As part of the short term plan, the factory will utilize natural bamboo vegetation near Bambassi town and has a strategic plan for improving and managing bamboo in the region towards its sustainable utilization.

Figure 34 : *Oxytenanthera abysinca*, located between Koncho – Daleti

7.2.3.3 Riverine vegetations

These vegetation types were noted along the Abbay River and other perennial rivers that are located in the power line route corridor and surrounding area. The riverine vegetation could be noticed clearly during the dry season and is dominated by ever green trees in contrast to the mixed woodland that are mainly deciduous, shedding their leaves during the dry season.

It consists the most important tree species from economic and ecological point of view. Typical tree species that were noticed in the Abbay riverine forest include *Acacia polyacantha, Tamarindus indica, Tamarindus africana, Teclea nobilis, Kigelia aethipioca* and *Cordia africana*. The line route will cross the Abbay and clearance of some of this vegetation may be required during the project construction. Riverine forest is also observed in perennial rivers such as Dabus, Tumet and Shegole rivers that will be traversed by the power line route. The species composition and density in these rivers is much lower compared to the Abbay river system.

7.2.3.4 Aquatic habitat

The major aquatic habitat in the project influence area is located in the Abbay and Dabus Rivers. The rivers are known to have a diversified fish resource, with fishing being conducted mainly for local consumption purpose. Small tributary rivers such as Sirba, Genber, Boka and Wa-u are also known with fish potential and the size of fish is smaller as indicated by local informants. No fish market or selling practice is found in the villages that are located near the rivers.

During the pre-feasibility study of Mandaya dam project sampling of fish was conducted in March 2007 on the Abbay River stretch that lies between Boka and Abaagole settlement centers. 12 species of fish were identified in the particular sampling section. The Joint Ethio-Russian Biological Expedition (JERBE) reported 24 species in Abbay river and seven fish species on the Dabus River based on sampling at the bridge along Nekemte-Asosa road. Many of the fish species are adapted to life in turbid and muddy waters. During the field survey turbid and muddy run off observed in most of the rivers. Other large aquatic life forms such as hippotami and crocodiles are present in the river systems of Dabus and Abbay.

7.2.3.5 Wildlife

The mixed woodland and riverine forest could be considered as an important habitat for various wildlife species. During the site survey in July – August 2008, however very limited wildlife species (baboons, Columbus monkey and common bushbuck) were observed. Information on wild animals in the project influence area was obtained from secondary sources and key local informants. Local informants indicated presence of elephants and other large wild animals such as leopard and lion around Menge, Sherkole and other part of the project area in the near past.

The establishment of settlements and clearance of vegetation for crop production has disturbed the wild habitat. The area is therefore no longer hospitable to these wild life species due to deterioration of habitat and increase in hunting practice.

Hunting of wild animals is considered an important traditional practice by the Berta and Gumuze ethinic groups that are found in the project area. For instance communal hunting is practiced in the dry season, from January to February, every year. A large number of people that include men and women participate and wild animals that inhibit in the riverine forest and mixed woodland cover are hunted. Individual hunting is carried out all the year round and practiced by hunters with spears and arrows. The major purpose of hunting is to obtain meat food.

7.2.3.6 Avian

Ethiopia provides habitat for more than 862 species of which 17 are endemic. Large bird population seasonally enters the country from different part of the world. According to information obtained from EWNHS, the Afro-tropical region including Ethiopia receives migrants from the northern hemisphere. The numbers of birds arriving in sub-Saharan Africa from Palaearctic amount to an estimated 3750 million birds, about one million of which are water-birds (Moreau 1972). Of the 29 million km² area of Africa, only 20 million km² is capable of receiving the migrants. The rift valley is the major route and with many wetland for the migratory bird.

Some bird species were observed during the site survey such as Heron, Grebe, Great Cormorant and Egret. Figure shows heron observed in the Abbay River course.

Figure 35 : Heron observed on Abbay River near Aba Gole village

7.3 SUDAN SECTION

7.3.1 TERRESTRIAL VEGETATION AND HABITAT

In the route corridor through Sudan, the main tree species are: *Selerocarya birrea* (Humeid); *Adansonia digitata* (Tabaldi); *Boswellia papyrifera* (Gafal); *Combretum aculeatum* (Habeel); *Terminalia brownie* (Subogh) and; *Tamarindus indica* (Aradaib).

The patterns of natural vegetation closely follow those of mean annual rainfall, although locally edaphic conditions can provide a stronger influence. However, the biotic factors (grazing, cutting, burning and cultivation) are now of almost equal importance to the physical environment in determining the exact composition of vegetation communities.

7.3.1.1 Savannah woodland

The route from Geisan to Damazine, along the RoW, passes through dense deciduous and evergreen Savannah woodland in combination with hilly vegetation on scattered Jebels. Heavy and tall grass cover dominate the area and ocassionally obstruct car mobility when accompanied with trees and shrubs. This grass cover is extending as a pure stand over a wide area and is alternating or mixing with a diversity of the cover. The area is dominated by dark brown cracking clays with thin surface mulch. This is alternating with dark brown sandy clay loam and very dark greyish cracking clays with surface crust. Most soils are classified as moderately suitable class. Limitations of land use are generally associated with wetness or topographic aspects.

<u>Acacia Thornland alternating with Grassland</u>

Between the 360 mm and 570 mm isohyets on the heavy clays grassland merges into *A. mellifera* thornland. Other tree species include *A. nubica, C. decidua, Cadaba glandulosa, C. rotundifolia and Boscia senegalensis.* The last three species often persist after A. mellifera has been cleared. Much of this vegetation is being cleared for small-scale sedentary and large-scale semi mechanised agriculture.

Grass species include *Cymbopogan nervantus*, *Sorghum purpereo-sericeum*, *Hypparhenia ruffa*, *Tetropogan cenchriformis* and *Cenchrus cilliaris*. Sufficient grass dry matter is produced to provide material for annual burning.

<u>Acacia seyal-Balanites Savanna</u>

Above 570 mm to the border with Ethiopia there is increasing dominance by *A. seyal* in association with *Balanites aegyptiaca*. *A. senegal* is retained for gum arabic harvesting whilst *A. seyal* is used for charcoal production. *B. aegyptiaca* becomes increasing prevalent because it is fire resistant, does not produce good charcoal and is hard to cut.

The gum Arabic is the exudates of *Acacia senegal* known as gum hashab and *Acacia seyal* known as "gum talh". Gum Arabic is used in food, beverages and pharmaceutical industries. The Gum Arabic Belt (GAB) comprises the major part of the low rainfall woodland savannah zone extending from the Western to the Eastern boundaries of Sudan on both sand and clay soils.

7.3.1.2 Flood plain vegetation

The route from Damazine to Rabak / Kosti passes nearby the Kenana Scheme where extensive and intensive irrigated sugar plantation is a dominant feature. Heavy clay soils alternate with clay-loam & sandy loam soils. The area is dominated by mechanized & traditional agricultural practices. The main crops are sorhum, cotton, millit, sun flower and sesame. Thorn savannah and scrub vegetation dominate the area with *Acacia Seyal*, *Balanitis aegyptiaca, Z. Spine Christi* and *Acacia Senegal* being the dominant tree species with an under-storey of grass cover. Irrigated agriculture, mechanized and traditional agriculture, forests and grazing are the dominant land use cover.

The area from ED-Duem to Jebel Aulia and up to Omdurman is covered by scanty Semi-desert scrub and grass land. Acacia tortillas are the dominant tree species growing on sandy loam soils. The area is thinly populated along the proposed route between Survey coordinate points K7 and K6. Few scattered small hills and wadis are encountered.

Seasonally River-flooded Grasslands

These grasslands are flooded annually to varying depths and periods and form the moisture, which yields dry season grazing essential to the Nuer and Dinka agro-pastoralists. Refer to figure 7.6. Two main types can be distinguished: (a) *Oryza longistaminata* dominant, and (b) *Echinochloa pyramidalis* dominant (Howell et al., 1988).

The dominant species *Oryza longistaminata* constitutes 80-90 percent of the standing crop. Oryza does not flower or reach maximum production unless it has been deeply flooded for several months. It yields one tonne/ha when not flooded to 7 tonnes/ha when deeply flooded for a long period. These grasslands are burnt each year early in the dry season. Although a perennial it can produce abundant seed. They provide high quality grazing for much of the year even into the dry season.

The *Echinochloa pyramidalis* grasslands are further away from the river and thus flooded less frequently (although a tall variant grows close to the river). It occupies Vertisols with much *gilgai* micro-relief. The species produces growth even during the dry season and is thus a year-round pasture. Associated species include *O. longistaminata*, *Sporobulus pyramidalis*, *Digitaria debilis* and *Echinochloa haploclada*.

Figure 36 : Flood plain grassland

Seasonally Rain-flooded Grasslands

Three types are recognized: (a) Echinoochloa haploclada grassland, (b) Sporobolus pyramidalis grassland, and (c) Hyperhennia rufa grassland.

Echinoochloa haploclada Between the river-flooded and the rain-flooded grasslands there is often a strip of land with light textured soils and slightly elevated, which is used for settlement and cultivation refer to figure 7.6 of irrigated crop in the flood plain. As livestock are concentrated here for long periods this grassland is heavily grazed. Nutritionally the grassland is of very high quality during the wet season but quality falls off during the dry season.

The *Sporobolus pyramidalis* is a tussock-forming species and is not widespread. It is characteristic of heavily grazed areas. It makes no growth during the dry season, is low in protein and during the dry season nutrient levels fall below those needed for maintenance. It is used to make string used in house construction.

The *Hyperhennia rufa* grasslands occupy level ground out of reach of river-flooding but are inundated by rain for varying periods. In some northern areas Hyperrhenia may be replaced by Setaria incrassata. Although biomass attains 6-7 tonnes/ha at the end of the wet season, 90 percent of this is stem and contains little of value to livestock. A high proportion of these grasslands are burnt each year. They are generally used at the beginning of the wet season and at the beginning of the dry season after burning. The grass provides a major source of thatching material.

Figure 37 : Irrigated Crop Of Sorghum In The Flood Plain

Swamp Vegetation

Three types of swamp vegetation are distinguished: (a) Cyperus papyrus swamp, (b) Typha domingensis swamp, and (c) Vosia cuspidata swamp.

The Cyperus papyrus swamps form a fringe along water courses, pools and other water with deep and constant depth. The plants form a floating mat upon which other species – mainly climbers are found.

The Typha domingensis form the most extensive swamps away from the main river channels. It is most likely that the vegetation is not floating but rooted into the substrate covered by very shallow water. There are few other plant species. This is probably the extensive swamp type in the Machar Marshes

The Vosia cuspidata vegetation is found next to flowing water and forms floating mats over the water. It is often associated with water hyacinth. Refer to figure 7.8.

Figure 38 : Floating mat on White Nile River close to the power line crossing point

7.3.1.3 Riverine Woodland

Pure stands of riverine woodland – "*sunt*" – are increasingly under pressure. The first trees to colonize a newly formed river bank are *Salix subserrata* and *Tamarix nilotica*. As the bank builds up xerophytic species such as *Ziziphus spina-christi* become established. On the lower terrace *A. nilotica* establishes itself, with *A. seyal* on the higher ground.

7.3.1.4 Semi-desert with shrub vegetation

Between the 75mm and about 250mm isohyets "Semi-desert Scrub" is the most prevalent vegetation type, and comprises a varying mixture of grasses and herbs, generally with a variable scatter of shrubs up to 4 meters high interspersed with bare earth.

South of Ed-Duem and up to Kosti the semi-desert vegetation gets a bit richer and changes into thorn Savannah and scrub of *A.tortillis*, A. *chrenbergiana, L. pyrotechnica* and *P. turgidum* with small pockets of *ziziphus spina-christi* and *A-nilotica* on depressions and wadis. The route traverses areas of low cover grassland with sparse shrubs and trees; the population density is low and scattered in single or groups of small villages. Traditional small size agriculture and rearing of sheep and goats is the dominant occupation for the inhabitants. The route from survey coordinate points 5 to point 3 on the Kosti – Ed Duem corridor passes through stabilized longitudinal sand dunes covered by *pannicum turgidum* and *L.pyrotechnica* surrounded by *A.tortilis* at the foot of the dune.

On sandy soils to the west of the Main Nile tree species include *Leptadenia pyrotechnica*, *A. Senegal* and *A. tortilis* subsp. *spirocarpa* and *raddiana*. On the clay plains there are a number of plant communities associated with specific habitat characteristics related to local topography and eroded, runoff and run-on sites. The most common tree species that have a wide “sociological tolerance” include (Obeid Mubarak, 1982): *Acacia tortilis* subsp. *tortilis* and *raddiana*, *A. nubica*, and *Caparis decidua. A. nubia* and *Calotropis procera* are common in the vicinity of villages and are indicators of overgrazing. Along the inundated areas of the Blue Nile *A. nilotica*, *A. albida* and *A.seyal* are common. *A. nilotica* is also found at the outlets to wadis which pour into the Nile and which receive flood water.

Grasses are mainly annuals. Heavy grazing and low rainfall ensures that there is insufficient dry matter for annual fires. In years of low rainfall and heavy grazing there can be an almost complete failure of annual plant growth. On very sandy soils *Panicum turgidum* is likely to be the dominant grass. This is an excellent grass for stabilizing sand dunes as well providing adequate browse. *Aristida spp.* are usually dominant on stabilized sands and on the shallow light textured surface materials, with *Schoenefeldia gracilis* dominating on the clay soils. Other ephemeral grass species include *Sporobulus cordofanus*, *Dactyloctenium aegyptium*, *Eragrostis cilianensis* and *Tragus berteronianus*. Refer to figure 7.9.

Figure 39 : Semi-desert conditions

7.3.1.5 Desert

North of the 75 mm isohyet generally desert or semi-desert conditions prevail with little or no vegetation except along wadis with a high water table. Occasional years of very good rainfall can transform areas of desert into valuable grazing areas known as “*gizzu*”.

The route from Omdurman to Dongola passes through flat desert terrain with sandy soils and very light vegetation. It traverses areas which are sparsely populated with subsistence agriculture along narrow strips on the Nile banks. Ephemeral grasses with few scattered trees of acacia species are rarely encountered, especially at depressions and water courses. Generally, the surroundings of the route are characterized by flat terrain with sandy loam soils and vast areas devoid of vegetation cover. The area from Dongola to the Egypt border is referred to as absolute desert characterised by sandy dunes and bare mountains and hills. The only area with vegetation is along the Nile where alluvial soils occur and irrigation agriculture is undertaken.

7.3.2 WILD LIFE

7.3.2.1 Fish

Over 100 fish species have been reported to prevail in the inland waters with different degrees of occurrence in the various localities. The commercially important fish are *Lates niloticus*, *Bagrus bayad*, *B. docmac*, (first class), *Oreochromis niloticus*, *Labeo spp*, *Barbus binny*, *Mormyrus spp*, *Distichodus spp* (second class), *Hydrocyon spp* and *Alestes spp* (for wet salting).

7.4 EGYPTIAN SECTION

7.4.1 TERRESTRIAL VEGETATION AND HABITAT

There are two main terrestrial habitats in the study area, these are mainly the desert habitat with associated oases habitats and the Nile valley and associated farmland. The desert habitat is quite extensive on both sides of the Nile River.

7.4.1.1 Desert

The landscape east of the Nile is undulating and rather mountainous desert. In contrast, the desert west of the river is completely flat sand desert with scattered oases such as Kurkur and Dungul. The two oases have been declared protected areas.

Most desert areas are devoid of vegetation. The little natural vegetation that exists is usually found in wadis or other catchment areas where surface water from scant rains or other sources accumulates. Desert vegetation consists of perennials (trees and bushes) that are found year round and annuals (usually small shrubs) that occur seasonally when there is sufficient rainfall.

In the Eastern Desert the western lime stone section is characterised by *Tamarix nilotica*, *Zilla spinosa*, *Salsola spp*., *Zygophyllum album* and *Calotropis procera*. Further eastwards in the sandstone *Acacia ehrenbergiana*, *Salsola spp*. and *Zilla spinosa* are dominant. While the eastern most limited igneous section within the Qena Governorate is dominated by *Acacia raddiana* and *Zilla spinosa*.

The Western Desert is more sparsely vegetated than the Eastern Desert. Nearly all vegetation is restricted to wadi beds, the most prominent flora in the areas visited were: *Cornulaca* *monacantha*, *Fagonia spp., Zygophyllum album*, *Schouwia thebaica*, *Leptadenia pyrotechnica*, *Tamarix nilotica*, *Acacia ehrenbergiana*, and *Acacia raddiana*.

Desert represents the larger proportion of Qena Governorate (more than 85%), and falls within one of the world's driest deserts. The Nile divides the desert into two distinct regions, the Western Desert and the Eastern Desert. Except for areas along or near the Nile Valley, the deserts are virtually unpopulated and represent large expanses of natural, largely unspoiled wilderness. The edges of the Nile Valley represent a transition area between the desert and fluvial habitats of the Valley. Formerly this zone was fairly broad, made of a patchwork of various habitats and feral lands. Today, along most the entire length of the Valley, land reclamation is taking place and extending agriculture into the desert margins and adjacent wadis, making the transition from arable to desert habitats very sharp. The ridges and plateaus on either side of the Valley generally act as natural barriers to further expansion.

Two primary microhabitats may be distinguished in the deserts: mountains and wadis, and plains. The mountain and wadi habitat is largely confined to the territory east of the Nile. In this habitat the scant vegetation is restricted to the major wadis and their main tributaries. The few ridges that overlook the Nile Valley on both sides provide refuge for some species that utilise the resources of the Valley and then retreat to the relative security of the neighbouring desert. Several bats, birds of prey and larger carnivorous mammals follow this strategy, for which these ridges are an important part of their habitat. Open gravel and sand desert occupy large parts of the Governorate. This, however, is the least productive of its habitats. West of the Nile the habitat is largely of this type, with almost non-existent vegetation.

7.4.1.2 Oases of the Western Desert

A number of oases are encountered in the Western Desert of the Governorate. Oases are areas where ground water reaches the surface and therefore support dense vegetation and quite a rich fauna. The dominating plant species in the oases are Dom- and Date Palms with fairly extensive groves of species of Acacia. The Argun Palm, which is a globally threatened species of very high conservation value, is encountered in the oases in the region which is traversed by the proposed line route.

The oases are the only source of water and vegetation in the desert areas. They therefore play an important role in the survival of certain desert animal species such as Spotted Sand Grouse, Hoopoe Lark and the highly threatened Dorcas Gazelle.

7.4.1.3 Farmland in the Nile Valley

Extensive and intensive irrigation agriculture has replaced virtually all of the original habitats and vegetation of the Nile valley, however most of the fauna has adapted to the human modified habitat. Within the farmland, a good portion of Egypt's bird species are confined and well adapted. Widespread reptiles include the Bean Skink, the Nile Monitor and the Square Marked Toad and the Egyptian Mongoose and Jackal are widespread carnivorous mammals in farmland areas.

Nile Valley Sunbird and Black Shouldered Kite are characteristic birds and the farmland is often a staging post for migrating birds with flocks of Cranes, White Storks and Glossy Ibis stopping there. In April 1997 the first breeding record of Namaqua Dove was found and there are good numbers of Shrikes and Bee-Eater on passage.

The Nile River and the numerous canals and drains connected to it to form a fairly extensive patchwork of wetlands. The most important of these is the river itself. Several primary wetland habitat types can be identified in Qena Luxor Governorate, mainly associated with the Nile.River The Nile River forms a longitudinal water body with an average width of about 1 km, extending the entire length of the Governorate. This large water body is the primary fishery in the Governorate. The seasonal fluctuations of the Nile play an important role in the ecology of the Nile ecosystem though having substantially fewer impacts than in the past when the Nile flooded in the winter months and dropped to very low levels during the summer months. The fluctuations of the water level constantly change the topography and morphology of the river, creating and altering habitats for wildlife. The flooding in the autumn leads to significant reductions in wildlife habitat along the shoreline of the river and an increase in reed beds and a reduction in areas of muddy and sandy banks.

In winter, many parts of the river are very shallow often supporting dense growths of aquatic weed such as Ceratophyllum demersum. Mats of floating vegetation, usually from canal clearings, often form at such shallow areas of the river; creating favourable microhabitats, particularly for birds and amphibians.

Several native plant species are dominant in the agricultural landscape of the region. Fields are doted with Acacia nilotica, while Tamarix aphylla is a common and widespread windbreaker on the periphery of cultivations, largely south of Naga Hammady, but disappeared in the northern part of the Governorate, being largely replaced by Casuarina and Eucalyptus. Dom Palm, Ziziphus spina-christi and Ficus are rather less widespread trees, the latter being less common. Tamarix nilotica, Cotropis procera occur intermittently in marginal lands and on the desert edge. Salix fringes canals and drains sporadically. *Alhagi graecorum* and *Desmostacia bipinnata* are the commonest non-woody native species occupying marginal lands, canal banks and fallow fields. Date Palm is widely cultivated and is an important crop and many birds appeared to be strongly associated with and benefit from native flora, particularly Nile Valley Sunbird (*Anthreptes platurus*), TurtleDove (*Streptopelia turtur*) Cattle Egret and Common Bulbul (*Pycnonotus barbatus*).

7.4.2 THE RIVER NILE, NILE BANKS AND NILE ISLANDS

The Nile, the Nile Banks and the Nile islands hold a diverse flora and fauna and are all of local and international importance for several species. (Appendix D provides an overview of characteristic and rare species to be found in the area).

Reed (Phragmites sp.) completely dominates the vegetation on the river bank on the stretch from Luxor to Kom Ombo and forms dense swamp vegetation together with Typha sp. There are some islands on this stretch of the river, which also hold dense reed vegetation.

The vegetation along the river bank is formed by a characteristic scrub, the Nile Tamarisk. The scrubland opposite Philae, houses a number of birds like Rufous Bushchat, Nile Valley Sunbird, Egyptian Nightjar and Vulture.

The water areas houses Greenshank, Whiskered- and Gulled-billed Tern and White-tailed Plovers. There are Pelicans with occasional records of Pink-backed Pelican. Over 6,000 water birds were wintering in lake between the two dams in 1989/1990 when the last bird count was carried out.

7.4.3 LAKE NASSER AND LAKE BANKS

Lake Nasser is one of the largest artificial lakes in the world and the line route passes along the western side of the lake.

The lake was created between the First and Second Cataract as a consequence of the construction of the Aswan High Dam, completed in 1971. It is an elongated body of water approximately 500 km long of which 350 km is in Egypt and 150 km inside Sudan. It has an average width of 15 km and a maximum depth of about 80 meters. Water level and volume fluctuates greatly, seasonally and from year to year, depending on the amount of water received. The seasonal fluctuation is about 10 meters. Lake Nasser contains a maximum of 130 billion m3 of water.

Lake Nasser is an extremely rich ecosystem supporting an abundance of fauna. When the Lake was established, water flowed onto the surrounding desert land and in following the configuration of the terrain many bights and inlets were created. These bights and inlets are called khors. There are 85 major khors Allaqui, Kalabsa and Tushka being the largest.

The shallow water in the khors support the richest flora and fauna in the Lake and provide good breeding and feeding grounds for fish because of their shallowness and abundance of phytoplankton.

The Kohrs are the habitats of the only surviving specimens of Nile Crocodile in Egypt. The characteristic and rare flora and fauna are encountered in Lake Nasser and in the surrounding areas.

7.4.4 FAUNA

7.4.4.1 Mammals

Even in the desert animals are found. The Slender-Horned Gazelle, which is endangered and has been extirpated throughout most of its range in Egypt, is encountered in the western desert.

Figure 40 : Gazelle found in the Western Desert

Other mammals known to occur in the area include; Dorcas Gazelle, Striped Hyena, Sand Fox, Hyrax and Cape Hare.

7.4.4.2 Fish

More than 190 different fish species are encountered in the Nile, with Nile Tilapia and Nile Perch perhaps being the most well known. Submerged vegetation is encountered on shallow waters in some areas of the river.

The lake abounds in fish, providing about 25,000 tons annually. The lake is in fact one of the most important sources of freshwater fish in Egypt. By far the most common fish are the Bolty (Nile Tilapia) and another Tilapia species Oreochromis gallilae. The two species represent (97-98%) of the fish catch in the lake.

7.4.4.3 Birds

The reed swamps are attractive to nesting water birds and are the reason for the area being important as a migration site for water birds from Europe and Asia. Over 20,000 migrating water birds were thus observed during the latest count carried out in 1989/1990. Ferruginous Duck, which is among the globally threatened species, is found in internationally important numbers during the wintertime (i.e. more than 1% of the entire world population). The globally threatened Red Crested Pochard migrates regularly in small numbers. The area is also an important staging area for migrating white storks. The most common residing breeding birds are Little Egret, Moorhen, Spur-winged Plover, Pied Kingfisher and Clamorous Reed Warbler.

The Lake is becoming increasingly important as migration areas for water birds. During January and February 1995, 56,000 water birds were counted on about 20% of the Lake. Thus, the total number of water birds spending the winter in the entire Lake could be in excess of 200,000 making it one of the most important wetlands in Egypt.

Qena-luxor has a relatively high diversity of avifauna amounting to several hundred species. Residents comprise less than 30% of the total species recorded; the majority are transit populations of passage migrants, winter visitors and summer breeding visitors.

Resident breeding birds are for the most part dominated by species inhabiting wetland and arable habitats, followed by the species adapted to life in the desert. Several birds are transit breeders occurring in Qena during the summer months, moving further south during the colder months.

A number of birds, particularly water birds spend the summer months in the Governorate, but do not seem to breed. Grey Heron (Ardea cinerea), for example, is a fairly common visitor in the summer, but nesting has not been recorded. Many birds winter in the Governorate, including significant concentrations of water birds wintering along the Nile River. Other bird species include two globally endangered species: Greater Spotted Eagle (*Aquila clanga*) and Ferruginous Duck (*Aythya nyroca*). Qena Governorate is situated on a major migration route for birds travelling between their winter quarters in Africa and summer breeding grounds in Europe and Asia. Migrants pass through the area twice annually during spring and autumn. Qena is of special importance for migratory soaring birds (species of birds, which depend on rising hot air thermals for their flight, such as large birds of prey and storks). Significant proportions of the world population of White Stork (*Ciconia ciconia*), probably more than half of the 500,000 storks passing through Egypt, biannually migrate through the Governorate. The Governorate is so located on the migration routes for several birds of prey (EPS, 2008).

Figure 41 : Duck species common in the aquatic environment of the study area

Following bird species are encountered in desert areas: Spotted Sand Grouse Cream Coloured Courser, Bar-tailed Lark, Hoopoe Lark, Temminck's Horned Lark, Desert Wheatear and Brown-necked Raven.

7.4.4.4 Reptiles and Amphibians

At least 27 Reptiles species and 4 Amphibian species have been known to occur in the Governorate Qena–Loxur to date. The greatest diversity of reptile species is found in the desert. All four amphibians known from the Governorate are confined to wetlands and cultivations, though the Green Toad (*Bufo viridis*) is capable of withstanding relatively arid conditions. All amphibians are fairly common or abundant. The Nile Valley Toad (*Bufo kassasii*), previously thought to be restricted to the Delta and Fayoum, was first recorded in the

Nile Valley south of Cairo in Qena Governorate. Very dense populations exist in swampy vegetation along the Nile River banks and in recently flooded sugarcane fields throughout much of the Governorate. Widespread reptiles in the Nile valley include the Bean Skink, the Nile Monitor and the Square Marked Toad.

8 SOCIO-ECONOMIC ENVIRONMENT

This section focuses on the existing Socio-Economic Environment of the proposed project influence area, which has been prepared with reference to the Eastern Nile Power Trade Program Study, Phase II: Regional Power Interconnection Feasibility Study – Inception Report, EDF et al, April 2008, Tropics, 2008; EPS, 2008 YAM, 2008 and the Country reports by Tecsult et al., 2006. The description provided in this section provides the Socio-Economic environment along the route corridor as submitted from the literature review, field observation and data collection.

8.1 BACKGROUND

The route corridor is described in detail in section 4, Project description, of the report. The Socio-Economic environment will be described according to the route sections described in table below and the associated regional administrative divisions within the specific countries.

Table 19 : Power line route specifications

No	Country	Administrative regions	Route Section	Total Length (km)
2 X 500 kV AC Power Lines – 130m ROW required				
1	Ethiopia	Benishangul Region (Agelo Meti, Wonbera, Sirba Abbay, Oda Godere, Menge and Sherkole)	Mandaya Dam to Sudan Border	158
2	Sudan	Blue Nile State, Sennar State,	Sudan Border to Rabak / Kosti	366
1 X 600 kV DC Power Line – 80m ROW required				
3	Sudan	White Nile State, Khartoum State and Northern State	Rabak / Kosti to Sudan Border	1, 130
4	Egypt	Aswan Governorate and Qena – Loxur Governorate	Sudan Border to Nag Hammadi	535

Source: EDF, November 2008, Module 2

8.2 ETHIOPIAN SECTION

8.2.1 ADMINISTRATIVE FRAMEWORK

The transmission line routing corridor passes through six woredas all of which are in Benishangul Gumuz Regional States. These woredas are Agelo Meti, Wonbera, Sirba Abbay, Oda Godere, Menge and Sherkole covering over 4,928,946 hectares of the Regional land mass.

The Benishangul Gumuz Regional State is one of the nine Federal States in Ethiopia established following the issuance of the Constitution of Ethiopia. The Regional State is located at the north-west part of Ethiopia, at a coordinate of 9^o17' to 12 ^{o}6' N latitude and 34 ^{o}10' to 37^o 4'E longitude.

The Benishangul-Gumuz Region is divided into three administrative zones namely Assosa, Kamashi and Metekel, refer to figure 8.1 for more details. The three zones are further subdivided in to twenty woredas and two special woredas. Assosa has eight woredas (of which one is special woreda), Kamashi has five woredas while Metekel has seven woredas of which one is a special woreda.

The topography of the region is dominantly plain lowlands. There is few mountains and gorges formed along the courses of Abbay river and its main tributaries (Dabus, Beles, Anger and Didesa). Abbay River cuts the region into two parts comprising of the northern half (Metekel) and the southern half (Assosa, Kamashi and Mao-Komo), the proposed line corridor starts from the Northen half at Mandaya and the rest of the route corridor is in the Southern half of the region up to the Ethiopia / Sudan Border.

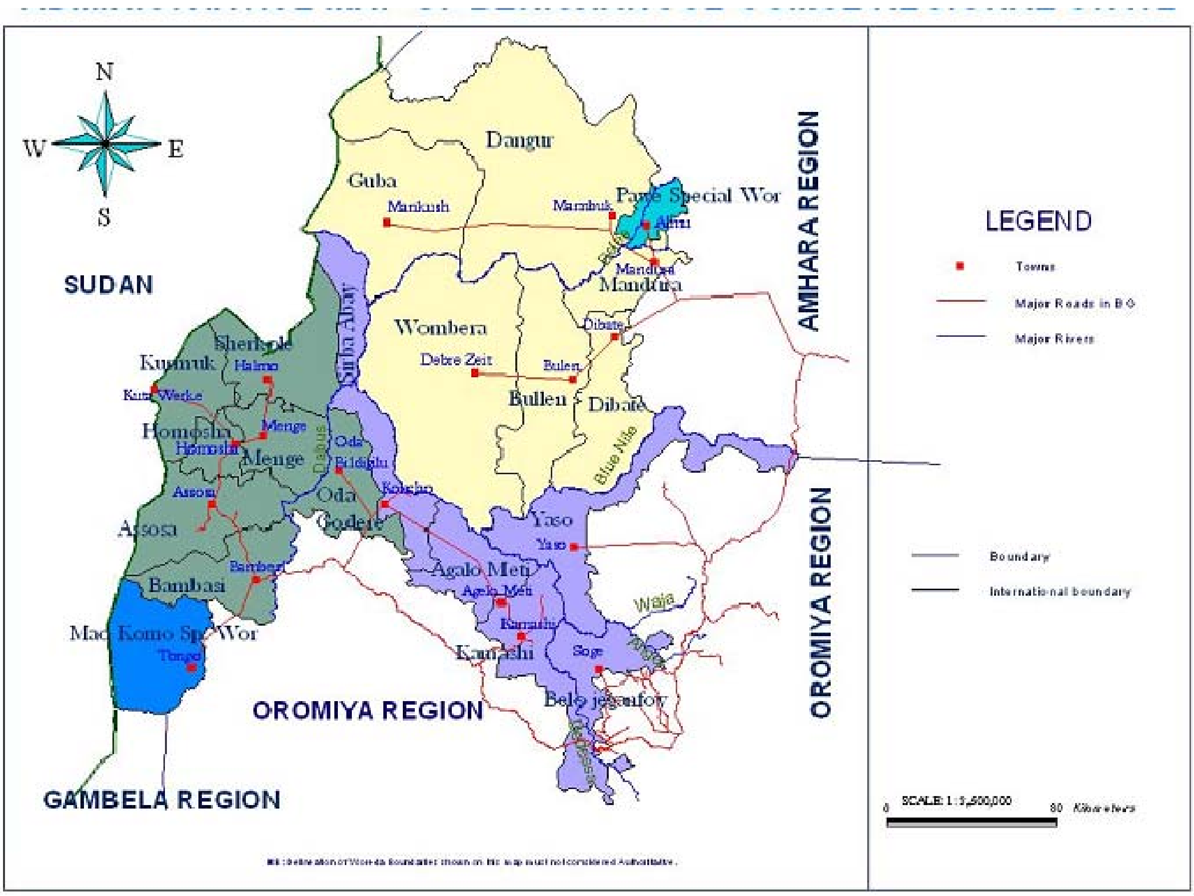


Figure 42 : Administrative Map of Benishangul Gumuz National Regional State

Source: Benishangul Gumuz Regional States, Bureau of Finance & Economic development

8.2.2 DEMOGRAPHIC CHARACTERISTICS

Population data that are essential for this socio-economic study were collected from various government institutions of the Region and the Central Statistics Agency (CSA) Statistical Abstracts during the site visit in August 2008. In this section population parameters such as population size, age, sex, are analyzed and presented.

Based on the 1994 Housing and Population Census conducted by CSA, the population of Benishangul Gumuz as of July 2008 is projected as 656,000 of which 49.7 % are female and 50.3 % are male. The people of the region are settled over 49,289.46 km^2 with an average population density of 13.3 people per km^2.

8.2.2.1 Population of the Project Woredas

The project influence area covering six project woredas had a total population of 178,113 in 2008, living over an area of 16,147.89 Km^2 with an average density of 11 people/Km^2.

As seen in table 8.2 Wonbera woreda has about 33% of the target area population but the project impact area in the woreda covers a very small portion of it (mainly the Mandaya substation area). Menge has the second largest population of the target woredas (23 %) followed by Oda Godere (17 %), Sherkole (11 %) and Agelo Meti (9 %). Sirba Abbay constitute 7 % of the project population. Like Wonbera, Agelo Meti has a very small fraction of its area affected by the line route corridor.

In the proposed project area of influence, a great majority of people live in rural areas. According to the CSA standards, there are only 2 urban towns in the project woredas. They are Menge (in Menge woreda) and Debre Zeit (in Wonbera woreda). The total number of people living in these urban settlements is 4,855 people. Out of this 2,316 are male and 2,539 are female. The remaining population live in the rural area. The current estimate shows that the total number of people living in the rural areas is 173,258. The route corridor of the project traverses the rural parts of the Woredas.

A study conducted by the regional government shows that there are about five indigenous ethnic groups of people in Benishangul (Berta, Gumuz, Shinasha, Mao and Komo). There are also a good number of Amharas and Oromo people in the Region. The project woredas are dominated by Berta followed by Gumuz people.

8.2.2.2 Population Density

The population density of the project area ranges from 6 to 26 persons per kilometre square. Menge is relatively densely populated among the project Woredas but very small density compared to other parts of Ethiopia. That is followed by Oda Godere (22 persons/Km^2) and Agelo Meti (13 persons/Km^2). Sherkole on the other hand is sparsely populated (6 persons/Km^2).

8.2.2.3 Area of the Project Woredas

Wonbera has the largest land area among the project woredas of 7,134.53 Km^2 (44.2 % of the project area) while Sirba Abbay has the least land area which is 1,308.44 Km^2 (8 % of the project woredas). Table below provides the details of the population characteristics.

Table 20 : Ethiopia-Sudan Power Line Routing Woredas

		Population					Area		
No	Woreda	Male	Female	Total	% of Female	% of Woreda	Km^2	% of Woreda	Pop. Density
1	Sherkole	9,449	9,969	19,418	51.34	10.90	3,204.22	19.84	6.20
2	Menge	19,933	20,363	40,296	50.53	22.62	1,500.63	9.29	26.90
3	Oda Godere	15,928	15,041	30,969	48.57	17.39	1,387.19	8.59	22.30
4	Sirba Abbay	6,609	6,184	12,793	48.34	7.18	1,308.44	8.10	9.80
5	Wonbera	28,673	30,331	59,004	51.40	33.13	7,134.53	44.18	8.30
6	Agelo Meti	7,947	7,686	15,633	49.17	8.78	1,612.88	9.99	13.00
Total		88,539	89,574	178,113	50.29	100.00	16,147.89	100.00	11.03

Source: CSA, Statistical Abstract, 2007

8.2.2.4 Household Size

Based on a study entitled “Socio-economic, Agriculture Forestry and Tourism Resources” undertaken by the Investment Office of Benishangul Gumuz Region, in 2004, the average family size of the region is reported to be 4.5 person per household.

The same study reported 3.9 and 4.5 people per family for urban and rural areas respectively.

8.2.2.5 Population Age Structure of Benishangul Gumuz, by sex and settlement

Age structure is an important parameter for measuring elements such as the labour force, school ages and the number of old and young people. The 1994 population housing census, provided age structure by gender of the Benishangul Gumuz as seen.

The table presents the population age structure as calculated in July 2000. From the available data, the population at young age group (below 15 years) makes up 44.1% of the total and those at old age group (above 64 years) constitute 2.6%. The proportion of the population aged 15-64 constitutes about 53.3% of the total.

The table also gives the structure by settlements, with the rural and urban areas having 44.6% and 39.6% of their population under 15 years of age while 52.8% (rural) and 58.6% (urban) of their population fall between 15 and 64 years of age. The remaining 2.6% and 1.8% is at the age of 65 years and above.

In conclusion Benishangul-Gumuz Region has a considerable number of people falling in the category of “working force”. It shows higher population at young ages and low proportion at old age, reflecting high fertility rate characterizing the population of the region.

On the other hand, the ratio of persons in the dependent age groups, the young and old, to those of the working ages (15-64 years of age) provides useful information on economic dependency burden. As can be seen from table, the young dependency ratio of the population in the year 2000 was 83 (i.e. ratio of population below the age of 15 years to population between age of 15 and 64 years). The corresponding figure for urban and rural areas is 68 and 85, respectively. The overall dependency ratio in the same year was 88 (i.e. ratio of young plus old to the population between 15 and 64 years). This indicates that for every 100 persons in the working age, they have to support 88 dependents.

Table 21 : Age Structure of Benishangul Gumuz Regional States

Age	URBAN + RURAL				URBAN				RURAL			
	Total		Male	Female	Total		Male	Female	Total		Male	Female
	No	%			No	%			No	%		
0-4	93,222	17.4	47,139	46,083	6,837	14.4	3,476	3,360	86,385	17.7	43,663	42,723
9-May	75,062	14	38,506	36,556	5,955	12.6	2,962	2,994	69,107	14.1	35,544	33,562
14-Oct	68,334	12.1	34,812	33,522	5,941	12.6	2,838	3,103	62,393	12.8	31,974	30,419
15-19	58,532	10.9	29.59	28,942	5,552	11.7	2,655	2,897	52,980	10.8	26,935	26,045
20-24	49,655	9.3	24,728	24,927	5,385	11.4	2,658	2,727	44,270	9	22,070	22,200
25-29	40,999	7.6	19,763	21,236	4,613	9.7	2,289	2,324	36,386	7.4	17,474	18,912
30-34	34,224	6.4	16,319	17,905	3,767	8	1,981	1,786	30,457	6.2	14,338	16,119
35-39	27,916	5.2	13,269	14,646	2,886	6.1	1,550	1,336	25,030	5.1	11,719	13,310
40-44	22,895	4.3	11,050	11,845	1,957	4.1	1,074	883	20,938	4.3	9,976	10,962
45-49	18,348	3.4	9,289	9,059	1,394	2.9	792	601	16,954	3.5	8,497	8,458
50-54	14,514	2.7	7,590	6,924	992	2.1	538	453	13,522	2.8	7,052	6,471
55-59	10,817	2	5,900	4,917	687	1.5	370	318	10,130	2.1	5,530	4,599
60-64	8,067	1.5	4,526	3,541	506	1.1	264	243	7,561	1.5	4,262	3,298
65-69	5,695	1.1	3,266	2,428	350	0.7	177	172	5,345	1.1	3,089	2,256
70-74	3,842	0.7	2,232	1,610	234	0.5	115	119	3,608	0.7	2,117	1,491
75-79	2,282	0.4	1,332	950	142	0.3	69	73	2,140	0.4	1,263	877
80+	2,215	0.4	1,283	931	133	0.3	59	74	2,082	0.4	1,224	857
Total	536,619	100	270,594	266,022	47,331	100	23,867	23,463	489,288	100	246,727	242,559

Source: The 1994 census for Benishangul-Gumuz, Volume II, Analytical Report, 1999

8.2.3 RELIGION

According to the 1994 census, there are Muslim, Christian and Traditional religion followers in the Region. Muslims comprises a higher proportion of the population of the region (44.1%) followed by Christians with 41.1%. Among the Christians, Orthodox Christians are the majority making up of 34.8% the total population of the region. Protestants and Catholics form 5.8% and 0.5% of the population, respectively. Traditional religion followers constitute about 13.0% of the population.

The religious composition of the population in the rural areas is almost the same as that of the regional average. In urban areas the proportion of Muslim and traditional religious decreases to 25.6 and 0.3%, respectively and the proportion of Orthodox Christians increase to 67.6%. Orthodox Christians and Muslims are found in all the zones although the Orthodox Christians dominate in Metekel. There is a higher Muslims concentration in Assosa zone.

8.2.4 ETHNIC AND LANGUAGE COMPOSITION

The indigenous people living in the project woredas are mainly Gumuz, Berta and Shinasha. In addition to the indigenous people, other various minority groups are found. The Amhara ethnic group is found in a large number in Benishangul Gumuz resulting from immigration at different times but mainly due to resettlement that took place in the past.

The 1994 census result indicates that the majority (25.1%) of the population of the region are Berta. Together with related Fadashi, Gamili and Gebato they comprise about 26.7%. Gumuz comprises 23.3% followed by Amhara 22.2%, Oromo 12.8%, Shinasha 7.0% and Agew/Awighi 3.8%. Other ethnic groups Tigraway, Kembata, Mao, hadiya, Komo, etc constituted 4.2% of the total population of the region. Of the five indigenous ethnic groups (Berta - Jebelawi, Gumuz, Shinasha, Mao and Komo), Mao (0.6%) and Komo (0.2%) are the Smallest.

The ethnic composition varies among the zones as well as between urban and rural areas. Thus, while Gumuz are the largest ethnic group in Kamashi (77.4%) and Metekel (33.3%) zones, Jebelawi and Fadashi together constitute 57.8% of the population of Assosa zone. Amharas are found mostly in Assosa (26%) and Metekel (23.8%) zones. Of the urban population, Amhara, Oromo, Shinasha Agew and Jebelawi, in that order, are the largest ethnic groups. Gumuz constituted only 1.1% of the urban population of the region.

With regard to language, Jeblawi language (the Berta people language), Jeblawigna, is the most widely spoken language 24.8% of the population of the region followed by Gumuz language (23.1%) as the second largest language spoken. Oromigna is spoken by 10.2% of the population as a second language followed by Amharic 7.4%.

8.2.5 SETTLEMENT PATTERN AND HOUSING CONDITION OF THE PROJECT AREA

The settlement pattern in the project affected area is mostly scattered. One can see a lot of clustered settlements along the main roads due to access to transportation and other infrastructures. There are also settlements all over the rural areas where access to the infrastructure is difficult. It takes hours normally of walking to travel the distance from one settlement to the other where settlements are sparsely distributed.

The settlement pattern creates huge problems in the provision of infrastructure and other services for the regional government. It is often a big challenge for mobilization, marketing and development interventions.

A study has been completed by Benishangul Gumuz Regional government to resettle the scattered people more closely together and along where water and infrastructure are better available (could be made available), as has been done near Boka in Sirba Abbay woreda – downstream of Mandaya dam site.

In the project woredas, families normally have houses for the head and spouse, children, cooking house, and others depending on the wealth of the households. However poor a household is, it has at least two houses and the number can reach up to four. On the average, a household can own three houses in the project area.

The quality of housing in the project area is very poor. Almost all rural people live in houses made of wood/bamboo and mud with thatched roofs (see figure 8.2 below). By contrast, in towns one can see houses made of wood plastered with mud, and roofs with corrugated iron sheets.

Figure 43 : Family houses in the Project Woredas

8.2.6 LIVELIHOOD AND ECONOMIC ACTIVITIES

The livelihood of the majority of the population of the project area and that of Benishangul-Gumuz is based on subsistence agriculture and animal husbandry. Farming is the major source of food and cash income. Sorghum and maize are the staple cereals produced in the project area.

Agriculture, though the major economic activity, does not support the families all year round. Figure shows some of the crops and agricultural activities in the project area near Gizen (Sherkole Woreda).

Farming using human labour and hoe

Sesame Crop in Gizen

Mango Tree

Livestock Grazing

Figure 44 : Farm Activities in the Project Area

Farming is predominantly subsistence in the Project Area, so hunting and wild food gathering is also common here and supplements farm income for own consumption.

The other economic activities supporting people's livelihoods in the proposed project area of influence include: trade, cottage industry and traditional gold panning. However these activities lack significance to enable people move from poverty conditions to more affluent lives. Refer to Figure for some economic activities supporting local people's livelihoods.

Cooperatives in Marble Extraction

Ready for gold mining

Gold Market

Market in the Project area

Figure 45 : Non-Farm Economic Activities

A high prevalence of extreme poverty and low levels of economic activities and the lack of social infrastructure characterize the economic development of the population living in the target woredas. According to the data obtained from the regions, the following indicators are prevailing in the target area:

- Low level of per capita income;
- Limited access to health service;
- Low education level and high illiteracy rate;
- Food deficiency and malnutrition;
- High morbidity and mortality, low life expectancy;
- Low productivity;

- Scattered population of indigenous communities;
- Low level of community participation;
- High prevalence of human and animal diseases, and
- Backward agricultural cultivation systems.

8.2.6.1 Agricultural Practices and Crop Production

The mainstay of the economy of the people in the project area is agricultural including livestock but mainly subsistence agriculture. Despite huge water and land potential in the project woredas agricultural production and productivity is very low and done using human labour and hoes. Irrigation practice is almost non existent. Key bottlenecks to agriculture and better productivity as reported by Food Security Office in Benishangul Gumuz Region are:

- Use of rudimentary farming tools mainly shifting hoe cultivation practices of indigenous people,
- Prevalence of crop diseases, pests (termites) and weeds (stringer) as well as poor storage facilities,
- Poor working culture of the indigenous people and high workload on women,
- High prevalence of human disease (malaria in particular) is reported to draw away from work about 40 % of the labor force,
- Poor rural infrastructure,
- Inadequate supply of agricultural inputs,
- Erratic rain fall and poor extension services.

A survey conducted by Benishangul Gumuz Rehabilitation and Development Associations (BRDA) showed that most households in Benishangul Gumuz region are not able to produce sufficient requirements of food even for their own consumption. Only few farmers are able to produce enough food to provide their food supply all round the year. Even those farmers considered producing more are reported to produce only 90% of their food from their farm (10% is still purchased meat and industrial food products are also purchased).

Major crops grown in the project affected woredas are sorghum, maize, pulse, oil seed, and sesame. The dominant crops are sorghum and maize which is the main source of household food supply. Shifting cultivation is a common practice among the Gumuz population. A piece of forest land is always cleared and burned for cultivation in Benishangul, where the forest wood is often stacked and burned to get rid of it.

The majority of the people use hoes and sticks to prepare the land for cultivation. In Oda Godere, however, the team observed a lot of people using oxen for ploughing (see figure 8.5).

Figure 46 : Farming by using oxen

8.2.6.2 Livestock

The contribution of livestock to household economy is small, due to difficulties in livestock rearing associated with livestock diseases and lack of modern livestock development techniques.

The cattle population which is the major livestock of the project area is 96,575 heads followed by goats at 84,509 heads, sheep reported to be 20,039, and donkeys are 10,144 heads. Refer to table for population of livestock.

Table 22 : Livestock population by type in the Project woreda

No	Woredas	Cattle	Sheep	Goats	Camels	Donkeys	Mules/ horses
1	Menge	1,123	954	19,623	0	3,229	148
2	Oda Godere	9,365	2,408	9,123	0	1,159	249
3	Sherkole	0	937	14,118	0	1,220	83
4	Sirba Abbay	5,927	3,347	10,674	0	533	25
5	Wonbera	32,626	13,762	21,860	0	2,468	1,350
6	Agelo Mite	6,257	4,123	11,757	0	434	84
Total		**96,575**	**20,039**	**84,509**	**0**	**10,144**	**1,190**

Source: BoFED of Benishangul Gumuz, 2006

8.2.7 OCCUPATION AND EMPLOYMENT

Past studies disclosed that the majority of the economically active population in Benishangul Gumuz works in agriculture including hunting forestry and fishing (97.1%). Only 0.5% of the economically active population is engaged in industrial sector (including mining & quarrying, manufacturing and construction). Some 0.7% were engaged in services sector. As a whole about 82% of the economically active population worked as agricultural and fishery workers, 0.6% worked in crafts and related trades workers, 0.4% as service workers and shop and market sales workers, and 0.3% as technicians (Socioeconomic Study of Benishangul Gumuz, 2004).

8.2.8 HOUSEHOLD INCOME AND EXPENDITURE

A household sample survey conducted in Benishangul Gumuz in 2003/04 produced very important results concerning income and expenditure of the people of the region (CSA, 2005).

According to the study, the main source of income of the people of the region is crop production, which constitutes 54% of the total income. It is followed by livestock raising (17%), wages and salaries (13%), and trades (6%). The main source of income of the surveyed population varies across the zones. Crop production is a primary income in Metekel zone (86%), while it is wages and salaries in Assosa zone (42%). In Kamashi zone crop production makes 34% followed by sales of non-agricultural products (10%).

The average annual income per household and per capita for the surveyed population of the region is 6,111 ETB (Ethiopian currency) and 1,358 ETB respectively.

Table 23 : Annual Income by Source in Benishangul Gumuz

Source of Income	Total Income	%	No. of Resp. (HH)	Average Income	
				PHH	PP
Sales of Agri-produce (Livestock)	60,775	16.6	37	1,643	365
Sales of Agri-produce (Grain)	199,310	54.4	46	4,333	963
Sales of Forest Products	2,400	0.7	1	2,400	533
Sales of Non-Agri-Products	10,750	2.9	8	1,344	299
Wages and Salaries	47,804	13.0	10	4,780	1062
Rent (Houses, Machinery, Animals)	13300	3.6	10	1,330	296
Deposit, Share Profit	2,782	0.8	7	397	88
Gift and/or Obtained for Free	1,815	0.5	3	605	134
Trades and Other Goods Marketing of Agri-products	20,721	5.7	10	2072	460
Other Incomes	6,998	1.9	9	778	173
Total	366,655	100	60	6,111	1358

Source: Household Survey of Benishangul Gumuz, 2003/04

As a whole for the surveyed population of the region, average annual expenditure is less than the average annual income. However, when looked at expenditure by zones the surveyed populations in Assosa and Kamashi zones spend more than they earn. This observation of the population of the proposed project area of influence indicates that the households do need extra effort to make ends meet.

Table 24 : Annual Expenditure by expenditure Items

No	Expenditure Items	Total Income	%	No of (HH)	Average Expenditure	
					EPHH	EPP
1	Food, Drinks & Related	212,786	62.3	60	3546	788
2	Clothing, Footwear& Related	52,285	15.3	60	871	194
3	House Rent, Energy & Water	3,644	1.1	12	304	68
4	Furniture, Household Equipment	19,531	5.7	50	391	87
5	Health, Education, Transport & Communication	34,793	10.2	57	610	136
6	Entertainment Culture	7,204	2.1	39	185	41
7	Non-consumption Expenditure for Social Affairs	2,380	0.7	24	99	22
8	Personal Care & Effects	4,383	1.3	12	365	81
9	Others	4,545	1.3	17	267	59
Total		**341,551**	**100**	**60**	**5693**	**1265**

Household Survey of Benishangul Gumuz, 2003/04

8.2.9 INVESTMENT

The Benishangul Gumuz Regional State (BGRS) is endowed with vast natural resources, and yet the majority of it’s people live in poverty and it is relatively backward as compared to most of other regional states of the country. Further more, despite the existence of immense exploitable resources such as fertile agricultural land, water resources, mineral resources, forests, fruit trees and others, investment effort is not adequate and as a result it is one of the least developed area in the country.

The Benishangul Gumuz Regional Government has prepared over 100 investment project profiles to promote investment in the region in 12 different investment sectors. The main sectors of investment in the project woredas are agriculture, marble, natural incense and gum, minerals, household and office furniture, Hotels and others.

There are certain incentives, that are provided to investors by the Regional Government. Among the incentives indicated in the proclamation made by the region, ‘Lisane Hig’; the following are the main ones:

- Provide urban areas without lease
- Those investors who participate in Agricultural sectors have the right to get rural land with out income tax and free from land hire for five (5) consecutive years.
- 100 % duty and tax exemption levied on imports of capital goods, equipment and vehicles as well as 15% of their capitals investment in spare parts.
- Loss carried forward for five years, etc.

	
Marble Production by National Mining Corporation< Daleti area	Marble Chips by Marble Cooperatives, Sirba Abbay
	
Traditional Gold Mine Sites in Menge Woreda	Incense Tree (Gum Arabic) in Sherkole Woreda

Figure 47 : Investment Area in the Project

The total applications for investment in the year 2006/7 have been 41. Out of these, 6 investors have already started operation with a total capital of 6,448,000.00 ETB. The rest-licensed investors are already under mobilization. 2 out of the 41 applied for investment, are foreign investors who desire to engage in the agricultural sector.

Table 25 : Investment Status in Benishangul Gumuz

No	Projects licensed	Capital (in million ETB)	Staff	Projects operational	Capital (in million ETB)	Staff	Projects under mobilization	Projects disqualified
1	7	5.69	1905	1	1.48	220	6	-
2	5	3.83	103	4	3.83	73	1	-
3	1	1.00	546	-	-	-	1	-
4	7	4.48	38	-	-	-	7	-
5	1	0.41	30	1	0.41	30	-	-
6	2	1.79	68	-	-	-	2	-
7	1	0.014	8	-	-	-	1	-
Total	**24**	**17.33**	**2,698**	**6**	**5.31**	**323**	**18**	**0**

Source: Project profile of Benishangul Gumuz

In addition to private individual investment efforts there are about 235 cooperatives operations in the project area. These cooperatives are engaged in marble extraction, gold panning and electrical operation including diesel electric generators.

Among the cooperatives operational in the project area, 60 are female while 175 are male.

In addition to those operational, about 68 cooperatives have obtained license from region to go in to different investment operation. They will be fully operational in a few months of time. These cooperatives will be engaged in marble, gold, bee keeping, animal breeding and other activities as seen in table 8.8 below.

Table 26 : Number of Cooperation Operational and Planed In the Project Woredas

No	Woreda	Activities	No. Operational			No. Planned
			Male	Female	Total	Total
1	Sherkole	Electric	62	2	64	2
		Gold			0	3
		Others			0	3
2	Menge	Gold	73	23	96	6
3	Oda Godere	Marble			0	2
		Gold			0	3
		Livestock			0	2
4	Sirba Abbay	Bee	40	35	75	14
		Gold			0	14
		Livestock			0	5
5	Agelo Meti	Gold			0	6
		Others			0	8
6	Wonbera	NA				
Total			**175**	**60**	**235**	**68**

Source: Benishangul Gumuz Investment Office, 2007

8.2.10 TRANSPORTATION AND COMMUNICATION

The region is connected with Addis Ababa by Air and Road. There is an air flight from Addis to Assosa three times a week via Jima and Gambella. There are buses from Addis Ababa to Assosa on a daily basis.

The project woredas are poorly connected by road with in the woreda (s). This is particularly true in the rural areas. There are no urban bus or taxi services in many of the project settlements including the rural towns. Transport infrastructure is inadequate. Hence the main means of transportation in the project woredas is human portage and pack animals mainly donkeys as shown in figure.

Figure 48 : Major Transport of Good and Passengers in the project Woredas

People have to travel on foot for long distance to reach the main roads and vehicle transport services. This precludes the possibility of development of the inland or rural areas as investors naturally prefer to invest only on areas where there is road access connecting to commercial centers and major towns. The lack of access road limits the expansion of schools, health facilities and government offices in remote areas of the region, and also prohibits distribution of consumer goods to the rural population. As a whole the absence of paved roads hinder the economic integration of the region and the Region's economy with the national economy.

In recent years there has been improvement in telecommunication and postal services in certain towns of the region, however the project woredas are still not well developed in telecommunication.

The mobile telephone service which has been introduced recently to many woredas is non existent in the project areas.

The project woreda towns have access to postal service either through permanent post office or agent postal service.

8.2.10.1 Rural Road Network

The poor road condition in most parts of the project woredas are known to hamper investment, trade and social affairs. There are about 787 Km good standard roads in the region. Even though the region's road density per 1000 Km^2 is 15.60Km (the national average is 32). Out of the earlier stated 787 Km roads which are found in the region 316 Km are supervised under the federal government.

There are also 2,230 Km dry season roads. These dry season roads which become impassable during the rainy season, were constructed by the regional government with the collaboration of communities.

Although the Regional Government gives maximum attention to road construction by allocating more than 50 % of its capital budget each year to road construction, the region is still poorly connected internally. Many woreda towns are not connected with the regional capital and with each other. For instance, woredas in Metekel zone can be reached from the regional capital, Assosa, via Nekemte and Bure in Oromia and Amhara Regions, respectively. Currently construction of a road to connect Assosa to Metekel including a big bridge on Abbay River is progressing well. When the new road from Sherkole to Guba is completed, it will connect woredas north of Abbay River with the capital of the region and the rest of the southern part of Abbay River.

Table 27 : Major Road Net of the Region and the Project AREA

Assosa Zone			Kamashi Zone			Metekel Zone		
From	To	Distance (km)	From	To	Distance (km)	From	To	Distance (km)
Assosa	Bambasi	42	Kamashi	Sirb Abbay	96	Mandura	Gilgel Beles	10
Bambasi	Tongo	70	Kamashi	Belojiganfoy	180	Gilgel Beles	Dangur	48
Assosa	Komosha	39	Kamashi	Yaso	312			
Komosha	Menge	20	Kamashi	Agelometi	17	Gilgel Beles	Pawe	18
Menge	Sherkole	36				Gilgel Beles	Guba	114
Sherkole	Gizen	34				Chagni	Dibate	35
Komosha	Kurmuk	60				Dibatc	Bulen	40
Assosa	Oda Godere	181				Bulen	Wonbera	75

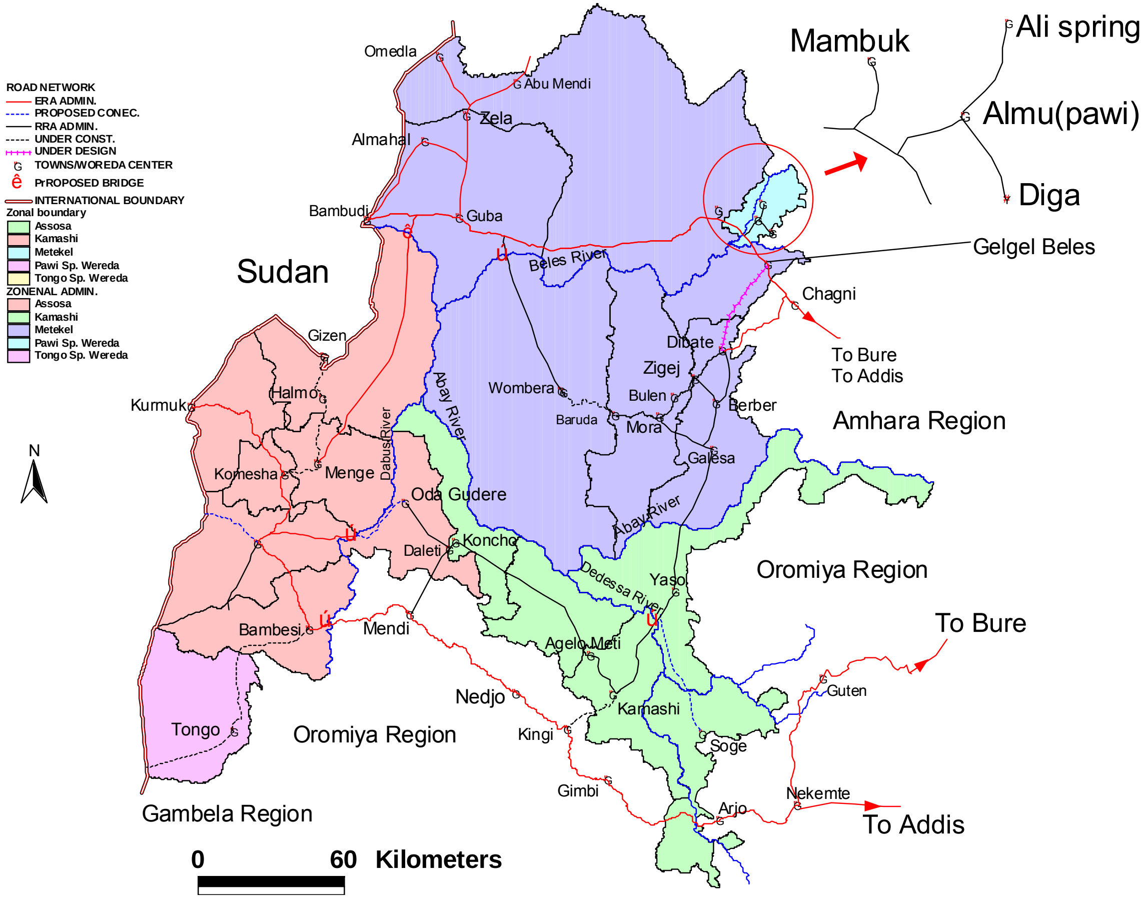


Figure 49 : Existing and Planed Road Network of Benishangul Gumuz

8.2.11 EDUCATION

Educational indicators are considered important parameters to measure the socioeconomic development of the project woredas. It gives an indication of the level of improvement and the overall living standard of the project area.

Availability of skilled manpower in the woredas is dependent on the educational status and availability of educational personnel and facilities. The cultural values of the society and poverty level of the people is also believed to affect the access to education.

8.2.11.1 Number of Schools, Students and Teachers

Although the efforts to improve educational status in Benishangul-Gumuz Region has been improving since the power takeover of the existing government (immense progress in the construction of schools, students' enrolment, number and qualification of teachers has taken place nationally), the effort in Benishangul Gumuz is not adequate given the area and due to inaccessibility of most of the woredas.

With regard to teachers there are about 1966 teachers in first cycle (grade 1-4), 1,078 teachers in second cycle (grade 5-8) and 394 teachers in high school (9-12). Regarding their qualification 100 % of first cycle teachers are qualified to the job while only 52. % and 35.8 % of the teachers are qualified in second cycle and high school respectively.

In the project woredas there are 83 high school teachers. 53 of them are diploma holders and 30 of the teachers have degrees.

When it comes to enrolment of the indigenous people (Berta, Gumuz, Shinasha, Mao, and Komo) only 50.4 % of the indigenous children of school age are enrolled in elementary education (first and second cycle). The figure is 78.5 % for ABE (alternative basic education) and 34.2% for secondary education.

Pupil-teacher ratio for Benishangul Regional State is 48:1 for first cycle, 47:1 for second cycle (the ratio is 89:1 for pupil to qualified teacher). For secondary education the ratio is 38:1 (the national standards are 50:1 for primary and 40:1 for secondary education). PTR (pupil to teacher ratio) in Benishangul is lower than the national standards. This low level, however, could reflect inefficiency of resource utilization. The following sections describe the existing situation in the educational system in Benishangul Gumuz Region by category.

Pre-Primary Level Education (KG)

NGO, local communities and private sectors run kindergarten (nursery) schools for children aged 4-6 in Benishangul Gumuz. The Regional Education Bureau provides supervision services for these KGs.

The numbers of kindergarten are growing from one year to the next .and there is a large increase in the number of kindergarten enrolment in the region. The kindergarten enrolment has grown from 939 in 2003 to 2218 in 2007. The number of kindergartens has increased in three fold (24 kindergartens) in 2007, from the 2003 figure (8 kindergartens). This shows that awareness in education among the general public is increasing (see figure 8.9).

Although kindergartens are increasing in a region wide, the project area has only one kindergarten located in Sirba Abbay at present with 88 students. The rural project areas do not have access to pre-primary education. Awareness in rural area is relatively lower than the urban areas about kindergarten education.

Table 28 : Enrolment in kindergartens in Benishangul Gumuz

Year	Enrolment			Teachers			No of KGS
	Male	Female	Total	Male	Female	Total	
2003	477	462	939	12	-	12	8
2004	799	711	1510	-	30	30	14
2005	818	776	1594	-	35	35	16
2006	770	750	1520	11	31	42	16
2007	1149	1069	2218	23	38	61	24

Source; Education Statistics, Annual Abstract, 2007, Benishangul Gumuz Regional States

<u>Elementary Level Education</u>

According to data obtained from the regional bureaus (BoFED and REB), there were 254 elementary schools (1-8) in 1990. Currently their number has increased to 317 in 2007.

Student's enrolment in elementary schools increased from 72,725 in 1990 to 144,672 in 2007, which shows 5.9 % annual increase for the last five years. Likewise, the number of elementary school teachers increased from 1,561 in 1990 to 3,044 in 2007. The project woredas have 30,702 students in 2007 academic year

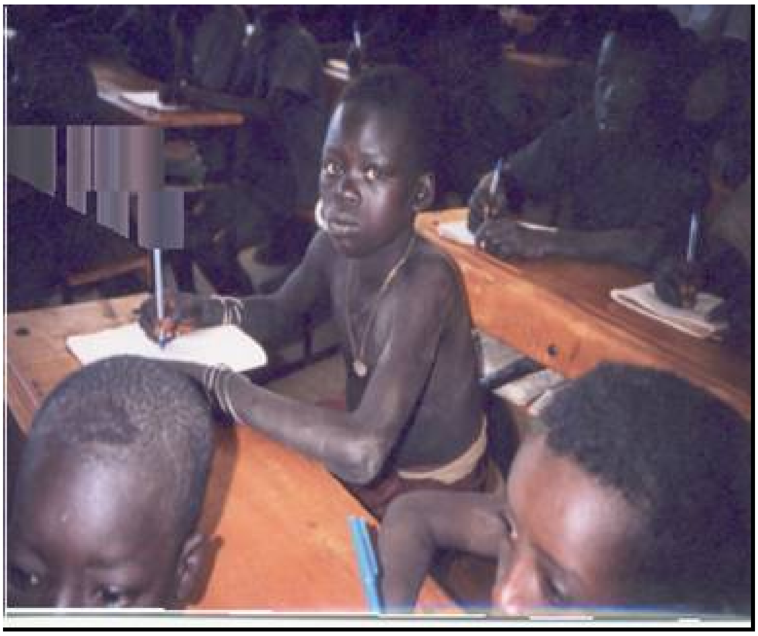


Figure 50 : Students in the project area (Source: Benishangul Gumuz BoFED)

Secondary Level Education

The number of secondary schools (Grade 9 to12) increased from 9 in 1990 to 27 in 2007. Student enrolment in the secondary schools increased from 2,742 in 1990 to 14,935 students in 2007. Similarly the number of secondary school teachers increased from 120 in 1990 to 394 in 2007.

Equipping and Staffing of the Schools

The schools in Benishangul-Gumuz Region are not adequately equipped and staffed. Effective teaching depends upon availability of qualified teachers, education materials and other facilities in general but these conditions are not fully met in most parts of the region including the project woredas.

Qualification of primary school level teachers is reported to have reached 100 % of the standards given by the Ministry of Education in recent years. At the secondary level only 20% of the teachers had the required standard of qualification in 2007. Shortage of qualified teachers arises from unwillingness of qualified professionals to go to teaching profession in general and remote areas of the region in particular because of poor transportation facilities, unavailability of electricity and other basic amenities. Many of schools in the region lack such basic facilities as libraries and/or reference books, and many other required services.

Lack of adequate equipment and furniture of the schools coupled with low qualification of teachers have a negative impact on the quality and efficiency of the education system in the region in general and the project woredas in particular. See educational status of the Regional state in tables 8.10 and 8.11 below.

Table 29 : Enrolment in Primary Education in 2007-Project Woredas

Woreda	Grade 1		Grade 2		Grade 3		Grade 4		Grade 5		Grade 6		Grade 7		Grade 8		TOTAL		
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	Both
Menge	617	409	556	444	716	544	715	300	530	101	248	48	275	28	242	26	3899	1900	5799
Oda Godere	924	653	670	449	696	324	398	177	260	112	234	35	143	43	153	47	3478	1840	5318
Sherkole	401	294	315	209	401	198	306	90	198	37	155	29	126	28	75	15	1977	900	2877
Agelo Meti	561	523	411	403	433	361	385	315	377	175	301	128	232	54	210	24	2910	1983	4893
Sirba Abbay	304	237	204	141	215	159	196	102	193	57	156	53	131	23	156	27	1555	799	2354
Wonbera	973	911	859	611	912	755	755	567	647	560	437	342	408	280	278	166	5269	4192	9461
Total	**3780**	**3027**	**3015**	**2257**	**3373**	**2341**	**2755**	**1551**	**2205**	**1042**	**1531**	**635**	**1315**	**456**	**1114**	**305**	**19088**	**11614**	**30702**

Table 30 : Enrolment in Secondary Education, 2007- Project Woredas

Woreda	Grade 9		Grade 10		Grade 11		Grade 12		TOTAL		
	M	F	M	F	M	F	M	F	M	F	Both
Menge	50	12	33	12	0	0	0	0	83	24	107
Oda Godere	68	20	49	5	0	0	0	0	117	25	142
Sherkole	65	13	63	15	0	0	0	0	128	28	156
Agelo Meti	85	12	156	30	0	0	0	0	241	42	283
Sirba Abbay	133	34	21	7	0	0	0	0	154	41	195
Wonbera	334	253	195	71	100	38	98	23	727	385	1112
Total	**735**	**344**	**517**	**140**	**100**	**38**	**98**	**23**	**1450**	**545**	**1995**

Gender Inequality in School Enrolment

In 2007 academic year, out of 30,702 total numbers of students in primary schools (1 - 8), in the project woredas 62.2 % (19,088) were boys and 37.8 % (11,614) were girls. The figure at the regional level shows 57.8 % % boys and 42.2 % for girls. Thus the participation rate for the girls is over 50% lower than that of boys in the project woredas.

The gender disparity is even higher in secondary schools (9-12) enrolment. While the share of boys in the total number of students enrolled in secondary schools in 2007 was 72.7%, the share of girls was 27.3 %. (Regional figure proves similar gender enrolment bias against female).

The wide gender inequity in educational participation is a result of cultural bias against education of females, demand for girls' labour at home, early marriage and discontinuation of schooling after attending lower grades.

Distribution of Schools by Woreda and Urban & Rural

The distribution of schools both elementary and secondary schools is uneven in urban and rural settlements. Most of the schools are concentrated in urban area. The disparity in the distribution of the schools is even more apparent and greater across the woredas.

According to information obtained from the regional BoFED (*BGNRS-Education Bureau, 2008*), 8% of the elementary schools and 83% of the secondary schools are in urban areas. The share of urban and rural in elementary schools is more or less proportional to their share of the population in 2003 the distribution of the secondary schools, however, is, very uneven in favour of the urban settlement

With regards to preparatory secondary schools Sherkole, Menge, Oda Godere, Sirba Abbay, and Agelo Meti, have no preparatory schools at all. They only run up 10 grades. Students have to go far away from their area to follow preparatory school which is a requirement to enter higher education.

The uneven pattern of distribution of the schools especially between urban and rural will have a negative impact on the indigenous people which constitute the majority of the population of the region who mostly live in rural areas. That is they have relatively little chance of sending their children to schools as the number of secondary schools are either very few or totally non-existent in rural areas.

8.2.12 PUBLIC HEALTH

The assessment of public health in the project area was made by the ESIA study team in July 2008. The health study attempts to assess health service status of project affected woredas including facilities and health personnel. The following aspects were considered in the public health assessment: quality of life and health effects; health facilities in the project area; health facilities and the ratio to the population; the burden of diseases; major diseases in the project area; HIV / AIDS; fertility; and mortality.

8.2.12.1 Quality of life and health effect

Overall, the quality of life in the project area is poor and affects negatively the health of inhabitants. Poor sanitation and hygiene services as well as lack of clean water are major issues that have an effect on the health of the people in most part of the woredas in question.

In addition, houses are often without windows, chimneys and ventilation and prohibits air circulation and increasing exposure to smoke. This is, reported in many studies to be the chief reason for widespread respiratory tract and eye infections in the project area

The dominant water-borne and water-related diseases include Schistosomiasis, Malaria, Onchocerciasis and Trypanosomiasis (human sleeping sickness). Others include acute watery and bloody diarrheas, intestinal parasites, scabies, etc; these are rampant in the project area due to unacceptably poor water supplies and absence of basic sanitation facilities.

8.2.12.2 Health facilities of the Project Area

There is no hospital and health station in any of the project woredas. Health centers are only available in Menge and Wonbera. There are about 28 health posts and health clinic in the project woredas. The details of the health facilities in the project area are presented in table below.

8.2.12.3 Health Facilities and their Ratios to the Population

Access to and quality of health care is an important indicator for the socio-economic well being of a society. The current policy of the Federal Ministry of Health recommends one health post for every 5,000 population, one health centre for every 25,000 people and one hospital for a population of 250,000. However, data obtained from woredas' offices of health indicates an overall health facility to population ratio of 1:12,600. This is a very low ratio even by the standards of Sub-Saharan African countries.

The number and types of primary health facilities available are shown in table There is no hospital in the project woredas. In most project woredas, patients who may need a higher health care have to travel a minimum distance of more than 150km to access medical care.

Therefore, the number of health facilities existing in the project area is far from being adequate to meet the demands of the population. In addition, the existing health facilities are severely under-staffed, ill equipped and under-supplied. The existing health facilities are built by Government in collaboration with communities, NGOs and multilateral organizations.

Table 31 : Health Personnel by Category, Project Woreda, 2003

Zone	Woreda	Doctor	Nurse	H.Assist.	Pharmacist	Lab. Tech	X-ray Tech.	Total Personnel
Assosa								
	Oda Godere		4					4
	Menge		12	1				12
	Sherkole		2	2				4
Metekel								
	Wonbera		5	1		2		8
Kamashi								
	Sirba Abbay		3					3
	Agelo Meti		5					5
Total Project Area			**30**	**4**		**2**		**36**

Source: Benishangul; Gumuz Health Bureau, 2008

Table 32 : Top 10 leading diseases in Project Woreda

Type of disease	Cases No.	Cases %
Malaria	186,432	40
Bronchitis	88,345	19
Gastric	66,368	14
Intestinal Parasites	46,248	10
Dysentery	26,876	6
Unknown	18,448	4
Rheumatism	14,722	3
Skin diseases	12,786	3
Eye diseases	1,560	<1
TB	467	<1
Total	**462,657**	**99**

Source: Benishangul; Gumuz Health Bureau, 2008

8.2.12.4 The Burden of Diseases

Review of the Mandaya Pre-feasibility Study (Health Section) (EDF and Scott Wilson, 2007) referring the issues found from woreda health offices reveals that the burden of disease, as measured by premature deaths of all causes, emanates primarily from causes preventable by simple public health measures. Communicable diseases and diseases resulting from malnutrition predominate.

According to the study the main factors to blame for the burden of ill health in Ethiopia include inadequate access to health services; poor access to clean drinking water and sanitation facilities; widespread poverty and ignorance. Access, in this case, includes not only scarcity of health facilities but also distances and physical barriers to right to use. Women and children have poorest access, chiefly due to their physiological make-up and the low social status accorded to them.

8.2.12.5 Major Diseases in the Project Area

The major diseases in the project-affected woredas include upper respiratory tract infections (URTI), malaria, diarrhoea and skin infections. Table below summarizes the leading diseases treated in the project area of Benishangul Gumuz. The patterns of disease are reported to be very similar in all project woredas, with slight variations in magnitude.

Reviews of health reports obtained from the Health Bureau and all health facilities disclose that malaria is the single most important public health problem in the project woredas. It accounts for more than 50% of morbidities and mortalities in all health facilities in the project area taken as whole. The chief reasons for the widespread occurrence of malaria include lack of environmental management to destroy mosquito breeding sites at community levels, unavailability of insecticide-treated mosquito nets (ITN), resistance of malaria parasites to most drugs currently on the market, and resistance of mosquitoes to insecticides.

8.2.12.6 HIV/AIDS

HIV/AIDS is a new disease vastly emerging in the area. It is believed to have been imported into the area with immigration of girls and young ladies from adjacent and outlying highland areas (regional profile, 2003).

A performance report issued by the Benishangul Gumuz Regional State Secretariat Office shows that the disease is prevalent and on the rise. According to the same information in current 2008 year 7,151 people live with the virus out of this 639 were pregnant women. 121 children are born with the virus every year. Out of the total HIV cases 5.7 % live in the urban area and 1.2 % live in the rural area. Women are more vulnerable than men. The above source reported that on the average 978 new cases are found every year. Regarding death rates 416 adults and 80 children die every year in Benishangul Gumuz.

The Benishangul Gumuz HIV/AIDS prevention and control office in cooperation with the regional government, NGOs (world vision Ethiopia and IRC), CBOs and FBOs is actively involved in controlling and preventing the disease through out the region.

Region has allocated budget, NGOs have established AIDS fund for the various activities to combat the disease and mainstreaming of HIV/AIDS by the above stated organizations.

Awareness creation is the major activities that the region is undertaking for effective intervention in controlling HIV/AIDS. The national HAPCO has employed a number of mechanisms to create awareness about HIV/AIDS among the people of the region. These include training workshops, conferences, establishing and supporting youth clubs and associations. In addition to that community mobilization is taken as the basic strategy through which the creation of awareness about HIV/AIDS, VCT, ART and PMTCT is strengthened.

Accordingly, the Benishangul Gumuz HIV/AIDS prevention and control office in collaboration with BoH and concerned sectoral institutions made a very successful advocacy campaign in the region.

ART (Anti-Retroviral Therapy) is provided to people living with the disease to extend life. Currently about 1,249 people who are living with the virus are able to have ART services in the region (1,730 people need ART every year). Chronic care service is also given in Assosa hospital, Pawe hospital and Assosa and Bambasi health centers. About 637 persons are currently using chronic care service in the region.

VCT (Voluntary Counselling and Testing) service started in the region in 1995 mainly the capital city and Pawe hospital. The service is still on going in the two hospitals and Bambasic and Asossa health centers,

To reduce the risk of transmitting HIV/AIDS from mother to child during pregnancy, delivery or breastfeeding, the region provides Prevention of Mother To Child Transmission (PMTCTS) in Assosa and Pawe hospitals, Bambasi and Assosa health centers. Accordingly 14,958 clients were provided with PMTCT services from 1996-1999 E.C. The risk of an infant acquiring the virus from an infected mother is about 25 to 35 %. See figure for details.

There are 18 health centers providing anti- HIV/AID services in the region, of which 8 provide retroviral services in 2008. In the same year 27226 people got VCT services of which 1112 people were tested positively. 958 (including) were given retroviral medicine. With the support of Global Fund 5 health stations, 3 Anti-HIV/AIDS medical centers 12 VCT centers are built. The 3 centers are located in Agelo Meti, Sirba Abbay and Sherkole (project woredas).

One of the major activities of the Secretariat is training of trainers aiming at training facilitators. Accordingly they have trained 60 trainers and the trainers have trained 1,748 facilitators.

Regarding the knowledge of HIV/AIDS, earlier study reveals that, the proportion of households who have heard about the disease could reach as high as 81.6%; and 18.4% as having not heard in the project area (Regional Profile, 2003). Knowledge about HIV/AIDS was reported to have been obtained from various sources of information such as: radio, religious leaders, market places, Health center's, Clinics, woreda meetings, hospitals and others. A study conducted in one of the project woredas by BoFED shows that among the interviewees 35.6% were informed through woreda meetings; 22.6% from listening the radio; 18.4% said they have no idea; 9.9% claimed they heard about the issue at market places; 7.3% from Clinics; 4.2% from health Center's and 0.3% from Hospitals and religious leaders.

On the other hand, according to the earlier study mentioned above, households knowledge on how the disease is transmitted revealed that 54.5% of the households have no idea how the virus is transmitted; 38.4% said from sexual affair with infected person; 2.6% believed it is because of sharing blades used by infected persons; 2.3% said sharing eating materials with AIDS patients; while a very insignificant proportion of households shared similar opinions such as the use of unsterilised syringes and blood transfusion could cause the disease.

8.2.12.7 Fertility

The 1994 housing and population census reported the Total Fertility Rate (TFR) in Benishangul Gumuz (i.e. the number of children a woman could have during her reproductive life) to be 3.4 children per woman. The reported Crude Birth Rate (CBR) is 24 births per 1000 mid year population and a General Fertility Rate (GFR) of 102 children per 1000 women at child bearing age. The reported TFR value for urban woman was 3.2, while for the rural woman it was 3.5 children per woman.

CSA has adjusted the reported level of TFR of urban and rural areas to 4.3 and 6.7 births per woman, respectively. The adjusted level of TFR for the whole Benishangul-Gumuz region was estimated to be 6.5. The adjusted CBR and GFR for the region was estimated to be 44.9 births per 1000 population and 191.2 children per 1000 women at child bearing age, respectively.

Detailed health indicators of the project woredas are presented in table 8.14 below.

Table 33 : Projected health indicators (2008)

No	Woreda	Pop. Profile EFY 2000					Estimated no. of HH	Total no of surviving infants at 1 yr of age	<5yr Child Pop.	Women in reproductive age 15-49	Total No of Estimated pregnancy	Estimated deliveries	Non Pregnancy women in the fertile age
		Total	Rural	Urban	Female	Male							
1	Mange	39504	31603	7901	20379	20125	8230	1355	6518	9441	1683	1683	7703
2	Sherkole	19041	15233	2808	10150	8891	3967	653	3142	4551	811	811	3713
3	Oda Godere	30374	24300	6075	14783	15591	6328	1042	5012	7259	129	129	5923
4	Wonbera	57723	43292	14431	29412	28311	12026	1980	9524	13796	2459	2459	11256
5	Sirba bay	12548	9411	3137	5921	6627	2614	430	2070	2999	535	535	2447
6	Agelo Meti	19313	14485	4828	9874	9439	4024	662	3187	4616	823	823	3766
Total		**178503**	**138324**	**39180**	**90519**	**88984**	**37189**	**6122**	**29453**	**42662**	**6440**	**6440**	**34808**

8.2.12.8 Mortality

Infant mortality rate, child mortality rate, under-five years mortality rate and life expectancy at birth are used to signify mortality measures. According to the 1994 census, the infant mortality rate (i.e, the probability of death in the first year of life) for the region is 140 per 1000 live births, that is 147 per 1000 live births for males and 133 per 1000 live births for female. The child mortality rate (i.e, the probability of death for children in the age of 0-4 years) for the Benishangul-Gumuz Region is 79 per 1000 children, i.e, 76 for males and 82 for females. Under five mortality rates are estimated to be 213 per 1000 for males, 205 per 1000 for females and 209 per 1000 children for both sexes.

Life expectancy at birth (i.e. the average length of life that would be observed in a population) for the region is 46.5 years, and 46 years for males and 47 years for females.

Table 34 : Health Facilities Available in the Project Woredas (in 2007)

No	Name of woreda	Zone	Type of Health Facility		No	Remark
1	Menge	Assosa	1	Health Posts	8	Government
			2	Health Stations	-	"
			3	Clinics	1	"
			4	Health Center	1	"
			5	Hospitals	-	"
2	Sherkole	Assosa	1	Health Posts	3	"
			2	Health Stations	-	
			3	Clinics	3	"
			4	Health Center	-	
			5	Hospitals	-	
3	Oda Bilidiglu	Assosa	1	Health Posts	6	Government
			2	Health Stations	-	
			3	Clinics	2	"
			4	Health Center	1	"
			5	Hospitals	-	
4	Wonbera	"	1	Health Posts	6	Government
			2	Health Stations		
			3	Clinics	1	"
			4	Health Center	1	"
			5	Hospitals	-	
5	Sirba Abbay	Kamashi	1	Health Posts	2	Government
			2	Health Stations	-	
			3	Clinics	2	One run by NGO (Boka clinic)
			4	Health Center	-	
			5	Hospitals	-	
6	Agelo Meti	"	1	Health Posts	3	Government
			2	Health Stations	-	
			3	Clinics	2	"
			4	Health Center	-	
			5	Hospitals	-	

8.2.13 WATER AND SANITATION SERVICES

Access to clean water and sanitation services are a severe problem in the Project Woredas. The majority of the project woreda people get the water from rivers or unprotected springs. Fetching water is the task of women and they are required to walk a long distance (30 minutes or more) from their villages to draw water from the rivers or any unprotected source.

Baseline Study conducted in some of the project woredas indicated that only very few cases of water treatment practice have been reported. 93% of the households reported that they do not have treated water for drinking. In addition, the study found very important results concerning sanitation in Menge Woreda which is summarized as follows:

- About 35% of the households reported that washing the hand before meal is important, while 46% reported that it is important to wash hands on all occasion. Few numbers of households reported the importance of washing hands after using latrine (2%), and before cooking (15%).

- The Kitchen is reported to be available only in 21% of the households, while the remaining 79% don't have a separate kitchen where they cook their food. Nearly all the households that do not have a separate kitchen reported that they would cook their food inside the house.

- Large number of households (87% and 68% of them) reported that they would dispose of rubbish and animal excreta in the back yard of the house.

- About 76% of the households do not have latrines, while 24% reported that they have one. All the households that have latrines reported that they are currently using them. The latrine types used included traditional pits and a hole in the ground.

- Small children's excreta are reported to be disposed into back yard of the house, the bush and latrine.

8.2.14 GENDER ANALYSIS

8.2.14.1 Production and Asset Ownership by women

Women in Benishangul Gumuz assume major responsibilities in farm and household activities for the family. They are engaged in agriculture production, house keeping, child raising, water and energy provision. In short they play significant role in the economic, social and other development in the society in the project area.

On the other hand women are the most disadvantaged group in the society. They are more susceptible than men for various reasons. Higher proportions of women are illiterate. They lack access to productive assets such as arable land. They lack the opportunities to participate in local decision making process. They have no access to improved technology. In general they are not benefiting from the economy sufficiently considering the key role they play in sustaining their families and communities.

The Women’s Affairs Bureau of the Benishangul Gumuz conducted a regional survey to know the status of women in the region in 2008. The results are not yet published but the team were kindly availed the data and unpublished report from the bureau. The findings are very relevant to the socio-economic study of the transmission line route of the Ethiopia, Sudan Egypt Interconnector.

From the recent regional study, the following salient results and the situations of women in sectoral development are outlined in table and can be briefly described as follows:

- The livelihoods of 87 % of the women surveyed are based on agriculture, 5 % on trade, 3.8 % are government employees.
- Although women in the project area play a major role in the economy most of them do not have the power to own the household asset or make decision on property and economy in the household. The study reveals that about 50 % of the women do not have the power to make decision on the household produce. They are highly marginalized.
- Out of the total of 10,018 employees in the public sector 3,099 (31 %) are female. The majority of the task force in governments are male. They constitute 6,920 (or 69 %) of the total labour force.
- Regarding the salary scale no woman earns salary in the bracket of greater than 18,000 Birr (compared to 46 male workers in that bracket). There are only 26 female workers or 17 % of total female employees in the salary scale of 1000 and 1799 Birr (male are 536 or 8 % in that range). The majority of the women fall between 200-599 salary range, they account 2,790 women (90 % of the women employed by the government), The comparable figure for male is 536 or 69 % of the total male employees. See table for the summary of results on salaries aggregated by gender.

Table 35 : Salary Category in Benishangul by Gender

No	Salary Scale	Number of Employees			Percent of Female
		Male	Female	Total	
1	200-299	1235	880	2115	41.61
2	300-599	3542	1910	5452	35.03
3	600-999	1561	283	1843	15.36
4	1000-1299	294	17	311	5.47
5	1300-1599	157	6	163	3.68
6	1600-1799	85	3	88	3.41
7	>1800	46	0	46	0.00
Total		**6,920**	**3,099**	**10,018**	

Source: Compiled from the study of Women's Affairs Bureau, 2008

Regarding professions of the government occupation, there are 26 (5.39 %) female and 456 or 94 % male employees in governments engaged as professional science category. 32 (9 %) women are working in administration (336 are male in the category). Major proportion of the women (1,792 or 58 % of them) are working as manual, crafts or clerical workers.

Table 36 : Gender Distribution of Government Employee in BG

No	Occupation	Employees			
		Male	Female	Total	% of Female
1	Professional Science	456	26	482	5.39
2	Administration	336	32	368	8.70
3	Semi-Professional	1028	335	1363	24.58
4	Clerical	989	906	1895	47.81
5	Crafts	261	65	326	19.94
6	Manual	1078	821	1899	43.23
7	Health Personnel	463	107	570	18.77
8	Teaching	2039	763	2802	27.23
9	Higher Post	268	16	284	5.63
Total		**6918**	**3071**	**9989**	**30.74**

Source: Women's Affairs Office, Benishangul Gumuz, 2008

8.2.15 ENERGY SERVICES

The woredas in the transmission line corridor are endowed with a large number of forest resources. These forest resources are the major source of energy used as fuel wood for cooking and lighting. Cooking is the major end use of the fuel wood required by the household in the area. A large number of people use fuel wood for lighting other than cooking in Benishangul as well as in the project area.

In Benishangul Gumuz Regional state 96.7 % of the energy consumed in 2004 came from wood, 1.8 % from agri-residue and the remaining 1.5 % came from modern fuel (Benishangul Gumuz Profile BoFED, 2005). Total fuel wood consumption in 2004 reached 623,913 m^3. Table gives a full description of the energy sources used in the areas through which the proposed route corridor passes.

Charcoal and dung are rarely used in the project area. Electricity is being introduced in many towns and rural settlement at this moment. To obtain electricity services, however, people need to change their thatched roof with corrugated iron sheet (requirement of EEPCO). Nevertheless many people can not afford to buy corrugated iron sheet for their houses and hence they have not benefited from the electricity which is now available in their areas.

In the absence of electricity, kerosene and diesel fuels are used solely for lighting in the project area with diesel being more broadly used than kerosene.

Table 37 : Energy Consumption by type of Fuel in the Project Area

Source: BGRS BoFED, 2004

Woredas	Rural families	Urban families	Area (ha)	Round/ split	BLT	charcoal as wood	Total wood	Residue	Dung as fuel	Charcoal	Gas oil	Kersne
Wonbera	8,701	672	734,436	46,034	21,654	664	68,353	5,387	157	100	121	9
Agelo Mete	2,874	-	152992	15,053	7,778	200	23,031	2,242	75	30	41	3
Sirba Abbay	2,099	-	134,096	10,946	4,850	104	15,900	802	8	16	27	2
Menge	7,863	59	148,224	25,201	11,596	4,468	41,265	3,924	91	670	189	24
Oda Godere	5,477	0	145,776	18,637	9,565	3,065	31,267	3,772	118	460	135	17
Sherkole	3,731	0	325,608	12,735	5,042	2,512	20,289	1,228	0	377	102	13
Subtotal	**30,745**	**731**	**1,641,132**	**128,607**	**60,484**	**11,013**	**200,104**	**17,355**	**448**	**1,652**	**616**	**68**

8.2.16 CULTURAL AND HISTORICAL VALUES

Benishangul Gumuz has rich archaeological and historical spots. A number of Archaeological investigations have been done in many places in the last couple of decades. Important archaeological research has been conducted in the region between the Blue Nile valley and the Sudanese border since in 1992 E.C. by an archaeological team from University Complutense of Madrid and directed by Dr. Victor M. Fernandez.

Benishangul was known by the name Sasu during the Axumitie Empire and it was an important market and gold center. Nations and Nationalities of Benishangul include Berta, Omo, Shinasha, Gumuz and Komo This research covered many parts of the region and has identified considerable heritage sites. It discovered caves, cave paintings, pottery remains and stone tools ranged from early Stone Age to middle Stone Age.

Sirba Abbay considered as one of the very important heritage sites and treated as number one of the archaeological sites covered by the team. The GPS location of these important heritage site could not be obtained, however distribution of the sites in the region can be seen in Figure.

This archaeological research recorded artefacts, flake, isolated lithic core tools in dark green volcanic rock (choppers and chopping tools, picks core scrapers hand axes and so on) between the southern bank of the Abbay River and Gumuz valley of Boka River. It recorded also rock out crop of Kaba (Assosa). The discoveries were categorized as early Stone Age and middle Stone Age.

In addition, there are important sites such as palaces, hot springs, grave yards, etc. in the Regional State, however, during the site visit no such important sites that would be affected by the transmission line corridor of the preferred options were seen. Figure shows all archaeological and historical sites found in Benishangul Gumuz Region.

Figure 51 : Grave Yard in Sherkole along the transmission line route corridor of option I

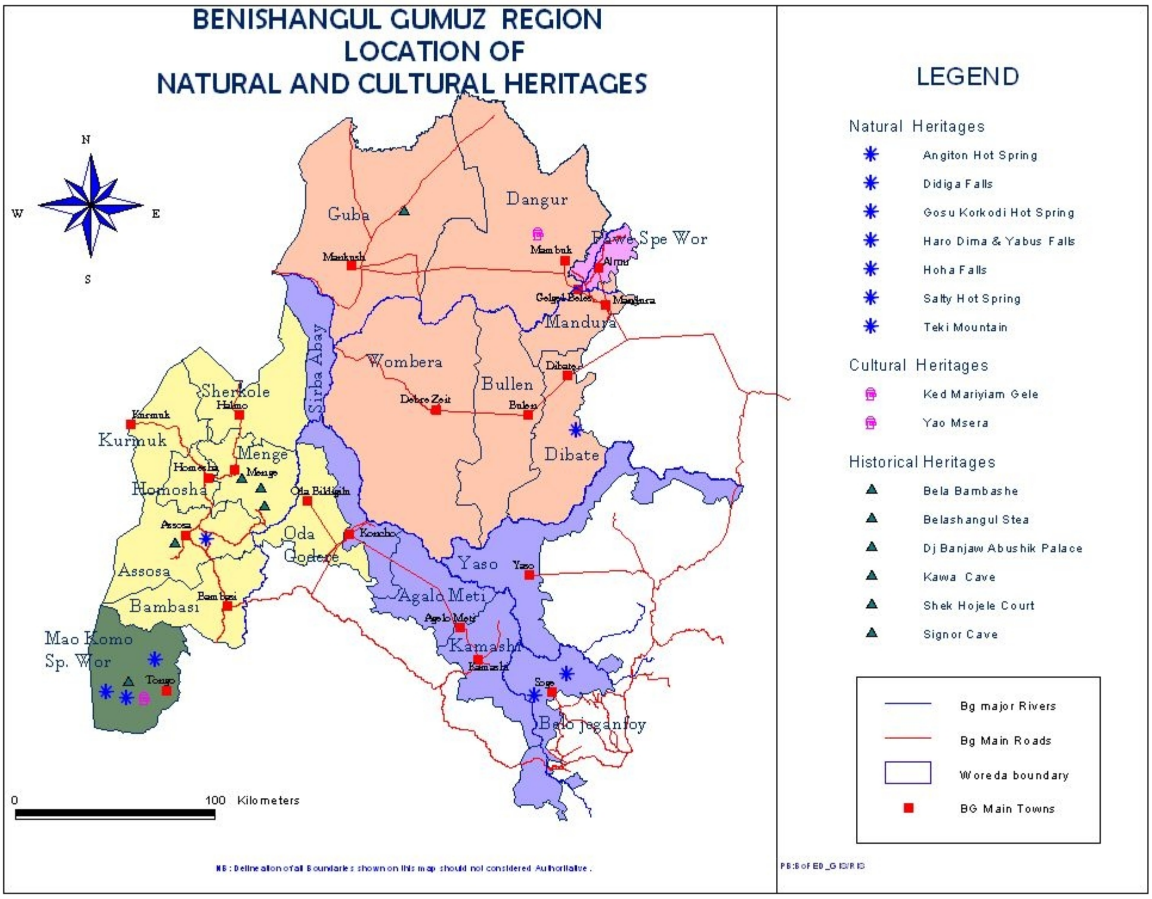


Figure 52 : Archaeological and Historical Sites in Benishangul Gumuz

(Source: Benishangul Gumuz, BoFED)

8.3 SUDAN SECTION

8.3.1 ADMINISTRATIVE FRAMEWORK

According to the Local Government Act of 2003, the Sudan has been divided into 26 States, some 16 located in the north and 10 in the south. Each State is divided into a number of Localities (Mahaliyat). The aim of decentralization is to improve the delivery of basic social services and address the severe spatial disparitries in access to education, health, water, agricultural extension and other government services.

The proposed route corridor for the transmission line from the Ethiopian/Sudan Border to the Sudan / Egypt Border traverses the five Local Government Admistrative States, these are:

- Blue Nile state
- Sennar State

- White Nile State
- Khartoum State
- Northern State at the Egyptian Border

The location of the above mentiones Local Government Admistrative States through which the route corridor passes can be seen from figure 8.12

The proposed transmission route runs through Blue Nile, White Nile, Sennar State, west of Omdurman (Khartoum State), and parallel to the Nile through Nahr Al Nil (River Nile State) and Shamalia (Northern States) to Egypt.

The east central states are characterized by traditional rainfall, smallholder agriculture, large semi-mechanized farming, and pastoralism. Livestock production comprises cattle, sheep and goats. These states are on the routes to terminal market in Khartoum state.

The profile of east central Sudan is extremely diverse. The three states of Blue Nile, Sennar and White Nile are inhabited by a mix of sedentary agriculturalists and nomadic or semi nomadic pastoralists. The social structure in the region is heterogonous. There are many pastoralists and nomadic groups, who raise cattle, grow some crops for subsistence and use defined north south and west east migrating route.

Through the northern states the traditional irrigated agriculture is practiced on the flood plains of the main Nile downstream of Khartoum State. With the exception of the Riverian Nile strip, the desert region, through which the proposed line passes, is underdeveloped, as the land can only support low-intensity pastoralism.

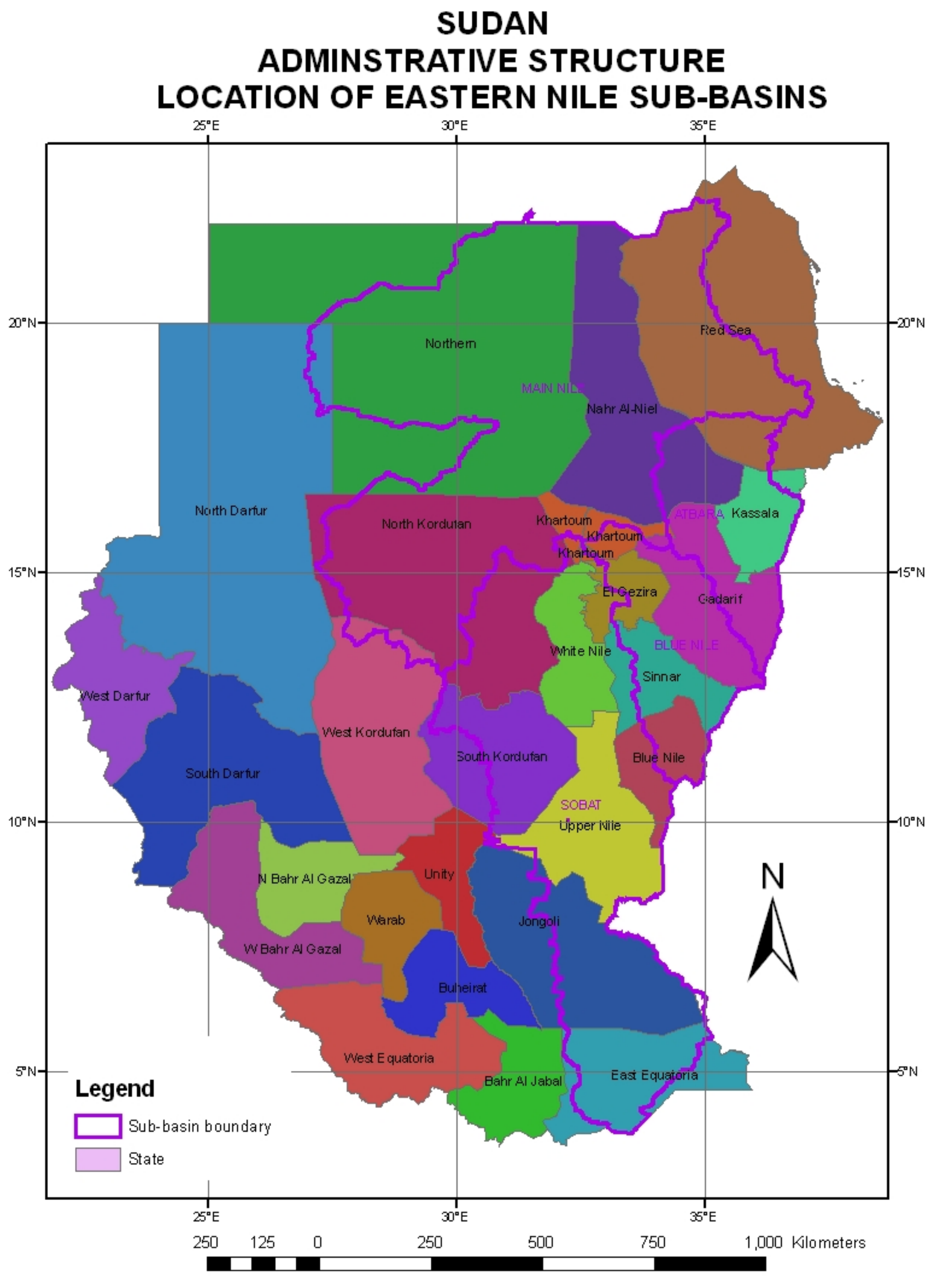


Figure 53 : Sudan: Adminstrative Structure with Eastern Nile Sub-Basin Boundaries.

(Source: ENTRO GIS data base)

8.3.2 POPULATION

The total population of the Blue Nile State in 2007 was estimated at 783,000 persons, that of the Sennar State in 2003 was estimated at 1,404,000, that of the White Nile State in 2003 was estimated at 1,595,000 and that of the Northern State was estimated to be 1,342,500 in 2002.

Refer to table for population characteristics of the states of the project area, figure 8.13 for a typical composition of a household in rural area of the study area and figure 8.14 for typical household dwelling place.

Table 38 : Population parameters for the Project Area States

State	Total Population	Growth Rate %	Rural %	Sex Ratios	Birth Rate	Death Rate	Household Size
Blue Nile	783,000	3.2	70.2	104.8	38.9	12.8	6.5
Sennar	1,404,000	2.6		98.9	339 per 1,000 live births	109 per 1,000 live births	6.5
White Nile	1,595,000	2.59	60.0	108.4	404 per 1,000 live birth	100 per 1,000 live births	6
Khartoum							
Northern	1,342,500	1.85	74.6	95			

Source: Sudan Transition and Recovery Database

Figure 54 : Typical household composition

8.3.3 ECONOMIC ACTIVITIES

8.3.3.1 Agriculture

Mechanised schemes

Industry in the project area is mainly based on crop processing and includes sugar, vegetables, oil, cotton, cotton mills, and leather works. Sennar, Kenana and Assalya produce sugar.

Evaluation of the irrigated agriculture indicates that their performance has been below potential. This is mainly due to dilapidated irrigation and drainage infrastructure. Environmental factors such as canal sedimentation have also contributed to low irrigation returns.

Modern rain-fed agriculture using tractors and disc harrows and sometimes mechanical harvesters is found in the east central states.

The mechanized farming land is leased by the state for individual investors whereby each individual is allotted "a farm". The size of the farm ranges from 1000 to 1500 feddans. These schemes are managed by both private and government sectors. Sometimes, rotation of dura, sesame and fallow with or without cotton are practiced, but often a piece of land is cropped with dura until the land loses its fertility and then abandoned completely.

Mechanized rain-fed agriculture has been accompanied by large scale destruction of the environment, declining yield and diminishing contribution to the agricultural GDP. Moreover, the uncontrolled expansion and replacement of other form of livelihood triggered conflict while it institutionalized poverty, inequalities and social grievances in the clay plain of east central Sudan.

Starting in the late 1950s large areas have been allocated for semi-mechanized farming. The allocation for the original demarcated schemes was originally made by the Mechanized Farming Corporation (MFC) a central institution which was dismantled in 1992, with intention to transfer the responsibilities to the regions under the regional government at that time. Un-demarcated schemes were mainly allocated by local authorities within the regions concerned. Allocation did not take into account the need of the other land users, especially the pastoralist (including the seasonal use of stock route). The expansions of areas of semi-mechanized farms were facilitated by the abolition of the native administration, so there were no checks on land allocation through customary administration. The expansion of mechanized farms has seemly exacerbated from locations demarcated for mechanized schemes, stock routes have been blocked by mechanized scheme. This has also been a critical factor in the deterioration of the natural resource base leading to destruction of vegetation cover used by nomadic pastoralist and has had negative impacts on the Dinder National park, a protected area. The semi-mechanized farming can be classified into unregulated developments which has intensified tensions between pastoralists and traditional farmers.

Traditional farming

Traditional peasant farmers grow sorghum, millet, sesame, groundnuts, vegetables and fruits. Production from traditional cultivation is low and many hazards are encountered such as water logging, plant diseases and pests. These in addition to bad management practices are responsible for the poor yield attained.

Irrigated agriculture falls into two broad categories: traditional irrigation and modern schemes. Under traditional systems, sorghum and millet are the main food crop. Other important produce for the domestic market includes sugarcane, wheat, and sunflower. The principal cash crop for export is sugarcane, cotton, sesame, groundnut, fruits, and vegetables. Refer to figure 8.15 Showing an irrigated crop of sorgum.

Figure 55 : Irrigated sorghum crop

Livestock production

The nomadic ethnic groups in the project area keep animals such as cattle, goats, sheep and camels. Livestock numbers have increased explosively especially in central Sudan. This, together with reduction in the total area of available rangeland has led to rangeland degradation.

Pastoralism as a land use type is practiced all over the project area and is determined by the rainfall intensity and distribution. Generally, livestock in the east central states depends on natural pastoral fields for the whole year except the period before the rainy season (March to June).

In the Blue Nile State, transhumance is practiced by Angasna, Kenana, African tribes such and Fallata and Um Barnru, and Rufaa. These tribes keep mostly cattle, only small ruminants (sheep and goats) are kept. The families of Angasna, Kenana, and Rufaa tribes are settled whereas the animals move about. The Angasna, Kenana, and Rufaa practice farming on small scale and mainly subsistence, hence they depend mainly on livestock and livestock product. For the normadic tribes, the whole family moves with the herd, they do not practice farming. The pattern of mobility of these groups in south north direction to avoid nocuous infects. They move northwards during the rainy season and they return to their homes during the dry season.

Transhumant pastralism in Sennar state is practiced mainly by Kawahla, Rufaa, West Africans, and Batahin. The families of these tribes are settled with the exception of West Africans. The mobility pattern is east - west. Transhumant move to the east and stay for four months (May-August) and return to the west and stay for four months (Dec.-March).

The system of native administration used to contribute significantly to the construction of fire lines and conservation of rangeland through mobilization of the community. Lack of communal management of grazing lands has led to deteriorated range conditions and is reflected in low animal productivity. The breakdown of many watering resources along the stock routes or at rainy and dry season grazing areas which were used for watering livestock has further forced livestock to graze around the limited remaining areas.

Transhumant pastralism in White Nile state is practiced by Salem, sab Mhamda, Rufaa, Gimara, Benni jarrar, shnabla, Hassaneya and Hasanat. The first five tribes keep mostly camels the other five keep cattle. Settled farmers grow sorghum, millet, maize, and cowpeas, as well as cash crops such as sesame and ground nuts. They also traditionally tap Gum Arabic. Livestock contribution to the household income is relatively less than that of crops. Sheep and goats are the most numerous species kept. Small numbers of cattle may also be kept. Village-based stock move only short distances from the villages.

Pastoralism as a land use type is practiced all over the White Nile State and is determined by the rainfall intensity and distribution. Generally, livestock in the state depends on natural pastoral fields for the whole year except the period before the rainy season (March to June).

8.3.4 COMMUNICATION

Paved roads connect the project area with the rest of the country. The Blue Nile State is connected with Khartoum through Damazine-Sennar 287 km highway. A 307 km road is connecting Rabak with Khartoum state. Rabak is connected to Jebellen which is 69 km long. In addition there is a 220 km road connecting Kosti-Sennar and a road connecting Kosti to El Obied in North Kordofan. The proposed transmission route will run parallel to the paved road which connects Khartoum to the Northern State (Shiran Al Shamal).

Kosti in White Nile State is the only river port connecting North Sudan to south Sudan which provides a cheap corridor to deliver goods and food assistance to the population of southern Sudan.

8.3.5 EDUCATION AND LITERATURE

Education and literacy levels in the project area are generally low and are far below the target set for the millennium development goals. (MDGS) with the BNS ranked the lowest in the country. According to Sudan transition and recover database (star base) 2003. There are 184 primary schools in BNS catered far by a total of 2,108 teachers. Enrolment rate in primary education in the state is 33.9% and the proportion of children starting grade one and completing grade five is 88.8%. The ratio of boys to girls in primary schools is 0.96 i.e. 96 girls per 100 boys. This reflects gender equality in primary education. The literacy rate of 15 year olds is 36.7% and ratio of literate females to males of 15-25 years old is 107 (Tables 8.20 & 8.21). Refer to figure 8.16 for typical school structure in the study area.

Table 39 : Primary enrolment rate by state, 2000

State	Attendance (%)
Blue Nile	27.9
Sennar	46.1
White Nile	57.7
Khartoum	76.8
Northern	71.8

Table 40 : Literacy rate for females aged 15 years and above

State	Attendance (%)
Blue Nile	36.7
Sennar	50.0
White Nile	51.6
Khartoum	74.9
Northern	71.5

Figure 56 : Typical primary school structures in the project area

Provision of good quality education services in the study area is hampered by lack of basic facilities like trained teachers, books, and teaching aids and conducive to school environments.

There are 539 primary schools in Sennar state catering for a total of 6,960 teachers. The registered schools totalled 26,112 pupils in the academic year 2001/2002, 50.1% girls and 49.9% boys.

The proportion of children starting grade one and completing grade 5 is 72.8%. The ratio of girls to boys in primary school is 50.1 girls to 49.9 boys, which indicates gender equality at the primary education level.

School environment and training of teachers directly affects academic attainment and education efficiency. The school environment (school buildings, facilities and teaching-learning materials) are extremely poor in the vast majority of schools. The percentage of trained teachers is 59.4%.

Education levels in White Nile State are very low compared to Khartoum state. The enrolment ratio in primary education in the state is 61.2% whereas in Khartoum state is 86.1%. The literacy rate of 15-24 years old was 51.6 and the ratio of literate females to male of 15 years old was 1.07. There are 679 primary schools catered for by a total of 13,804 teachers. The registered students in the schools are 178,872 pupils in the academic year 2000/2001 compared to 1999/2000 was 2.7%

8.3.6 PUBLIC HEALTH

Health as a social indicator has enormous human development importance. Table below shows the distribution of health facilities in the project area.

There are nine hospitals in Blue Nile State with 271 beds. There is one specialist, one specialized hospital, 14 dispensaries (4 closed), 76 dressing stations (31 closed), 46 PHCU (22 closed), in addition to one blood bank and two X-ray units.

There are 17 hospitals in Sennar state with 1,022 beds. There are 3 Hospitals with specialists, one specialized hospital, 36 health centers, 122 dispensaries 152 dressing stations, in addition to five blood banks and five x-rays units.

There are 17 hospitals in White Nile State with 1,266 beds, in addition to five hospitals with specialists. The total number of physician in the state is 96. The medical assistant manpower in the state is as follows: 111 technicians, 359 medical assistance, 742 nurses, 20 public inspection offices, 523 certified midwives, and 57 trained midwives.

Health facilities per 100,000 populations for the Northern State (1993-2000) show a decline between 1993 and 2000. This indicates that while the population is growing over the years, this is not being marched with increase of public health facilities.

Table 41 : Health facilities per 100,000 people in Northern State (1993 – 2000)

Facility	1993	2000
Hospitals	2.4	3.3
Health Centres	9.4	7.6
Dispensaries	16.3	10.4
Dressing Stations	12.5	7.0
PHC	13.7	13.2

Source: State Encyclopedia 2000

8.3.7 DISEASES

The most common diseases in the project area are malaria, bilharzia, tuberculosis, acute respiratory diseases, diarrhoea, global acute malnutrition (GMA) and severe malnutrition (SAM) is also common among children. Poor sanitation in both rural and urban settlements has a negative impact on human health and life quality. Poor environmental conditions, and sanitation, and low health coverage, contributes among others to morbidity and mentality of the population.

The poor health services in the project area is reflected in high infant mortality rate (25.9% in Blue Nile State) and low access to adequate sanitation (16.7% in Blue Nile State) and poor access to save drinking water (38.37% in Blue Nile State) according to UNICEF 2004.

In Sennar State nutritional deficiency percentage in 1998 indicates that 8.0% of the population suffers severe malnutrition while 18.6% had moderate malnutrition. Poverty in the state contributes to nutritional deficiency. Insufficiency of food is reflected in nutritional deficiency recorded in the state.

HIV/AIDS data on AIDS is not available but it is believed that AIDS is becoming a vulnerability in the project area especially in Blue Nile State. Women have greater vulnerability to HIV/AIDS than men due to a range of epidemiological, biological and socio-economic reasons.

The prevalence of those diseases tend to peak during the rainy season. The phenomena attributed to deteriorating water sources and shortage of food. At the end of dry season and beginning of the rainy season is typically a time when:

Food supplies are becoming strained some households begin to rely on less preferred food.

- Food supplies are becoming strained some households begin to rely on less preferred food
- Households being forced to rely on less sources of drinking water.
- Vector borne and infectious diseases (especially malaria) are more prevalent.

The main problems encountered by health services in the states include shortage of health cadre, lack of equipment especially for diagnoses, and high costs of medical treatment.

Table 42 : Distribution of environmental health manpower in the project area, 2000

State	Inspector	Officer	Worker	Population/ Inspector	Population/ Officer
Northern	3	5	301	170,154	170,154
River Nile	7	10	36	12,600	38,200
Sennar	4	10	465	27,850	111,400
Blue Nile	14	13	N/A	99,222	106,854
White Nile	4	4	232	149,653	149,653

Source: State Encyclopaedia

8.3.8 WATER AND SANITATION

The project area is endowed with a variety of water resources- perennial rivers, seasonal water courses, rainfall and underground water, yet water is not available. Water deficit in Blue Nile State, for example, is estimated to be 83% in 2003, with only 23.7% having had access to safe drinking water. The majority of the population relies entirely on natural water sources, valleys, streams and shallow unprotected wells. Women are the principle collector of water and responsible for family hygiene. In some places they travel a distance as far as 3-5 km to acquire water for drinking and cooking. Basic facilities for both solid and liquid waste disposal are almost entirely lacking. Many urban houses are without appropriate sanitation facilities and public toilets. Poor sanitation has adverse effect on community health. Sanitation in rural areas is almost non-existent.

Table 43 : Population with access to clean drinking water and sanitation

State	% Population with access to Clean Drinking Water	% population with access to Sanitation
Blue Nile	24	63
Sennar	74	55
White Nile	39	54
Northern	71	79

Source: State Encyclopedia, 2000

The Blue Nile River is the main hydrological feature of the state it provides water and electricity for the major irrigated schemes in central Sudan after the establishment of Sennar Dam in 1925. Moreover many seasonal water courses traverse the state and provide an important source of drinking water. Hafirs and dams are important sources in the rural areas where agriculture workers and nomads use to settle.

White Nile State suffers shortage of safe drinking water despite the presence of the White Nile. This scattered settlement throughout the state makes providing services a difficult job.

Away from the White Nile into the Northern State, water distribution is extremely unequal with major seasonal and annual variations. Underlying this variability is a creeping trend towards generally drying and desert conditions. This means that the nomadic tribes have to move long distances with use of donkey drawn carts to access water. Therefore water availability decreases with increase in dry conditions from semi-desert to desert conditions.

8.3.9 CULTURAL AND HISTORICAL VALUES

The cultural and historical values are important for the area north of Khartoum to Dongola and the Sudan / Egypt border. Therefore more effort was put into carrying out a preliminary survey to determine the impacts of the proposed route on important cultural and historical sites in this part of the study area.

The survey of the proposed line route corridor between Geisan and Omdurman (North of Khartoum) involved the inspection, whenever practically possible, of the various points along the route. No archaeological remains were observed at any point along the whole stretch of the corridor. Apart from the spacing of the points the reason for the absence of ancient remains seem to be that early human settlements and associated cemeteries usually favour locations where water sources are easily accessible. The proposed points on the west bank of the White Nile are located at spots far away from the river bank.

Archaeological surveys conducted in connection with development projects are generally divided into two broad categories. First, surveys that are carried out within massive territories in connection with the building of dams or the establishment of agricultural schemes; second, surveys of long corridors prior to road or pipeline construction or the erection of transmission line pylons. Such corridors are rarely wider than about 100 metres. The archaeological surveys of route corridors present little difficulties since it is always possible to recommend re-routing when archaeological sites were encountered, transmission lines, by virtue of their discontinuity, involve much less investigation compared to those related to road building or the laying of pipelines.

Within the Clay Flood Plains, experience indicates that ancient remains are highly unlikely to be found in flat areas but favour either inselbergs of the Basement complex (such as Jebel Moya) or Qoz (stabilized sand dunes) areas. During the survey of the clay flood plains between the Blue and White Niles it was noticed that none of points of significant importance are located on such areas.

8.3.9.1 Archaeological Survey of the Omdurman-Dongola Route Corridor

Compared to the southern sector of the route corridor, the archaeology of the northern sector is relatively better known. Archaeological research, however, was largely confined to areas close to the Nile flood plain, where most of the monumental and large settlement sites are located. The northern route corridor passes along the western perimeter of the Bayuda Desert. A limited archaeological reconnaissance of the region was performed in the Bayuda in 1954 (Chittick 1955). Along the 300 km. track leading from Ghazali to Matemma the reconnaissance party was able to locate a large number of post-Meroitic tumuli burials and Christian box-graves. The western perimeter of the Bayuda has recently been surveyed by a team of the Sudan Archaeological Research Society (SARS) for the location of archaeological sites which might be endangered by the construction of the Omdurman-Ganetti road (Mallinson, 1997; Mallinson et al, 1998). The SARS team members were able to identify a total of 192 archaeological sites dating to the Palaeolithic, Mesolithic, Neolithic, Meroitic and Post-Meroitic periods (Mallinson et al, 1998, 43-4).

<u>Survey and observation on the outward route – From Omdurman to Dongola</u>

Some 50m west of distance road sign of 8Km from Omdurman, an isolated small burial mound was located on high rising ground. The superstructure consists of a pile of ferricrete rocks. The cairn is roughly circular and is about 2m in diameter. The burial is apparently intact and may belong either to the Post-Meroitic or Christian periods. Refer to figure 8.17.

Figure 57 : Isolated Burial West of distance road sign of Point 8Km from Omdurman to Dongola

At distance road sign of 196 km from Omdurman, west of the tarmac road, a group of about 6 mound graves were observed. The superstructures consist of a circular ring of black rocks and an in-fill of rubble. This type of burial is usually assigned to the Post-Meroitic period, but from other northerly areas along the Nile this style of structure is known to have been common during Kerma period. It is possible that similar structures are located at a distance further to the west, but needs verification. Refer to figure 8.18.

Figure 58 : Group of Burials near distance road sign of 196 Km from Omdurman to Dongola

At road distance sign of 199 Km on the Omdurman – Dongola road, several burial mounds are located to the west of the tarmac. The survey party was able to count at least ten structures. These are similar in shape to those located at Km 196. Similarly it seems that another group similar structures are located further to the west at about a distance of ½ km.

<u>On the return journey from Dongola to Omdurman</u>

A number of groups of burial mounds were identified. Four relatively large burial mounds were recognized at 17 30 14.2 N 31 28 41.5 E. The superstructures are made up of a circular ring of black sandstone with a rubble in-fill. The tops of the mounds are flat and on some of them quartz pebbles are placed at the top. The largest cairn has a diameter of about 10m. The structures could possibly be of Post-Meroitic date. Refer to figure 8.19.

Figure 59 : Burial site possibly of Post-Meroitic date

Three jointed circular structures were identified on a high rising location west of the tarmac road at 17 30 12.1 N 31 28 41.1 E. Each circle is about 1m in diameter. The structures do not seem to be burials; however, the diameters are too small for a dwelling, refer to figure 8.20.

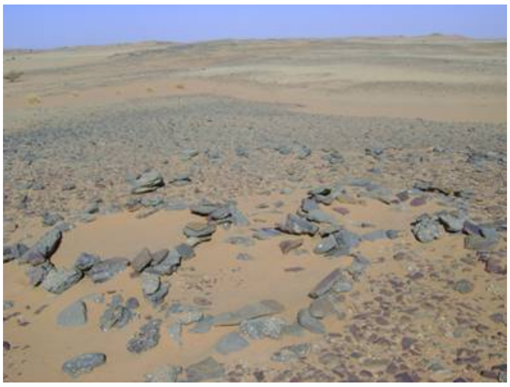


Figure 60 : Jointed Circular Structures

At least 6 circular cairns were identified at 17 07 4.3 N 31 35 43.3 E . These could be either Post-Meroitic or Christian burials.

At distance road sign of 185 km on the Dongola Omdurman road, a group of 5 cairns, structures were recognized. 7 mound burials were identified at 17 05 20.8 N 31 36 28.2 E. These are constructed of an outer stone ring. The flat tops are covered with small ferricrete stones. This type of burial is sometimes attributed to the Kerma period, but in the absence of excavations it is difficult to ascertain the date.

The results of the surveys indicate and confirm that the route corridor does pass through an area with a high concentration of archaeological artefacts.

8.4 EGYPT SECTION

8.4.1 ADMINISTRATIVE FRAMEWORK

The proposed route corridor traverses two main Administrative regions of the Aswan Governorate and the Qena Governorate. From the Sudan / Egypt Border the route passes through the Aswan Region and then terminates in the Qena Region at Nag Hammadi. The basic statistics on the three project area administrative regions are presented in the table

Table 44 : Administrative regions of the project area

Governorates	Population	Area (Km^2)
Aswan	1,184,432	62,726
Qena	3,001,494	10,265
Luxor	451,318	2,410

8.4.2 DEMOGRAPHIC CHARACTERISTICS

The three administrative regions which are traversed by the proposed route corridor have different population characteristic. To determine the likely impact of the proposed transmission system, a study and analysis of the population characteristics was undertaken. The various aspects are outlined in table.

8.4.2.1 Population of the Project Regional Governorates

The Qena Governorate is divided by the Nile which separates the areas to the east and west, and on both sides, a longitudinal area with width of 10 – 20Km of fertile river fluvial deposits meanders through the desert. This is the area where almost all the population is concentrated. The region has a total population of 3,001,494 representing 4.1% of the total Egyptian population. The total area of the Governorate is some 10,265 km^2. Approximately 15% of the land lies in the Nile Valley, the remainder being split between the Western Desert and the Eastern Desert. Of the total area only approximately 1,600 km^2 is cultivated and inhabited, the rest being desert areas outside the main river valley. The proposed route corridor does not pass through the Nile valley, but it traverses the western desert at a distance of more that 5 km along the edge of cultivated Nile valley. Therefore, the population of directorate is given as indicative of the people living close and not within the proposed route corridor. These are the people who are likely to be affected during both the implementation and operation of the project.

Approximately 21% of the population may be described as living in urban areas with 79% living in rural areas. In common with most areas of Upper Egypt, Qena is an area of net out-migration the migration rate for the proportion of the population moving from the Governorate was estimated at 7.1% Population density in Qena Governorate is up to 1,581 individuals/km^2. This figure is made significantly greater by the fact that only 15% of the Governorate is inhabited and cultivated, of which only about 5% is devoted to residential areas and dwellings. The majority of the population is thereby constrained by the physical nature of the landscape and may utilise less than 5% of the land area.

The Governorate (Supreme Council) of Luxor has a total population of 451,318 representing 0.6% of the total Egypt population. The Supreme Council of Luxor in southern province level, and bordered on all sides by Qena. Luxor, the main town in the central city council, is located at a distance of approximately 670 km south of Cairo and about 220 km southwest of Hurghada, a northern city of Aswan. The area of Luxor is about 2410 km^2. And populated and cultivated area is 228 Km^2 which represents 9.41% of the total area of the Governorate, the rest of the area is a desert extending east and west on both sides of the Nile Valley which has an average width of 10 Km on both right and left bank of the Nile River.

Aswan Governorate has a total population of 1,184,432, this represents 1.63% of the total population of Egypt. The Governorate is located at the extreme south of Egypt. It is bordered by Qena governorate to the north, the Red Sea governorate to the east, the Wadi El Gadida governorate to the west and the Republic of Sudan to the south. The Governorate is located some 880 km from Cairo. The Governorate extends some 480 km from north to south. The total area of the governorate is 62,726 km^2.

The valley along the Nile is basically green farmland. The area west of the Nile valley is flat and sandy desert with a few small, uninhabited oases. East of the Nile valley the landscape is hilly and rather mountainous desert. The proposed route corridor traverses the inhabited desert area west of the Nile valley.

8.4.2.2 Number of Households and average size in the Project Governorates

As can be seen from table, the project Governorates have the following numbers of households: Aswan has 269,654; Luxor has 98,520; and Qena has 632,074. The household or family sizes range from 4 to 5 persons per household.

Table 45 : Population characteristics in the project area

State	Total Population	Annual Growth Rate %	Number of Households	Average Household Size
Aswan	1,184,432	2.3	269,654	4
Qena -	3,001,494	2.3	632,074	5
Luxor	451,318	2.5	98,520	5

Source: Egyption Statstic year book 2006

8.4.2.3 Population Age Structure of the Project Governorates

From the statistics in the Egyptian Statistics year book for 2006, the age structure of the population has higher numbers of those who are under 15 years old followed by those who are over 45 years. This indicates that there is a higher percentage of younger people who are still dependent. This means there are fewer people having to support a higher number of individuals. The age structure is as given in Table.

The data for age structure in Qena shows that almost half the population (51%) are in the 15-59 age group, and just over 42% under the age of 14. Approximately 19% of the population are in the 0-6 years age group. Approximately 66% of the population are married. The sex structure of Qena Governorate is quite well balanced with approximately 49.7% of the population being female. There are small variations between Markazes and between urban and rural areas.

Table 46 : Population Age Structure in the project area

State	Total Population	Under 6 Years (%)	Under 15 Years (%)	Over 45 years (%)
Aswan	1,184,432	13	31	20
Qena -	3,001,494	15	35	18
Luxor	451,318	12	29	24

Source: Egyptian Statistic year book 2006

8.4.3 LIVELIHOOD AND ECONOMIC ACTIVITIES

Gross Domestic Product (GDP), gives an indication of the total value of goods and services produced within an economy, this will give an indication on which sectors that support livelihoods in a particular area. In the study area, particularly the case of Qena and Luxor Governorates, there is a lot of utilisation of both national and foreign resources. Luxor city generates a significant income from the tourism sector since it is horsts a good number famous and important archaeological, cultural and historical sites. Table presents the Qena- Luxor GDP by sector for the year 1997 and it is presented in GDP Segregated by Sector in Qena Governorate (2007). This indicates that the major sectors supporting livelihoods in the study are Agriculture and Tourism related services.

Table 47 : Gross Domestic Product by sectors in Qena and Luxor, 1997

Sector	Total GDP (Million L.E)	% of GDP
Agriculture (A)	1,366.8	30.37
Manufacturing (M)	584.6	12.99
Construction (C)	137.1	3.04
Transportation and Communication (T&C)	295.9	6.58
Financial Services (FS)	212.3	4.72
Government & Public Services (G&PS)	697	15.49
Electricity and Water (E&W)	249.1	5.54
Trade, Restaurants and Hotels (T&R&H)	957	21.27
Total	**4,499.8**	**100**

Source: GDP by Sector in Qena, 2007

8.4.4 EDUCATION

In Egypt, adult illiteracy rates decreased from 55.4% to 39.2% over the period 1976 to 1996. This downward trend is matched in study area Governorate as shown in Table. However illiteracy rates in the Governorate remained on average slightly over 50% in 1996; Central Agency for People Mobilisation and Statistics (CAPMAS) figures from 1999 also indicate that levels of illiteracy in Qena are still slightly over half the population with the average for the Governorate at 51.76%. In all the study area, illiteracy rates are markedly higher in rural areas than in urban areas.

Table 48 : Education Levels for three decades in Qena

Education type	1976	%	1986	%	1996	%
Illiterate	880,297	72.1	1,014192	63.0	878,747	50.1
Read & Write	190,825	15.6	336,764	21.0	449,856	25.7
University Graduate	141,397	11.6	230,422	14.3	386,142	22.0
University Post-Graduate	7,633	0.6	24,726	1.7	37,760	2.2
Total	**1,220,152**		**1,606,104**		**1,752,405**	

Source:central statistics department

8.4.5 ACCESS TO PUBLIC SERVICES

Housing conditions are key indicators of socio-economic development. Poor and vulnerable communities and households often lack access to utility services. A brief summary of people's access to the key utility services is given below.

8.4.5.1 Access to Water

In Qena approximately 60% of water supplies are derived from the River Nile and approximately 40% from groundwater sources. The provision of water supply is described in more detail in Section 3. This section will describe people's access to water in or near the home. Generally, people's access to water may be through treated, piped water (either in their home, in their building or outside their building), from a hand pump or from "other" sources i.e. from a well, directly from the Nile or from irrigation canals etc. The distribution of people with no access to water in the home. A summary of different modes of access to water is given in table Central Statistics Department.

8.4.5.2 Access to electricity

Every village in Egypt has access to electricity and electric light. However, not every household has access to electricity in their homes. In Qena nearly 94% of the population has access to electricity in their homes. A summary of access to electricity in the home across the different Markazes is given in Table.

Table 49 : Population with Access to electricity according to Town areas (Markazes) in Qena

Town Area (Markaz)	Access to Electricity (%)
Qena	95.11
Naga Hammady	94.55
Qus	94.57
Abu Tesht	91.89
Isna	96.34
Dishna	92.32
Armant	95.20
Farshut	95.38
Naqada	93.10
Qeft	96.64
El Waqf	87.01
Average	**93.83**

Source: CAPMAS(1999)

8.4.5.3 Access to Sanitation

At present, the only sewerage network of any substance in Qena Governorate is in Qena City itself. The network in Qena is connected to a Municipal Sewage Treatment Works, the only centralised sewage treatment works in the Governorate. Other smaller sewerage networks do exist, however, they are connected to communal septic tanks or partial treatment and soak away systems. Approximately 73% of the Governorates population are not connected to any type of sewerage network. The figure ranges from nearly 86% of the population in El Waqf to just under 38% in Qena town.

8.4.5.4 Poverty Indicators

Poverty is not simply an issue of income. When asked, the poor people themselves highlight a range of other issues such as health, safety, education food and basic services exclusion by state and society. People's experience of poverty may also vary greatly. Issues such as illiteracy and access to water may be used as poverty indicators and give an indication of relative poverty rather the actual income. Combining just two indicators, illiteracy and no access to water in the home.

8.4.6 PUBLIC HEALTH

8.4.6.1 Life Expectancy

Life expectancy at birth is one of the basic indicators of human development. At a national level, life expectancy in Egypt in 1998 was 66.9 years. This figure increased markedly from 1976 when the average life expectancy was 55.0 years, reflecting the improvement in health status. For Qena Governorate, life expectancy in 1998 was slightly below the nation average at 65.8 years, compared to 53.6 years in 1976.

8.4.6.2 Child Mortality

According to EHDR 2002, Child mortality rate per 1000 live births dropped to 39.1 in 1998, from 80.0 in 1961. In Qena, female child mortality rates were lower than males in the age group less than 28 days, but higher in the age group 28 days to one year. Child mortality rates for age one to five years as well as total child mortality rates in Qena are approximately equal for females and males.

8.4.6.3 Common Diseases in the Study area

According to Health Directorate of Qena Governorate for the year 2002, some diseases were recorded in addition to their associated mortality cases. Among 587-recorded cases of Hepatitis, 7 people died, and from 2214 cases of Pneumonia there were 6-recorded deaths. In addition there were 337 recorded cases of Typhoid. Table gives a list of diseases and the associated deaths. This is an indication of the diseases that occur in the area. The following diseases are found in the area: Leprosy; Hepatitis C; TB; Typhoid, Measles, Dysentry; Tetanus; Polio; Brucelosis; Meningitis; Cholera; Diphtheris; Mumps; Rubella; Malaria; Rabies and HIV/AIDS. However the diseases reported to have been the main contributor to deaths are the first seven mentioned in the July 2006 report.

8.4.7 HISTORICAL AND CULTURAL HERITAGE

Egypt has a rich and diverse cultural heritage dating back more than 7,000 years before the present. Egypt is internationally renowned for its archaeological and historic sites and a wide variety of sites are present in Upper Egypt. Therefore an overview of the location of cultural heritage relative to the route corridor was undertaken in order to assess the likely impact of the project both at construction and operational phase.

8.4.7.1 Luxor

Originally, Luxor was part of Qena Governorate, however the significance of the sites present in the local area, such as the Luxor and Karnak temples and the Valley of the Kings (where the treasures of Tutankhamun's tomb were originally discovered) has attracted a great numbers of visitors. The uniqueness and numbers of sites present in close proximity of Luxor and the numbers of visitors and corresponding development pressures from hotels and tourist developments, led to the establishment of a separate administrative status of what was the former Markaz of Luxor. In 1989, Luxor was given the unique administrative status of the "Supreme Council of Luxor".

The River Nile splits Luxor into sides. The east side where you find the Karnak and Luxor temples, was called the living city during the ancient times and the west side called the city of the dead because the sun sets in the West. All the Tombs and the funeral temples are located on the Western Bank of Luxor (the city of the dead). Temples on the east bank include the funeral temple of Amonphes the third father of king Aknaten. His temple (now in ruins) was used as a quarry to rebuild other temples and has been largely replaced by two big statues of Memnoun (each one a single piece of stone weighing 900 tonnes, representing king Memnoun looking towards the sunrise).

The west side includes the world famous Valley of the kings where 62 tombs have been discovered. The most famous one being king Tutankhamun's which was found in 1922 by an English Egyptologist. The west side also includes the Valley of Queens where 75 Tombs have been discovered. The most famous of which is Queen Nefertary (wife of Rameses second). The tombs of the Nobles, which lies between the kings and queens has more than four hundred Tombs. The temple of Ramses third, called Medaint Habu is also located on the west side. It is regarded as one of the most beautiful funeral temples with well preserved wall paintings.

The route corridor in this section will run parallel to the existing power line corridor further away from the sites of cultural and historical significance.

8.4.7.2 Qena Governorate

In addition to the sites located within the Supreme Council of Luxor there are two major tourist sites in Qena Governorate that attract international and local tourists and generate income from official entry tickets, these are Isna Temple in Isna Markaz and Dendara Temple in Qena Markaz. Ticketing arrangements were also initiated for El Moalla, a Pharaonic rock-cut cemetery located in Isna Markaz; however, to date this site has received virtually no foreign visitors. Map 16 illustrates the major tourist sites and other major cultural heritage sites in Qena Governorate.

<u>Dendara Temple</u>

Dendara temple comprises components from Pharaonic, Greco-Roman and Coptic times. The necropolis contains tombs from the Early Dynastic period to the First Intermediate Period (3,100 – 2,050 BC), as well as burials of birds, dogs and cows associated with the goddess Hathor, whose temple is the most important monument at the site. The surviving buildings in the temple enclosure date from the 30th Dynasty (380 – 343 BC) to the Roman Period (30 BC – AD 395), and include the main temple to Hathor, sanatorium, two shrines known as "birth" temples and a Christian basilica, all of which are preserved inside a mud brick enclosure wall.

East of the Temple was the town, where there are ruins of a Roman Period temple. Dendara Temple is a major tourist site in Upper Egypt and is visited by tourists both from cruise ships on the Nile and via road in coach convoys directly from Luxor. In 2000, the temple was visited by 124,647 visitors.

The above site is very far from the proposed route corridor, however the above description has been given to emphasise the importance of this area in heritage aspects.

Isna Temple

Isna temple comprises components from Pharaonic, Roman-Roman, Coptic and Islamic times. Isna was in important town in Pharaonic times and a centre for the worship of the Lates fish (Nile Perch). The earliest surviving record dates from the 18th Dynasty (c. 1,450 BC). In the early centuries AD, it was one of the main centres of Christianity in Egypt. In the Middle Ages the town regained its importance as a caravan station for routes from the south and Sudan.

The principal historic remains in Isna consist of the Greco-Roman temple of the ram god, Khnum, which is decorated with carved reliefs form the 1st – 3rd centuries AD. The temple which is located near the centre of the town, now lies approximately 9 metres bow the modern street level, due to the accumulation of silt and debris. The temple has never been completely excavated, as the rear portion of the building is buried under the surrounding residential buildings. Qena - Isna Temple is so a major tourist site in Upper Egypt and is visited by tourists both from cruise ships on the Nile and via road in coach convoys directly from Luxor. In the four-month period from October 2000 to January 2001, the temple was visited by 67,949 visitors

The above described site is far from the proposed route which follows the existing power line route corridor. The above description has been given to emphasis the importance of the area as regards significant heritage sites.

9 POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS AND PROPOSED MITIGATION MEASURES

9.1 INTRODUCTION

This Section of this ESIA report provides a prediction of potential impacts of the proposed project and attempts to propose mitigation measures for the significant negative impacts and enhancement measures for the positive impacts. The analysis of potential impacts to determine their severity is also another aspect dealt with in this section.

From the discussion in this section, costs of effective environmental management begin to emerge. Therefore this section provides the foundation of all the cost components of the estimated environmental budget presented in Section 13 of this report. Some of the costs are related to resettlement and compensation. The undertaking of a detailed Resettlement Action Plan (RAP) was beyond the remit of this assignment and would also be premature given the need to undertake a detailed design phase. Costs provided are therefore indicative only and are provided as an indication for project planning purposes only. The refined costs are expected in the next phase when detailed survey and line re-aligning is concluded and a detailed RAP undertaken for the route. The RAP will involve a detailed assessment of impacts of the project on structures, fruit trees, crops and agricultural land to be taken up by the powerline towers. The costing of mitigation measures is a normal and important part of the ESIA process to ensure inclusion of estimated environmental and social management costs in the total project costs.

There will be two types of impacts expected related to the loss of land due to the project. This relates to temporal/limited loss and permanent loss of land. Temporal / limited loss would relate to the land which will be taken up by the Right of Way (130 m for the 2 x 500 kV AC line from Mandaya to Kosti and 80 m for the 600 kV DC Line from Kosti to Nag Hammadi). During the year of construction, the land directly within the Right of Way shall not be available for any other purposes, however after construction is completed, the said land within the ROW will be available for limited uses such as grazing and growing of low ground crops. On the other hand, the land to be taken up by the construction of tower bases, substations and access roads will fall in the category of permanent loss because this land will never be available for other uses. Therefore compensation aspects will be related mainly to the permanent loss of land, however for temporal / limited loss, compensation will mainly be related to the loss of crop production for the year of construction and loss of fruit trees which will be found within the right of way.

This section also provides the key areas of focus in the Environmental and Social Management Plan (ESMP), which is presented in Section 10 of this report. .

As outlined in Section 2 of this report, the potential environmental impacts of the installation of the proposed Ethiopia-Sudan-Egypt power transmission line and its associated substations were assessed through a critical consideration of the existing baseline environmental and socio-economic conditions along the route corridor. The consideration of baseline was done through data collected from field observations and investigations, interviews with key stakeholders such as government officials, review of relevant documents and public consultation in areas directly affected by the project. The baseline was therefore analysed in view of the proposed project activities to determine potential impacts likely to arise from all the project activities from pre-construction, construction to operation. The identified potential impacts were analysed with consideration of magnitude and severity to determine the level of significance. This section therefore gives more attention to the significant impacts and proposed mitigation and enhancement measures to be implemented during construction and operation phases of the project.

9.2 Overview Of Impacts

9.2.1 Positive Impacts

9.2.1.1 Direct Positive Impacts

The project will potentially present positive opportunities for the local people along the route corridor, this may come in the form of temporary employment during the construction phase, as well as through income generated by the sale of food and other consumables to migrant workers. For the local people who own quarries, income will be generated from the project through the sale of building materials that can be procured locally.

The most significant positive impact of the Project would be to facilitate trade in environmentally clean hydropower which will delay the development of other energy generated from technologies that enhance the climate change. The eastern Nile countries would be able to make a significant reduction in carbon dioxide generation. The other aspect would be the economic benefit that will accrue to the countries through trading of electricity through generation and wheeling charges. This will facilitate economic growth in the Eastern Nile Countries being Ethiopia, Sudan and Egypt

9.2.1.2 Indirect Positive Impacts

The most positive impact of the Project could be the provision of electricity to communities adjacent to the ROW. Electricity would support overall investment in education and strengthen the ongoing effort of capacity building to overcome critical constraints in the implementation of development programmes. Essential to this effort would be power supply to health facilities for the installation of cold storage facilities for the safe transportation and storage of vaccinations and other vital medications. The supply of power to the education and health sectors will facilitate installation of pipes water system to improve the water supply and sanitation facilities. This is a basic requirement for good hygiene for public institutions.

Given the detailed socio-economic profiles presented in section 8, which indicate that most Project affected communities are severely under-serviced, it is evident that power supply to local communities facilitated by this Project would have positive development implications. Local electrification would also have benefits in regard to women’s work burden (e.g. pumped water and electricity would spare them the daily responsibilities of collecting water and firewood).

9.2.2 NEGATIVE IMPACTS

The main potential adverse impacts of the Project would occur primarily during the construction stage. The following negative impacts are associated with the construction phase of the project:

- Permanent loss of land under various uses, with some loss of structures and consequent resettlement, due to land acquisition for construction of transmission towers and substations;
- Temporary and limited air and noise pollution due to construction activities and increased traffic due to construction activities;
- Minor permanent loss of vegetation due to land acquisition for the reasons mentioned above and for the establishment of right of way (ROW) of 130 meters for the AC Line and 80 meters for the DC Line;
- Minor permanent loss of commercially important trees and agricultural land due to the establishment of ROW and construction activities;
- Minor permanent loss of biodiversity as a result of loss of flora and loss of habitat for fauna;
- Increased risk of communicable diseases during the construction phase due to influx of labour from out side the project areas.

Many of these effects will be short term and reversible, stemming from ground disturbance, operation of equipment, and construction of temporary work camps, and construction material processing and storage.

The main potential adverse impacts have been identified on the basis of whether they occur during pre-construction, construction or operation in the following section. This is to facilitate implementation of mitigation measures which are outlined in the Environmental Management and Social Plan (ESMP) included in Section 10 of this report.

9.3 PHASING OF ENVIRONMENTAL IMPACTS AND MITIGATION

9.3.1 PRE-CONSTRUCTION

The pre-construction activities and associated impacts are those activities and mitigation measures that should be implemented before the commencement of construction to ensure smooth implementation of construction activities.

9.3.1.1 Expectations of Improvement in Livelihood

These are associated with expectations of the residents of villages along the transmission alignment. Information about the interconnection spreads and each person perceives either the benefits they receive or losses. Based on such perceptions they take decisions in anticipation of the Project benefits.

In the Project area of influence, the information about the Project raises hopes of the villagers of power supply to their villages and anticipation of improvement in their lives. Some have started to think of converting flour mills from diesel powered grinders to electricity supply in order to reduce costs of fuel. They also anticipated a rise in trading activities as a result of construction and temporary or permanent employment.

This is an indirect positive impact that needs to be reinforced by project awareness campaigns that should include all aspects of the project. The awareness campaign should be undertaken in close collaboration with the local authorities. This is one of the key tasks of the Environmental Coordination Unit.

9.3.1.2 Land to be taken up by the project

There will be negative impacts on land associated with the construction of camps (temporary loss) and storage of construction materials, and foundations for the towers (permanent loss), especially if such construction is carried out on agriculturally productive land.

The majority of land to be taken up can be divided into semi-permanent and permanent. The land taken up by the ROW can be classified as semi-permanent as this would be available for a few types of land use after the construction period. Land use such as growing of low crops and grazing of animals would still be carried out in the right of way. However the land to be used for construction of individual towers, sub stations and access roads would be taken up permanently and would not be available for any other uses. Table below outlines the total areas required for the Right of Way, the towers and the substation. There will be additional land required for the construction of road access, but this was not available at the time of preparation of this report.

It is therefore estimated that approximately 20,152 ha of land will be affected by the Project. Of this land about 20,077 ha will be of a semi-temporary nature during the construction and establishment of the ROW, this land will be available for limited uses after construction. However, 75 ha of this land will be taken up permanently by tower bases and substations. This impact of loss of land is quite significant in the agricultural and wooded lands of mainly section from Mandaya, Ethiopia, to the area North of Khartoum, Sudan. The impact would be less significant in the areas from North Khartoum to Nag Hammadi as this is mainly desert area with the line route following an already established power line corridor. Additional amount of land shall be taken up permanently through the establishment of access roads especially in areas where new access would have to be established. The access routes of 5m width will take up a significant amount of land, however the exact amount of land will be established during detailed surveying and this information was not available at the time of preparation of this report.

Table 50 : Estimated land requirements for the Project					
No.	Country	Section of the Route	Total Length (Km)	Total Area to be taken up on temporal basis	Permanent land to be taken
		SUB STATIONS			
ETHIOPIA		Mandaya AC Substation	-	--	6 ha
SUDAN		Kosti HVDC Station	-	-	7 ha
EGYPT		Nag Hammadi HVDC Station	-	-	7 ha
2 X 500 kV AC Power Lines – 130m ROW required					
1	Ethiopia	Mandaya Dam to Sudan Border	158	2,054 ha of ROW	6 ha as Tower base areas
2	Sudan	Sudan Border to Rabak / Kosti	386	4,758 ha of ROW	15 ha as Tower base areas
		1 X 600 kV DC Power Line – 80m ROW required			
3	Sudan	Rabak / Kosti to Sudan Border	1, 130	9,040 ha of ROW	23 ha of Tower base areas
4	Egypt	Sudan Border to Nag Hammadi	535	4,280 ha of ROW	11 ha of Tower base areas
		TOTAL	**2,209 Km**	**20,152 ha**	**75 ha of Tower base areas**

9.3.1.2.1 Mitigation measures

The process of detailed survey and route re-alignment shall be made with special consideration of environmental and social impacts to ensure that the re-aligned route corridor will have minimal impacts on the permanent loss of agricultural land, crops, fruit trees and structures

The loss of farm land especially during construction, can directly affect local farmers who depend on agriculture to survive and sustain their households. Therefore land to be lost from each farmer should be assessed and compensation calculated.

Compensation shall be worked out for permanent loss for towers and substations. All land to be taken up permanently (75 ha) as outlined in Table, shall be paid for at the prevailing market value for the particular piece of land, taking into account the forfeited landuse. (For the purpose of making an estimate for compensation, a uniform rate of US$ 5,000 /ha.has been used). An amount of US$ 375,000 (75 ha x US$ 5,000) is estimated to be used for compensation for permanent loss of land. Though a uniform market value of land has been used, on the ground the value of land differs considerably. On the lower range would be the agricultural land in Ethiopia compared to the high value and scarce agricultural land in Egypt.

The agriculture disturbance during the year of construction especially in the ROW and areas which will be used as access roads shall be paid for as annual crops compensation and livelihood safeguard program at the amount of US$ 5,345,000 and US$ 1,250,000 respectively as presented in section 13 of the environmental costs, Tables 13.1, 13.2 and 13.3

The assessments and payments for compensation related to loss of land shall be paid during the pre-construction period to ensure the people are ready and prepared for the disturbance that will be associated with the construction activities. This will ensure the directly affected people are prepared for the project. Refer to table for details related to loss of land mitigation., the figures outlined in the table is extracted from section 13 and associated tables.

The contractor shall be directed to ensure as much as possible, only land that fall in the ROW is disturbed during the construction period, this will minimise the amount of disturbance caused to agricultural land. Any further land disturbed during project activities would need to be compensated.

Table 51 : Compensation aspects by Country

COMPENSATION ASPECTS	ETHIOPIA	SUDAN	EGYPT
Land related compensation (US$)	60,000	225,000	90,000
Annual crops related compensation (US$)	1,172,000	4,173,000	
Fruit trees related compensation (US$)	3,910,000	1,910,000	
House structures related compensation (US$)	50,000	200,000	15,000
Proposed livelihood safeguard programs (US$)	540,000	600,000	110,000
Country Compensation Totals	5,732,000	7,108,000	215,000
Permanent land loss (tower bases & substations) (Ha)	12	45	18

9.3.1.3 Structures to be affected by the project

The preferred route has been proposed in such a way that it would avoid settlements and important structures such as houses and farm buildings; however, there will still be a reduced number of structures which will be affected. Although undertaking a detailed Resettlement Action Plan (RAP) was not part of the terms of reference for this study, an attempt was made to make a rough estimate of numbers of people and households to be affected. In some cases, the population density was used to arrive at the numbers in order to give an estimate of compensation that needs to be paid for relocation of affected structures. It should be noted that the numbers given would have to be refines when the RAP is undertaken for the whole route corridor during the next phase before commencement of implementation.

In Ethiopia, the preferred route (Mandaya to the Ethiopia / Sudan border) was adjusted to avoid major settlements and only affects a few farm and village structures. (preliminary route was to affect 612 houses while the preferred route will affect 161 houses). The route is mainly through agricultural land.

In Sudan the route which will have impact on dwellings and other structures is the sections from the Ethiopia / Sudan Border to Kosti and the sections from Kosti to North Khartoum. These are mainly agricultural lands and losses will relate to village and farm structures.

In Egypt, the route passes through desert land, but the impact on structures will be mainly in the area around Nag Hammadi. The area where the substation is proposed is planned agricultural land and the line connecting to the existing Nag Hammadi substation is densely settled and will anticipate a number of houses to be affected in obtaining the Right of Way for the connecting line.

9.3.1.3.1 Mitigation measure

The valuation, assessment and determination of adequate compensation shall be made during the pre-construction period. As a requirement from the procedures for compensation for Ethiopia, Sudan and Egypt, a Compensation assessment committee should be formed in each country which should include a representative from the affected local communities to ensure transparency. Compensation shall be paid and adequate time given to the affected households to relocate. A period of 6 months shall be given to the people to enable them to put up other structure to facilitate relocation from the ROW. For this report and estimated amount of US$ 265,000 has been set aside to facilitate compensation for structures directly affected by the project.

Establishing/Pegging and final alignment of Transmission Line are the first site activities before mobilisation of equipment which will involve final survey and soil investigations required for final design of line and tower foundations. After determining tower locations, and before commencement of civil works the Contractor will make a terrain reconnaissance which may include rock drilling tests at each tower location. This provides a final opportunity to make minor realignments to the route to avoid any further environmental and social impacts. This activity shall be done in close association with the Environmental coordinator to ensure further mitigation measures of avoiding disturbance to structures is undertaken.

All mitigation measures shall be outlined in the Environmental and Social Management Plan (ESMP) which shall be made part of the contracts to be signed with all contractors and subcontractors to ensure that the Contractors are held responsible for implementation of the environmental mitigation measures.

9.3.2 CONSTRUCTION PHASE

9.3.2.1 Impact on Air Quality

There would be no major emissions related to operation of construction equipments for erecting towers and stringing of transmission cables. However, there may be limited deterioration of air quality from increased suspended particles during the construction of access roads and clearing of vegetation along the ROW, especially since it is recommended that construction take place during the dry season. Most construction activities will be undertaken far from residential area, no major impact is anticipated in that regard. Urban and rural population densities are very low in route corridor in general. The limited impact discussed above could be avoided through implementing the necessary preventive measure where ever the construction of access road and other construction activities with potential impact on air quality are taking place.

Deterioration of air quality during the project construction period could lead to increased duct and particulates in the air leading to poor air quality, affecting the local people especially those whose habitation is close to access roads and construction sites. Though the preferred proposed line route is located 1 to 5 km away from major towns and settlements, however some rural communities are located close to the ROW and proposed access routes and therefore may experience considerable change in air quality during construction phase of the project.

9.3.2.1.1 Proposed Mitigation

- Spray the ground with water and placing hoardings around stockpiles of aggregate.
- Use of machines and vehicles that are maintained in good condition and therefore with lower emissions

Immediate re-vegetation of disturbed area for road access and other construction related activities.

9.3.2.2 Soil erosion Impact

The present soil erosion rate in the project influence area is considered low (0-11 % of the project woredas having moderate erosion hazard, CRA report 2006). The site visit also confirmed the situation and no gully or eroded locality. It is related to dense natural vegetation cover, limited crop production and livestock grazing, low population density with consequent tolerable impact on the natural environment. Opening of road access and establishment of towers will directly the vegetation cover and lead to increased soil erosion. Road access may also bring about open access to the natural environment and uncontrolled deforestation of the natural vegetation for various purposes.

9.3.2.2.1 Proposed Mitigation

- Clearance of vegetation should be monitored by the Environmental Coordination Units Staff to ensure that vegetation clearance is undertaken to the required level so as to minimize loss of vegetation cover and hold the soil intact.

- Limit construction activities to dry periods as much as possible.

- Restoration of affected area for construction purposes, planting of trees and grass along the alignment, especially on sloppy surfaces

Construct physical conservation measure where ever required such as in deep cutting and sloppy routing.

9.3.2.3 Impact on potential mineral resource and extraction

This impact is significant in the route section of Ethiopia where traditional gold mining is an important economic activity of the local communities in the project area of influence. Both male and female in different age group participate in the gold mining activities in many parts of the project area as observed during the field survey. During the project construction period some of the gold mining localities may be disturbed or lost; but the magnitude of impact and location will be known after the actual route line design has taken place. In addition to that there is no individually owned gold mining land hence difficult to calculate compensation for the individuals.

Potential of marble and on-going extraction was noticed in the power transmission route corridor in Koncho and Daleti area, in Ethiopia. Compared to the existing resource potential, the loss due to tower establishment is considered insignificant.

This aspect shall be re-assessed upon undertaking detailed survey, route re-alignment and a detailed RAP for the finalised route corridor. This will bring out the areas which will be taken up by the ROW, where mining activities will not be allowed.

9.3.2.3.1 Proposed Mitigation

- Impacts could be avoided by moving the transmission line corridor away from major activities areas.

- The compensatory measure shall be designed to improve the overall livelihood of the community.

9.3.2.4 Impact on water resources

The impact on water resource should be temporary and will be mainly related to increased turbidity of water resources and leakage of chemicals from construction machinery and vehicles. Over 70 % of the people in the project woredas depend on natural water sources such as springs and river run off for water supply. The construction of access road and towers may interfere with the natural drainage systems and modify flow of surface water, and these changes can contribute to soil erosion, flooding, channel modification, downstream scouring and sedimentation in streams and other drainage channels.

The major rivers in the transmission route corridor are Abbay, Tumet and Dabus Rivers in Ethiopia. The power transmission route will cross these rivers and a number of other small perennials and dry streams in Ethiopia. The line will also cross the While Nile in Sudan. Effluent discharged from temporary campsites, as well as cements slag during construction, could result in pollution risks to streams and rivers intercepting the transmission line route. The impacts may continue to exist beyond the project construction period unless adequate rehabilitation and drainage work is conducted.

9.3.2.4.1 Proposed Mitigation

- Care should be deployed to prevent pollution of natural water sources through undertaking of activities in accordance with the ESMP (see section 10).
- Towers should be located at enough distance from drainage lines so as to minimize interference to natural drainage systems.
- Construction of new water schemes to Improve the safe water supply coverage in the project area (present safe water supply coverage is below 30% in the region where the line traverses in Ethiopia). This shall be determined in close consultation with the Local Authorities during the RAP process.

9.3.2.5 Impact on natural vegetation

Clearance of the natural vegetation will be required for the construction of access road, installation of tower, stringing, construction camp site, stores and other construction related activities.

This impact will be significant in wooded areas from Mandaya in Ethiopia to Damazin in Sudan. As discussed, in section 7, the woodland consists of tree species that have important value to the local communities by providing natural wild fruit, incense and other economic values. The species diversity is the same as route follows the same agro-ecological lines and in some sections they have similar composition. Majority of the woodland is of communal use hence the mitigation measure to benefit the local communities would be required. There may be individually owned important trees that usually planted near homestead area. These should be compensated to the respective individual through detail survey, which shall be undertaken as part of the RAP.

9.3.2.5.1 Proposed Mitigation

- Limit as much as possible unnecessary clearance of natural vegetation outside the ROW, access routes and the substation sites.
- Replant all damaged vegetation area used for temporary construction work and remove any invasive alien species introduced during the works
- Progressively conduct compensatory re-vegetation for lost vegetation due to the ROW (the site shall be determined in consultation with the concerned regional and woreda natural resource office)

- Whenever important individual trees can not be avoided, the owners of the trees shall be compensated accordingly

- Establish and Implement communal tree re-planting program estimated at US$ 223,000 as estimated for the three countries in section 13, Tables 13.1, 13.2 and 13.3.

9.3.2.6 Impact on wildlife

It is understood that the power transmission route does not traverse in any nationally protected wildlife conservation areas in any of the three participating countries. Information collected during the field survey, confirmed presence of various wildlife species within different sections of the route. The diversity of wildlife is higher especially in rivers and densely vegetated areas. However, various types of wildlife have been found to occur even in desert route section. Therefore construction of access road, installation of tower, stringing, construction camp site, stores and other construction related activities will directly affect the wildlife habitat and subsequently lead to migration of the wildlife to relatively undisturbed habitat. Compensation not applicable in this case, but mitigation measure of re-vegetation of disturbed areas may reduce the impact

The wildlife population has already been affected due to hunting, increased deforestation to expand and start crop cultivation. Constructed access road will open up the chance of illegal hunting hence should be banned during the construction period and following time unless approved by the concerned organization.

9.3.2.6.1 Proposed Mitigation

- Limit working in the night, especially near areas known with wildlife population

- Conduct conservation awareness campaigns for the construction workers in order for then to avoid hunting during their work.

- Rehabilitate important terrestrial wildlife habitat through re-vegetation

9.3.2.7 Impact on aquatic habitat

As indicated in the baseline environmental survey the most important aquatic habitat in the project area is found in the Blue Nile (Abbay), Tumet and Dabus, White Nile and Main Nile Rivers, lakes, wadis and oases. Impact on the aquatic life will be related to construction of crossing structures that will disturb the aquatic fauna due to increased noise, erosion from construction related activities. The location of the line route crossing on the Blue Nile (Abbay) was noted with presence of high population of hippos and the crossing of the White Nile was noted as important fishery area. Construction activities that increase sedimentation and pollution of the water resource should be prevented.

9.3.2.7.1 Proposed Mitigation

- During the tower installation and stringing care should be taken not to affect hippos and other aquatic fauna.

- Prevent pollution of water sources from hazardous waste this may include but not limited to safe handle & storing and disposal of hazardous waste.
- Prevent waste water produced at construction camp from entering directly in to rivers.
- Safe distance location sewerage or toilets of camp sites
- Ensure safe clearance for river crossing is maintained to ensure safety of river users

9.3.2.8 Impact on health

Most of the project area is known with high malaria cases as indicated in the baseline study of this report. The various activities related to the project construction can Increase the risk of malaria and other water related diseases due to creation of suitable foci for mosquito and other disease vectors.

During the project construction period many skilled labourers will come in relation to project construction activities. These workers from outside the communities could increase the risk of spreading communicable diseases such as HIV/AIDS to local communities.

9.3.2.8.1 Proposed Mitigation

Both workers and communities should be made aware of health implications and preventative measures should be provided by the Project construction contractor in collaboration with the regional health bureau. Health related mitigation measures programs implementation cost is estimated at US$ 165,000.

9.3.2.9 Occupational and Road Safety Impacts

Some construction work pose risk of accidents on construction workers. Furthermore people moving in to the areas of the construction could be exposed to accidents of falling and flying objects. The construction phase and the operational phase pose different kinds of occupational health impacts. During surveying and ROW clearing, the workers may be exposed to injuries related to falling trees and snake bites. At construction phase, the workers would be exposed to construction related hazards such as falling from towers during both tower construction and cable stringing, injuries related to assembly of machinery and equipment.

The increased construction traffic, therefore support shall be given to road safety enhancement activities during construction phase such as speed limit signs, warning signs to motorists on construction and replacement of clear road signs.

9.3.2.9.1 Proposed Mitigation

- At mobilisation, safety awareness should be undertaken on all the workers. The supervisors and foremen should be trained in First Aid and ensure that each team has a First Aid kit. The contractors shall be required to come up with a code of conduct for the workers which should include safety issues. The code of conduct shall be approved by the Environmental Coordination Unit Staff.

- The construction teams should be given a clear communication procedure in case of accidents in the field, with clear guidelines how to handle occupational health related accidents

- Workers need to be instructed in safe work practices and provided with appropriate protective clothing and equipment.

- People from surrounding communities should be excluded from risky construction sites wherever possible.

- Road safety related mitigation measures are estimated to cost US$ 25,000

9.3.2.10 Noise

Noise resulting from access road and transmission line construction may disturb the local communities and local fauna. This impact will be of a temporary nature.

9.3.2.10.1 Mitigation measures

This impact will be minimised by ensuring that the plant and machinery used are in good condition. The working hours should be limited to daylight hours only to ensure there would be no noise during the time when people are asleep.

9.3.2.11 Soil Erosion

The construction of foundations for transmission line towers and access roads can potentially increase the risk of soil erosion especially in areas that have a tendency to high soil erosion hazard. In addition soils can undergo compaction due to use of heavy machinery.

9.3.2.11.1 Mitigation measures

- The construction process in high rainfall areas should be restricted to dry season period to minimise erosion. Deliberate soil erosion control should be done during construction in erosion susceptible areas, by installing soil protection works in areas sensitive to erosion.

- There should be restricted use of heavy machinery and vehicles to designated work areas.

9.3.2.12 Cultural and Archaeological conservation

Some sections (such as north of Khartoum to Sudan / Egyptian border and the whole route in Egypt) of the route has a high concentration of cultural and archaeological relics, therefore during construction, if the construction workers are not aware of the possibility of finding the relics, this may result into destruction of the important historical heritage sites.

9.3.2.12.1 Mitigation measures

The construction teams when working in the particular sections of the route shall work closely with the archaeological specialists. The particular construction teams shall be trained in identification of sites of historical importance. A procedure shall be given to them on what should be done when a discovery is made.

9.3.3 OPERATION PERIOD

9.3.3.1 Drainage & erosion

Lack of proper rehabilitation of camp site and insufficient drainage provision may lead to erosion at later stage of development. The opened access may facilitate deforestation of vegetation cover that will ultimately result in erosion.

9.3.3.1.1 Proposed mitigation

- Periodic inspection for presence of erosion hazard in relation to safety of towers is required, especially those that are located near drainage lines.
- Monitor implementation of re-vegetation program and vegetation cover condition.

9.3.3.2 Maintenance of ROW and clearance

The impact related to ROW clearance is significant in wooded and grasslands. Natural and human induced fires are common and could cause large damage on the transmission line if ROW clearing is not undertaken during the project operation. The Vegetation in the ROW easily grows up during the rainy period. The natural fires would follow in the dry period that clears out vegetation, especially grass and shrubs cover, therefore the ROW maintenance should be done at least once a year after the rainy season to prevent fires inducing faults on the line.

During operational phase, the use of herbicides for clearing of vegetation re-growth in substation areas will be inevitable due to difficulty in undertaking manual clearing of vegetation with the sensitive electrical equipment and installations. This aspect is only applicable to the Mandaya and Kosti substations which require vegetation control.

9.3.3.2.1 Proposed Mitigation

- Conduct periodic monitoring to maintain clearance between conductors and vegetation
- Ensure employment of local people in the ROW clearing activities
- Trees at the edge of the ROW should be trimmed rather than being cut completely
- Approved herbicide types should be utilised for vegetation control. Appropriate storage facilities should be provided for in the substation infrastructure. Appropriate training should be given to staff in safe handling of the herbicites.

9.3.3.3 Health Effects of Electromagnetic Fields (EMF)

The major health issue related to operation of High Voltage transmission lines is possible health impacts of electromagnetic fields (EMF) associated with power transmission lines. Electric and magnetic fields (EMF) are invisible lines of force that surround any electrical device. Power transmission lines, electrical wiring, and electrical equipment all produce EMF. There are many other sources of EMF as well. Electric fields are produced by voltage and increase in strength as the voltage increases. In summary, voltage produces an electric field and current produces a magnetic field.

Based on a recent in-depth review of extensive scientific literature (World Health Organization's International EMF Project), the WHO has concluded that "despite extensive research, to date there is no evidence to conclude that exposure to low level electromagnetic fields is harmful to human health" (http://www.who.intpeh-emf/WhatisEMF/en.html). The low levels referred to by the WHO are levels expected to be found outside the 65m (130m) ROW proposed for the 500kV lines and the 80 m DC line. It is concluded therefore that provided the proposed 65m and 80m ROW is enforced along the proposed transmission line routes, there will not be any adverse health affects to people along the route.

9.3.3.3.1 Proposed Mitigation

Impact of EMF from the power transmission route can't be avoided; however the impact could be prevented by avoiding permanent settlement and other public facilities out of the EMF impacting zone. As part of this effort the following needs to be conducted during the project operation period:

- Monitor for new settlement and other facilities in the established ROW that have 130 m corridor for the AC Line and the ROW of 80 m for the HVDC line
- Monitor the well being of people in the newly established settlement
- Training/public education on the impact of EMF and the need to keep away from the High Voltage lines.

9.3.3.4 Impact Risk of Bird Collision

Based on the site visit and available information, the proposed power transmission route does not have effect on bird's movement and migration, however the areas along the main Nile are known to be areas of significance for migratory birds. Though the proposed route passes far from the aquatic environment, a monitoring programme should be undertaken and if any migratory routes are established the following mitigation measures should be implemented.

9.3.3.4.1 Proposed Mitigation

- Conduct strict environmental monitoring of birds' movement - should be conducted in sections where routine collision of birds may be encountered
- Install bird diverters on conductors at 'hotspots' or wherever significant bird migratory routes are observed.

10 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

10.1 INTRODUCTION

This Section addresses the Environmental and Social Management Plan of the project. The section is important to ensure that the recommendations proposed in this report are implemented by assigning the various tasks to the contractors and project management team. With the assignment of tasks, the environmental monitoring and auditing will have clear benchmarks and those responsible for achieving the given targets. This section therefore operationalises the ESIA report and its key recommendations. The cost estimates presented in Section 13 therefore is meant to facilitate the implementation of the Environmental management Plan.

Attached to this EMP is the monitoring program that will be carried out during the project implementation. Also key will be the Environmental audit that is planned to be undertaken at the end of project implementation, to check how the EMP has been implemented.

The EMP presented in this section is a model EMP which should be updated and edited to be aligned with and in accordance to the various contracts and sub-contracts of the project.

10.2 DETAILS OF THE ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

10.2.1 ADMINISTRATION OF THE ESMP

The EMP will be administered by the project consultants through the Environmental Coordination Units for each country. The Environmental Coordination Units will therefore be the key institutions to administer the ESMP and ensure that all activities are implemented as recommended in this report. The Environmental monitoring aspects will be based on the tasks and activities outlined in this ESMP.

10.2.2 INSTITUTIONAL STRENGTHENING AND TRAINING

The three Environmental Coordination Units from EEPCO, NEC and EEH will need strengthening both in terms of resources and capacity in terms of being able to implement the Environmental and Social Management plan of the project. EEPCO, NEC and EEH are the key institutions in charge of electricity transmission systems in Ethiopia, Sudan and Egypt respectively.

Therefore, it will be the first key assignment for the Supervision Consultant and ENTRO to ensure capacity building is undertaken for the assigned Staff from the three institutions. The following capacity should be enhanced:

- Training in implementation of Environmental and Social Management Plans, include practical sessions and visit to sites or areas of success.
- Field practicals to be undertaken in the route corridor to familiarise the teams on what to look for in their monitoring programmes
- Environmental reporting procedures

- Basic equipment needed for monitoring
- Reliable 4x4 transport for each Unit

No	Training Recipients	Type of Training	Environmental Aspects to be covered	Training Conducting Agency
1	EEPCO, NEC and EEH Environmental Coordination Units Staff	Lecture System Workshops Group Discussion Visit to case study	Environmental overview Environmental regulations & acts Environmental issues associated with power transmission projects Environmental Management Plans Identification of Cultural, historical artefacts and sites and procedure for reporting and rescue of the resources Environmentally sound construction management	Environmental and Social Specialists, Supervision Consultant
2	NEC, EEPCO and EEH Operation/Maintenance Staff	Seminar Workshop Lectures	Environmental Management Plan implementation Environmental pollution associated with power transmission projects Best environmental practices	Environmental and Social Specialists, Supervision Consultant
3	Contractor's Staff	Seminar Workshop Lectures	Environmental overview Environmental impact assessment Environmental Management Plan implementation Environmental regulations & Acts Environmental pollution associated with power transmission projects Environmentally sound construction management Power transmission projects and environmental issues Identification Cultural artefacts and procedure for reporting to relevant authorities	Environmental and Social Specialists, Supervision Consultant EEPCO/NEC/EEH Environmental Coordination Units Staff

Table 52 : Training Aspects before Commencement of Construction

10.2.3 COMMUNITY AWARENESS

Work with the Local Authorities to inform all communities along transmission route of schedule of implementation of Project, their rights to compensation, livelihood enhancement programs, and health awareness programs. Raise project awareness amount the local communities along the route corridor.

10.2.3.1 Location and time period

This shall be done before the commencement of construction activities and it should be done throughout the route corridor.

10.2.3.2 Responsibility

Environmental Coordination Units from EEPCO, NEC and EEC. To be undertaken in close consultation with the project consultant.

10.2.4 LAND AND BUILDING ACQUISITION

Coordinate the valuation and assessment of the land and structures to be affected along the ROW and access roads.

Ensure the compensation is accepted by the affected people and ensure payment processing and payment is done in good time to allow for relocation before the commencement of construction.

10.2.4.1 Location and time period

Throughout the route corridor.

10.2.4.2 Responsibility

Environmental Coordination Units from EEPCO, NEC and EEH. To be undertaken in close consultation with the project consultant.

10.2.5 CLEARANCES, APPROVALS AND PERMITS

Obtain written permission from landholders to conduct activities on their land prior to commencing these activities, and provide copies to the Environmental Coordination Staff. Obtain consent for borrow pit operation from the landowner with prior approval of the rehabilitation proposal of the borrow areas from the Engineer Provide a copy of all necessary permits to the Engineer.

Update detailed environmental management and monitoring plans in line with any specific requirements and ensure adherence to all permit terms and conditions during implementation.

10.2.5.1 Location and time period

This shall be done through out the ROW and shall be undertaken before commencement of the construction

10.2.5.2 Responsibility

The Environmental Coordination Units shall be responsible for obtaining all clearances, approvals and permits and copies of the same shall be given to the Consultant in charge of the various project components.

The Contractors shall be responsible for adhering to the conditions of each permit.

10.2.6 HEALTH AND SAFETY ISSUES

This aspect refers to both construction workers and the local communities along the proposed route corridor. Therefore a detailed Health and Safety Plan for workers and impacted communities should be prepared to by the Project Consultant and the Environmental Project

Coordination Unit Staff for each country. The health and Safety Plan should address the following issues:

- At mobilisation, health and safety awareness to be undertaken on all the workers and local communities in close proximity to the route corridor.
- The supervisors and foremen to be trained in First Aid and ensure that each team has a First Aid kit.
- The contractors for the various components of the project to come prepare a code of conduct for the workers which should include health and safety issues. The code of conduct shall be approved by the Environmental Coordination Unit Staff.
- The construction teams to have a clear communication procedure in case of accidents in the field, with clear guidelines how to handle occupational health related accidents
- Measures to prevent the spread of HIV/Aids such as free condoms
- Provision of suitable and sufficient safety equipment for workers
- Use of child / forced labour to be prohibited

10.2.6.1 Location and time period

On site training for all contractors on the route corridor. All communities along the route corridor. This should be done before the commencement of construction, at mobilisation of contractors.

10.2.6.2 Responsibility

The Environmental Coordination Units in association with the Local authorities. Local committees dealing with HIV/AIDS should be engaged to undertake the HIV/AIDS awareness through all communities and Construction Staff.

The contractor shall make his staff available for the awareness seminars.

The contractors shall prepare the code of conduct for the workers and shall be responsible to ensure the workers abide by the set conditions

10.2.7 CONDITION OF CONSTRUCTION PLANT, MACHINERY AND VEHICLES

Undertake trial run of Contractor's plants, machinery and vehicles for ascertaining that their emission and noise levels conform to the standards stipulated by relevant national environmental requirements.

10.2.7.1 Location and time period

This shall be done at the contractors' camps and storage facilities. This shall be done as soon as specific plant, machinery and vehicles are mobilised to site, but before they start work on the project.

10.2.7.2 Responsibility

The contractor shall be responsible to undertake the trial runs of the specific equipment. This shall be done in the presence of the Supervising Consultant and the Environmental Coordination Units Staff

10.2.8 VEGETATION CLEARANCE

Clearly mark out the extent of clearing within the approved worksite areas with pegs at 50-m intervals or less. Identify and mark individual trees for retention within the marked extent of clearing. Seek approval for clearing from the Environmental Coordinator at least 1 week prior to any proposed clearing.

Inspect and approve all correctly located and pegged clearing sites. Vegetation clearance shall only be undertaken once consent to clear strip plantation / individual trees along the alignment has been obtained from each owner. Instruct all construction workers to restrict clearing to the marked areas and not to harvest any forest products for personal consumption.

Ensure that all clearing is undertaken with minimal disturbance to the surrounding environment, within the extent of approved sites only.

Stockpile cleared shrub foliage where possible within the ROW for later use by the local communities.

10.2.8.1 Location and time period

This shall be done throughout the route corridor and specific sites that require vegetation removal. Shall be undertaken before commencement of vegetation clearing for each section of the route.

10.2.8.2 Responsibility

The Contractor shall be responsible for marking out areas to be cleared and the Environmental Coordination Unit Staff shall be responsible for approval of areas to be cleared. The Environmental Coordination Unit Staff shall be responsible for inspection and approval of cleared sites.

10.2.9 VEGETATION CLEARANCE AND PROTECTION

To restrict vegetation clearance to the minimal area necessary, and thereby prevent damage to vegetation outside the work site. To properly dispose of cleared vegetation.

The Construction Contractor shall restrict vegetation clearance to the minimal area necessary and prevent damage to vegetation outside this area. This shall be achieved by surveying and pegging each work site and have it approved by the Environmental Coordination Unit Staff before the commencement of clearing.

Where earthworks are proposed, site clearance shall be staged so that no site is cleared more than two weeks before the earthworks to minimize the time that cleared areas are exposed and vulnerable to soil erosion.

10.2.9.1 Location and time period

Throughout the route corridor where construction shall be undertaken.

10.2.9.2 Responsibility

The Contractor shall be responsible with implementing the mitigation measures. The Environmental Coordination Unit Staff shall approve all pegged sites before commencement of clearing by the Contractor.

10.2.10 ROAD SAFETY AND CONSTRUCTION TRAFFIC MANAGEMENT

Construction traffic causing damage to local roads due to overloading, increase in congestion, and increased road safety hazards. Contractor and subcontractors, to use appropriate vehicles, and to comply with legal gross vehicle and axle load limits. Contractor to repair damage at own expense. Contractors will be responsible to ensure minimising road safety hazards and inconvenience to other road users by taking all appropriate measure. The Contractor shall provide clear road signs and speed limit notices for all access routes that are used by other motorists.

Identify vehicle access tracks and parking areas prior to commencement of construction. Ensure construction workers are aware of the locations of these areas and that vehicles are restricted to these areas.

10.2.10.1 Location and time period

Through out the route corridor and the associated access roads. This shall be done during periods when construction process is going on in the power line sections

10.2.10.2 Responsibility

All Contractors shall be responsible to ensure all mitigation measures are implemented.

10.2.11 SOIL EROSION AND SEDIMENTATION

Prior to commencement of works construct necessary temporary/ permanent erosion and sedimentation control structures. Ensure topsoil is left in a non-compacted condition following completion of works. Ensure re-vegetation at the earliest time.

Following completion of works prepare areas for rehabilitation by re-vegetation or engage local community to plant vegetation. Where culverts or pipes have been installed, line water flow exit points with stone or cement rip-rap for a length of two metres.

Identify and map all areas where soil disturbance will occur. For each of these areas, identify appropriate sediment control structures and install structures prior to commencement of work. Identify vehicle access tracks and parking areas prior to commencement of construction. Ensure construction workers are aware of the locations of these areas and that vehicles are restricted to these areas. Where possible a bund or trench shall be constructed on the down slope of the construction areas to divert run-off to sediment control structures. The bund or trench shall be removed upon completion of construction works.

Construction materials containing fine particles e.g. aggregates, limestone etc. will be stored in an enclosure away from water bodies to ensure that sediment laden water does not drain into nearby water courses. Trees and grass will be planted on slopes and other suitable places along the alignment to stabilise works areas.

10.2.11.1 Location and time period

Throughout project work areas and camp sites, the efforts shall be implemented through out the construction period.

10.2.11.2 Responsibility

The Contractor shall be responsible to ensure all mitigation measures are implemented and the works will be part of the daily work schedules for the construction works.

The Environmental Coordination Unit Staff shall be responsible for monitoring the works and approval of interventions undertaken.

10.2.12 WATER POLLUTION

Ensure that potential sources of petro-chemical (including fuels and bituminous materials) pollution are handled in such a way to reduce chances of spills and leaks by:

- Training all workers in safe handling of petro- chemicals.
- Minimise soil sedimentation as outlined under sediment control.
- Contractor to make suitable arrangements for water requirements and to provide alternative supply to any users affected by contractor’s abstraction of local water source.

10.2.12.1 Location and time period

Through out the work, storage and camp sites. The aspects have to be implemented through out the construction period.

10.2.12.2 Responsibility

The Contractor shall be responsible for the implementation of the measures related to water pollution prevention.

10.2.13 MANAGEMENT OF STOCKPILES, SPOIL HEAPS AND BATTERS

Consult with nearby landholders and community about suitable locations for stockpiles and spoil heaps. Site plans shall include all drainage provisions for construction sites.

Locate stockpiles or spoil heaps so there is no blocking of drainage lines. If stockpile locations are not level, the base shall be levelled and contained.

If a spoil heap or stockpile containing fine sediments is to remain bare during high rainfall periods, it shall be covered to prevent erosion and sediment run-off.

Where spoil heaps and stockpiles are large, they must be subject to stability calculations for provision of toe wall to safeguard against slips occurring.

If local landowners or community groups plan to use spoil locally, a suitable site must be prepared to which the spoil can be dumped.

In the event of spoil being available, it shall be used to backfill waste disposal pits. These areas should then be re-vegetated using local communities.

10.2.13.1 Location and time period

This is through out the route corridor where construction works would be undertaken. This will be through out the whole period of construction.

10.2.13.2 Responsibility

The Contractor will be responsible for ensuring mitigation measures related to this aspect are implemented to ensure rehabilitation of construction sites.

10.2.14 GENERAL WASTE MANAGEMENT ON CONSTRUCTION SITES

Construction sites generate various other types of waste such as left over building materials, pieces of steel, bolts and nuts, empty bags of cement, equipment packaging materials, and other wastes. The impact is more localised for the substation construction sites and more spread out on the tower construction for the powerline. The following measures shall be implemented:

- The various waste shall be separated according to types. Sorting shall be done as follows: metal and steel waste; paper waste; wooden wastes
- Develop strategy for safe disposal of the various waste with preference to recycling and re-use alternatives

10.2.15 WORKFORCE CAMPS

Locate, peg and seek approval from the Environmental Coordination Unit Staff for workforce camp sites. The Environmental Coordination Unit Staff shall inspect and approve all correctly located camp sites. The Contractor shall provide and maintain proper drinking water, worker's health check-up, and sewage and waste disposal facilities at the camps. Ensure recycle or dispose of solid waste as directed by the Environmental Coordination Staff.

10.2.16 WORKFORCE MANAGEMENT

Liaise with affected communities regarding proposed construction activities. It is important the privacy and lives of the local people is not disturbed by the project work force, therefore the contractor should ensure that workers act in a responsible manner to local people and do not harvest or take personal resources, forest products or wildlife. In this regard the Contractor should ensure that:

- No or minimal wood is burnt by any construction workers on or off site.

- Provide kerosene or gas for all workforce cooking needs.
- Restrict working hours near habitations to between 06.00-18.00 hrs
- Develop a code of conduct for the workers which shall include appropriate workforce behavioural aspects

The Environmental Coordination staff shall be responsible for monitoring adherence to the established code of conduct for the construction workers.

10.2.17 SANITATION AND WASTE DISPOSAL IN CONSTRUCTION CAMPS

Camps shall be located at a minimum distance of 100 m from water sources. Sufficient measures will be taken in the construction camps, i.e. provision of garbage tanks and sanitation facilities including septic tank and soak pits. Waste in septic tanks will be cleared periodically. Drinking water will meet National Standards. Garbage will be collected in bins and disposed of daily. Special attention shall be paid to the sanitary condition of camps.

The Contractor shall be responsible to ensure mitigation measures are implemented.

10.2.18 DUST NUISANCE AND GASEOUS AIR POLLUTION

Vehicles delivering materials shall be covered to reduce spills and dust blowing off the load. Use of water tankers to control dust at construction sites adjacent villages/houses. Vehicles and machinery will be regularly maintained so that emissions conform to National Standards.

The Contractor shall be responsible to ensure the mitigation measures are implemented.

10.2.19 NOISE

Workers in vicinity of sources of loud noise will wear earplugs and their working time should be limited. Construction would be stopped from 21:00 to 06:00 hrs at construction sites located within 150 m of residential areas. Machinery and vehicles will be maintained to keep noise at a minimum.

The Contractor will be responsible for implementing the mitigation measures.

10.2.20 CULTURAL RESOURCES

If archaeological relics or remains are discovered, the appropriate authority should be notified immediately. The construction should be stopped until the authorised organisation assesses the remains and approves continuation of work after appropriate measures are implemented. An Archaeologist will supervise any necessary excavation to avoid any damage to the relics.

The Contractor and all project staff shall be trained in the identification of these important historical/cultural artefacts, relics and sites.

10.2.21 FINANCING OF EMP

Section 13 does outline cost estimates for implementation of this EMP, however a number of mitigation measures to be implemented shall be part of the daily work schedules and the contractor will finance them through the normal construction works. A total amount of US$ 17,515,300 has been estimated to finance the various components of this EMP.

Tables 10.2, 10.3 and 10.4 give generic outlines of the EMSP per country. These can be developed further at implementation and included in the Contractors' contracts to ensure that the recommended environmental measures are implemented during project implementation.

Table 53 : Environmental management plan (Ethiopian Section)

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget (US$)
Training and capacity building:	Pre-construction/construction	▪ The necessary training has to be given to relevant organization at Local and region level. ▪ Their capacity has to be improved to conduct the monitoring efficiently.	▪ Project Supervision Consultant ▪ EEPCO ▪ Key local Stakeholder institutions ▪ ENTRO	260,000 Institutional capacity building (to cover training, transport and other equipment for efficient monitoring)
Detail community consultation	Pre –construction	▪ Each households in the ROW have to be informed prior to construction commencement ▪ Resettlement area has to be identified in consultation with affected community and concerned government organ.	▪ EEPCO ▪ Affected communities ▪ Local regional administration	15,000 socio-economic monitoring (To cover compensation and resettlement monitoring)
Deterioration of air quality: the impact is considered insignificant as settlement centers are very much limited in the power line routing. Mitigation is required in settlement areas.	Construction/ maintenance work during operation	▪ Modern equipments should be used if possible and well maintained to minimize air pollution ▪ Ensure construction work vehicles are well maintained to minimize emission and noise ▪ Avoid residential areas as much as possible.	▪ Project Contractor ▪ Regional and federal EPA ▪ EEPCO	50,000 To be covered under general monitoring of construction work

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget (US$)
Soil erosion & land degradation: Clearance and destruction of vegetation cover for opening access road, establishment of towers and other civil works activities.	Construction	▪ Limit construction activities season to least sediment load season ▪ Clearly mark area to be cleared of vegetation; no clearing of vegetation out side the working area ▪ Replant and construct physical conservation measures, as appropriate to area disturbed by construction activities	▪ Project Contractor ▪ Federal /regional environmental offices ▪ Regional natural resource office ▪ EEPCO ▪ Project Consultant	50,000 general Monitoring of Construction 123,000 tree re-planting provision
Impact on Water quality Effluent from temporary camp site, oil and other chemicals from construction machinery and activities may pollute water sources and affect human and livestock population. Increased sediment in could affect water quality of rivers.	Construction	▪ As much as possible avoid construction activities related with soil erosion during the rainy season ▪ Make sure of proper handling and use of toxic compounds during construction ▪ Prevent clearing of trucks and other vehicles near or in the water bodies to avoid chemical contamination ▪ Proper sitting of construction camps with provision for safe disposal of solid and liquid wastes from construction workers	▪ Project Contractor ▪ Assigned (national/internatio nal)Environmental Supervisor ▪ Federal /regional environmental offices ▪ EEPCO ▪ Project Consultant	5,000 water quality monitoring 50,000 general monitoring of Construction
Impact on aquatic life Affect aquatic life due to increased sediment load at and below construction	Construction	▪ Limit construction activities season to least sediment load	▪ Project Contractor ▪ Project Consultant ▪ Regional and	50,000 general monitoring of construction works

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget (US$)
sites due to construction activity induced soil erosion.		▪ Replant and construct physical conservation measures, as appropriate to area disturbed by construction activities	federal EPA ▪ ENTRO ▪ Regional natural resource office ▪ EEPCO	5,000 water quality monitoring
Impact on natural vegetation The natural vegetation will be removed by stringing power line and tower erecting borrows areas, construction of access roads. Road access may facilitate the rate of deforestation during the project operation period.	Construction/Operation	▪ adhere to principles of environmental conservation during the construction period in order to avoid excessive destruction of vegetation, ▪ avoid damping construction spoils in cliffs and dry river beds where rare plants are available, ▪ Compensate by replanting for the loss of natural vegetations. ▪ Conservation and sustainable utilization of natural resource in the surrounding area ▪ Use approved herbicides in clearing vegetation re-growth in substation areas	▪ Project Contractor ▪ Project Consultant ▪ Regional and federal EPA ▪ ENTRO ▪ Regional natural resource office ▪ EEPCO	50,000 general monitoring of construction 123,000 re-planting provision 50,000 Generic BMP for disturbed areas
Impact on crop production construction activities related with erecting power transmission towers, stringing of power lines, establishment of camp site could damage crops on temporary and permanent basis.	Construction	▪ An early notification and consultation with the affected farmers ▪ Proper sitting of construction camps and other facilities	▪ EEPCO ▪ ENTRO ▪ Federal /regional environmental offices ▪ Regional	60,000 for permanent loss of land 1,172,000 for annual crops compensation

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget (US$)
		▪ Limit construction activist as required and install good workmanship ▪ Install proper compensation	Administration Offices	
Impact on settlements All houses with in the 130m ROW should be relocated and future establishment of houses and other pubic facilities with in the ROW will not be allowed.	Pre-construction/ Construction/Monitoring during operation	▪ An early notification and consultation with the affected households. ▪ Prepare & implement a resettlement plan that contains all the necessary public facilities.	▪ EEPCO ▪ ENTRO ▪ Federal /regional environmental offices ▪ Regional / Local Administration Offices	50,000 for compensation for structures 540,000 for livelihood safeguard 15,000 for Socio-economic Monitoring 240,000 Local Community gain program
Impact on perennial fruit and wild fruit trees: There may be limited impact on perennials and wild fruits due to construction activities such as tower establishment and access road opening.	Construction	▪ Conservation of similar natural vegetation in the surrounding ▪ Compensate for perennials lost that are owned by individual households. ▪ Assist sustainable utilization of the lost resource in the neighbouring area	▪ EEPCO ▪ ENTRO ▪ Federal /regional environmental offices ▪ Regional Administration Offices	3,910,000 for fruit tree compensation
Impact on public health: During the project construction, influx of people will come leading to increase the risk of transmittable diseases; construction activities related with erection of tower and stringing of power lines may result in accidents to works and local people.	Construction	▪ Health education to employees and local people that are participating in the project construction activities ▪ Prevent movement of local people during power line stringing.	▪ Regional health offices ▪ EEPCO ▪ ENTRO ▪ Project Consultant ▪ Project Contractor	55,000 for health centre support and awareness

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget (US$)
		▪ Ensure proper sanitation and waste disposal ▪ Appropriate camp sitting		
Road Safety: The increased construction traffic may lead to high levels of road traffic accidents, During construction, the	Construction	▪ support shall be given to road safety enhancement activities during construction phase such as speed limit signs, warning signs to motorists on construction and replacement of clear road signs	▪ Project Contractor ▪ EEPCO	5,000 for road safety

Note:

EEPCO in this EMP refers to the Environmental Coordination Unit Staff that will be designated by the EEPCO

Table 54 : Environmental management plan (Sudan Section)

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget
Training and capacity building:	Pre-construction/construction	▪ The necessary training has to be given to relevant organizations at region level. ▪ Their capacity has to be improved to conduct the monitoring efficiently.	▪ Project Consultant ▪ ENTRO ▪ NEC	260,000 Institutional capacity building program
Detail community consultation	Pre –construction	▪ Each households in the ROW have to be informed prior to construction commencement ▪ Resettlement area has to be identified in consultation with affected community and concerned government organ.	▪ NEC ▪ Affected communities ▪ Local / Regional administration	50,000 socio-economic monitoring
Deterioration of air quality: the impact is considered insignificant as settlement centers are very much limited in the power line routing. Mitigation is required in settlement areas.	Construction/ maintenance work during operation	▪ Modern equipments should be used if possible and well maintained to minimize air pollution ▪ Ensure construction work vehicles are well maintained to minimize emission and noise ▪ Avoid residential areas as much as possible.	▪ Project Contractor ▪ Project Consultant ▪ NEC ▪ Regional and federal Environmental Offices	110,000 to be covered under general monitoring of Construction

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget
Soil erosion & land degradation: Clearance and destruction of vegetation cover for opening access road, establishment of towers and other civil works activities.	Construction	▪ Limit construction activities season to least sediment load season ▪ Clearly mark area to be cleared of vegetation; no clearing of vegetation out side the working area ▪ Replant and construct physical conservation measures, as appropriate to area disturbed by construction activities	▪ Project Contractor ▪ Project Consultant ▪ Federal /regional environmental offices ▪ Local / Regional natural resource office ▪ NEC	110,000 to be covered under the general monitoring of construction
Impact on Water quality Effluent from temporary camp site, oil and other chemicals from construction machinery and activities may pollute water sources and affect human and livestock population. Increased sediment in could affect water quality of rivers.	Construction	▪ As much as possible avoid construction activities related with soil erosion during the rainy season ▪ Make sure of proper handling and use of toxic compounds during construction ▪ Prevent clearing of trucks and other vehicles near or in the water bodies to avoid chemical contamination ▪ Proper sitting of construction camps with provision for safe disposal of solid and liquid wastes from construction workers	▪ Project Contractor ▪ Project Consultant ▪ Federal /regional environmental offices ▪ NEC	5,000 for water quality monitoring 110,000 to also be covered under general monitoring of construction

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget
Impact on aquatic life Affect aquatic life due to increased sediment load at and below construction sites due to construction activity induced soil erosion.	Construction	▪ Limit construction activities season to least sediment load ▪ Replant and construct physical conservation measures, as appropriate to area disturbed by construction activities	▪ Project Contractor ▪ Project Consultant ▪ Regional and federal EPA ▪ ENTRO ▪ Regional / Local natural resource office ▪ NEC	110,000 to be covered under general monitoring of construction 5,000 for water quality monitoring
Impact on natural vegetation The natural vegetation will be removed by stringing power line and tower erecting borrows areas, construction of access roads. Road access may facilitate the rate of deforestation during the project operation period.	Construction/Operation	▪ adhere to principles of environmental conservation during the construction period in order to avoid excessive destruction of vegetation, ▪ avoid damping construction spoils in cliffs and dry river beds where rare plants are available, ▪ Compensate by replanting for the loss of natural vegetations. ▪ Conservation and sustainable utilization of natural resource in the surrounding area	▪ Project Contractor ▪ Project Consultant ▪ NEC ▪ Regional and federal EPA ▪ ENTRO ▪ Regional/Local natural resource office	110,000 under tree re-planting 50,000 under generic BMP for disturbed areas
Impact on crop production construction activities related with erecting power transmission towers, stringing of power lines, establishment of camp site could damage crops on	Construction	▪ An early notification and consultation with the affected farmers ▪ Proper sitting of construction camps and	▪ NEC ▪ ENTRO ▪ Federal /regional agricultural offices ▪ Regional	225,000 for permanent loss of land 4,173,000 for compensation of

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget
temporary and permanent basis.		other facilities ▪ Limit construction activist as required and install good workmanship ▪ Install proper compensation	Administration Offices ▪ Affected communities	annual and irrigated crops
Impact on settlements All houses with in the 130m ROW should be relocated and future establishment of houses and other pubic facilities with in the ROW will not be allowed.	Pre-construction/ Construction/Monitoring during operation	▪ An early notification and consultation with the affected households. ▪ Prepare & implement a resettlement plan that contains all the necessary public facilities.	▪ Affected communities ▪ ENTRO ▪ Regional Administration Offices ▪ NEC ▪ Federal /regional environmental offices	200,000 for compensation for houses and other structures 600,000 for livelihood safeguard program 50,000 socio-economic monitoring 300,000 for community gain program
Impact on perennial fruit and wild fruit trees: There may be limited impact on perennials and wild fruits due to construction activities such as tower establishment and access road opening.	Construction	▪ Conservation of similar natural vegetation in the surrounding ▪ Compensate for perennials lost that are owned by individual households. ▪ Assist sustainable utilization of the lost resource in the neighbouring area	▪ Affected communities ▪ ENTRO ▪ Federal /regional Agricultural offices ▪ NEC ▪ Local/Regional administration	1,910,000 compensation for fruit trees

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget
Impact on public health: During the project construction, influx of people will come leading to increase the risk of transmittable diseases; construction activities related with erection of tower and stringing of power lines may result in accidents to works and local people.	Construction	▪ Health education to employees and local people that are participating in the project construction activities ▪ Prevent movement of local people during power line stringing. ▪ Ensure proper sanitation and waste disposal ▪ Appropriate camp sitting	▪ Regional / Local health office ▪ ENTRO ▪ NEC ▪ Project Consultant ▪ Project Contractor	55,000 for health centre, awareness and care
Cultural and Archaeological conservation measures: The route corridor from North Khartoum to the Sudan/Egypt border is rich in archaeological relics, therefore special care and monitoring will be required during construction phase of the project to ensure conservation and preservation of relics.		▪ special care and monitoring will be done during construction phase of the project ▪ Teams shall work closely with archaeologist ▪ Possible preservation shall be made for any discovery	▪ NEC ▪ Archaeologist ▪ Project Contractor ▪ Project Supervision Consultant	60,000 archaeological conservation
Road Safety: The increased construction traffic may lead to high levels of road traffic accidents	Construction	▪ support shall be given to road safety enhancement activities during construction phase such as speed limit signs, warning signs to motorists on construction and replacement of clear road signs	▪ Project Contractor ▪ NEC	10,000 for road safety

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget
Security enhancement: Some sections of the route are remote and would therefore expose the project and construction staff to security risks		▪ Support shall be given to national security wings to provide adequate security during construction	▪ NEC ▪ National Security	80,000 allowances for security officers

Note:

NEC in this EMP refers to the Environmental Coordination Unit Staff which will be designated by NEC

Table 55 : Environmental management plan (Egypt Section)

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget
Training and capacity building:	Pre-construction/construction	▪ The necessary training has to be given to relevant organization at local and region level. ▪ Their capacity has to be improved to conduct the monitoring efficiently.	▪ Project Consultant ▪ EEHC ▪ ENTRO	180,000 Institutional capacity building
Detail community consultation	Pre –construction	▪ Each households in the ROW in Nag Hammadi have to be informed prior to construction commencement ▪ Compensation and Resettlement area has to be identified in consultation with affected community and concerned Local Government Authority. ▪	▪ EEHC ▪ Affected communities ▪ Local / Regional administration	50,000 socio-economic monitoring
Deterioration of air quality: the impact is considered insignificant as settlement centers are very much limited in the power line routing. Mitigation is required in settlement areas.	Construction/ maintenance work during operation	▪ Modern equipments should be used if possible and well maintained to minimize air pollution ▪ Ensure construction work vehicles are well maintained to minimize emission and noise ▪ Avoid residential	▪ Project Contractor ▪ Project Consultant ▪ Regional and federal EPA Offices ▪ EEHC	65,000 Monitoring of construction

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget
		areas as much as possible.		
Impact on Water quality Effluent from temporary camp site, oil and other chemicals from construction machinery and activities may pollute Nile water and canals and affect the water quality which may affect the human and livestock population.	Construction	▪ Make sure of proper handling and use of toxic compounds during construction ▪ Prevent cleaning of trucks and other vehicles near or in the water bodies to avoid chemical contamination ▪ Proper sitting of construction camps with provision for safe disposal of solid and liquid wastes from construction workers	▪ Project Contractor ▪ Project Consultant ▪ EEHC ▪ Federal /regional environmental offices ▪ ENTRO	10,000 generic BMP for disturbed areas 65,000 general monitoring of construction
Impact on crop production construction activities related with construction of substation, erecting power transmission towers, stringing of power lines, establishment of camp sites could damage crops on temporary and permanent basis.	Construction	▪ An early notification and consultation with the affected farmers ▪ Proper sitting of construction camps and other facilities ▪ Limit construction activist as required and install good workmanship ▪ Work out proper compensation	▪ Affected communities ▪ ENTRO ▪ Federal /regional environmental offices ▪ EEHC ▪ Local / Regional administration	90,000 compensation for agricultural land 300,000 community gain program

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget
Impact on settlements All houses with in the 80m ROW in Nag Hammadi should be relocated and future establishment of houses and other pubic facilities within the ROW will not be allowed.	Pre-construction/ Construction/Monitoring during operation	▪ An early notification and consultation with the affected households. ▪ Prepare & implement a resettlement plan that contains all the necessary public facilities.	▪ Affected communities ▪ ENTRO ▪ Federal /regional environmental offices ▪ EEHC ▪ Local / Regional Administration	150,000 compensation for houses 50,000 socio-economic monitoring 300,000 community gain program 110,000 livelihood safeguard program
Impact on perennial fruit trees: There may be limited impact on perennials fruit trees due to construction activities such as substation construction and tower establishment and access road opening.	Pre-Construction /Construction	▪ Compensate for perennials lost that are owned by individual households. ▪ Assist sustainable utilization of the lost resource in the neighbouring area	▪ Affected communities ▪ ENTRO ▪ Federal /regional environmental offices ▪ EEHC ▪ Local / Regional Administration	300,000 livelihood safeguard program
Impact on public health: During the project construction, influx of people will come leading to increase the risk of transmittable diseases; construction activities related with Substation construction and erection of tower and stringing of power lines may result in accidents to works and local people.	Construction	▪ Health education to employees and local people that are participating in the project construction activities ▪ Prevent movement of local people during power line stringing. ▪ Ensure proper sanitation and waste disposal ▪ Appropriate camp	▪ Regional / Local health offices ▪ ENTRO ▪ EEHC ▪ Project Consultant ▪ Project Contractor	55,000 health centre and awareness

Description of impacts & environmental issues	Phase Anticipated	Proposed mitigation	Responsible Organ	Estimated Budget
		sitting		
Cultural and Archaeological conservation measures: The route corridor in Egyptian is rich in archaeological relics, therefore special care and monitoring will be required during construction phase of the project to ensure conservation and preservation of relics.		▪ special care and monitoring will be done during construction phase of the project ▪ Teams shall work closely with archaeologist ▪ Possible preservation shall be made for any discovery	▪ EEH ▪ Archaeologist ▪ Project Contractor ▪ Project Supervision Consultant	60,000 archaeological conservation
Road Safety: The increased construction traffic may lead to high levels of road traffic accidents, During construction, the	Construction	▪ support shall be given to road safety enhancement activities during construction phase such as speed limit signs, warning signs to motorists on construction and replacement of clear road signs	▪ Project Contractor ▪ NEC	10,000 for road safety
Security enhancement: Some sections of the route are remote and would therefore expose the project and construction staff to security risks	Pre-Construction /Construction	▪ Support shall be given to national security wings to provide adequate security during construction	▪ NEC ▪ National Security	80,000 allowances for security officers

Note:

EEHC in this EMP refers to the Environmental Coordination Staff who will be designated by EEHC

11 ENVIRONMENTAL MONITORING PLAN

11.1 INTRODUCTION

Environmental monitoring is an essential component of project implementation. It facilitates and ensures the follow-up of the implementation of the proposed mitigation measures, as they are required. It helps to detect possible environmental hazards and/or detect unpredicted impacts over time. Monitoring includes:

- Visual observations;
- Selection of environmental parameters at specific locations;
- Sampling and regular testing of these parameters.

Monitoring should be undertaken at a number of levels. Firstly, it should be undertaken by the Contractor at work sites during construction, under the direction and guidance of the Supervision Consultant who is responsible to ensure the contractor abided by the EMP. At another level is the overall monitoring by the Environmental Coordination Units of the implementing agencies (EEPCO, NEC and EEH) in the three countries. The main project staff responsible for this monitoring plan are the Environmental Coordination Units' Staff assigned to the project.

The purpose of the environmental monitoring program is to ensure that the envisaged outcome of the Project is achieved and results in the desired benefits to Ethiopia, Sudan and Egypt. To ensure the effective implementation of the EMP it is essential that an effective monitoring program be designed and carried out. The environmental monitoring program provides such information on which management decisions may be taken during construction and operational phases. It provides the basis for evaluating the efficiency of mitigation and enhancement measures and suggests further actions that need to be taken to achieve the desired Project outcomes. An environmental monitoring program is outlined in Table.

On the other hand the National Environmental Authorities shall be responsible for reviewing the quarterly environmental monitoring reports that shall be submitted to the Implementing Agencies.

The aspects presented below shall comprise the key monitoring aspects.

11.2 WATER QUALITY MONITORING

Construction camps are often a source of significant surface and groundwater pollution if not managed and sited properly. It is recommended therefore that monitoring of any effluent, waste water, or rainfall runoff discharged from campsites will be undertaken. This would encourage the Contractor to implement proper wastewater treatment facilities on site through the use of settling and treatment ponds.

The parameters to be analysed should include the following:

- pH
- EC
- SS

- Turbidity
- Colour
- NH4+
- NO3-
- Total P
- Fe
- Al
- DO
- BOD
- Grease and oil
- Total coliform

If the discharged effluent does not meet the Ethiopian, Sudanese and Egyptian Water quality standards, then the Contractor must take further treatment measures or refrain from discharging effluent directly into nearby watercourses.

In addition, general monitoring of sediment loads in the streams close to construction sites should be monitored during the rainy seasons. This will assist in detecting levels of erosion that may be attributed to the construction activities of the project.

11.3 NOISE LEVELS MONITORING

Although noise during construction is not expected to be a significant problem attributed to the Project, periodic sampling of Contractor equipment and at work sites should be undertaken to confirm that they do not cause excessive noise. Noise level monitoring would be supplemented by consulting with Project Affected People to identify the level of noise and the level of monitoring required.

11.4 SOIL EROSION MONITORING

The excavation of earth for the construction of towers, temporary and permanent access roads, work camps and storage facilities will exacerbate soil erosion. It will, therefore, be the responsibility of the Contractor to ensure the implementation and effectiveness of erosion control measures. Focus should be given to work sites where soil is disturbed and its immediate environ as well as along the ROW during and after vegetation clearing.

11.5 MONITORING OF VEGETATION CLEARING

The Environmental Coordination Unit Staff shall closely monitor the adherence to procedure for clearing by the Contractor. The unique trees marked out for preservation shall be monitored to ensure preservation during the construction period.

11.6 MONITORING REHABILITATION OF WORK SITES

The Environmental Coordination Unit Staff shall closely monitor the rehabilitation of camp sites and other work sites to ensure that the Contractor undertakes the recommended mitigation measures for all work sites upon completion of works. Once a site is rehabilitated it should be “signed off” by The Environmental Coordination Units’ Staff.

11.7 MONITORING OF ACCIDENTS/HEALTH

The Environmental Coordination Unit Staff shall monitor that the Contractor has made appropriate signs and posted them at appropriate locations on access roads and on towers and substations to minimise/eliminate risk of electrocutions. In addition the Environmental Coordination Unit Staff shall monitor that:

- Measures to create awareness regarding sexually transmitted diseases, primarily HIV/AIDS, and other diseases such as malaria are taken;
- Preventive measures to reduce/eliminate malarial and other infections where ever appropriate are put in place;
- Periodic health surveys are carried out along the transmission route;

EEPCO, NEC and EEH through the Environmental Coordination Units Staff will have overall responsibility to oversee that all environmental measures are put in place and that regulations are enforced. The Construction Supervision Consultant should assist EEPCO, NEC and EEH in this process in order to make sure that contractors fulfil the environmental requirements.

The following parameters could be used as indicators:

- Presence of posted clearly visible signs on road sides, towers and substations;
- Presence of adequate sanitary facilities at campsites;
- Level of awareness of protection and prevention among local people on the sexually transmitted diseases;
- Level of awareness of communities pertaining to dangers/risks associated with power lines;
- Presence/absence of unique stands of indigenous trees along the power line establishment route; and
- Accident reports. Records on actual accidents associated with the establishment of the transmission line could be compiled with the help of local peasant association officials, teachers/students of local schools.

11.8 ENVIRONMENTAL MONITORING REPORTING

The Environmental Coordination Units Staff shall prepare comprehensive quarterly environmental monitoring reports. The reports shall be submitted to the implementation Agencies and the Environmental Authorities for review. The Supervising Consultant shall present the reports to the Contractors to enhance their efforts in implementation of the project EMP.

The reports shall form an important basis for the end of project environmental auditing procedure.

11.9 COST OF MONITORING PROGRAMME

The environmental monitoring shall be funded as part of the support to the Environmental Coordination Units for the three countries. An amount of US$ 350,000 is estimated as part of Section 13 to cover the cost of monitoring. The monitoring costs comprises: monitoring of construction work; socio-economic monitoring; and water quality monitoring. To enhance the capacity of stakeholder institutions to be able to undertake monitoring, a programme for capacity building is proposed. The main environmental aspects to be monitored and the agencies responsible are outlined in table below. The break down of monitoring activities and costs per country is as outlined in Table below.

Table 56 : Environmental Monitoring Plan Aspects and Parameters

Environment Component	Project Stage	Parameter to monitor	Standard	Location	Frequency	Implementation
Land Acquisition and Compensation	Pre-construction	Ensure compensation paid as per RAP	RAP	Along ROW for all RAPs	Monthly until complete	EEPCO/NEC/EEHC
Water Quality	Construction	pH, EC, SS, turbidity, colour, NH4+, NO3-, total P, Fe, Al, DO, BOD, grease & oil, total coli form	EPA guidelines for Ethiopia, Sudan & Egypt	Construction Camps	Monthly during operation of camp	EEPCO/NEC/EEHC
Noise Levels	Construction	Noise levels on dB (A) scale	EPA guidelines for Ethiopia, Sudan & Egypt	At equipment yards	Monthly as required by Supervision Consultant	EEPCO/NEC/EEHC
		Noise levels on dB (A) scale	EPA guidelines for Ethiopia, Sudan & Egypt	Noise level metre kept at a distance of 15m from edge of ROW	As directed by the Supervision Consultant	EEPCO/NEC/EEHC
Soil Erosion	Construction	Turbidity in storm water	EPA guidelines for Ethiopia, Sudan & Egypt	As identified by NEC/EEPCO/EEH	Pre-monsoon and post monsoon seasons	EEPCO/NEC/EEHC
Vegetation Clearing	Construction	Monitor clearing to ensure consistent with EMP	EMP	Along ROW and works areas	As required	EEPCO/NEC/EEHC
Rehabilitation of Work Sites	Construction	Monitoring to ensure all work sites are progressively rehabilitated	EMP	Work camps, material storage sites, along ROW	As required	EEPCO/NEC/EEHC
Health	Construction	Signs, posters displayed, health awareness lectures, mosquito nets in malarial areas for each worker, health checks for workers	EMP	Along ROW, work camps and surrounding areas	Monthly	EEPCO/NEC/EEHC
Accidents	Construction	Safety training for workers, accident reports, community consultation	EMP	Along ROW	Monthly	EEPCO/NEC/EEH

Table 57 : Cost of undertaking the Environmental Monitoring Plan

Environmental Aspects	Monitoring Activity	Frequency	Cost per Country (US$)	Total Cost (US$)
General Environmental Monitoring of Construction	-Adherence to set code of conduct -Location of camp sites -Vegetation clearing -Pollution prevention measures -Waste management -Soil erosion aspects -Site rehabilitation -health and safety aspects	Continuous throughout the construction period – this will be the main task of Environmental Coordination Unit Staff, the work will be on full time basis in close collaboration with the Supervising Consultant	Ethiopia – 50,000 Sudan – 110,000 Egypt – 65,000	225,000
Socio-economic Monitoring - resettlement	-Compensation process monitoring -Coordination of local committees and valuation of structures and other items to be affected by the project -Ensure adequate compensation is paid	Pre-construction activities, to be undertaken before commencement of construction activities	Ethiopia – 15,000 Sudan - 50,000 Egypt – 50,000	115,000
Water Quality Monitoring	-Establishment of monitoring points -Ensure water quality samples are taken on specified parameters -Analyse trends of water quality results	- Monthly samples during the construction phase near construction sites close to river systems	Ethiopia – 5,000 Sudan – 5,000	10,000
			TOTAL	**350,000**

12 INTERAGENCY/ PUBLIC/ NGO INVOLVEMENT IN THE ESIA PROCESS

This section gives highlights on a key aspect in the ESIA process, the public consultation and participation. Though there was limited time and budget on undertaking a detailed RAP process, the teams were encouraged to ensure a reasonable level of public consultation and participation was incorporated in the field data collection process. It is recommended that a detailed RAP process be undertaken in the next phase of the project, this will facilitate adequate public consultation and participation. The public consultation and participation aspect was undertaken to ensure verification of baseline information and getting the views of the stakeholders on the various aspects of the project. The public consultation / participation process was used to disseminate information on the project in order to raise the project awareness for the people and regions directly affected by the proposed project. The public consultation is also referred to as stakeholder consultation.

The presentation is done according to the consultations undertaken in the member countries, being Ethiopia, Sudan and Egypt. At the end of this section are appendices giving the list of people and institutions consulted and the notes and minutes of the discussions.

12.1 STAKEHOLDER CONSULTATION IN ETHIOPIA

Public consultation was conducted with various stakeholders at regional and woreda (Sub-regional) level administration including all major sectors. The consultation focused on environmental and social impact caused by the transmission line route corridor of Ethiopia-Sudan-Egypt Interconnection. The public consultation conducted and the inputs from the participants are summarized in the following sections.

An ESIA team consisting of an environmentalist, a socio-economist, transmission engineer and a surveyor visited the Benishangul Gumuz Regional State and four Woredas where the Transmission Line Route Corridor of Ethiopia-Sudan-Egypt Interconnection passes, during the month of July 2008. Refer to Appendix E for the list of people and institutions consulted and Appendix H for notes and minutes of discussions for the various groups of stakeholders consulted.

12.1.1 PUBLIC PARTICIPATION

The team had consulted the communities of the affected people, elders, Kebele officials, Woreda officials, and representatives of public and private institutions, women and dwellers of the area as well as individuals. Refer to figure 12.1 of one of the discussion meetings with the local people in the areas along the route corridor of the proposed line.

The communities participated in the discussion and indicated that they were happy about the proposed development taking place in their area. It was also emphasised that they expected the compensation, safeguard and livelihood improvement projects together with other proposed environmental mitigation measures that would be undertaken by the project proponents will guarantee a better life for the communities along the route corridor.

They expressed that in addition, they expected provision of job opportunities for their young people, investment attraction initiated by the project and the development of many small businesses following the development of the area which will lead to a marked positive change in their lives.

Figure 61 : Public Consultation Meetings in Oda Godere Woreda Area

12.1.2 CONSULTATIONS WITH AUTHORITIES

The ESIA team visited many government offices, NGO and private institutions in the Benishangul Gumuz Regional State to discussed the project and obtain feed back for the concerned authorities and key personnel including experts. Refer to next figure of some of the participants in the Benishangul Gumuz Regional Head Quarters at Asosa.

The team explained to the authorities regarding its mission and briefed him about the proposed electric transmission line from Mandaya-Ethiopia to the Sudan and Egypt as well as the possible impacts of the project. Finally the team asked the opinion of the authorities and their views are summarized as follows.

The first public institution visited was the Regional President office. The team discussed about Ethio-Sudan Transmission Line with Ato Yaregal Asheshim, the president and Ato Kinde Haile, advisor to the president on July 14, 2008 at 8:30 am in the morning. Then the team visited BoFED, BoARD, Regional EPA, Women's Affair Office, Health Bureau, Education Bureau, HIV Secretariat, IRC (relief organization), Land and Sea Development (private investor) and Women's Professional Association.

Figure 62 : Regional Public Consultation in Benishangul Gumuz Regional State

12.1.2.1 General views on the negative impacts of the proposed project

The authorities have concerns that the project can displace some people and could damage the natural environment. It can also cause the loss of public and private properties. The line corridor can affect infrastructure (mainly roads) as well as cultural and historical places such as archaeological sites, hot springs in Boka.

But as long as proper compensation is paid displaced people could be resettled in the vicinity of their residence since there is no land problem in Benishangul Gumuz. Land can be made available to affected people for both their agriculture and to build their houses. The concerned authorities promised to cooperate and facilitate the required land.

The authorities also said that maximum attention should be paid for the irreplaceable archaeological and historical resources as well as for endemic natural habitat. The line corridor should avoid such sites.

12.1.2.2 General views on the positive impacts of the proposed project

The authorities also emphasized that although the project may have very minimal negative impacts that are possible of mitigation, it has immense benefits to the Eastern Nile Region, the Country, Benishangul Gumuz, and to the Woredas of project influence area.

In summary the project is expected to bring the following benefits.

(1) Improve eco-tourism,

(2) Eliminates power shortage in the area and hence attracts investments,

(3) Create job opportunities because of the economic development induced by the power system developed and the construction of the line,

(4) Marble and other investment will not face energy problem in the future

(5) Brings growth in the region

(6) Creates opportunity for fishing industry and expands fishing activity (when dam is built)

(7) Creates awareness among the communities about development as well as the need to change their life style and

(8) Establish healthy cooperation among the three eastern Nile Region Countries.

12.2 STAKEHOLDER CONSULTATION AND PARTICIPATION IN SUDAN

Stakeholder consultation and participation was the key way used in ensuring reliable data and information collection and verification for the proposed route corridor. The transmission planning staff of the National Electricity Corporation were key in the preferred route selection within Sudan. This was done to ensure the proposed project fits in well with the future plans of transmission expansion for Sudan. Therefore the NEC team was at hand to accompany the EDF/Scott Wilson team in the key sections on the route that needed verification such as the White Nile crossing, the Substation location at Kosti and the route from Kosti to North Khartoum.

The key personnel in the NEC were also consulted on various aspects related to the proposed project and key aspects for consideration during project development. Figure shows the NEC officials consulting with EDF staff on the preferred route at Ed Dueim town.

The professional team of the Local Consultant YAM consulted a wide range of stakeholders. Those interviewed included ordinary inhabitants of areas along the proposed line route, herders, farmers, government officials and regional local government officials. The list of people consulted during field data collection is outlined in Appendix F.

The general views of the stakeholders were that the project information should be made available to all stakeholders and a system of reporting back and keeping the stakeholders aware should be initiated to ensure sufficiently high project awareness among all the key stakeholders.

On the other hand the stakeholders consulted expressed optimism that the project will result into economic benefits for the country.

Figure 63 : Field Consultations with the NEC Officials for Route Selection

12.3 STAKEHOLDER CONSULTATION AND PARTICIPATION IN EGYPT

The Scott Wilson Staff and the local consultant (EPS) undertook stakeholder consultation within the key institutions and organisations. The general views from the institutions visited were as presented below. Refer to Appendix G for the list people and institutions consulted and Appendix I for the notes and minutes of discussions.

12.3.1 MAIN POWER SECTOR (EEHC)

The various senior Officials who were consulted pointed out that they did not expect major negative impacts to result from the proposed project which may be a cause for serious concert from the institution that is mandated to manage all aspects of electricity in Egypt. The Officials indicated that the nature of impacts of transmission line may not call for objections like other projects, but that it was important to insure the recommended clearances as stipulated in the law are adhered to. This would ensure protection of the power lines and the people.

Figure 64 : Discussion EEHC Staff at Nag Hammadi Substation

12.3.2 GOVERNORATE OF QENA

The Scott Wilson and EPS team gave a brief on the Eastern Nile Power Project. His Excellency the Governor had no objection to carry the implementation of the project and recommended that there was need to get approval from the Ministry of Housing, Utilities and New Communities for the line route before commencement of construction, to ensure that there is no conflict with future development plans.

Figure 65 : Discussion with HE Governor of Qena

Figure 66 : Some Qena Local Authority Staff who attended the Consultative Meeting

12.3.3 SOUTH VALLEY UNIVERSITY

The consultation was made with the Head of the University and he expressed delight that the team had made an effort to make consultation with the institution. He indicated that the institution was a depository of important information related to the baseline of the proposed route corridor. He further expressed interested to help and participate in the future phases of the study.

12.3.4 ENVIRONMENTAL SECTOR AT ASWAN

The Environmental Office Officials emphasized on the important of environmental studies for the project and its impacts on air quality, water quality and population aspects along the route of the proposed transmission line. They therefore recommended that good baseline information on air quality should be generated to ensure that the likely impacts arising from the transmission line would be isolated. This would call for monitoring programmes during the construction phase of the project. Refer to figure showing some of the staff at the Aswan Office of the Environmental Agency.

Figure 67: Environmental Agency Staff at Aswan

The list of people consulted and the minutes of meeting with the above stakeholders are in presented in Appendix I.

13 COST ESTIMATES FOR ENVIRONMENTAL MITIGATION, ENHANCEMENT AND MONITORING

13.1 INTRODUCTION

Section 13 provides an opportunity for costing of the proposed environmental and social mitigation and enhancement measures to ensure that the recommendations are duly funded and can therefore be implemented as part of the project. Attached to the environmental management is a comprehensive environmental monitoring programme.

It should however be stressed that the following costings are essentially indicative and may be subject to change. In particular, it should be noted that this study has not included the detailed Resettlement Action Plans which would normally be undertaken nearer to project implementation. As a result, many of the costs indicated below will require confirmation or revision in due course.

The total indicative environmental cost given in this section is what is attributed to environmental and social management for the project. The forecast cost of US$ 22,239,413.00 represents a significant percentage of the total project cost and should of necessity be treated as part of the total eventual project cost. A 10 percent contingency is added to take care of any cost escalation or change in cost of recommended mitigation measures. The indicative environmental cost is presented according to the countries giving a grand total to represent the total environmental cost associated to the project.

13.2 ENVIRONMENTAL AND SOCIAL MITIGATION AND ENHANCEMENT MEASURES

There are a number of mitigation and enhancement measures recommended in this report. There are some measures that do not need separate costing but will be incorporated in the project implementation. Measures such as employment of local people along the route corridor and procurement of building materials within the project areas would ensure benefits accrue to the local communities by taking deliberate measures during the implementation periods. However, there are some mitigation and enhancement measures that would need to be specifically funded for implementation; these are the measures that are reflected in this section and have been costed accordingly. These aspects include:

- Compensation and resettlement
- Livelihood enhancement programmes
- Public health (workers and local people) enhancement programmes
- Vegetation restoration and replanting programmes
- Soils conservation and erosion prevention measures
- Institutional capacity building
- Community benefit programmes
- Community Health and environmental awareness programmes.

13.3 ENVIRONMENTAL MONITORING

Environmental Monitoring is a key component of the Environmental Management Plan of the Project. Environmental aspects of the existing baseline would form the important basis for monitoring during the implementation of the project. An essential element of monitoring is the capacity building of the institutions that would be required to undertake this important task. This includes human capacity building, relevant equipment provision and operational support during the project implementation period. Defining the key environmental and social parameters which have to be monitored will ensure that the contractors adhere to the recommendations of this report and will therefore be a key indication of sufficient success of the environmental programme. The following parameters would have to be monitored:

- Adequate compensation and efficient implementation of resettlement programmes
- Capacity building of relevant agencies
- Water quality of the rivers and streams within the route and project sites
- Sedimentation and erosion levels
- Noise levels
- Traffic incidences where the construction machinery will use the same existing roads as access roads
- Vegetation clearance and re-vegetation aspects
- Public health and disease occurrences
- Project awareness and acceptance levels
- Incidence and progress reporting levels to relevant agencies
- Road safety aspects
- River crossing areas and all mitigation measures associated with the areas

13.4 ENVIRONMENTAL AUDIT

In addition to routine, periodic environmental monitoring, environmental audits should be undertaken by an independent entity within the first three months of commissioning of the project. The environmental audit will seek to provide answers on whether the environmental management plan has been adequately implemented. The audit report shall be submitted to relevant authorities in each country.

13.5 THE ETHIOPIA SECTION

Information obtained during the site visit and relevant data at regional and federal level are the basis for estimating compensation for the power transmission line proposed.

The environmental cost estimates address the indicative costs that are related to compensation of the physical, biological and socio-economic negative impacts that will take place during the project's construction and operation. Moreover indicative costs for livelihood safeguards, replanting, community gain as well as environmental management and monitoring costs are included. The costs are summarized in USD as shown in tables 13.1 and 13.2 below. The following aspects have been considered in coming up with the environmental cost for the Ethiopian section:

(1) *Compensation for permanent loss of agricultural land:* Compensation for land that will be permanently taken up by tower base areas and substations. It is estimated that 6 ha will be taken up for construction of the substation and another 6 ha will be taken up by tower base areas. The estimated cost is calculated as 12 ha X US$5,000 =. US$60,000. The indicative value of US$5,000 is used for estimate purposes only as the value of land may be different due to differences in existing land use and other prevailing conditions at the time of compensation. These values will be refined when the RAP and assessments are done at a later stage of the project.

(2) *Compensation or Annual Crops:* Compensation for lost rain-fed production from arable land (maize and sorghum are the dominant crops under rain-fed farming) in tower construction areas, access roads and other project works. This compensation would be given to cover the first two years of construction phase. It is anticipated that after construction, farmers would be able to use the wayleave for limited agricultural purposes. The loss of cropping along the line routes will not be permanent, except for the very small cumulative area occupied by towers and access roads. The total crop land lost by the project is estimated to be 573.1 ha, that includes permanent and temporary loss. The temporary loss is calculated for a maximum of two years and the total 547.1 ha. Crop yield estimated at US$1,021,610.

Table 58 : Estimated compensation for crops

Crops	Crops %	Crops ha	Productivity (Tons/ha)	Total Crop (Tons)	Av. Cost/T US$ 2007/8	Total cost (I Yr)	2 YEARS
Maize	40	218.84	20.14	4,407.44	52	229,186.88	458,373.76
Sorghum	30	164.13	12.8	2,100.86	52	109,244.72	218,489.44
Sesame	30	164.13	6.74	1,106.24	156	172,373.44	344,746.88
Total		**547.1**				**510,805.04**	**1,021,610.08**

(3) *Compensation for Fruit trees*: Compensation cost for fruit trees lost during construction and operation. The project may cause the loss of 47.26 hectares of fruit trees, mainly mango. It is estimated that there would be 200 fruit (Mango) trees per hectare (200 trees x 47.26 ha = 9,452 trees) so that compensation value is estimated at US$414 per tree x 9, 452 trees = US$3,913,128 in total

(4) *Compensation for houses:* Cost of replacing houses lost due to the transmission line corridor in Ethiopia. From the population density of the route corridor, it is estimated that 54 households live within the ROW and each household has 3 house structures and

therefore about 164 structures will be affected. Estimated average cost of house structure will be US$3,500 which will work out to an indicative total of US$574,000.

(5) *Implementation of livelihood safeguard program:* Cost of income generation projects introduced to ensure that directly affected people and communities are not disadvantaged by the project and have access to viable income generating opportunities in the resettlement areas. This consists of a grant to facilitate the setting up and initiating of various income-generating projects which will be decided by the communities themselves. The estimate can be broken down as follows: Small scale entrepreneur machinery such as sewing machines, carpentry equipment, grinding mills, housing structures estimated at US$440,000 with support for construction and operating costs estimated at a total of US$100,000

(6) *Health Centre (health personnel and associated employees):* Contribution to upgrading health facilities to benefit local project employees, their families and other local people. This is separate from the contractor's obligations and will help counteract any likely health problems associated with the construction workforce. A health awareness campaign (focusing on HIV, STDs or other transmittable diseases) should be initiated, free condom distribution to workers, voluntary testing and counselling would be part of the cost.

The estimated cost would be broken down as follows: Capital costs for a vehicle at US$35,000; tents at US$10,000 and basic equipment and facilities at US$5,000 (amount to US$50,000). In addition, there will be support to the Regional HIV AIDS institution in allowances for field workers - US$5,000 on annual basis for three years; Funding of Regional Health team to undertaken awareness for the Project workers and the local communities along the route (team of three for 30 days at US$ 65 per day = US$5,850); Support to Regional HIV/AIDS institution for setting up of VCT at construction sites (provide allowances for teams of two Staff for 90 days at beginning of construction at US$65 per day = US$11,700); vehicle running costs estimated at US$10,000 (Amount to US$27,550 is estimated as running costs)

(7) *Replanting:* Cost of replanting and restoring areas disturbed by construction activities and ensuring that woody biomass is replaced where possible (focus will be given to restore vegetation species that have significant ecological and economic importance) It is estimated that 1,210 ha of forested areas would be cleared as part of the ROW. However through Community and local schools' support nurseries shall be raised to progressively replant some degraded areas at compensation. In this program 50,000 trees are expected to be planted at an indicative cost of US$3 per tree.

(8) *Generic Best Management Practices for Disturbed Area:* Remediation of areas disturbed/contaminated by construction activities, including locations exposed to increased risk of erosion, over and above responsibilities of the contractor. (Primarily focus on conservation oriented construction; physical conservation may be included as required). Nominal value of US$50,000 indicated.

(9) *Water Quality Monitoring:* Cost of checking water quality in the project area over and above the contractor's obligations. These shall be done on a monthly basis for three years at a cost of US$150 per month for reagents in the portable lab which will be procured as part of institutional support to the Environmental Coordination Units (36 months x US$150 = US$5,400)

(10) *Monitoring of Construction Work:* Monitoring/auditing construction and adherence to the ESMPs. The running costs of the Environmental Coordination Unit for three years and vehicles and equipment are covered under the institutional capacity building component. This component relates to specific monitoring structures and equipment that will be required as issues arise such as erosion monitoring, noise monitoring, forests and forestry products management. The indicative total amount of US$50,000 also covers funding for any expert consultation where the particular expertise needed for assessment is not available among the Environmental Coordination Staff (such as agricultural expertise).

(11) *Socio-Economic Monitoring:* Cost of ensuring effective implementation of the livelihood safeguard program and providing services to redress grievances; cost of monitoring disbursements under the compensation / mitigation program and the health status of the local community. Coordination of compensation committee established to process compensation will be covered under this component. A team of 10 regional officials and local communities' representative will be supported in terms of travel costs, allowances and meetings facilitation. An estimated amount of US$15,000 to cover this component is indicated.

(12) *Institutional Capacity Building Program:* Institutional capacity building for local institutions to cope with the modalities of a large construction project in their locality and support to national agencies responsible for advising on and inspecting aspects of implementation including environmental mitigation activities. The environmental management units responsible for management and monitoring of the mitigation measures lack the capacity to discharge their duties effectively, therefore dedicated transport would be provided and limited operational costs met to ensure they provide the required support to the project during the implementation period. These include the Units in EEPCO, BGNRS EPA, Health Bureau, Road Authority of BGNRS. Key components under capacity building would include: training, transport, basic monitoring equipment.

Monthly operating costs (allowances at US$50 per day for 20 days of each month for three years (5 Staff x US$55 x 20 days = US$5,500 per month)) for the establishment of a unit with 1 Environmentalists, 1 Forester, 2 Social Scientists, 1 Environmental Health Specialist, were estimated at US$ 5,500 per month for three years (US$5,500 x 36 months = US$198,000). An additional US$ 2,000 per month will be required for service of vehicles and fuel (2,000 x 36 months = US$72,000). Total estimated Environmental coordination Unit operating costs for three years is US$270,000. Additional funds would be required to establish field equipment and other materials.

Field equipment required: 2 vehicles at US$ 35,000 each; portable water quality lab. at US$ 10,000; 5 GPS at US$1,000 each, other necessary equipment (computers, printers, photocopiers. cameras and recorders) estimated at US$20,000, short term training in environmental monitoring at US$ 15,000. Field equipment and training is estimated at US$120,000

(13) *Community Gain:* As part of the resettlement programmes, contribution to health, water supply, sanitation, schools/education and veterinary services. Specific services and activities will be decided by the Local authorities and affected people. At this stage, a rough estimate of the fund required is made, however details of how the fund will be used will be determined during the RAP process. Estimate provided is meant to cover the following:

- support to health institutions of a grant of US$15,000 per year for 3 years = US$45,000,
- drilling of 15 boreholes at US$ 3,000 each = US$45,000,
- grant of US$5,000 to 10 local schools = US$50,000,
- grant of US$10,000 to provision of veterinary services support in three districts = US$30,000
- grant related to agricultural support to disturbed farmers (seed and fertiliser) for two years at US$30,000 per year = US$60,000
- (Community gain total = US$230,000)

(14) *Road Safety:* Support to road safety enhancement activities during construction phase such as speed limit signs, warning signs to motorists on construction and replacement of clear road signs. Nominal value US$5,000.

(15) *Post Construction Environmental Audit*: One time cost of checking the construction site remediation after the contractor has left (final payment of contractor will be tied to a successful audit inspection). This is a key activity to ensure aspects of ESMP are implemented adequately during project implementation. (This is a 10 man-day assignment at US$ 500 per man-day = US$5,000).

Table 59 : Summary of Cost Estimate of the Environmental and Social Mitigation Measures (Ethiopia)				
No.	**Item**	**Capital Cost (USD)**	**Recurrent Cost (USD)**	
			Construction Phase	**Operation Phase**
1	Compensation for permanent loss of agricultural land	60,000		
2	Compensation for annual crop	1,021,610		
3	Compensation for Fruit Trees	3,913,128		
4	Compensation for houses	574,000		
5	Implementation of livelihood safeguard program	440,000	50,000	50,000
6	Health centre (project employees & locals)	50,000	27,550	
7	Replanting	150,000		
8	Generic BMP for disturbed areas	50,000		
9	Water quality monitoring		5,400	
10	Monitoring of construction work	10,000	40,000	
11	Socio-Economic Monitoring (resettlement)		15,000	
12	Institutional capacity building program	120,000	260,000	10,000
13	Community gain (Social Service Proposed)	95,000	125,000	10,000
14	Road Safety Enhancement measures		5,000	
15	Construction Phase Environmental Audit		5,000	
Sub Totals		6,483,738	532,950	70,000
Contingency (10 %)		648,374	53,295	7,000
TOTAL		7,132,112	586,245	77,000
Grand Total (USD)				**7,795,357**

13.6 THE SUDAN SECTION

The Sudan route corridor is the longest section of the power line and traverses three different types of terrain with different mitigation and enhancement aspects. The three types of environmental conditions are:

- Open forests with grassland and scattered agricultural fields - Ethiopia/Sudan Border to Damazin.
- Fertile flood plain grassland with agriculture - Damazin to Kosti and Kosti to North of Khartoum.
- Open Desert terrain - North of Khartoum to Egyptian Border.

The section of the route with open forest with grassland and scattered agriculture will mainly require mitigation related to clearing of forests, compensation of fruit trees and agricultural crops, household structures and measures related to increase in traffic on the rural roads which will be used as access roads during the construction.

The section of the route with fertile flood plain grassland and agriculture has a higher population and large village establishments which will require more compensation on the village structures, agricultural crops, fruit trees, road safety aspects and livelihood enhancements for some affected communities.

The section with open desert terrain is sparsely populated, the desert communities exist at scattered intervals, provision of critical requirements for some communities such as the water supply should be considered as some have to walk very long distances to fetch water. The area is also very rich with cultural and archaeological relics; therefore there will be need for close monitoring by an archaeologist during the construction period. In the event that any artefacts are discovered, rescue and preservation will be required.

The indicative environmental cost estimates for the Sudan section therefore address the costs that are related to compensation of the physical, biological, socio-economic, cultural archeological impacts that will take place during the project's construction phase. In addition, costs for livelihood safeguards, replanting, community gain, monitoring and environmental auditing costs are included. The costs are summarized as shown in tables 13.3 and 13.4. The following aspects will contribute to the environmental cost within the route corridor of the project in Sudan:

(1) *Compensation for permanent loss of agricultural land*: Compensation for land that will be permanently taken up by tower base areas and substations. It is estimated that 7 ha will be taken up for construction of the substation at Kosti and another 38 ha will be taken up by tower base areas. The estimated cost would be 45 ha X US$5,000 =. US$225,000. The value of US$5,000 is used for estimate purposes only as the value of land may be different due to differences in existing land use and other prevailing conditions. This figure will be refined when the definitive RAP and assessments are done at a later stage of the project.

(2) *Compensation or Annual Crops*: Compensation for lost agricultural production from arable land in tower construction areas, access roads and other construction works. This compensation would be given to cover the first two years of construction phase. It is anticipated that after construction, farmers would be able to use the wayleave for limited

agricultural purposes. The loss of cropping along the line routes will not be permanent, except for the very small cumulative area occupied by towers and access roads which will be compensated under permanent loss of land. The total crop land lost by the project is estimated to be 3,500 ha. The temporary loss is calculated for a maximum of two years and the total 3,455 ha. Crop yield estimated at US$ 5,654,260 as shown below:

Table 60 : Estimated compensation for crops

Crops	Crops %	Crops ha	Productivity (Tons/ha)	Total Crop (Tons)	Av. Cost/T US$ 2007/8	Total cost (I Yr)	2 YEARS
Maize	40	1,382	20.14	27,833.48	52	1,447,340.96	2,894,681.92
Sorghum	60	2,073	12.8	26,534.40	52	1,379,788.80	2,759,577.60
Total		**3,455**				**2,827,129.76**	**5,654,259.52**

(3) *Compensation for Fruit trees*: Compensation cost for fruit trees lost during construction and operation. The project is estimated to cause a loss of 500 hectares of fruit trees, mainly mangoes trees and date palm trees. It is estimated that there would be 10 fruit trees per hectare (10 trees x 500 ha = 5,000 trees. Compensation estimated at US$382 per tree x 5,000 trees.

(4) *Compensation for household structures*: Cost of replacing houses which fall within the transmission line corridor in Sudan. From field observations, it is estimated that 100 households live within the ROW (area from Ethiopian Border to North of Khartoum). With average of 3 houses per household and the estimated average value per house is US$4,000. Estimate for compensation is therefore 300 houses x US$4,500 = US$1,350,000

(5) *Implementation of livelihood enhancement programs*: Cost of implementation of community livelihood enhancement programmes such as support to agricultural production and water supply aspects to directly affected people and communities. This is a grant to facilitate the setting up and initiating of various income generating projects which will be decided by the communities themselves. The estimate can be broken down as follows: Small scale entrepreneur machinery such as sewing machines, carpentry equipment, grinding mills, housing structures estimated at US$500,000 with support to operating costs estimated as a total of US$100,000.

(6) *Health Centre* (support to health personnel and associated employees): Contribution to upgrading health facilities for local project employees, their families and other local people. Health mitigation for both project staff and local people along the route corridor to counteract the likely health problems associated with the construction workforce. Health awareness campaigns (focusing on HIV, STD's and any other transmittable diseases) should be initiated and voluntary HIV testing and counselling would be part of the cost.

The estimated cost would be broken down as follows: Capital costs for a vehicle at US$35,000; tents at US$10,000 and basic equipment and facilities at US$5,000 (amount to US$50,000). In addition, there will be support to the Regional HIV AIDS institution in allowances for field workers – c. US$5,000 on annual basis for three years; Funding of

Regional Health team to undertaken awareness for the Project workers and the local communities along the route (team of three for 30 days at US$ 65 per day = US$5,850); Support to Regional HIV/AIDS institutions for setting up of VCT at construction sites (provide allowances for teams of two Staff for 90 days at beginning of construction at US$65 per day = US$11,700); vehicle running costs estimated at US$10,000 (Amount of US$27,550 is estimated to cover running costs)

(7) *Replanting*: Cost of replanting areas disturbed and ensuring that woody biomass is replaced where possible (focus will be given to restore vegetation species that have significant ecological and economic importance). It is estimated that 2,000 ha of forested areas would be cleared as part of the ROW. However through Community and local schools' support nurseries shall be raised to progressively replant some degraded areas as compensation. In this program 50,000 trees are expected to be planted at a cost US$3 per tree.

(8) *Generic Best Management Practices for Disturbed Area*: Restoration and rehabilitation of areas disturbed by construction activities, including locations exposed to increased risk of erosion, over and above responsibilities of the contractor. (Primarily focus on conservation oriented construction; physical conservation may be included as required)

(9) *Water Quality Monitoring*: Cost of checking water quality in the project area over and above the contractor's obligations. Support to relevant environmental units in undertaking the water quality monitoring programme in the project area. These shall be done on a monthly basis for three years at a cost of US$150 per month for reagents in the portable lab which will be procured as part of institutional support to the Environmental Coordination Units (36 months x US$150 = US$5,400)

(10) *Monitoring of Construction Work*: Due to the length of the route, there would be need for more support to the Environmental Coordination Unit. Support will be given to the Environmental Coordinator Unit to undertake environmental monitoring of construction phase to ensure adherence to the recommended Environmental Mitigation and enhancement programmes.

The running costs of the Environmental Coordination Unit for three years and vehicles and equipment are covered under the Institutional capacity building component. This component relates to specific monitoring structures and equipment that will be required as issues arise such as erosion monitoring, noise monitoring, forests and forestry products management. This amount will also cover funding for any expert consultation where the particular expertise need for assessment is not available among the Environmental Coordination Staff such as agricultural expertise.

(11) *Socio-Economic Monitoring*: The Environmental Coordination Units will be responsible to ensure compensation procedures are followed and adequate compensation given to the people affected. Cost of ensuring effective implementation of the livelihood safeguard and enhancement program and providing services to redress grievances; cost of monitoring disbursements under the compensation/mitigation program and the health status of the local community. Coordination of compensation committee established to process compensation will be covered under this component. A team of 10 regional officials and local communities' representative will be supported in terms of travel costs, allowances and meetings facilitation. An estimated amount of US$50,000 to cover this component is given.

(12) *Cultural and Archaeological conservation measures*: The route corridor from Dongola to the Egyptian Border is rich in archaeological relics, therefore special care and monitoring will be required during construction phase. The presence of an archaeological expert will be required on site for the period of two years during construction. The amount provided for therefore will support the payment of allowances to the archaeologist and will also cover rescue and preservation activities for relics discovered during the construction works. The amount would also cover awareness campaign to the construction workers on identification of sites and artefacts. A dedicated vehicle will be required at US$35,000 and an amount of US$5,000 will be reserved for any relevant equipment required to support the monitoring. An amount of US$20,000 is estimated to cover allowances (1 Staff x US$65 per day x 15 days in a month x 24 months = US$23,400) and production of awareness materials at US$2,000.

(13) *Institutional Capacity Building Program*: Institutional capacity building for local institutions to cope with the modalities of a large construction project in their locality and support to national agencies responsible for advising on and inspecting aspects of implementation including environmental mitigation projects. The environmental management units responsible for management and monitoring of the mitigation measures lack the capacity to discharge their duties effectively, therefore dedicated transport would be provided and limited operational costs met to ensure they provide the required support to the project during the implementation period. These include the National Electricity Corporation (NEC), Local Authorities, health and agriculture.

Monthly operating costs (allowances at US$50 per day for 20 days of each month for three years (5 Staff x US$55 x 20 days = US 5,500 per month)) for the establishment of a unit with 1 Environmentalists, 1 Forester, 2 Social Scientists, 1 Environmental Health Specialist, were estimated at USD 5,500 per month for three years (US$5,500 x 36 months = US$198,000). An additional US$ 5,000 per month will be required for service of vehicles and fuel (US$5,000 x 36 months = US$180,000). Total estimated Environmental coordination Unit operating costs for three years is US$378,000. Additional funds would be required to establish field equipment and other materials.

Field equipment required: 2 vehicles at US$ 35,000 each; portable water quality lab. at US$ 10,000; 5 GPS at US$1,000 each, other necessary equipment (computers, printers, photocopiers. cameras and recorders) estimated at US$20,000, short term training in environmental monitoring at US$ 15,000. Field equipment and training is estimated at US$120,000

(14) *Community Gain*: As part of the resettlement programmes, contribution to health, water supply, sanitation, schools/education, and veterinary services. The particular services will be decided by the Local Authorities and the affected local people. Estimate provided is meant to cover the following:

- Support to health institutions of a grant of US$30,000 per year for 3 years = US$90,000,
- drilling of 30 boreholes at US$ 3,000 each = US$90,000,
- grant of US$5,000 to 15 local schools = US$75,000,
- grant of US$10,000 to provision of veterinary services support in four districts = US$40,000

- Grant related to agricultural support to disturbed farmers (seed and fertiliser) for two years at US$50,000 per year US$100,000
- (US$395,000)

(15) *Road Safety*: Support to road safety enhancement activities during construction phase such as speed limit signs, warning signs to motorists on construction and installation of clear road signs. Nominal value US$10,000

(16) *Security Measures*: There are some sections of the route corridor where the contractors and all the project staff would need special protection. The support should therefore be given to the national security wings to ensure that all project staff are protected and allowed to operate without security risk. This cost would cover minor operations support such as subsistence allowances to the assigned security teams. Estimated bases on 10 security Staff x US$50 per day x 20 days in a month x 36 months = US$360,000

(17) *Post Construction Environmental Audit*: This shall be undertaken by an independent consultant to ensure the recommended measures would be fully implemented and Environmental coordination adequately done and report shall be submitted to relevant stakeholders. This will be a one time cost of checking the construction phase of the project (final payment of contractor will be tied to a successful audit inspection). This is a 40 man day assignment at US$500 per man day = US$20,000.

Table 61 : Summary of Cost Estimate of the Environmental and Social Mitigation Measures (Sudan)

No.	Item	Capital Cost (USD)	Recurrent Cost (USD)	
			Construction Phase	Operation Phase
1	Compensation for permanent loss of agricultural land	225,000		
2	Compensation for annual crop	5,654,260		
3	Compensation for Fruit Trees	1,910,000		
4	Compensation for house structures	1,350,000		
5	Implementation of livelihood safeguard program	500,000	50,000	50,000
6	Health centre, awareness and care (project employees & locals)	50,000	27,550	
7	Replanting of trees	150,000		
8	Generic Best Management Practice for disturbed areas	50,000		
9	Water quality monitoring		5,400	
10	Monitoring of construction work, Environmental Coordination Unit	20,000	90,000	
11	Socio-Economic Monitoring (resettlement)		50,000	
12	Cultural and Archaeological conservation	40,000	25,400	
13	Institutional capacity building program	120,000	368,000	10,000
14	Community gain (Social Service Proposed)	165,000	230,000	
15	Road Safety enhancement (Signs and warnings)	10,000		
16	Security enhancement measures		360,000	
17	Post construction environmental audit		20,000	
Sub Totals		10,244,260	1,226,350	60,000
Contingency (10 %)		1,024,426	122,635	6,000
TOTAL		11,268,686	1,348,985	66,000
Grand Total (USD)				**12,683,671**

13.7 THE EGYPTIAN SECTION

The section of the route corridor in Egypt passes mainly through desert terrain with no settlements and no major human activities; however the route corridor does pass close to some communities that will need community assistance and enhancement programmes. Capacity building for monitoring would be of great benefit to the Governorates of Aswan and Qena. The route does pass within the planned agricultural development areas. In these areas compensation will be required in terms of loss of agricultural land, crops and a few structures. The areas are also very rich with cultural and archaeological relics; therefore there will be need for close monitoring by an archaeologist during the construction period. In the event that any artefacts are discovered, rescue and preservation will be required. Table below gives a breakdown of the environmental costs. The following aspects contribute to the environmental costs of the route corridor in Egypt:

(1) *Compensation for permanent loss of agricultural land*: Compensation related to the specific areas on agricultural land where towers will be constructed. This will also include costs related to lost production from arable land in construction areas, access roads and other works. This aspect is applicable in Nag Hammadi where the location of the substation is in the newly reclaimed desert land for agriculture and is estimated that 7 ha will be taken up and 2 ha will be taken up by the tower bases. The value of land is very high and it is estimated to be around US$10,000 per hectare in this area.

(2) *Compensation for houses and structures*: Cost of replacing houses which fall within the transmission line corridor in Egypt. This aspect is applicable in Nag Hammadi with the connection line between the proposed substation and the existing substation. For the ROW to be acquired, an estimated 10 houses will be affected and these are well constructed town structure which would have high replacement costs of US$15,000 to US$20,000.

(3) *Implementation of livelihood enhancement programs*: Cost of implementation of community livelihood enhancement programmes such as support to agricultural production for the communities near the route corridor. This is a grant to facilitate the setting up and initiating of various income generating projects which will be decided by the communities themselves. The estimate can be broken down as follows: Small scale entrepreneur machinery such as sewing machines, carpentry equipment, grinding mills, housing structures estimated at US$100,000 with support to operating costs estimated at US$10,000.

(4) *Health Centres* (support to health personnel and associated employees): Contribution to upgrading health facilities for local project employees, their families and other local people. Health mitigation for both project staff and local people along the route corridor to counteract the likely health problems associated with the construction workforce. Health awareness campaigns (focusing on HIV, STD’s and other transmittable diseases) should be initiated.

The estimated cost would be broken down as follows: Capital costs for a vehicle at US$35,000; tents at US$10,000 and basic equipment and facilities at US$5,000 (amount to US$50,000). In addition, there will be support to the Regional HIV AIDS institution in allowances for field workers - US$5,000 on annual basis for three years;

Funding of Regional Health team to undertaken awareness for the Project workers and the local communities along the route (team of three for 30 days at US$ 65 per day = US$5,850); Support to Regional HIV/AIDS institutions for setting up of VCT at construction sites (provide allowances for teams of two Staff for 90 days at beginning of construction at US$65 per day = US$11,700); vehicle running costs estimated at US$10,000 (Amount to US$27,550 is estimated to cover running costs)

(5) *Generic Best Management Practices for Disturbed Area*: Restoration and rehabilitation of areas disturbed by construction activities – nominal value of US$10,000

(6) *Monitoring of Construction Work*: The Environmental Coordination Unit will be in charge of monitoring of environmental aspects during construction phase Support will be given to the Environmental Coordinator Unit to undertake environmental monitoring of construction phase to ensure adherence to the recommended Environmental Mitigation and enhancement programmes.

The running costs of the Environmental Coordination Unit for three years and vehicles and equipment are covered under the institutional capacity building component. This component relates to specific monitoring structures and equipment that will be required as issues arise such as air/dust pollution monitoring, noise monitoring. The total amount of US$65,000 will also cover funding for any expert consultation where the particular expertise need for assessment is not available among the Environmental Coordination Staff such.

(7) *Socio-Economic Monitoring*: The Environmental Coordination Unit will be responsible to ensure compensation procedures are followed and adequate compensation given to the people affected. Cost of ensuring effective implementation of the livelihood safeguard and enhancement program and providing services to redress grievances; cost of monitoring disbursements under the compensation/mitigation program and the health status of the local community. Estimated total value of US$50,000

(8) *Cultural and Archaeological conservation measures*: The route corridor in Egyptian is rich in archaeological relics, therefore special care and monitoring will be required during construction phase of the project. The presence of an archaeological expert will be required on site for the period of two years during construction. The amount provided for therefore will support the payment of allowances to the archaeologist and will also cover rescue and preservation activities for relics discovered during the construction works. The amount would also cover awareness campaign to the construction workers on identification of sites and artefacts. A dedicated vehicle will be required at US$35,000 and an amount of 5,000 will be reserved for any relevant equipment required to support the monitoring. An amount of 23,400 is estimated to cover allowances (1 Staff x US$65 per day x 15 days in a month x 24 months = US$23,400) and production of awareness materials at US$2,000

(9) *Institutional Capacity Building Program*: Institutional capacity building for local institutions to cope with the modalities of a large construction project in their locality and support to national agencies responsible for advising on and inspecting aspects of implementation including environmental mitigation projects. The environmental management units responsible for management and monitoring of the mitigation measures lack the capacity to discharge their duties effectively, therefore dedicated transport would be provided and limited operational costs met to ensure they provide the required support to the project

during the implementation period. These include the Egyptian Electricity Holding Company (EEHC), Egyptian Electricity Transmission Company - Southern Area, Governorates of Aswan and Qena, Egyptian Environmental Affairs Agency.

Monthly operating costs (allowances at US$50 per day for 20 days of each month for three years (4 Staff x US$55 x 20 days = US 4,400 per month)) for the establishment of a unit with 1 Environmentalists, 2 Social Scientists, 1 Environmental Health Specialist, were estimated at USD 4,400 per month for three years (US$4,400 x 36 months = US$158,400). An additional US$ 5,000 per month will be required for service of vehicles and fuel (5,000 x 36 months = US$180,000). Total estimated Environmental coordination Unit operating costs for three years is US$338,400. Additional funds would be required to establish field equipment and other materials.

Field equipment required: 2 vehicles at US$ 35,000 each; portable water quality lab. at US$ 10,000; 4 GPS at US$1,000 each, other necessary equipment (computers, printers, photocopiers. cameras and recorders) estimated at US$20,000, short term training in environmental monitoring at US$ 15,000. Field equipment and training is estimated at US$119,000

(10) *Community Gain*: As part of the local community gain programme, consideration shall be given to contribute to health, water supply, sanitation, schools/education, agriculture and veterinary services. The particular services will be decided by the Local Authorities and the affected local people.

- estimate provided is meant to cover the following:
- support to health institutions of a grant of 10,000 per year for 3 years = 30,000,
- facilitation for water supply at selected 3 points US$ 15,000 each = 45,000,
- grant of 5,000 to 5 local schools = 25,000,
- grant of 25,000 to provision of veterinary services support in four districts = 100,000
- grant related to agricultural support to disturbed farmers (seed and fertiliser) for two years at US$15,000 per year = US$30,000
- (US$210,000)

(11) *Road Safety*: Support shall be given to road safety enhancement activities during construction phase such as speed limit signs, warning signs to motorists on construction and replacement of clear road signs.

(12) *Security Measures*: There are some sections of the route corridor where the contractors and all the project staff would need special protection. The support should therefore be given to the national security wings to ensure that all project staff are protected and allowed to operate without security risk. This cost would cover minor operations support such as subsistence allowances to the assigned security teams. This cost would cover minor operations support such as subsistence allowances to the assigned security teams. Estimated bases on 10 security Staff x US$50 per day x 20 days in a month x 24 months = US$240,000

(13) *Post Construction Environmental Audit*: This shall be undertaken by an independent consultant to ensure the recommended measures would be fully implemented and Environmental coordination adequately done. The audit report shall be submitted to relevant stakeholders. This will be a one time cost of checking the construction phase of the project (final payment of contractor will be tied to a successful audit inspection). This will be a 30 man day assignment at US$500 per man day.

Table 62 : Summary of Cost Estimate of the Environmental and Social Mitigation Measures (Egypt)

No.	Item	Capital Cost (USD)	Recurrent Cost (USD)	
			Construction Phase	Operation Phase
1	Compensation for loss of agricultural land	90,000		
2	Compensation for houses	200,000		
3	Implementation of livelihood safeguard program	100,000	10,000	
4	Health center, awareness and care (project employees & locals)	50,000	27,550	
5	Generic Best Management Practice for disturbed areas	10,000		
6	Monitoring of construction work, Environmental Coordination Units	40,000	25,000	
7	Socio-Economic Monitoring (resettlement)		50,000	
8	Cultural and Archaeological conservation	40,000	25,400	
9	Institutional capacity building program	119,000	328,400	10,000
10	Community gain (Social Service Proposed)	50,000	160,000	
11	Road Safety enhancement (Signs and warnings)		10,000	
12	Security enhancement measures		240,000	
13	Post construction environmental audit		15,000	
Sub Totals		**699,000**	**891,350**	**10,000**
Contingency (10 %)		**69,900**	**89,135**	**1,000**
Total		**768,900**	**980,485**	**11,000**
Grand Total (USD)				**1,760,385**

14 CONCLUSION

During phase I of the ENTRO Eastern Nile Power Trade Investment Study (EDF, 2007), a strategic assessment was undertaken of key alternatives for the development of the Project. This extensive study focussed, primarily, on options for hydropower generation along the Abbay River as well as other hydropower options along the Blue Nile and other power generation mixes. It was found that the least cost of generation of 25 to 40 US$/MWh were those of Ethiopian hydropower generation, which includes Mandaya, compared to 60 US$/MWh for combined cycle gas turbines(CCGT) and other more costly generation options of crude oil fired turbines. With this analysis on the available energy source alternatives to the Eastern Nile member countries, it was concluded that the proposed transmission line will facilitate the provision of least cost and environmentally cleaner hydropower to the region. From this background, the alternative to develop the proposed interconnector should therefore be supported.

The proposed route corridor of the project was subjected to field verification of the preliminary route in order to come up with a preferred route corridor with less environmental and social impacts. This means the preferred proposed route on which this ESIA was based, is the best alternative for the route corridor. There is scope for further refining of the route during the detailed survey and line re-alignment stage, which shall be undertaken in close consideration of environmental and social issues to ensure minimal adverse impacts. Therefore, the final route which will be used to develop the powerline will have the least environmental and social impacts.

Based on field data collection, consultations with project affected people, local, regional and national government agencies and other organisations and analysis of the project activities, and taking into account the proposed mitigation and enhancement measures, it can be concluded that it is unlikely that the Project will have significant adverse environmental social and social impacts.

Most adverse impacts predicted will be of a temporary nature especially during the construction phase of the project and these adverse impacts (as outlined in section 9) can be managed to acceptable levels through implementation of the recommended mitigation measures. Section 10 outlines the basis for an eventual Environmental and Social Management Plan which will ensure that the recommended mitigation and enhancement measure are implemented during the project implementation process. In addition section 11 outlines the monitoring plan which will ensure effective monitoring of adequate implementation of proposed measures.

The monetary values of all proposed mitigation measures have been duly calculated where possible or subject to estimations based upon assumptions or experience elsewhere; these costs are therefore essentially *indicative* and may be subject to change. Nevertheless a total *indicative* cost of environmental and social management of US$22,239,413.00 has been included as part of the total forecast project costs. This will ensure that when arranging project financing, a component will be dedicated to environmental and social management aspects of the project. However it is recommended that the cost values indicated in the report should be validated and revised as appropriate in due course.

Nevertheless, given the above measures, it can be concluded that the overall benefit from the Project will greatly outweigh the few adverse impacts and, given adequate funding, those adverse impacts will be adequately mitigated. The project should therefore be supported in all approval stages by the different National Environmental Authorities in the three Eastern Nile member countries, Ethiopia, Sudan and Egypt.

Indicative costs related to compensation for agricultural land, crops, fruit trees and structures to be affected within the Right of Way has been estimated at US$ 14,997,998. As mentioned above, this estimated cost should be subject to further refinement after the detailed powerline route survey and route re-alignment. It is therefore recommended that a detailed project impact assessment be undertaken to formulate a comprehensive Resettlement Action Plan (RAP). This RAP will be the ultimate basis for the compensation recommended in this report and shall be undertaken as one of the key pre-construction activities. The compensation shall be closely monitored and undertaken in accordance with the existing compensation regulations in the member countries (Ethiopia, Sudan and Egypt). In conclusion, it is envisaged that any adverse socio-economic impacts of the project will be adequately mitigated to ensure the project affected people are well compensated for the various aspects of losses suffered way before commencement of project construction phase.

The three member countries (Ethiopia, Sudan and Egypt) have environmental legislation relevant to the proposed power transmission line project. Through stakeholder consultation and analysis of relevant environmental legislation, it was found that the ESIA process for this project is in conformity with the Environmental Management requirements for new development projects. It is however proposed that - before commencement of implementation phase of the project - this report shall be updated and revised in readiness for submission to the relevant National Environmental Agencies for review and approval.

To facilitate continuity in environmental management of the project environmental aspects, the key Electricity Sector Institutions (EEPCO, NEC and EEH) in the three countries have been assigned the role of environmental coordination of all aspects of the proposed project. The Environmental Coordination Unit Staff will have the responsibility to ensure that the Environmental and Social Management Plan (ESMP) is adequately implemented. To facilitate the Units' ability to effectively monitor the ESMP implementation, a comprehensive capacity building programme is proposed as a key part of the ESMP of this project.

APPENDIXES

APPENDIX A List of Persons involved in the Compilation of the ESIA

Scott Wilson Ltd,
6-8 Greencoat Place,
London,
SW1P 1PL,
United Kingdom

Technical Reviewers:

Louise Porteus
Technical Director
Scott Wilson

Fraser Patterson
Corporate Responsibility
Scott Wilson

Julie Raynor
Principal Environmental Scientist
Scott Wilson

Environmental and Social Impact Assessment Author:

Elenestina Mwelwa
Senior Manager – Environment and Social Affaires Unit
ZESCO

Environmental and Social Impact Assessment Assistance:

Nyundo Armitage
Environmental Consultant
Scott Wilson

Egypt ESIA Authors:

Electrical Power Systems Eng. Co
Cairo, Egypt

Speedotrans
Cairo, Egypt

Ethiopia ESIA Authors:

Tropics Consulting Engineers
Addis Ababa, Ethiopia

Sudan ESIA Authors:

YAM CdC, Khartoum Sudan

APPENDIX B Terms of Reference for the ESIA Sub Consultants

Baseline data collection to facilitate compilation of environmental and social impact assessment (ESIA) for the route of the interconnector

Proposed route of the Power Line

APPENDIX B.I ETHIOPIAN SECTION

ASSIGNMENT OF TASKS TO TROPICS

The consultants shall concentrate on the specific tasks allocated to them in their contract, signed in Cairo June 2008, and will submit the reports and data and information collected to Scott Wilson on a date not later than 29th August 2008.

The Team

Team to undertake baseline data collection and compilation: 2 environmentalists / ecologists, a socio-economist, a geologist and a surveyor and Engineer (as outlined in the Contract).

Review and Update of the Policy, Legal and Administrative Framework

The Consultant will be provided with a draft chapter of the Policy, Legal and Administrative Framework prepared by Scott Wilson.

The Consultant should review this chapter to ensure it contains an up-to date detailed description of the policy, legal and administrative framework for Environmental, Social and Electricity sector management in Ethiopia. The description shall include the national utility compensation policy and grievance procedures as relates to the electricity sector.

Existing Baseline Conditions - Physical Environmental Aspects

The existing physical, biological and socio-economic environment along/adjacent to proposed Rights of Way (ROW) will be described. In particular attention shall be given to the following:

- Existing land use;
- Soils and geology;
- Air quality;
- Noise;
- Traffic;
- Visual and aesthetic aspects;
- Ecological systems, both terrestrial and aquatic aspects;
- Archeological and Cultural Aspects.

It is understood that a lot of this information will be available through the land route survey already being conducted.

Socio-economic Environment

The existing socio-economic environment along / adjacent to the proposed Transmission route shall be described. The consultant will provide the detailed description of socio-economic environment disaggregated by population, gender, health, education, civil society and societal framework in the project area. In particular attention shall be given to the following:

- Population size;
- Age and sex;
- Literacy levels;
- Education and health facilities;
- Health aspects – prevalence of HIV/AIDS and Malaria;
- Fertility and mortality rates;
- Livelihoods and economic activities;
- Formal and informal employment levels;
- Implementation of donor-funded projects in all economic and social sectors in the project area; and
- Productive factors and asset ownership disaggregated by gender.

Impacts, Mitigation and Management

The Consultant should provide a brief overview of the significant potential environmental and social impacts identified, together with their thoughts on suitable mitigation and management.

This can be provided in note form and the aim is to ensure that the Consultant has the opportunity to provide professional opinion on the potential impacts of the project.

Plan for Public Consultation

This is an important part of the assignment, therefore the consultant shall produce a plan for public consultation which should be submitted to Scott Wilson for approval. An outline plan should be provided to Scott Wilson in advance of the site visit.

The public consultation plan shall include a detailed stakeholder analysis to focus on the key stakeholders who should be consulted during the study. Preliminary stakeholder engagement will be undertaken during the site visit.

Stakeholder Inventory

The identified stakeholders shall be compiled into an inventory, stating the mission of each stakeholder. The main categories of stakeholders shall include the following:

Government Ministries of Energy, Natural Resources, Water Resources, Environment, Agriculture, Finance, Transport, Communication, Fisheries, Health and Social Welfare of Ethiopia;

Power Utilities of Ethiopia;

Local Administrations in the project area;

Civil society organizations active in the project area dealing with gender inequalities, indigenous people, poverty alleviation, rural development and environment;

Stakeholders directly affected by the project;

Universities and other academic institutions with relevant specialist knowledge; and

National and International private sector.

Public Consultation tools

The Consultant shall give a brief description of information and consultation tools which shall be used during the study.

Workshop organization

The consultant shall assist in the organization of a national workshop for presentation of study results and facilitate feedback on the Study

Submission of Report

The consultant shall submit a report containing the following:

- Review and inclusion of necessary data for the Legal Chapter
- Detailed description of baseline data in the project area
- Physical Environmental Aspects
- Socio-economic Environment
- Outline of potential significant environmental and social impacts, mitigation and management measures.
- Public Consultation framework and feedback results

The report shall be submitted to Scott Wilson not later than 29th August 2008

Plan for participation in fieldwork – 20th July to 30th July.

APPENDIX B.II SUDAN SECTION

ASSIGNMENT OF TASKS TO YAMS

In view of the reduced scope of the ESIA Work, the consultants shall concentrated on the specific tasks allocated to them and will submit the reports and data and information collected to Scott Wilson on a date not later than 15th September 2008.

The Team

Team to undertake baseline data collection and compilation: a socio-economist and an environmentalist.

Detailed description of the Policy, Legal and Administrative Framework

The Consultant provide a detailed description of the policy, legal and administrative framework for Environmental, Social and Electricity sector management in Sudan. The description shall include the national utility compensation policy and grievance procedures as relates to the electricity sector.

Physical Environmental Aspects

The existing physical, biological and socio-economic environment along/adjacent to proposed Rights of Way (ROW) will be described. In particular attention shall be given to the following:

- land requirements in ROW,
- land acquisition,
- visual and aesthetic aspects,
- corona aspects,
- electrical and magnetic field aspects,
- Archaeological and Cultural aspects
- Ecological aspects

Socio-economic Environment

The existing socio-economic environment along / adjacent to the proposed Transmission route shall be described. The consultant provide the detailed description of socio-economic environment disaggregated by population, gender, health, education, civil society and societal framework in the project area. In particular attention shall be given to the following:

- population size
- age and sex

- literacy levels
- education and health facilities
- Health aspects – prevalence of HIV/AIDS and Malaria
- fertility and mortality rates
- livelihoods and economic activities
- formal and informal employment levels
- Implementation of donor-funded projects in all economic and social sectors in the project area
- Productive factors and asset ownership disaggregated by gender

Plan for Public Consultation

This is an important part of the assignment, therefore the consultant shall produce a plan for public consultation which should be submitted to Scott Wilson for approval. The public consultation plan shall include a detailed stakeholder analysis to focus on the key stakeholders who should be consulted during the study.

Stakeholder Inventory

The identified stakeholders shall be compiled into an inventory, stating the mission of each stakeholder. The main categories of stakeholders shall include the following:

- Government Ministries of Energy, Natural Resources, Water Resources, Environment, Agriculture, Finance, Transport, Communication, Fisheries, Health and Social Welfare of Egypt
- Power Utilities of Egypt
- Local Administrations in the project area
- Civil society organizations active in the project area dealing with gender inequalities, indigenous people, poverty alleviation, rural development and environment
- Stakeholders directly affected by the project
- Universities and other academic institutions with relevant specialist knowledge
- National and International private sector.

Public Consultation tools

The Consultant shall give a brief description of information and consultation tools which shall be used during the study.

Workshop organization

The consultant shall assist in the organization of a national workshop for presentation of study results and facilitate feedback on the Study

Submission of Report

The consultant shall submit a report which will contain a detailed description of baseline data in the project area. The report shall contain the following:

- Detailed description of the project and the proposed route
- Detailed description of the Policy, Legal and Administrative Framework
- Physical Environmental Aspects
- Socio-economic Environment
- Public Consultation framework and feedback results.

The report shall be submitted to Scott Wilson not later than 15th September 2008

Plan for participation in Field Work: 31st July to 14th August 2008.

APPENDIX B.III EGYPT SECTION

ASSIGNMENT OF TASKS TO EPS and SPEEDOTRANS

The consultants shall concentrate on the specific tasks allocated to them as outlined in their contract, signed in Cairo June 2008 and will submit the reports and data and information collected to Scott Wilson on the date not later than 15th September 2008.

The Team

Team to undertake baseline data collection and compilation: a socio-economist and an archaeologist (As outlined in the contract)

Review and Update of the Policy, Legal and Administrative Framework

The Consultant will be provided with a draft chapter of the Policy, Legal and Administrative Framework prepared by Scott Wilson.

The consultant should review this chapter and ensure it contains an up to date detailed description of the policy, legal and administrative framework for Environmental, Social and Electricity sector management in Egypt. The description shall include the national utility compensation policy and grievance procedures as relates to the electricity sector.

Existing Baseline Conditions - Physical Environmental Aspects

The existing physical, biological and socio-economic environment along/adjacent to proposed Rights of Way (ROW) will be described. In particular attention shall be given to the following:

- Archeological and Cultural aspects
- Existing land use;
- Soils and geology;
- Air quality;
- Noise;
- Traffic;
- visual and aesthetic aspects,
- corona aspects,
- electrical and magnetic field aspects,
- Ecological aspects

It is understood that a lot of this information will be available through the land route survey already being conducted.

Socio-economic Environment

The existing socio-economic environment along / adjacent to the proposed Transmission route shall be described. The consultant will provide the detailed description of socio-economic environment disaggregated by population, gender, health, education, civil society and societal framework in the project area. In particular attention shall be given to the following:

- Population size
- Age and sex
- Literacy levels
- Education and health facilities
- Health aspects – prevalence of HIV/AIDS and Malaria
- Fertility and mortality rates
- Livelihoods and economic activities
- Formal and informal employment levels
- Implementation of donor-funded projects in all economic and social sectors in the project area; and
- Productive factors and asset ownership disaggregated by gender

Impacts, Mitigation and Management

The Consultant should provide a brief overview of the significant potential environmental and social impacts identified, together with their thoughts on suitable mitigation and management.

This can be provided in note form and the aim is to ensure that the Consultant has the opportunity to provide professional opinion on the potential impacts of the project.

Plan for Public Consultation

This is an important part of the assignment, therefore the consultant shall produce a plan for public consultation which should be submitted to Scott Wilson for approval. An outline plan should be provided to Scott Wilson in advance of the site visit.

The public consultation plan shall include a detailed stakeholder analysis to focus on the key stakeholders who should be consulted during the study. Preliminary stakeholder engagement will be undertaken during the site visit.

Stakeholder Inventory

The identified stakeholders shall be compiled into an inventory, stating the mission of each stakeholder. The main categories of stakeholders shall include the following:

- Government Ministries of Energy, Natural Resources, Water Resources, Environment, Agriculture, Finance, Transport, Communication, Fisheries, Health and Social Welfare of Egypt
- Power Utilities of Egypt
- Local Administrations in the project area
- Civil society organizations active in the project area dealing with gender inequalities, indigenous people, poverty alleviation, rural development and environment
- Stakeholders directly affected by the project
- Universities and other academic institutions with relevant specialist knowledge; and
- National and International private sector.

Public Consultation tools

The Consultant shall give a brief description of information and consultation tools which shall be used during the study.

Workshop organization

The consultant shall assist in the organization of a national workshop for presentation of study results and facilitate feedback on the Study.

Submission of Report

The consultant shall submit a report containing the following:

- Review and inclusion of necessary data for the Legal Chapter
- Detailed description of baseline data in the project area
- Physical Environmental Aspects – particularly archaeological and cultural heritage
- Socio-economic Environment
- Outline of potential significant environmental and social impacts, mitigation and management measures.
- Public Consultation framework and feedback results

The report shall be submitted to Scott Wilson not later than 15th September 2008

Plan for participation in fieldwork: 15th August to 24th August 2008.

APPENDIX C List Of The Identified Families, Genera And Species In Sudan

Appendix C: List of the identified families, genera and species (Damazine,Geisan and Bau) in Sudan			
No	**Family**	**Species**	**Vern.names**
1	Anacardiaceac	Lannea fruitcosa (Hochst. Ex A. Rich). Engl	Leyun-Ghallub
2	Anacardiaceac	Lannea schimperi (A.Rich.) Engl.	Leyun-Amzag-Suda
3	Anacardiaceac	Sclerocarya birrea (A. Rich.) Hochst	Humeid
4	Anclepiadaceae	Calotropis procera (Aiton.) Aiton	Usher
5	Balanitaceac	Balanites aegyptiaca (L.) Del.	Hegleeg (Laloub)
6	Bombacaceac	Adansonia digitata Linn.	Tabaldi (Gongulis)
7	Bignoniaceae	Stereospermum kunthianum Cham.	Khashkash Abiad
8	Burseraceae	Boswellia papyrifera (Del.) Hochst	Trag Trag
9	Capparaceae	Boscia angustifolia a. rich.	Irg Al Sraih
10	Capparaceae	Boscia senegalensis (Pers.) Lam. Ex Poir	Mokheit
11	Capparaceae	Cadaba rotundifolia forssk	Kurmut
12	Capparaceae	Capparis deciduas (Forssk.) Edgew	Tundub
13	Capparaceae	Capparis tomentosa Lam.	Irg Al Gulum
14	Capparaceae	Crateva adansonii DC	Dabker
15	Capparaceae	Maerua angolensis DC	Shagar ElZaraf
16	Combretaceae	Anogeissus leiocarpus (DC) guill & Perr	Sahab – seilk
17	Combretaceae	Combretum aculeatum Vent., choix	Habeel Shehait
18	Combretaceae	Combretum ghasalense Engl. & Diels	Habeel Um Ismaeel
19	Combretaceae	Combretum glutinosum Perr. Ex DC	Habeel Khrisha
20	Combretaceae	Combretum hartmannianum Schweinf	Habeel Al Gabal
21	Combretaceae	Combretum lamprocarpum Diels	Habeel El Grouz
22	Combretaceae	Combretum molle R.Br. Ex G. Don	Habeel Khrisha Kabeira
23	Combretaceae	Terminalia brownie Fresen	Subagh – Shaf
24	Combretaceae	Terminalia laxiflora Engl. & Diels	Subagh – Darut
25	Caesalpinioideae	Cassia arereh Del	Al Gaga
26	Caesalpinioideae	Piliostigma reticulatum (DC) Hochst	Kharub – Abu khmeira
27	Caesalpinioideae	Tamarindus indica L.	Aradaib
28	Mimosoideae	Acacia polycantha Willd	Kakamoot
29	Mimosoideae	Acacia Senegal (L.) willd	Hashab
30	Mimosoideae	Acacia seyal var fistulal.Schwinf. Oliv	Sufar Abiad
31	Mimosoideae	Acacia seyal var seyal Del	Talih Ahmar – Talih
32	Mimosoideae	Acacia nubica Benth	Laut
33	Mimosoideae	Acacia mellifera (Vahl.) Benth	Kitir

Appendix C: List of the identified families, genera and species (Damazine,Geisan and Bau) in Sudan			
No	**Family**	**Species**	**Vern.names**
34	Mimosoideae	Albizzia lebbeck (L.) Benth	Degn El basha Akhdar
35	Mimosoideae	Dichrostachys cinera (L.) white & Arn.	Kadad
36	Mimosoideae	Entada Africana guill. & Perr	Al Entada – Layuok
37	Mimosoideae	Pithecellobium dulce (Roxb.) Benth	Tamer hindi
38	Papilionoideae	Dalbergia melanoxylon guill. & Perr	Abnos – Babanos
39	Papilionoideae	Lonchocarpus laxiflorus guill. & Pe	Khashkash Azrag
40	Papilionoideae	Pterocarps lucens guiL. & Perr	Taraya
41	Loganiaceae	Strychons innocua Del.	Um Bukheisa
42	Meliaceae	Azadirachta indica A. Juss	Neem Baldi
43	Moringacea	Moringa olifera Lam.	Moringa
44	Ochnaceae	OCHNA AFZELII r.Br. ex Oliv.	Lessan al klib
45	Palmac (Arecaceae)	Hyphaene thebaica (L.) Mart.	Dom – Saaf
46	Rhaminaceae	Ziziphus abyssinica Hochst. A. rich	Siddir Al Feel
47	Rhaminaceae	Zizphus spina-christi (L.) Desf.	Siddir – Nabag
48	Rubiaceae	Gardenia hutea	Abu Gawi – AlGardenia
49	Rubiaceae	Xeromphis nilotica Stapf.	Shidr el Marfein
50	Sreculiaceae	Sterculia Africana Fiori	Tartar
51	Sterculiaceae	Sterculia setigera Del	Tartar
52	Tiliaceac	Grewia flavescens Juss	Abou Dlouac
53	Tiliaceac	Grewia mollis Juss	Guddeim Basham
54	Tiliaceac	Grewia tenax Ascher & Schweinf	guddeim

Source: Haitham Mostafa,, 2006. M.Sc. Thesis, University of Khartoum

Appendix D

Characteristic and rare species encountered in the Wadies of the Eastern Desert and the oases of the Western Desert

Appendix D: Characteristic and rare species encountered in the Wadies of the Eastern Desert and the oases of the Western Desert

	Wadis of Eastern Desert	Oases of Western Desert
Vegetation	Acacia sp (*Acacia raddiana*)	Argun Palm (*Medemia argun*)[1)] Acacia (*Acacia radiate*) Acacia (*Acacia ehrenbergiana*) Date Palm (*Phoenix dactylifera*) Dom Palm (*Hyphaene thebaica*)
Reptiles	Gecko (*Ptydactylus hasselquesti*) Small-spotted Lizard Schockari Sand Snake	Lizard (*Acanthodactylus scuttelatus*) Horned Viper
Birds	Barbary Falcon (*Falco pelegrinoides*) Humes Tawny Owl Egyptian vulture Sand Partridge Desert Lark Trumpeter Finch (*Rhodopechys githaginea*) Mourning Wheatear Hooded Wheatear Blackstart Brown - necked Raven	Pharaoh Eagle Owl (*Bubo ascalaphus*) Laughing Dove (*Streptopelia senegalensis*) Hoopoe (*Upupa epops*) Olivaceous Warbler (*Hippolais pallida*) Trumpeter Finch (*Rhodopechys githaginea*)
Mammals	Dorcas gazelle (*Gazella dorcas*) Striped hyena (*Hyena hyena*) Cape Hare (*Lepus capensis*) Rock Hyrax (*Procavia capensis*) Rüppels Sand Fox (V*ulpes rueppelli*)	Dorcas gazelle (*Gazella dorcas dorcas*)[2)] Striped Hyena (*Hyena hyena*) Rüppels Sand fox (V*ulpes rueppelli*)

Source: EPS, November 2008

Appendix E
List of Contacted Organizations and People in Ethiopia

Appendix E: List of Contacted Organizations and People in Ethiopia				
No	**Name**	**Organization**	**Position**	**Telephone**
	Federal Level			
1	Ato Solomon	Environmental Protection Authority	Evaluation Department Head	0116-464878
2	Dr. Fatuma	ENTRO	Manager	
3	Ato Gosaye Mengistu	Ministry of Mines and Energy	Department Head	0911-254116
4	Ato Girma Demissie	EEPCo-EMU	Head	011-1562050
5	Ato Zelealem Gebre Hiwot	EEPCo		0911-605566
6	Ato Alemayehu Desta	EEPCo-EMU	Expert	011-1562050
7	Ato Yohannes Yosef	EEPCo-EMU	Expert	011-1562050
8	Ato Zelalem G/Hiwot	EEPCo	Distribution Planning Head	
	Benishangul Gumuz			
9	Ato Yaregal Aysheshim	BGRS	President	
10	Ato Yosef	BG Road Authority	A/Manager	0911-715231
11	Ato Kebede Feyisa	BG Road Authority	Road Engineer	0911-935928
12	Ato Commander Negash	Health Office	Planning Head	0912-078462
13	Ato Nasesa Wubete	Education Bureau	Bureau Head	057-7750431
14	Ato Asrat Getachew	Education Bureau	Administrator	057-7750434
15	Ato Abod Ahmed	Menge Woreda Administration	D/Adminstrator	0911-904226
16	Ato Tone Ayele	Menge woreda ARD office		
17	Ato Mustefa Abdulahi	Menge Woreda Administration	Administration	
18	Ato Murad	BGNRS EPLAUA	A/Manager	577751292
19	W/R Serke Mohammed	Women's Association		057-7751776
20	Ato Hailu Kibret	Women's Affairs Office	Expert	0911-758145
21	Ato Anteneh Shawi	Sirba Abbay Administration	Adminstrator	0981-190325
22	Ato Yalelet Alen	Sirba Abbay ARD office	expert	981190325
23	Ato Hailu Bebur	Sirba Abbay Administration	D/Adminstrator	0981-190326
24	Ato Kedir Zenabdin	Oda Godere Administration	Adminstrator	0981-190431
25	Ato Kasim Osman	Daleti Town	Adminstrator	
26	Ato Mekonnen Berhane	IRC	D/Manger	
27	Hussen Mussesa	Cherkole Security	Head	0911-975068
28	Shimelis Tesfaye	Bo Education	Expert	911571343
29	Ateyb Nurhussen Ateyb	B0ARD	Expert	
30	W/O Hirut Feyesa	BoARD	Expert	913023908

Appendix E: List of Contacted Organizations and People in Ethiopia				
No	**Name**	**Organization**	**Position**	**Telephone**
31	Ato Bekele Guta		team leader	912
32	Ato Endrias Wolde	Cooperative Office	Head	757775691
33	Ato Tesfaya Asmare	Cooperative Office	Expert	757775691
34	Ato Getachew Mammo	Cooperative Office	Expert	757775691
35	Ato Fekadu Numera	Land and Sea Bamboo Development	Manager	
36	Ato Zirihun Abebe	Land and Sea Bamboo Development	Expert	911718776

Appendix F
List of Contacted and Consulted People and Groups in Sudan

Appendix F: List of Contacted and Consulted People and Groups in Sudan

Name	Position / Occupation
Faroug Abdel Gadir	A farmer near point K6
Mohamed Ibrahim	A herder near a water point
El Siddig Ahmed Saad	A citizen from Kalagi village
Ali Musa Khogali	A farmer from Saada village (K6)
Ibrahim Mohamed	Omda (Native administration) Wad Khair village
Mostafa Daoud Yousif	Director, Survey Department, Damazine
Ramadan Yassin Hamed	Advisor to the governor (Wali) for INGO affairs (Damazine)
	Executive Director for NGO affairs (Damazine)
El Rabie Abdel Bagi	Giessan Governor (Mutamad)
El Aagib Abbas Zaroug	Met with a group of villagers near Giessan
Salih Mohamed Salih	At several points along the Route
Groups of Herders	A group of engineers
National Electricity Corporation	

Appendix G
List of People and Organizations Consulted in Egypt

Appendix G: List of People and Organizations Consulted in Egypt

Names	Title	Organization
Eng. Fawzia Abou Neima	EEHC Board Member	EEHC
Eng. Ismaeil Teleb	Vice Chairman of Transmission Co. Southern Area	
Eng. Abdel Rahim Hamaza	Managing Director, Electrical Network Studies	
His excellence Mr. Magdy Ayoob	The Governor	Qena Governorate
Mr. Fayez Abdel Aziz	General Secretary	
Eng. Dhareeh Hashim	Road and Bridge Authority	
Eng. Jehfer Taha	Directorate of Roads	
Dr. Husien Farghaly	Undersecretary, Ministry of Health	
Mr. Zakaria Mohamed	Undersecretary, Ministry of Social Affairs	
Miss Zainab Mohamed	Head of Environmental Office	
Prof / Mustafa Mahmoud	Professor of the Graduate Institute of Social Service at Qena- Aswan Member of local Council and Member of Compensation Committee	Supreme Council of Luxor
Prof / Abbas Mansour	The President	South Valley University
Prof / Mahmoud Khaddar	Vice-President	
Dr / Mahmoud Ali Hassan	General Manager	EEA Aswan
Eng / Ibrahim Hussein	Deputy Branch Manager	
Chemist / Kamal Shahat	Environmental researcher	
Chemist / Nabil Abdel-Mohsen	Environmental researcher	
Chemist/ Abd Elmonsef Mohamed Mahmoud	Environmental researcher	
Chemist / Mahmoud Ramadan	Environmental researcher	

Appendix H
Minutes of Public Consultations in the Project Area - Ethiopia

Appendix H : Minutes of Public Consultations in the Project Area - Ethiopia

Public consultation was conducted with various stakeholders at regional and woreda level administration including all major sectors. The consultation focused on environmental and social impact caused by the transmission line route corridor of Ethio-Sudan Interconnection.

The public consultation conducted and the inputs from the participants are summarized in the following sections.

An ESIA team consisting of an environmentalist, a socio-economist, transmission engineer and a surveyor visited the Benishangul Gumuz Regional State and four Woredas where the Transmission Line Route Corridor of Ethio-Sudan Interconnection passes through from July 12 up to July 23, 2008.

The first government organ visited was the Regional President office. The team discussed about Ethio-Sudan Transmission Line with Ato Yaregal Asheshim, the president and Ato Kinde Haile, advisor to the president on July 14, 2008 at 8:30 am in the morning.

The team explained to the president considering its mission and briefed him about the proposed electric transmission line from Ethiopia to the Sudan and Egypt as well as the possible impacts of the project. Finally the team asked the opinion of the president and his views are summarized as follows.

On the negative side the project can displace some people and could damage the natural environment. But as long as proper compensation is paid they could be resettled in the vicinity of their residence since there is no land problem in Benishangul Gumuz. Land can be made available to affected people for both their agriculture and to build their houses.

Maximum attention, however, should be paid for the irreplaceable archaeological and historical resources as well as for endemic natural habitat.

Though the project may have very minimal negative impacts that are possible of mitigation, it has immense benefits to the Eastern Nile Region, the Country, Benishangul Gumuz, and to the Woredas of project influence area.

As benefits the project is expected to

1. *Improve eco-tourism,*
2. *Eliminates power shortage in the area and hence attracts investments,*
3. *Create job opportunities because of the economic development induced by the power system developed and the construction of the line,*
4. *Marble and other investment will not face energy problem in the future*
5. *Brings growth in the region*
6. *Creates opportunity for fishing industry and expands fishing activity and*
7. *Creates awareness among the communities about development as well as the need to change their life style*

Finally I would like to inform you that the regional government will do every thing possible for the realization of the project and will provide maximum support to the team.

The president later instructed Ato Kinde to write a letter to all the project woredas for his signature requesting their cooperation to the team and arrange the consultation at the woreda level.

Ato Kinde Haile gave similar opinion about the project while we were in his office. He also prepared the letter of cooperation addressing to Scherkole, Menge, Oda Godere, Sirba Abbay and Agelo Meti woredas to be signed by the president of the Regional State.

In addition to that Ato Kinde organized consultation at the regional level on the behalf team, consisting of all the regional bureaus including Women's Affairs Office of the region and other regional public organs to be held on 16/07/08. The flowing list of decision making stakeholders that should be present in the consultation meeting was given to Ato Kinde.

CONSULTATION WITH BENISHANGUL GUMUZ REGIONAL ADMINISTRATION

The Regional consultation took place as scheduled with Ato Kinde. All public officials were present the meeting. The team explained about the Ethio-Sudan Interconnection Project and possible benefits and effects of the project. The explanation was followed by opinion and comments of the participants summarized below.

Ato Berhanu, Finance and Economic Development Bureau Head

The project is a good project. In the past Abbay was benefiting only the Sudan and Egypt the inclusion of Ethiopia in the benefit sharing is a new progress and to be supported by the Region. He asked the following questions.

- *The down stream countries may need the soil what happens if the soil is trapped in Ethiopia? Does that create dispute among the countries?*
- *How much of the land does the transmission line corridor affect?*
- *How is this line compatible with the previous transmission lines of the grid system in Ethiopia?*
- *What development other than power trade is expected in this project?*

Answers: The team requested the participants to note the present mission (Transmission Line Route and the impacts) and not to mix issues of the hydropower dam project which was exhaustively discussed with the public and stakeholders two years back. Hence dwell focus on the TLR as much as possible. Further more the team explained that the soil is not needed downstream any more, the effect of the transmission line corridor is limited because of careful selection of the line route. The grid line and the current project transmission line are separate and independent. The project enhances and initiates significant development in the region.

Ato Minilik, Water Resources Development Bureau Head

Cooperation in power trade among the three countries is praiseworthy. The flood and the silt problem downstream is one of the major reasons that facilitated this cooperation none the less it is a good start to jointly develop the Abbay River.

There are, however two major negative impacts in Ethiopia that needs special attention. Theses are:

- *The area that is inundated by the dam is two large*
- *Ethiopia will need a lot of money for cleaning the silt in the dam.*

He also said sufficient compensation must be given to people and communities affected.

<u>As answerers to the above question the team said that Inundation due to Mandaya Hydropower Project is very little it is only 120 households and no public and private infrastructure is affected. Since Mandaya Hydropower is to be built in a very deep gorge there will not be silt problem for the next hundred years. Compensation will be paid according to the Ethiopian law and in line with the World Bank procedures.</u>

Dr. Makonnen, Agricultural and Rural Development Bureau Head

There has been a lot of discussion about Abbay River but never in the current context of regional cooperation. The cooperation established among the three countries is supportable.

The project, however, should pay special attention to the settlements at Abagole, Wawu, Jale and others. First these settlements are using the Abbay River for drinking water they might be denied this when the project is implemented. Second there are many problems relating to displacement such as infrastructure and property loss. Third there are number of springs in Abagole that are used for remedial purposes for different kinds of diseases and a large number of people from various part of the region are coming to the place to use the hot spring. Therefore these things should be addressed properly.

Ato Zewde, Investment Office Head

Large investment activities are taking place in Yasso Woreda but the electric towers might affect the Kamashi Yasso Road and that will hamper the development effort by the investors. Care should be taken in that regard.

Ato Murad, Environmental Protection Authority

The transmission line corridor affects natural resources and settlements 130 m wide space along the168 km line. In addition there is a study conducted by Addis Ababa University about

Protected area in the region and it is better if you get hold of that study and take into consideration.

Other than that the project is commendable and we all support it.

Ato Beyene, Works and Urban Development Bureau

There are some infrastructures such as Kamashi-Yasso Road and incense trees in the area that the team need to consider before project implementation.

Ato Kinde, Advisor to the President

Although the project has many benefits the negative impacts should be minimized as much as possible.

Figure 68: Regional Public Consultation in Benishangul Gumuz Regional State

CONSULTATION WITH MENGE WOREDA ADMINISTRATION

In the afternoon of 14/07/08 the team went to Menge woreda for consultation with stakeholders. In Menge the team met with Ato Abod Ahmed Deputy Administrator (also acting administrator) and Mustefa Abdulahi (Organizational Affairs Head).

The authorities summoned sectoral office heads and some individuals from the surroundings for the consultation. Then the consultation was held in the woreda office.

The team briefed the participants about the meeting and the project and disclosed the nature of the project that is undertaken by Eastern Nile Technical Regional Office which is established by Ethiopia, the Sudan and Egypt.

After the explanation the discussion started. The following were the summary of the discussion.

Ato Mustefa Abdulahi, Woreda Administration

Abbay is a notational resource which was not utilized by Ethiopian until now. But these joint cooperation by the three countries is a holy idea that we all should encourage and provide support. The construction of the hydropower in our region is one step ahead to get out of poverty in the region.

The project will encourage investors and expand and facilitate investment. It will provide opportunities to potential investors in the region and induce development in the area.

It will also create job opportunities to the poor communities of the woreda. The income of the woreda will also increase due to higher tax levied from increased investment and job opportunities.

The negative impacts expected on settlement and crop land will not be major issue if proper compensation is given and the affected are resettled. The woreda has sufficient lad and can be made available for resettlement including for agriculture. Finally he promised full cooperation of the woreda and all public sector organs to the project success.

Lieutenant Birru from Police Office:

In general the project will have immense regional and national benefits. The woreda police force will be mobilized to safeguard the security of the project.

Ato Tena Ayele Agricultural and Rural Development Office Head

The statements given by the previous speakers are valid (no need to repeat the benefits and negative impacts). In the past Abbay river never gave any benefits to the communities. On the contrary erosion has been a problem in the area where the soil is washed away in to the river and carried to places where it is no more required. This erosion affects the productivities of our land. The project should address the above mentioned erosion problem that is caused by the project.

The office will fully cooperate in identifying agricultural and natural resource and in subsequent activities during construction that takes place along the transmission routing.

Ato Adam, Public Health

The case of Abbay has been puzzling for every Ethiopian. The Sudan and Egypt are benefiting from this resource at the same time as it is hurting Ethiopia because of the huge amount of erosion. As a result the land and the people remained poor despite this valuable natural resource. The current efforts of the three countries are commendable in view of the power trade advantages mutually obtained by the three countries.

Therefore the health office will give its maximum support required by the project in the area of its expertise.

Ato Getachew Yitay, Information Office Head

This cooperation is a long overdue tasks by the three countries it will benefit the countries and we will discharge our responsibilities to make the project successful.

Ato Mubarech Ashafifi, Sheria Law (Office) Head

The project is commendable and it is long overdue. The three countries could have achieved a lot of results had they began this cooperation a long time ago. The Sheria would do what ever it can to support the project.

Ato Nur Taha, Community Elder

This project cooperation is at its initial stage but I consider it as a development in progress. Had we started long ago our region would have been developed by now like Addis Ababa and Ethiopia would have developed like Egypt or other better developed Country. I am hopeful it would register an excellent result when the project is implemented and power trade is started.

Ato Ayehu Alemayehu, Education and Capacity Development Office Head

The idea of developing Abbay was there during Haileselassie and the Derg regimes but it could not be realized due to capacity and disagreement among the three countries. It is good to hear some progress in that regard and the cooperation is a good beginning we all fully support the project.

Figure 69: Partial View of the Consultation in Menge Administration Office

CONSULTATION IN SHERKOLE WOREDA ADMINISTRATION

On 17/07/08 the team conducted public consultation in Sherkole Woreda. It discussed about its mission and project impacts along the transmission line route corridor and immediate vicinities in Sherkole Woreda Administration. People present in the meeting were high woreda officials and individuals living in the woreda. Some of the participants only spoke and understood Arabic language and hence translators were used during the discussions.

The discussion is summarized below.

Ato Fetih Adere, Information Office Head

The project you explained about is good news to the communities in the woreda. We appreciate consulting about the project that concerns us. Any past projects were studied and implemented with out the knowledge of the woreda and affected people. Such consultation found to be unique to the ENTRO projects.

In our opinion the project has multiple benefits including availability of electric power to the communities, will improve the life style of the people in the woreda, and create job opportunities and the like.

On the other hand the project will clear the forest resources, cause the loss of properties, and displace people from their places. It will also disrupt artisan gold mining activities widespread in the communities, takes agricultural land of people along the corridor. If the damages is properly mitigated the project is supportable by the communities in view of its benefits.

Education and Capacity Building Office Head

We appreciate consulting us about this important project. We are glad that we are in this meeting.

One important aspects of this project is that it creates cooperation sense of friendship among the three stakeholder countries. It will facilitate healthy neighborhood in the Eastern Nile Region.

The Sherkole communities will benefit from the project in the following ways.

- *The young people in the woreda particularly in the area of project influence will get job opportunities during construction and in developments instigated by the project.*
- *We might be able to benefit from the project in the form of electricity which is lacking in the woreda.*
- *The project will encourage investment and development in the area.*
- *We will be able to receive national and international media news and program because of the availability of electricity for TV, Radio, etc.*
- *Infrastructure such as health, education and others will be improved due to the development activities introduced after the project.*

This project might have some negative impacts but the negative impacts I imagine are possible of mitigation and some even could be avoided.

In general the project is highly beneficial to the woreda people and we will support it.

Community Elder

Most of the people are living in thatched roof tukulus how can they get electricity unless they change their roof by corrugated iron sheet?

Ato Hamid Ahmed, Woreda Speaker of the House

This project is a very good it can give advantages to the woreda community. It will strengthen the cooperation already started among the three countries. Create job opportunities and many other advantages will follow.

Ato Abdulwuhab Maru, Agriculture and Rural Development Office

There is no electricity in the Woreda until now but after the project we might be able to get electricity. The youth in the area will stop migrating to the Sudan because of the job that will be created during the project construction and implementation as well as improved investment in the area.

Wild life will be naturally protected when people get electric power at the same time the forest resources will be conserved due to relatively little fuel wood requirement in the future.

If the project is executed and implemented the community will benefit in many ways and hence we support it.

Ato Salah Abdela, Credit and Saving Office Head

When we think of the pros and cons of the project we find that the benefits outweigh the negative impacts. If electricity is introduced to the communities the use of fuel wood decrease substantially. Forest resources will be conserved, the wood resources will be used for better things in a rationale manner, the woreda will be interconnected to international infrastructure. In my opinion the project should be supported.

Ato Nibrete Sigate, HIV Secretariat Office Head

We feel good to hear that the communities should be consulted and we thank the project proponent and the team for their efforts. In brief I would say that the project will have immense benefits as stated by the speakers before me. But clearing of the forest resources during construction should be minimized as much as possible.

Figure 70: Public Consultation in Sherkole Woreda Administration Office

CONSULTATION IN ODA GODERE WOREDA ADMINISTRATION

On 19/07/2208 the team met with woreda acting administrator and explained the purpose of its coming to the woreda. Finally asked him to arrange a meeting consisting of woreda representatives, head of sector offices, representative of women, prominent elders and some dwellers of the kebele

A large number of people came to attend the meeting in Oda Godere. They were drawn from all public institutions in the area, elders and dwellers of the affected communities of the woreda. They provided important feedback regarding the line routing

The discussion was made open by explaining the purpose of the meeting and disclosing possible impacts of the project. The team also requested the participant to give us feed back and their opinion about the project. The consultation proceeded as follows.

Ato Kedir Zenabdin, Woreda Acting Administrator (& Deputy Administrator)

He said the project is a good scheme that is expected to enhance development in the area. What ever negative impacts it has, it will not be worse than the current poverty status of the *people in the area. They have high expectation about the project to bring development in the woreda and change the status of the people. The people want the project to be realized at any cost.*

Ato Sadik, Administration and Justice Office Head

Since this is a development it will change the woreda greatly. We are ready to accept the negative impacts. We support the project until it is operation.

Ato Abud Kalif, Kebele Dweller

We will not say no when such great project is coming to our woreda. Since this is a development we will support and contribute what ever is in our capacity.

Second Corporal Habtamu Gemechu from the Woreda Police

This is a good idea. The reason for backwardness of our woreda and region is because of the lack of such development in the area. Such project can take us out of chronic poverty prevalent here. We can not oppose to this project we rather support it to our level best. The project, however, will be useless unless it is implemented as soon as possible. Our people are in support of this kind of development projects.

Ato Endalkachew Haile, Education and Capacity Building Office Head

The project is good considering their benefits. I have a feeling, however, that these big towers cause big problem due to their sizes and things relating to transmission of power. Detailed study should be conducted and all the necessary precaution and mitigation measures should be in place before implementing the project.

Ato Gemer, Community Elder

This project is as you saw is totally supported by all participants here but should be implemented the soonest possible and should give desired benefit to the people.

Figure 71: Consultation in Oda Godere Woreda Administration Office

CONSULTATION IN SIRBA ABBAY WOREDA ADMINISTRATION

The Sirba Abbay consultation took place on July 21, 2008. The team began its task by explaining its mission to the woreda administrator and requesting for public meeting.

Meeting was held with stakeholders and the participants were drawn from affected kebeles, woreda administration, women and elders from project of influence area. As usual the team explained about the project and the reason why it has called the meeting.

Some remembered that similar consultation during the pre-feasibility study for the Mandaya Dam. Discussion was started by the Woreda Administrator Ato Anteneh Shawi.

Ato Anteneh Shawi, Woreda Administrator

On behalf of the Woreda people I want to express our strong desire for the project. We very much support it. The team came here two years back to consult us about the Mandaya Hydropower Development and by that our people were happy. But since then a lot of people are repeatedly asking about the implementation of the hydropower dam. It is over two years since that discussion why is it such a long delay?

The project might affect the community to some extent but since mitigation measure will be taken and compensation will be given to lost property we will support it.

Again we would like to see the dam and this electric transmission line constructed as soon as possible.

Ato Yadesa Dibe, Education and Capacity Building Office Head

We strongly support this project. The benefit is not only to our woreda but also to the Region and the country. This is a mega project where the benefit outweighs the damage. Our major concern is the delay in the implementation.

Ato Tadele Gudeta, Woreda Deputy House of Speaker

It is two years since we heard about the development of the hydropower and the delay is frustrating.

As mentioned the project gives advantage to Ethiopia, the Sudan and Egypt. Because it is developed jointly it has political and cultural advantage on top of economic benefits to the countries involved.

People affected in this project can be compensated and resettled. When they are resettled their life could not be worse what it had been and in most case it could be better than their previous life style.

The dam and the electric line can facilitate power trade and strengthen other trade among the countries eventually. This project brings multiple developments to our area. I would like to express our delight about the project and our office will provide the necessary support to the project.

Ato Alemu Yimer, Wored Office Head

In my opinion what has been mentioned and discussed here is valid but the main issue is when will this project be started? We would like to see the project implemented immediately.

Since this project is thought a good idea by the woreda administration and the people we would like to have continued consultation about the implementation and integration of the development with other woreda activities.

Ato Mamecha Kano, Community Elder

Please tell us the extent of the impacts what infrastructure, houses and other property is affected by the dam and the electric line.

The team recalled that no infrastructure is affected but about 120 families will be displaced by the Mandaya dam half of them in Amhara Region and reminded the participants that this was discussed with stakeholders during the study two years back. However, the transmission line route corridor will affect limited houses, crop land and forest resources. The line will be routed away from settlements, infrastructure and property and yet still there will be minimal impacts to the community. In case of any damage compensation shall be paid and proper mitigation measure will be taken.

Ato Anteneh, Woreda Administrator

Can the woreda get any advantage because of the power trade development?

Answer: The woreda might gain from the development taking place in the woreda and it gets benefits in the form of tax and improved infrastructures if investments are increased

Ato Tariku Melese, Woreda Court Office Head

The inundation of the dam could be major threat to the people and the woreda should be properly addressed. Is there land for resettlement in the woreda?

The project requires further discussion until all people of the woreda understand it properly.

Answer: The average population density of the woreda is about 5 / km² so land acquisition for the displaced due to dam and TLR corridor is not a problem in the woreda and the region.

Ato Debele Dano, Militia Office Head

To avoid future grievances and dispute the impacts should be clearly identified and disclosed. Proper mitigation measures should be studied.

Ato Tamene Bekere Woreda Public Relation

Impact on Dabus, marble and other development should be properly assessed and mitigated. Other than that the project should be implemented as soon as possible we support it.

Ato Mamecha

The impacts on the water habitat such as fish should be carefully assessed.

W/o Chimari Kitila (lady) Dweller

We support the project. The women think that if the project is implemented it will enhance development in our area that in turn will decrease the burden on women.

Women in these communities are the most disadvantaged.

Most of household and farm burden is borne by them. We are responsible for fetching fire wood and water. We travel a long distance to obtain them. If our communities get electricity and the area is developed that burden will decrease so we strongly support such development.

Figure 72 : Consultation in Sirba Abbay Woreda Administration Office

Participants in the Public Consultation at the Regional Level

Ethio-Sudan Transmission Line Routing

Public Consultation: List of Participants

Region: Benishangul-Gumuz
Woreda: Assosa.
Kebele: -
Date: 09/11/2000

No	Name	Organization/ Occupation	Telephone	Signature
1.	MEBRATU JANO	EPA / team leader	0911812739	
2	MURAD MIFTA	EPA A/head	0911707057	
3	Kelilem Ashrafi	WAO	0911704167	
4	TARIKU WOUBAYEHU	T/I/T/I	057 775 0357	
5	Beyene Alemu	RRA/Acting head	0577750326	
6	Nigatu Tadesse	planning & program	0912074066	
7	Zelalem . Mengesha	Saving & credit institution	0911907076	
8	Zerihun Teklu	B.C.I.C.T. planning	0913142232	
9	Asresahegn Abeje	F/S/P/S/D/P/P/O	0911712690	
10	ABUYE SHEKURE	" "	0917856456	
11	Tadele Terefe	Works & Urban Bu	0913056485	
12	Segenu Belede	BOCB	0913250130	
13	Dessalegn Regassa	Bureau of Health	0911433666	
14	ATom mhammed	Trand offes	0911905757	
15	IBRAHIM SIRAG	information/B	0911707056	
16	ZEWUD TEBEFA	Investment office	0911641749	
17	Dr. Mekonnen Golosa	BoAgriculture & RD	0911853004	
18	WOBHU BAKO	Youth and Sport B	0911015151	
19	Berhanu Garna	BOFED	0911156102	
20	Nasissa Wubetie	Education bureau	0911704201	
21	MINILIK Wube	Water Min Ene Bureau		
22	RAMADAN ASHENAFI	Admin Security Bureau		
23	Kinde Haile	Adm. offic	0577750141	

Participants in the Public Consultation in Menge Woreda Administration

Ethio-Sudan Transmission Line Routing

Public Consultation: List of Participants

Region: 6/ B/G
Woreda: Menge
Kebele: K 01
Date: 07/11/2000

No	Name	Organization/ Occupation	Telephone	Signature
1	[illegible]	[illegible]	[illegible]	[illegible]
2	TONI Ayele	M/Agri & R/D	–	[illegible]
3	BEGIDU ADNEIN	Menge w/c/B/Ed/office		[illegible]
4	Ahmed S/ed	" " F/E "		[illegible]
5	Adam Kitchil	M/ H/ H/O		[illegible]
6	Getachew Yitorih	information office	[illegible]	[illegible]
7	ISSA BESIRA	Menge finance	[illegible]	[illegible]
8	Hamid Atraeb	[illegible]		[illegible]
9	Jemenne wraJembe	wuman [illegible]		[illegible]
10	[illegible] BiRu BiDa	[illegible] wereda Police		[illegible]
11	[illegible]	[illegible]		[illegible]
12	[illegible]	[illegible]		[illegible]
13	[illegible]	[illegible]		[illegible]
14	Abeya Dame	Mange sup court		[illegible]
15	Missana gelene	[illegible]		[illegible]

Participants in the Public Consultation in Cherkole Woreda Administration

Ethio-Sudan Transmission Line Routing

Public Consultation: List of Participants

Region: Ben-Gumuz
Woreda: Cherkole
Kebele:
Date: 15/7/2008

No	Name	Organization/ Occupation	Telephone	Signature
1	[illegible]	[illegible]		
2	[illegible]	″		
3	[illegible]	″		
4	[illegible]	″		
5	[illegible]	″		
6	[illegible]	″		
7	[illegible]	[illegible]		
8	[illegible]	[illegible]		
9	[illegible]	[illegible]		
10	[illegible]	[illegible]		
11	[illegible]	[illegible]		
12	[illegible]	[illegible]		
13	[illegible]	[illegible]		
14	[illegible]	[illegible]		
15	[illegible]	[illegible]		
16	[illegible]	″		
17	[illegible]	[illegible]		
18	[illegible]	″		
19	[illegible]	[illegible]		
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21	[illegible]	[illegible]		
22	[illegible]	[illegible]		
23	[illegible]	[illegible]		
24	[illegible]	″		
25	[illegible]	[illegible]		
26	[illegible]	[illegible]		
27	[illegible]	[illegible]		
28	[illegible]	[illegible]		
29	[illegible]	[illegible]		
30	[illegible]	[illegible]		
31	[illegible]	[illegible]		
32				
33				

Participants in the Public Consultation in Oda Bilugidilu Woreda Administration

Ethio-Sudan Transmission Line Routing

Public Consultation: List of Participants

Region: Benishangul Gumuz.
Woreda: ODA Gaadere
Kebele:
Date: 19/07/2008

No	Name	Organization/ Occupation	Telephone	Signature
1	[illegible]	[illegible]		
2	[illegible]	[illegible]		
3	[illegible]	[illegible]		
4	[illegible]	[illegible]		
5	[illegible]	[illegible]		
6	[illegible]	[illegible]		
7	[illegible]	[illegible]		
8	[illegible]	[illegible]		
9	[illegible]	[illegible]		
10	[illegible]	[illegible]	[illegible]	
11	[illegible]	[illegible]		
12	[illegible]	׳׳ ׳׳		
13	[illegible]	׳׳ ׳׳		
14	[illegible]	׳׳ ׳׳		
15	[illegible]	׳׳ ׳׳		
16	[illegible]	׳׳ ׳׳		
17	[illegible]	[illegible]		
18	[illegible]	[illegible]		
19	[illegible]	[illegible]		
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21	[illegible]	[illegible]		
22	[illegible]	[illegible]		
23	[illegible]	׳׳		
24	[illegible]	׳׳		
25	[illegible]	׳׳		
26	[illegible]	׳׳		
27	[illegible]	׳׳		
28	[illegible]	׳׳		
29	[illegible]	׳׳		
30	[illegible]	׳׳		
31	[illegible]	׳׳		
32	[illegible]	׳׳		
33	[illegible]	[illegible]		

Annex 1.5: Participants in the Public Consultation in Sirba Abbay Woreda Administration

Ethio-Sudan Transmission Line Routing

Public Consultation: List of Participants

Region:
Woreda: S. Be Abby
Kebele:
Date: 21/07/08

No	Name	Organization/ Occupation	Telephone	Signature
1	[illegible]	[illegible]	0981190316	
2	Haile Badur	Sirba Abaye woreda	0981190325	
3	Mussa Awol	" " "	0981140325	
4	Tadele Geleta	Deputy speaker		
5	DEBELI DINO	[illegible]		
6	TESO KARA	[illegible]		
7	[illegible]			
8	[illegible]	[illegible]		
9	[illegible]	Head office		
10	[illegible]	[illegible]		
11	[illegible]	[illegible]		
12	[illegible]	[illegible]		
13	[illegible]	" "		
14	[illegible]	[illegible]		
15	[illegible]	" [illegible]		
16	[illegible]	" [illegible]		
17	Yalelet Alemeh	[illegible]	[illegible]	
18	Tarikke MELESE	[illegible]	"	
19	[illegible]	[illegible]	"	
20	[illegible]	[illegible]		
21	[illegible]	[illegible]	[illegible]	
22	[illegible]	[illegible]	" "	
23	EMIRU Amolla	head health office	" "	
24	[illegible]	[illegible]	" "	
25	[illegible]	[illegible]	" "	
26	Yadeta Dibi	Sirba Abay Education	0981190325	
27	[illegible]	[illegible]	[illegible]	
28	[illegible]	[illegible]		

Appendix I
Minutes of Meetings with Stakeholders in Egypt

Meeting with Main Power Sector Institution (EEHC)

Notes For The Discussion With Egyptian Electricity Holding Company Eng. Fawzia Abou Neima, EEHC Board Member, On Sunday 17th August 2008 At Egyptian Electricity Holding Company Offices In Cairo

The meeting started with a brief discussion of the Eastern Nile Power Trading initiative on the proposed transmission line. As the Official was well aware of the different aspects of the ENTRO project, the Scott Wilson / EPS team went ahead to ask Eng. Fawzia to help the team with some key environmental consideration they should take into account during the study.

Eng. Fawzia therefore reminded the team that it was important that at feasibility level the following considerations should be taken into account air quality aspects, water quality aspects and various population aspects in the route of the power line. In cases where necessary, public hearing meetings would be called to ensure the people fully understand the project, and the commencement of the project would be smooth without anyone objecting or protesting. However, she pointed out that the nature of impacts of transmission line may not call for objections like other projects. She reminded the team on the importance of ensuring recommended clearances as stipulated in the law; this will ensure protection of the power lines and the people. Eng. Fawzia provided a copy of the law on recommended power line clearances.

The Team requested Eng. Fawzia to highlight the compensation procedure in power line projects. As response to this, she outlined the procedure as laid down by the law. The Committee is constituted by the regional government in the area. The permanent committee, comprising all key sectors, will undertake compensation assessments and valuations and recommend to the developer the amount that should be given to the affected people as compensation. Then the Electricity company would pay the compensation. Only in the case that people resist the compensation, when the case is take to the President who would make a decree concerning the project, on public use and benefit of the people. She pointed out that such cases were very rare, that in most cases negotiations are done and agreements reached with the affected people.

Brief on the Discussion With Eng. Ismaeil Hassan Teleb, Vice Chairman of Egyptian Electricity Transmission Co. Southern Area – 16th August 2008, 14.00 Hrs at the ETC. Offices

The meeting commenced with a brief on the Eastern Nile Power Trade project of the transmission line from Ethiopia, through Sudan to Egypt. The line will have 2 X 500 kV double circuit AC lines from Mandaya in Ethiopia to Rabak in Sudan (570km), to the DC Converter station which will be located at Rabak. The line will then become an 800kV DC line from Rabak, Sudan to Nag Hammadi in Egypt (1,6506 km)

Eng. Teleb then welcomed the delegation of went on to introduce the project which is under discussion with the Ministry of Electricity and Energy of establishing a 500 kV Substation at the area between Nag Hammadi and Aswan. The planned line will solve a lot of electricity demand problems in the area. He further informed the team that he had already acquired the piece of land needed for the substation. He welcomed the idea of this line because it was going to fit in very well with the plans he has for the Southern Region.

The team then brought Eng. Teleb attention to the points of discussion on the agenda. On the voltage levels and associated clearance levels, he referred the team to the Egyptian Standard that stipulates all the required information. He was quick to point out that no buildings are allowed under transmission lines; however agricultural activities were allowed under the lines except for areas taken up by the tower foundations.

The approval procedures for transmission line projects were also outlined which start with studies and detailed discussions with all the electricity holding companies, followed by obtaining of land and way leaves from the Army and any relevant authorities. Since transmission line projects have minimal impacts, the discussions with Stakeholders are limited to only key and relevant stakeholders. The magnetic field considerations are attended to at design stage.

On relevant issues considered during compensation Eng. Teleb Indicated that the main aspect is the land taken up the tower foundations, now they have tested design of foundations at 66kV and 220kV which take up less area to ensure less compensation to affected stakeholders. The compensation is by both as stipulated in the law, but also sometimes by mutual discussion with the owners of the land or property. The Electricity Company pays compensation.

Notes for the Discussion With Egyptian Electricity Holding Company Eng. Abdel Rahim A. Helmi Hamza, Managing Director, Electrical Network Studies on Sunday 17th August 2008 at Egyptian Electricity Holding Company Offices in Cairo

The meeting started with a brief discussion on the Eastern Nile Power Trading initiative on the proposed transmission line. As the Official sits on the Technical Committee of ENTRO, he was well aware of the different aspects of the project. Therefore the Scott Wilson / EPS team went ahead to allow Eng. Hamza to give a brief on the Electricity System of Egypt.

Eng. Hamza outlined the power voltages in Egypt as follows: 500kV -which is the main backbone of the Transmission network in Egypt; 220 kV; 132 kV - this is in the process of being upgraded to 220kV and; 66kV - which feed the distribution network. He further went ahead to highlight the main reason why Nag Hammadi was chosen as a terminal point for the ENTRO line, this was because it is an important load centre with major industries such as the Aluminium Plant.

Eng. Hamza highly recommended that the proposed DC line should come in with the 500 kV because that is the highest voltage level in Egypt. He gave the following reasons for his proposal: that the 800 kV line would be too costly and that it has never been used before in Africa; the N-1 criterial standard of Egypt in case of an outage, if you loose 1,000 kW, the system can still be able to stand to avoid black out. However the team reminded Eng. Hamza, that since he sits on the Technical committee, this is a matter he can be able to bring up the next time the committee meets. The team promised to take note of the matter.

Eng. Hamza then gave highlights of countries in the region with whom Egypt is trading power with and also gave highlights of the future regional power trading plans.

Meeting at Governorate of Qena

Summary of discussion with the Qena Local Government Officials on 19th August 2008 in the town of Qena Officials Present:

1.	His excellence Mr. Magdy Ayoob, the Governor	
2.	Mr. Fayez Abdel Aziz	General Secretary
3.	Eng. Dhareeh Hashim	Road and Bridge Authority
4.	Eng. Jehfer Taha	Directorate of Roads
5.	Dr. Husien Farghaly	Undersecretary, Ministry of Health
6.	Mr. Zakaria Mohamed	Undersecretary, Ministry of Social Affairs
7.	Miss Zainab Mohamed	Environmental Office of Qena

The EPS team gave a brief of the project to the officials.

The Officials were generally happy about the project; however there was a strong recommendation for the Project to have close consultation with the Ministry of Development in Cairo which has the future development plans for the area to ensure that the route of the project does not conflict with the future development plans. The Governor expressed a desire to be involved at every level of the project.

The Environmental Office officially emphasized the need of the project take care of the road crossings and to keep a safe distance when proposed line is running adjacent to the roads and other infrastructure.

Meeting at South Valley University

On Monday 18 August at 03:00 pm the team has visited the south valley university and met with the president of the university, who has a good back ground of academic studies of environment.

The vice president for environmental affaires was invited to this meeting.

The team described the proposed project and many points were raised during the meeting, the university president appreciates the subject and they are interested to participate in this study. The University President indicated that the Institution was an important depository of vital baseline information for the proposed route corridor.

Meeting at Aswan Environmental Sector

The meeting started with a brief discussion on the project description and beneficial for all three countries. The Environmental Office officials emphasized on the important of environmental studies for the new project and its impacts for air quality, water quality and population aspects at the route of the transmission line. The Officials emphasised the need for monitoring of baseline conditions and conditions during the implementation of the project

They mentioned that, they are ready to help for any issues of the environment aspects at line corridor.

General Authority

For Roads Bridges and Land Transport (GARBLT)

Central Department for the eighth Zone

Professor / Director of the EMU

Dear, Sir
Referring to the meeting held on Monday 18/8/2008 Concerning Special high-voltage line project funded by ADB.

Please note that the project does not conflict with the main road network, with the need to take into account when implementing the following:

1. The distance from the edge of the asphalt of the road west desert be not less than 250 meters.

2. When intersecting the high voltage main line with the main roads, the wire must not be less than 6 meters from the surface.

Please kindly take that in consideration and your instruction to the necessary

Please accept my sincere respect

in 24/8/2008

President Aladarhantrsais

Engineer /

Gharib Abdel-Majid Hashim

Qena Governorate

Directorate of Road and Transport

Mr. /General Secretary in Qena

(Office of Environmental Affairs)

Dear Sir,

Referring to phone reporting to the Directorate on 21/8/2008 concerning the meeting that was held on Monday 18/8/2008 and the subject was " private high-voltage line project " funded by ADB.

Kindly informed that Directorate have direction for completing the studies or implementation of the project.

We hope to be briefed.

Please accept my sincere

Director-General

Engineer / Taha Ahmed Abdul Rahim

Appendix J
Landsat 7 ETM (Satellite Imagery)

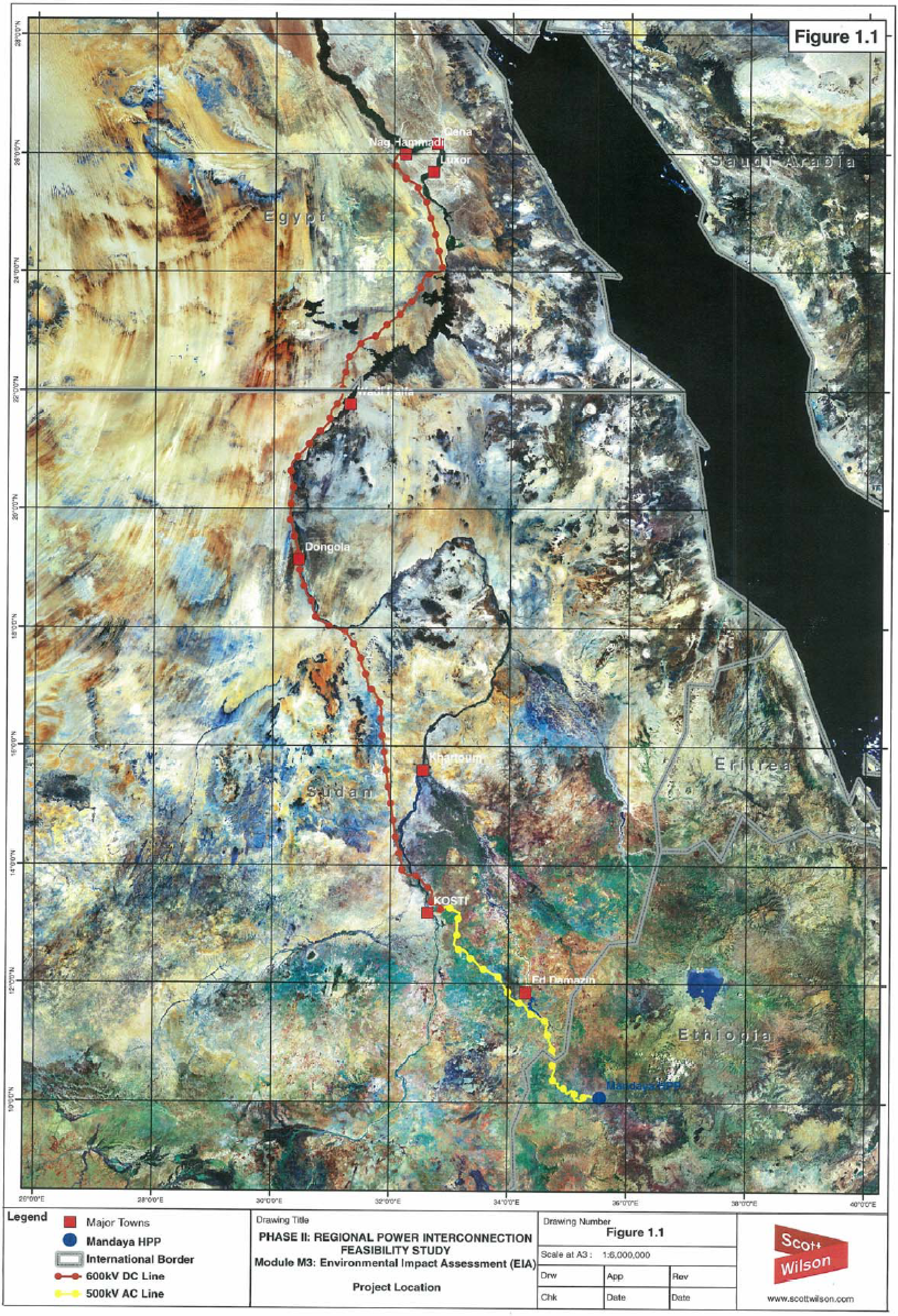
Figure 1.1
Nag Hammadi
Qena
Luxor
Saudi Arabia
Egypt
Wadi Halfa
Dongola
Khartoum
Sudan
Eritrea
KOSTI
Ed Damazin
Ethiopia
Mandaya HPP
28°0'0"N
26°0'0"N
24°0'0"N
22°0'0"N
20°0'0"N
18°0'0"N
16°0'0"N
14°0'0"N
12°0'0"N
10°0'0"N
26°0'0"E
28°0'0"E
30°0'0"E
32°0'0"E
34°0'0"E
36°0'0"E
38°0'0"E
40°0'0"E
Legend
Major Towns
Mandaya HPP
International Border
600kV DC Line
500kV AC Line
Drawing Title
PHASE II: REGIONAL POWER INTERCONNECTION FEASIBILITY STUDY
Module M3: Environmental Impact Assessment (EIA)
Project Location
Drawing Number
Figure 1.1
Scale at A3 : 1:6,000,000
Drw
App
Rev
Chk
Date
Date
Scott Wilson
www.scottwilson.com

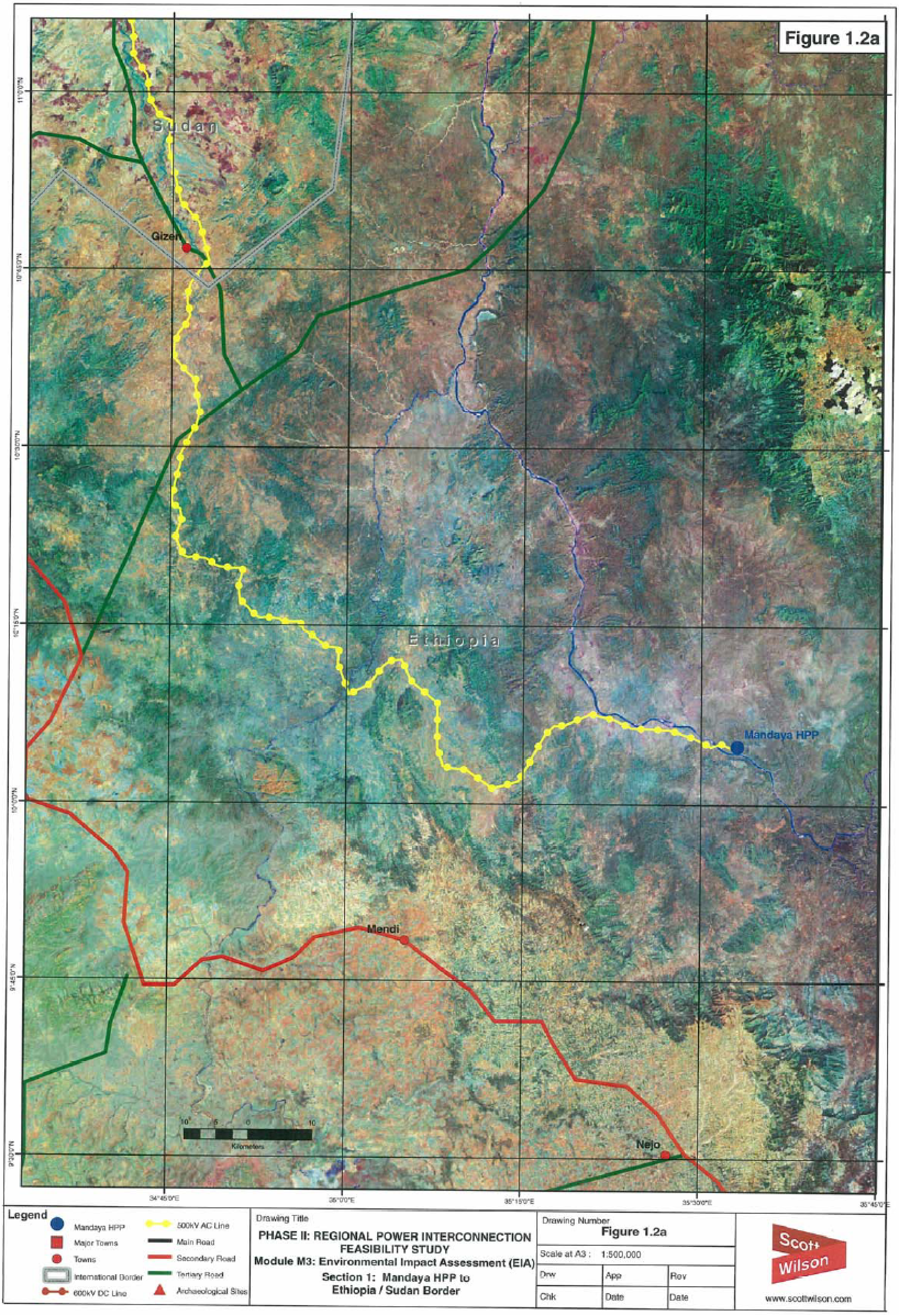
Figure 1.2a
Sudan
Gizen
Ethiopia
Mandaya HPP
Mendi
Nejo
11°0'0"N
10°45'0"N
10°30'0"N
10°15'0"N
10°0'0"N
9°45'0"N
9°30'0"N
34°45'0"E
35°0'0"E
35°15'0"E
35°30'0"E
35°45'0"E
10 5 0 10
Kilometers
Legend
Mandaya HPP
Major Towns
Towns
International Border
600kV DC Line
500kV AC Line
Main Road
Secondary Road
Tertiary Road
Archaeological Sites
Drawing Title
PHASE II: REGIONAL POWER INTERCONNECTION FEASIBILITY STUDY
Module M3: Environmental Impact Assessment (EIA)
Section 1: Mandaya HPP to Ethiopia / Sudan Border
Drawing Number
Figure 1.2a
Scale at A3 : 1:500,000
Drw
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Rev
Chk
Date
Date
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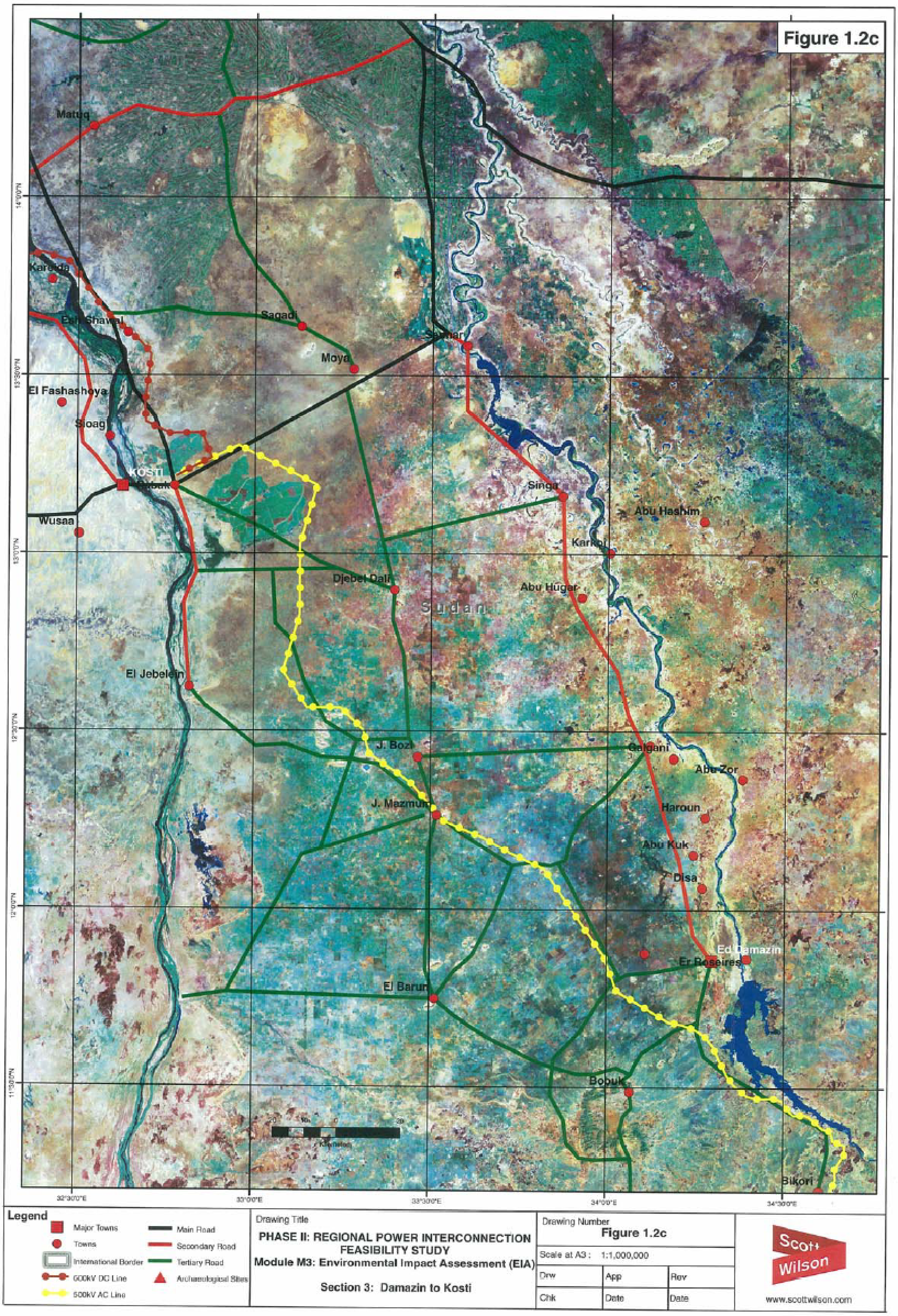
Figure 1.2b
Haroun
Abu Kuk
Disa
Ed Damazin
Er Roseires
Sudan
Bikori
Kelli
Gizen
Ethiopia
Kilometers
34°0'0"E
34°15'0"E
34°30'0"E
34°45'0"E
35°0'0"E
Legend
Major Towns
Towns
International Border
600kV DC Line
500kV AC Line
Main Road
Secondary Road
Tertiary Road
Archaeological Sites
Drawing Title
PHASE II: REGIONAL POWER INTERCONNECTION FEASIBILITY STUDY
Module M3: Environmental Impact Assessment (EIA)
Section 2: Ethiopia / Sudan Border to Damazin
Drawing Number
Figure 1.2b
Scale at A3 : 1:500,000
Drw
App
Rev
Chk
Date
Date
Scott Wilson
www.scottwilson.com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Matuq
Kareida
Esh Shawal
Sagadi
Moya
Sennar
El Fashashoya
Sioag
KOSTI
Rabak
Wusaa
Singa
Abu Hashim
Karkoj
Djebel Dali
Abu Hugar
Sudan
El Jebelein
J. Bozi
Galgani
Abu Zor
J. Mazmum
Haroun
Abu Kuk
Disa
Ed Damazin
Er Roseires
El Barun
Bobuk
Bikori
Legend
Major Towns
Towns
International Border
600kV DC Line
500kV AC Line
Main Road
Secondary Road
Tertiary Road
Archaeological Sites
Drawing Title
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Module M3: Environmental Impact Assessment (EIA)
Section 3: Damazin to Kosti
Drawing Number
Figure 1.2c
Scale at A3 : 1:1,000,000
Drw
App
Rev
Chk
Date
Date
Scott Wilson
www.scottwilson.com

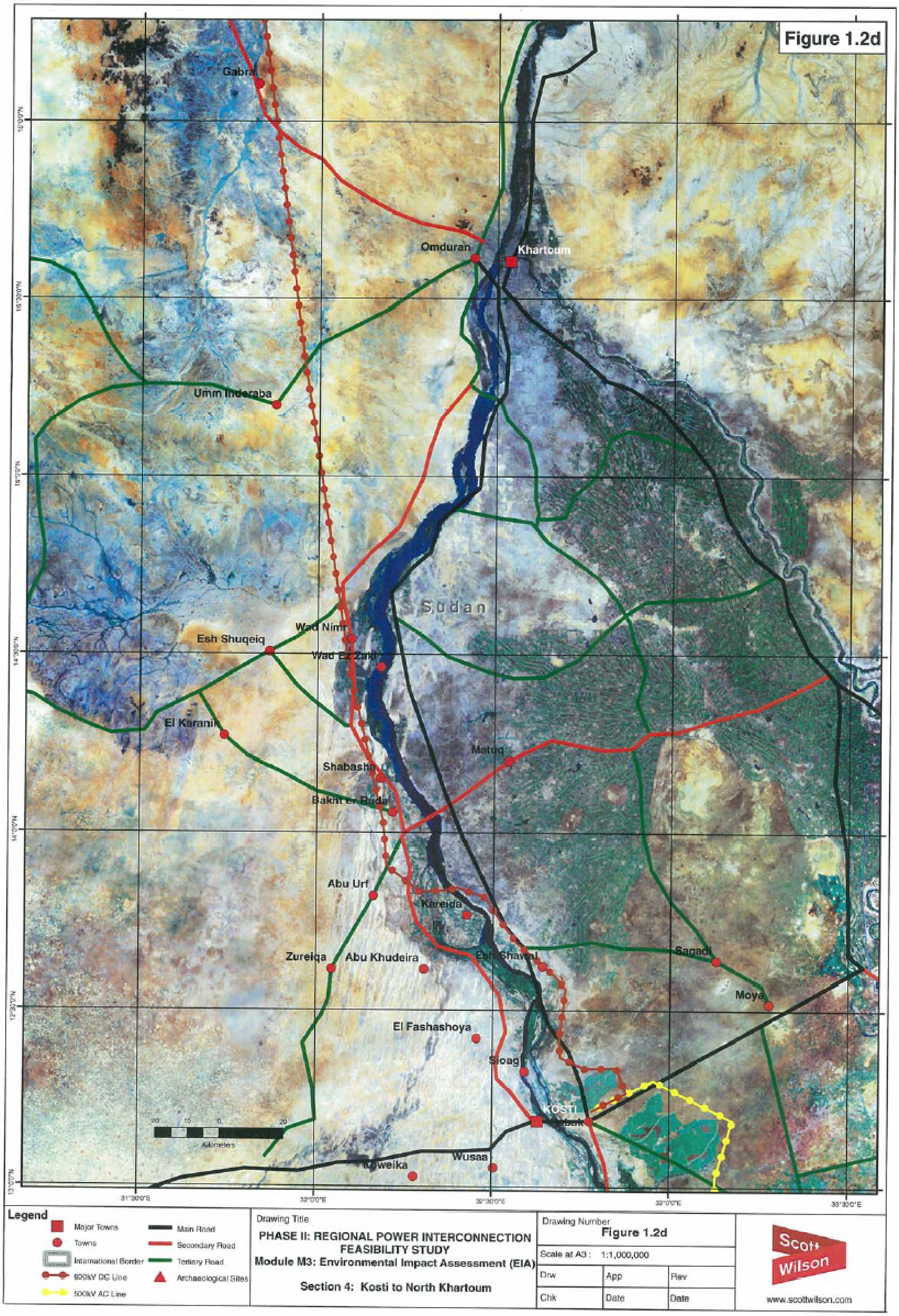
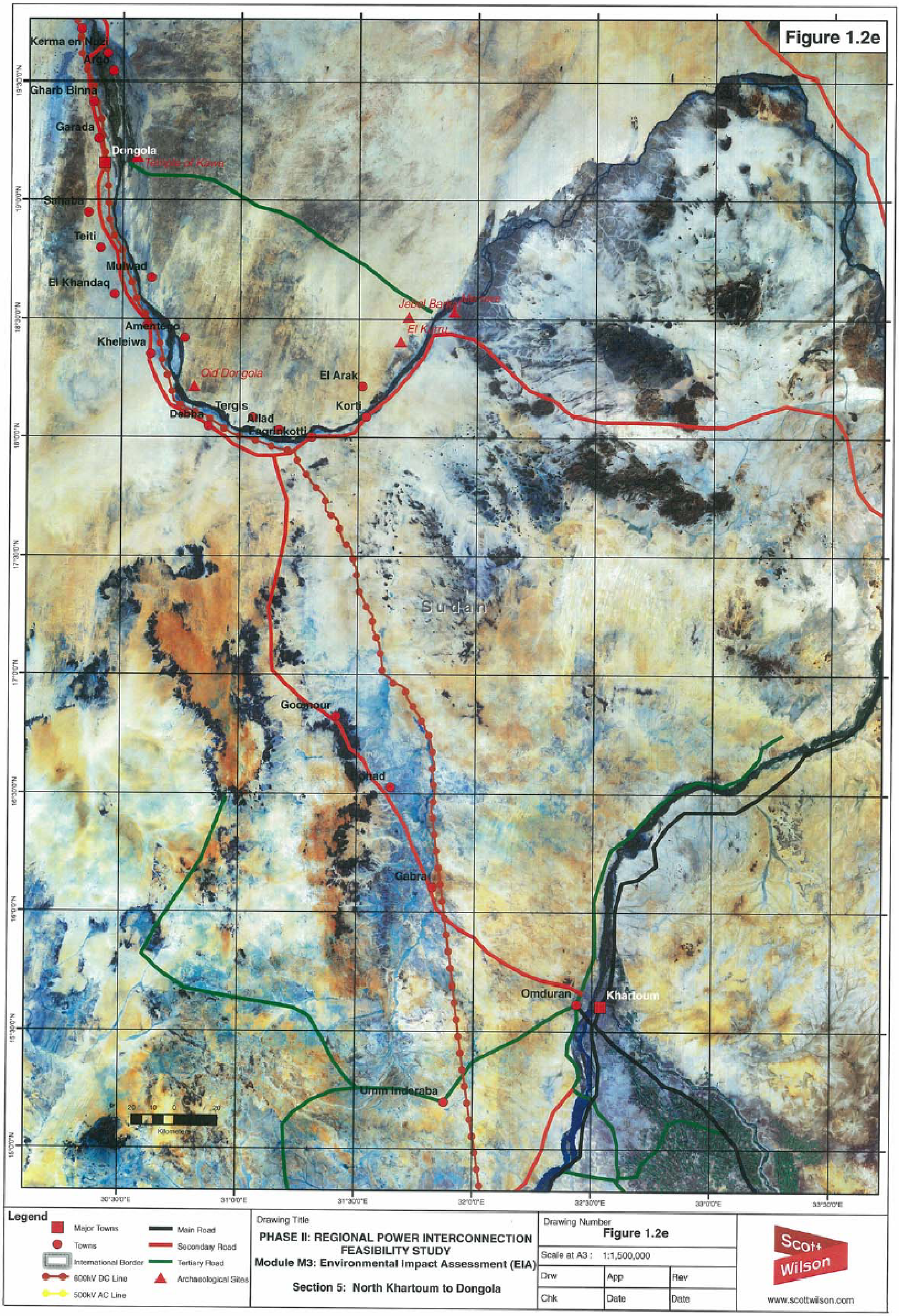


Figure 1.2d
Gabra
Omduran
Khartoum
Umm Inderaba
Sudan
Esh Shuqeiq
Wad Nimr
Wad Ez Zaki
El Karanik
Matuq
Shabasha
Bakht er Ruda
Abu Urf
Kareida
Zureiqa
Abu Khudeira
Esh Shawal
Sagadi
Moya
El Fashashoya
Sloag
KOSTI
Wusaa
Kilometers
Legend
Major Towns
Towns
International Border
600kV DC Line
500kV AC Line
Main Road
Secondary Road
Tertiary Road
Archaeological Sites
Drawing Title
PHASE II: REGIONAL POWER INTERCONNECTION FEASIBILITY STUDY
Module M3: Environmental Impact Assessment (EIA)
Section 4: Kosti to North Khartoum
Drawing Number
Figure 1.2d
Scale at A3 : 1:1,000,000
Drw
App
Rev
Chk
Date
Date
Scott Wilson
www.scottwilson.com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Kerma en Nuzi
Argo
Gharb Binna
Garada
Dongola
Temple of Kawa
Sahaba
Teiti
Mulwad
El Khandaq
Amentego
Kheleiwa
Old Dongola
El Arak
Korti
Tergis
Dabba
Allad
Fagrinkotti
Jebel Barkal
Merowe
El Kurru
Sudan
Goomour
Gabra
Omduran
Khartoum
Umm Inderaba
Kilometers
Legend
Major Towns
Towns
International Border
600kV DC Line
500kV AC Line
Main Road
Secondary Road
Tertiary Road
Archaeological Sites
Drawing Title
PHASE II: REGIONAL POWER INTERCONNECTION FEASIBILITY STUDY
Module M3: Environmental Impact Assessment (EIA)
Section 5: North Khartoum to Dongola
Drawing Number
Figure 1.2e
Scale at A3 : 1:1,500,000
Drw
App
Rev
Chk
Date
Date
Scott Wilson
www.scottwilson.com

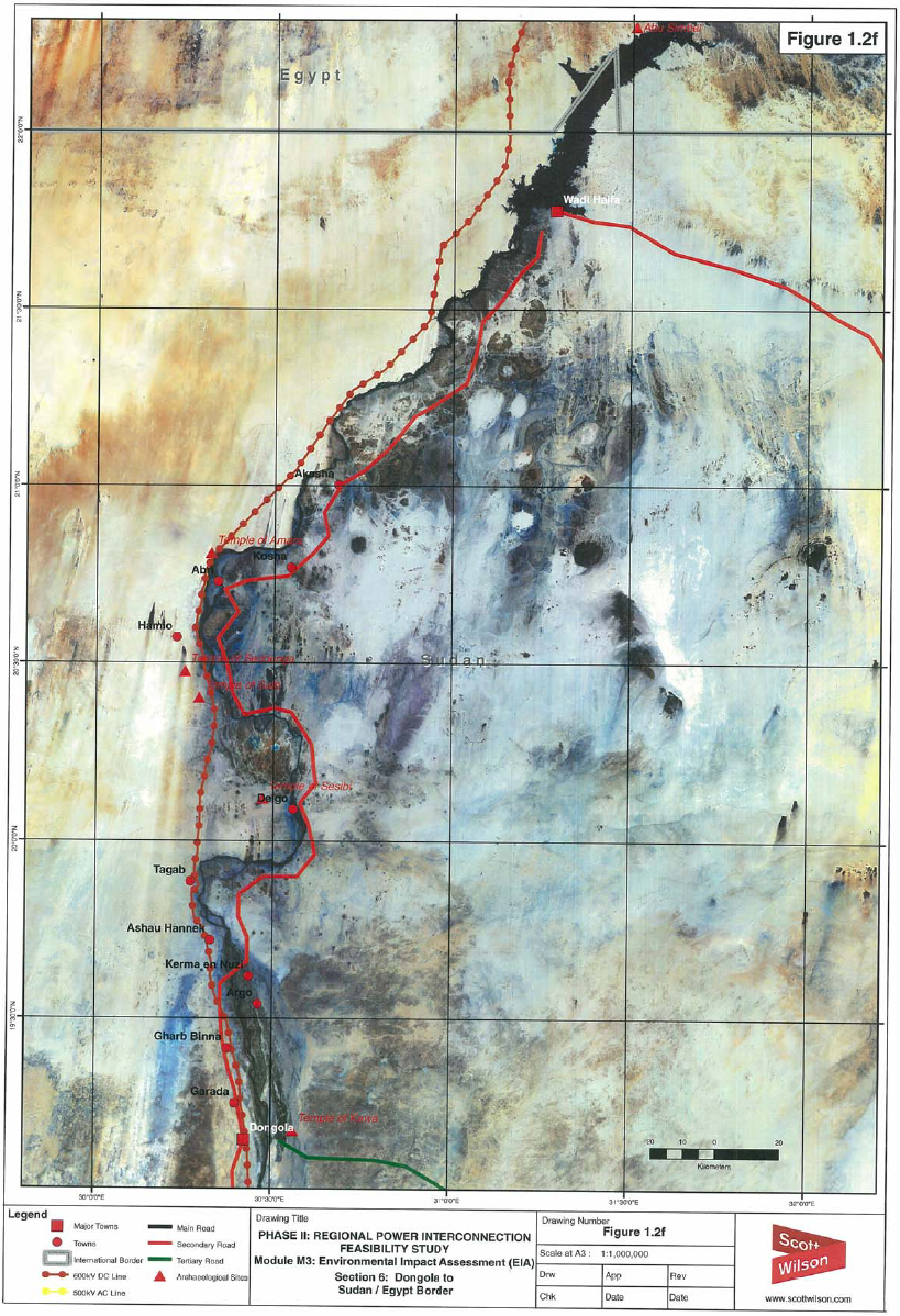
Figure 1.2f
Egypt
Sudan
Wadi Halfa
Akasha
Temple of Amara
Kosha
Abri
Hamlo
Delgo
Temple of Sesibi
Tagab
Ashau Hannek
Kerma en Nuzl
Argo
Gharb Binna
Garada
Dongola
Temple of Kawa
Kilometers
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31°30'0"E
32°0'0"E
Legend
Major Towns
Towns
International Border
600kV DC Line
500kV AC Line
Main Road
Secondary Road
Tertiary Road
Archaeological Sites
Drawing Title
PHASE II: REGIONAL POWER INTERCONNECTION FEASIBILITY STUDY
Module M3: Environmental Impact Assessment (EIA)
Section 6: Dongola to Sudan / Egypt Border
Drawing Number
Figure 1.2f
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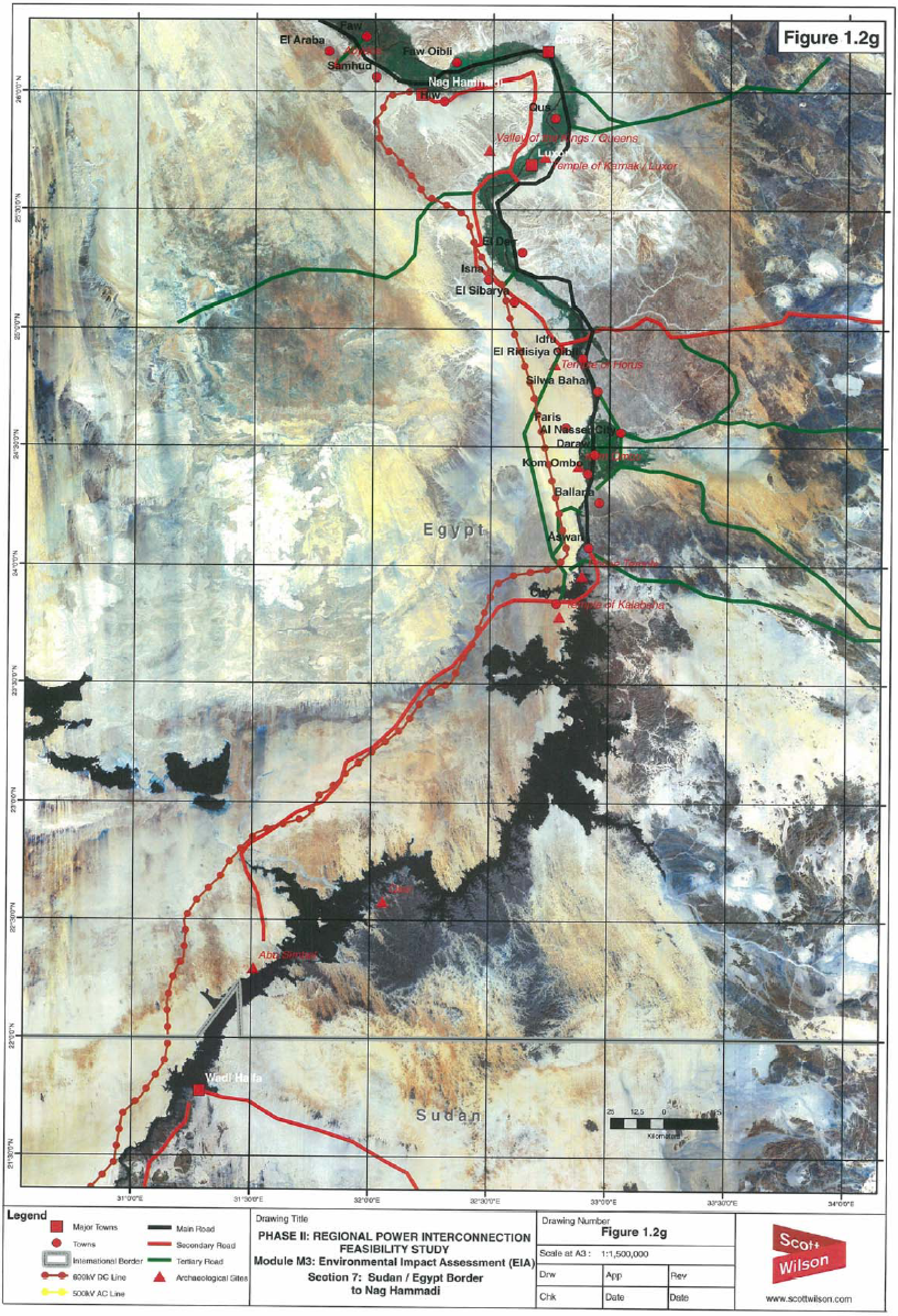
Figure 1.2g
El Araba
Faw
Faw Oibli
Samhud
Qena
Nag Hammadi
Hiw
Qus
Valley of the Kings / Queens
Luxor
Temple of Karnak / Luxor
El Deir
Isna
El Sibarya
Idfu
El Ridisiya Oibli
Temple of Horus
Silwa Bahari
Faris
Al Nasser City
Daraw
Kom Ombo
Ballana
Egypt
Aswan
Temple of Kalabsha
Abu Simbel
Wadi Halfa
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Legend
Major Towns
Towns
International Border
600kV DC Line
500kV AC Line
Main Road
Secondary Road
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Archaeological Sites
Drawing Title
PHASE II: REGIONAL POWER INTERCONNECTION FEASIBILITY STUDY
Module M3: Environmental Impact Assessment (EIA)
Section 7: Sudan / Egypt Border to Nag Hammadi
Drawing Number
Figure 1.2g
Scale at A3 : 1:1,500,000
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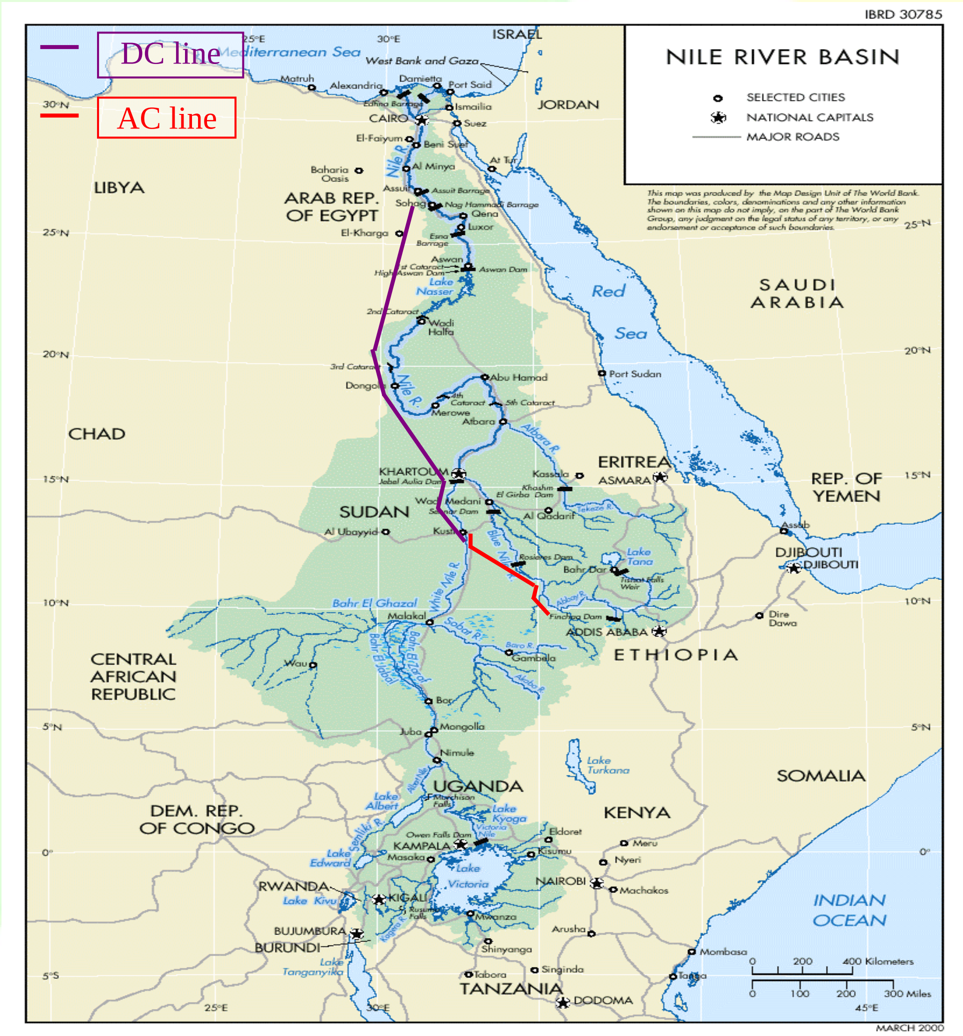
Nile Basin Initiative
Eastern Nile Subsidiary Action Program
Eastern Nile Technical Regional Office

EASTERN NILE POWER TRADE PROGRAM STUDY



M6 - PHASING & ARRANGEMENT

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ABBREVIATIONS AND ACRONYMS

AC	Alternative Current
ASCR	Aluminium Conductor steel Reinforced
DC	Direct Current
DCS	Distributed Control System
EDF	Electricité de France
EHV	Extra High Voltage
EN	Eastern Nile
ENTRO	Eastern Nile Technical Regional Office
GPS	Global Positioning System
HMI	Human Machine Interface
HPP	Hydro Power Plant
HV	High Voltage
HVDC	High Voltage Direct Current
ICCP	Institute for Certification of Computing Professionals
IEC	International Engineering consortium
LAN	Local Area Network
LV	Low Voltage
MMI	Man Machine Interface
NBI	Nile Basin Initiative
OHL	Over Head Line
O&M	Operation and Maintenance
OPGW	Optical Ground Wire
PDH	Plesiochronous Digital hierarchy
SCADA	Supervisory Control And Data Acquisition
SDH	Synchronous Digital Hierarchy
SVC	Static Voltage Compensator
TSO	Transmission System Operator

EXECUTIVE SUMMARY

This document, corresponding to Module 6 Phasing and Arrangement, provides with proposals regarding for the construction of the interconnection.

Two scenarios are introduced, with or without anticipation. In the scenario called with anticipation, Ethiopia and Sudan are interconnected by 2015 through one line of AC 500kV double circuits. The main steps of interconnection development are :

- Scenario without anticipation
  - Commissioning in 2020 of the whole interconnection
  - Commissioning in 2030 of Border connection
- Scenario with anticipation
  - Commissioning in 2015 of the anticipated interconnection part between Ethiopia and Sudan
  - Commissioning in 2020 of the whole interconnection
  - Commissioning in 2030 of Border connection

An implementation arrangement is proposed in this Phasing and Arrangement study depending on cost estimates and estimated time to execute the works, engineering, procurement, control and management activities for line and station buildings.

The report is based on the hypothesis that:

- There will be different contractors depending the specified works (OHL or Substation).
- One contractor per country for the OHL construction.
- For HVDC and Electrode station in Nag Hammadi and Kosti, theses works are in the same lot in order to have the same company and no compatibility issue for DC equipments.
- In Nag Hammadi, the construction of 500 kV substation and the connection of HVDC station to existing Nag Hammadi substation is affected to the same lot of the HVDC station building.
- One main control centre will be in charge of interconnection supervision, supported by a back-up centre. These monitoring facilities will be connected to each above element of interconnection by means of a telecommunication backbone (optical fiber) and Digital Control Systems, that will be also used for local station and transmission line control.
- The proposed arrangement is optimised and it will be a challenged implementation. The implementation took account that each lots could be sub-contracted and that some works could be executed only during 8 months per year due to rainy season, for example overhead line section building between Kosti and Khartoum.

The arrangement works of Egypt/Ethiopia/Sudan interconnection are divided in ten lots: five for Over Head Lines AC/DC construction, four for AC/DC substation and one for control centre and appropriate supervising equipments.

The phasing introduced in this document considers the time for study validation and works construction. The different dates did not take account the bidding process (validation of study, Tender documents, etc) for construction and consulting services.

1 GENERAL REQUIREMENTS

1.1 GENERAL

This section provides general description on the phasing and arrangement for the regional interconnection project between Ethiopia, Sudan and Egypt.

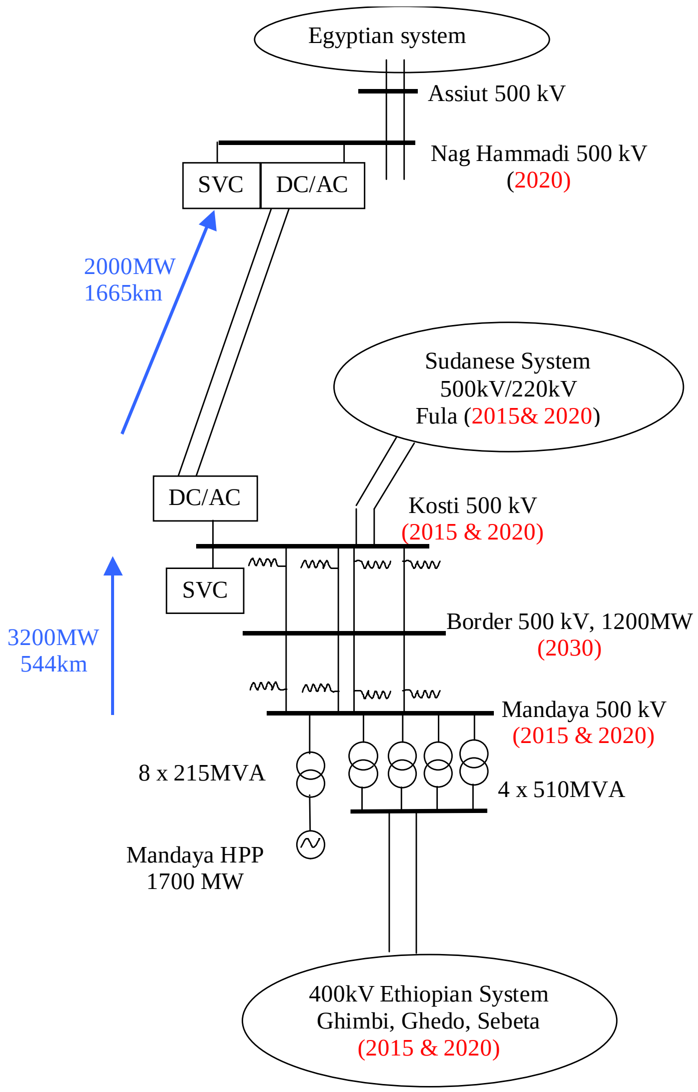


Figure 1 : Interconnection Scheme and Schedule

1.2 SCENARIO WITHOUT ANTICIPATION

1.2.1 STEP 1 COMMISSIONING IN 2020

- Construction of Mandaya 500/400 kV substation equipped with four 510MVA transformers.
- Construction of Kosti AC-DC 500 kV substation.
- Construction of Kosti HVDC and electrode station.
- Construction of Kosti SVC.
- Construction of double line 500 kV double circuits line Mandaya to Kosti and connection to Kosti 500 kV substation.
- Mandaya to Sebbetta connection with a 400 kV double circuit line through Gheddo substation.
- Preparation of the future 500 kV Border substation connection.
- Mandaya HPP to Mandaya 500 kV substation connection.
- Construction of Nag Hammadi HVDC and electrode station.
- Construction of one bipole ± 600 kV line Kosti to Nag Hammadi and connection to Nag Hammadi HVDC station .
- Connection to Nag Hammadi 500kV substation.
- Building of a monitoring infrastructure (control centers (centralized), telecom links, remote terminal units at stations).

1.2.2 STEP 2 COMMISSIONING IN 2030

- Connection of Border HPP to the interconnector without significant shutdown duration of the interconnector.

1.3 SCENARIO WITH ANTICIPATION

1.3.1 STEP 1 COMMISSIONING IN 2015

- Construction of Mandaya 500/400 kV substation building equipped with two 510 MVA transformers.
- Construction of Kosti AC/DC 500 kV substation
- Construction of one line 500 kV double circuits line Mandaya to Kosti and connection to Kosti 500 kV substation.
- Mandaya to Sebbetta connection with a 400 kV double circuit line through Gheddo substation.
- Preparation of the future 500 kV Border substation connection.
- End of commissioning part 1 of control centers and corresponding telecom facilities.

1.3.2 STEP 2 COMMISSIONING IN 2020

- Mandaya HPP to Mandaya 500 kV substation connection
- Installation of the two complementary 500/400 kV transformers in Mandaya substation.
- Installation of a second 500 kV double circuit line from Mandaya to Kosti 500 kV substation.
- Construction of Kosti HVDC and electrode station.
- Construction of Kosti SVC.
- Construction of Nag Hammadi HVDC and electrode station.
- Construction of one bipole ± 600 kV line Kosti to Nag Hammadi and connection to Nag Hammadi HVDC station .
- Connection to Nag Hammadi 500kV substation.
- Entire commissioning of control centers and corresponding telecom facilities.

1.3.3 STEP 3 COMMISSIONING IN 2030

- Connection of Border HPP to the interconnector without significant shutdown duration of the interconnector.

2 LOTS DESCRIPTION

2.1 LOT 1 (SVC)

The scope of work for Lot 1 contract is the supply of a turn-key complete turn-key Static Var Compensator (SVC), connected at the Kosti Substation (Sudan).

The successful Bidder shall be responsible for the design, engineering, fabrication, delivery, civil works, erection, installation, testing commissioning and field verification of the SVC.

All equipments shall be designed as needed to meet the requirements in this Specification. Any equipment and/or function of the SVC not specifically specified herein should be designed as required by the overall design of the SVC system in order to ensure the satisfactory operation of the same.

The successful Bidder's Scope of Works shall include all equipment up to and including the pads of the breaker connecting the SVC to the 500 kV main bus.

In particular the following is to be included in the successful Bidder's Scope of Works:

1. All engineering, fabrication and supply of the components of the SVC, their assemblies and accessories.
2. The thyristor valves for reactive power control, including their protection, control, monitoring and cooling system.
3. All reactors and capacitor banks as required by the design.
4. Harmonic filters as required by the specified harmonic performance levels.
5. Surge protection as required.
6. All power transformers required by the SVC system.
7. All instrument transformers as required.
8. All circuit breakers and disconnect switches as required.
9. All switchgear equipment on the primary side of the step-down transformer, incl. circuit breakers, disconnect switches, instrument transformers, surge arresters, etc., as required.
10. All necessary equipment for the control, protection, signaling and measurement system of the SVC and its interface to the Customer network control, as required. (using compliant telecommunication protocol with control centers).
11. System for fault recording as required.
12. Operator's interface (HMI) as required.
13. Auxiliary AC and DC power distribution, including protection, batteries and chargers as required.
14. An automatic switch between the two Customers supplied AC feeders (if applicable).

15. Surge protection and overhead lightning protection of the SVC yard as required.
16. SVC yard lighting as required.
17. All equipment support structures and foundations as well as trenches, as required.
18. All bus work including steel structures, foundations, insulators, connectors, joints, fittings etc., as required.
19. A ground mat installed at the SVC yard, and connected to the existing substation ground mat.
20. All power and control cables for the equipment in the SVC yard.
21. Complete SVC building with foundation, plumbing, lighting, fire protection and electrical outlets as well as facilities for ambient temperature and humidity control, as required.
22. Any other equipment and engineering required for the proper functioning of the SVC.

The successful Bidder shall furnish recommended spare parts for the SVC system as well as all special tools needed for the maintenance of the SVC, as required. The scope of spare parts and special tools must be coordinated with the requirements/guarantees for reliability and availability (refer to Section 6 below).

The following services shall be part of the successful Bidder's Scope of Works:

1. Delivery of all equipment under the Scope of Works to the Site at Kosti Substation as well as the civil works, erection, installation, assembly, commissioning and field verification of all equipment supplied as required to form a complete SVC system.
2. Design and installation of a proper ground mat at the site. The grounding mat is to be connected to the existing grounding system in the substation
3. Commissioning of the complete SVC.
4. Testing of individual components as well as the whole SVC system (field verification) as required.
5. One week of on-site training of the Customer's personnel, which will enable them to operate and maintain the SVC.

2.2 LOT 2 (HVDC AND ELECTRODE STATIONS)

The works carried out under the Lot 2 contract shall include the design, supply, construction, installation and commissioning of the following permanent plants:

- Converter station "A" in KOSTI in Sudan
- Converter station "B" in NAG HAMMADI in Egypt
- Complete Electrode station in KOSTI in Sudan

- Complete Electrode station in NAG HAMMADI in Egypt
- AC 500kV Nag HAMMADI substation in Egypt
- OHL connection of converter station and AC 500 kV in NAG HAMMADI (Egypt)

2.2.1 CONVERTER STATION AND ELECTRODE STATION

The Contractor shall design, produce material, manufacture, test at the factory, transport and deliver to the sites, install, test, commission, put into operation and guarantee the attainment of certain performance criteria with respect to the plants.

The Contractor shall deliver to each converter station one complete set of special maintenance equipment and tools together with necessary measuring and testing equipment, which are needed for a proper maintenance of the converter stations. These special tools and maintenance equipment include all the equipment that is only available from the Contractor and his sub-suppliers.

The maintenance, measuring and testing equipment may be used during installation, but any such tool or device which is damaged by the Contractor shall be refinished, re-paired or replaced by the Contractor at no extra cost to the Owner.

The Contractor shall organize and conduct, as part of the Scope of Supply, training programs and courses for operation and maintenance personnel prior to the test on site, see Section 2.10.

Trainees' travel and living expenses will be born by the Owner.

The Scope of Supply shall include all spare parts necessary for safe operation and maintenance within the stated availability and reliability limits, and for scheduled maintenance of the two converter stations for the first **5 years** of operation.

If a spare part must be used during the Defects Liability Period it shall be replaced at the Contractor's expense.

If during the Defects Liability Period an item should fail, and if no such spare part item was recommended to be kept in stock, the Contractor shall replace this faulty item at his expense, and in addition provide another item to the Owner.

2.2.2 AC 500 KV SUBSTATION

The works carried out under this Lot Contract shall include the design, supply, construction, installation and commissioning of the AC 500 kV in Nag Hammadi (Egypt).

The scope of work will cover all works on the following items:

- Design and test of HV apparatus
- Design and test of LV apparatus (protection relays & metering)
- Transmission installation in each substation:
    - Main electrical scheme and general layout of the substations
    - Fundamental requirements for the substation (electrical mechanical, climatic, special if any),

- Insulation requirement (selection of insulation level, minimum clearance of the live parts),
- Particular requirements for HV equipment (switchgear, Power transformer, instrument transformer, surge arrester, reactors, etc …).
- Particular requirements for LV equipment (distance protection, differential protection, meters, etc. …).

➢ Digital Control System, to enable local and remote control of power equipment, as well as connection with optical fiber backbone.

➢ Spare parts

2.2.3 OHL 500 kV Connection in Nag Hammadi

The contract will cover all works necessary to complete the following: route-survey, soil studies, design, supply, construction, testing and commissioning a 500 kV double circuit AC overhead line (approximately 3 km) between Nag Hammadi Converter substation and 500 kV existing Nag Hammadi substation.

The line is equipped of double circuit 500 kV three-phase, four sub-conductor DOVE ACSR (Aluminum Conductors Steel Reinforced) per phase overhead transmission line and two earthwires (OPGW+ACSR 125/30) on self-supporting horizontal formation galvanized steel towers. Composite Fiber Optic Overhead Ground Wire (OPGW) shall be used for overhead transmission lines to serve dual function as optical fiber communication link and shielding wire.

The actual proposed route will be finalized after final survey, to be carried out by the contractor and approved by the Employer / Project Manager

The Works will comprise the following:

➢ Final topographical survey, soil investigation, plotting and picketing,

➢ Calculation and design of all towers (Terminal towers, Angle towers, Suspension towers), calculation and design of foundations, calculation and design of earthing, determination of all equipment and fitting (Insulators, conductor clamps, Earthwires (optical fiber), conductors and fittings, accessories (dampers, clamps, warning signs, etc), calculation of spans and sags, line route profile,

➢ Manufacture, factory test, supply, shipping, loading and unloading, transport from Docks to Stores and or sites of all equipment, construction of line (site preparation, foundations, tower assembling and erection, line stringing, etc…), setting to work, care and remedying of defects of plant and civil works, testing, site cleaning.

➢ Access road, civil works, construction/installation, erection, field test, commissioning and maintenance during the product liability period for the supply of steel towers (including the stubs of towers), conductors, OPGW, insulators, hardware and accessories and all works related to transportation and erection.

➢ The provision of samples, drawings, operation and maintenance manuals as per details in the Specification.

➢ All machinery, vehicles and office facilities needed for the Contractor's work and his Sub-Contractor's work shall be provided by the Contractor.

- The arrangement, maintenance and care of store(s) for the material and equipment supplied by the Contractor including necessary arrangements for guarding of store(s) and provision of guards.
- Establishing of a detailed implementation plan in co-operation with the Project Manager
- Establishing of outage plans in co-operation with the Project Manager
- Spare parts

The scope includes also the detailed design studies of tower, soil studies, civil works, specially the determination of tower foundation type (pile or footing), the earthing calculation note, the calculation of reinforcement bars, drawings, bending schedule and bill of quantities.

All components and accessories necessary for safe and efficient operation at site in accordance with sound engineering practice shall be included in the supply.

2.3 LOT 3 (400-500 KV SUBSTATIONS)

The works carried out under this Lot 3 contract shall include the design, supply, construction, installation and commissioning of the following AC 400kV- 500kV MANDAYA substation located in Ethiopia. The scope of work will cover all works on the following items:

- Design and test of HV apparatus
- Design and test of LV apparatus (protection relays & metering)
- Transmission installation in each substation:
    - Main electrical scheme and general layout of the substations
    - Fundamental requirements for the substation (electrical mechanical, climatic, special if any),
    - Insulation requirement (selection of insulation level, minimum clearance of the live parts),
    - Particular requirements for HV equipment (switchgear, Power transformer, instrument transformer, surge arrester, reactors, etc …).
    - Particular requirements for LV equipment (distance protection, differential protection, meters, etc. …).
- Digital Control System, to enable local and remote control of power equipment, as well as connection with optical fiber backbone.
- Spare parts

2.4 LOT 4 (AC/DC 500 KV SUBSTATIONS)

The works carried out under this Lot 4 contract shall include the design, supply, construction, installation and commissioning of the following AC/DC 500kV KOSTI substation in Sudan. The scope of work will cover all works on the following items:

- Design and test of HV apparatus
- Design and test of LV apparatus (protection relays & metering)
- Transmission installation in each substation:
    - Main electrical scheme and general layout of the substations
    - Fundamental requirements for the substation (electrical mechanical, climatic, special if any),
    - Insulation requirement (selection of insulation level, minimum clearance of the live parts),
    - Particular requirements for HV equipment (switchgear, Power transformer, instrument transformer, surge arrester, reactors, etc …).
    - Particular requirements for LV equipment (distance protection, differential protection, meters, etc. …).
- Digital Control System, to enable local and remote control of power equipment, as well as connection with optical fiber backbone.
- Spare parts

2.5 LOT 5 (500 KV AC LINE IN ETHIOPIA)

The contract of LOT OHL 5 will cover all works necessary to complete the following: route-survey, soil studies, design, supply, construction, testing and commissioning of 2 lines 500 kV double circuit AC overhead line between Mandaya substation (Ethiopia) and Sudan-Ethiopian Border.

The line is equipped of double circuit 500 kV three-phase, four sub-conductor DOVE ACSR (Aluminum Conductors Steel Reinforced) per phase overhead transmission line and two earthwires (OPGW+ACSR 125/30) on self-supporting horizontal formation galvanized steel towers. Composite Fiber Optic Overhead Ground Wire (OPGW) shall be used for overhead transmission lines to serve dual function as optical fiber communication link and shielding wire.

The overhead lines shall be terminated at the incoming gantry structure of Mandaya (Ethiopia) substation and Border Tower. The actual proposed route will be finalized after final survey, to be carried out by the contractor and approved by the Employer / Project Manager

The Works will comprise the following:

- Final topographical survey, soil investigation, plotting and picketing,
- Calculation and design of all towers (Terminal towers, Angle towers, Suspension towers), calculation and design of foundations, calculation and design of earthing, determination of all equipment and fitting (Insulators, conductor clamps, Earthwires (optical fiber), conductors and fittings, accessories (dampers, clamps, warning signs, etc), calculation of spans and sags, line route profile,
- Manufacture, factory test, supply, shipping, loading and unloading, transport from Docks to Stores and or sites of all equipment, construction of line (site preparation, foundations, tower assembling and erection, line stringing, etc), setting to work, care and remedying of defects of plant and civil works, testing, site cleaning.

- Access road, civil works, construction/installation, erection, field test, commissioning and maintenance during the product liability period for the supply of steel towers (including the stubs of towers), conductors, OPGW, insulators, hardware and accessories and all works related to transportation and erection.
- The provision of samples, drawings, operation and maintenance manuals as per details in the Specification.
- All machinery, vehicles and office facilities needed for the Contractor's work and his Sub-Contractor's work shall be provided by the Contractor.
- The arrangement, maintenance and care of store(s) for the material and equipment supplied by the Contractor including necessary arrangements for guarding of store(s) and provision of guards.
- Establishing of a detailed implementation plan in co-operation with the Project Manager
- Establishing of outage plans in co-operation with the Project Manager
- Spare parts

The scope includes also the detailed design studies of tower, soil studies, civil works, specially the determination of tower foundation type (pile or footing), the earthing calculation note, the calculation of reinforcement bars, drawings, bending schedule and bill of quantities.

All components and accessories necessary for safe and efficient operation at site in accordance with sound engineering practice shall be included in the supply.

2.6 LOT 6 (500 KV AC LINE IN SUDAN)

The contract of LOT OHL 6 will cover all works necessary to complete the following: route-survey, soil studies, design, supply, construction, testing and commissioning a of 2 lines 500 kV double circuit AC overhead line between Sudan-Ethiopian Border and Kosti substation (Sudan).

The line is equipped of double circuit 500 kV three-phase, four sub-conductor DOVE ACSR (Aluminum Conductors Steel Reinforced) per phase overhead transmission line and two earthwires (OPGW+ACSR 125/30) on self-supporting horizontal formation galvanized steel towers. Composite Fiber Optic Overhead Ground Wire (OPGW) shall be used for overhead transmission lines to serve dual function as optical fiber communication link and shielding wire.

The overhead lines shall be terminated at the incoming gantry structure of Kosti (Sudan) substation and Border Tower . The actual proposed route will be finalized after final survey, to be carried out by the contractor and approved by the Employer / Project Manager

The Works will comprise the following:

- Final topographical survey, soil investigation, plotting and picketing,
- Calculation and design of all towers (Terminal towers, Angle towers, Suspension towers), calculation and design of foundations, calculation and design of earthing, determination of all equipment and fitting (Insulators, conductor clamps, Earthwires (optical fiber), conductors and fittings, accessories (dampers, clamps, warning signs, etc), calculation of spans and sags, line route profile,

- Manufacture, factory test, supply, shipping, loading and unloading, transport from Docks to Stores and or sites of all equipment, construction of line (site preparation, foundations, tower assembling and erection, line stringing, etc)), setting to work, care and remedying of defects of plant and civil works, testing, site cleaning.
- Access road, civil works, construction/installation, erection, field test, commissioning and maintenance during the product liability period for the supply of steel towers (including the stubs of towers), conductors, OPGW, insulators, hardware and accessories and all works related to transportation and erection.
- The provision of samples, drawings, operation and maintenance manuals as per details in the Specification.
- All machinery, vehicles and office facilities needed for the Contractor's work and his Sub-Contractor's work shall be provided by the Contractor.
- The arrangement, maintenance and care of store(s) for the material and equipment supplied by the Contractor including necessary arrangements for guarding of store(s) and provision of guards.
- Establishing of a detailed implementation plan in co-operation with the Project Manager
- Establishing of outage plans in co-operation with the Project Manager
- Spare parts

The scope includes also the detailed design studies of tower, soil studies, civil works, specially the determination of tower foundation type (pile or footing), the earthing calculation note, the calculation of reinforcement bars, drawings, bending schedule and bill of quantities.

All components and accessories necessary for safe and efficient operation at site in accordance with sound engineering practice shall be included in the supply.

2.7 LOT 7 (± 600 KV DC LINE IN SUDAN)

The contract of LOT OHL 7 will cover all works necessary to complete the following: route-survey, soil studies, design, supply, construction, testing and commissioning a ± 600 kV bipole DC overhead line between Kosti substation (Sudan) and Bohad village, on the road between Khartoum and Abu Dorm .

The line is equipped of bipole ± 600 kV two-phase, six sub-conductor CURLEW ACSR (Aluminum Conductors Steel Reinforced) per phase overhead transmission line and one earthwire OPGW on self-supporting horizontal formation galvanized steel towers. Composite Fiber Optic Overhead Ground Wire (OPGW) shall be used for overhead transmission lines to serve dual function as optical fiber communication link and shielding wire.

The overhead lines shall be terminated at the incoming gantry structure of Kosti (Sudan) substation and tension tower situated at Bohad village. The actual proposed route will be finalized after final survey, to be carried out by the contractor and approved by the Employer / Project Manager.

The Works will comprise the following:

- Final topographical survey, soil investigation, plotting and picketing,
- Calculation and design of all towers (Terminal towers, Angle towers, Suspension towers), calculation and design of foundations, calculation and design of earthing, determination of all equipment and fitting (Insulators, conductor clamps, Earthwires (optical fiber), conductors and fittings, accessories (dampers, clamps, warning signs, etc), calculation of spans and sags, line route profile,
- Manufacture, factory test, supply, shipping, loading and unloading, transport from Docks to Stores and or sites of all equipment, construction of line (site preparation, foundations, tower assembling and erection, line stringing, etc)), setting to work, care and remedying of defects of plant and civil works, testing, site cleaning.
- Access road, civil works, construction/installation, erection, field test, commissioning and maintenance during the product liability period for the supply of steel towers (including the stubs of towers), conductors, OPGW, insulators, hardware and accessories and all works related to transportation and erection.
- The provision of samples, drawings, operation and maintenance manuals as per details in the Specification.
- All machinery, vehicles and office facilities needed for the Contractor's work and his Sub-Contractor's work shall be provided by the Contractor.
- The arrangement, maintenance and care of store(s) for the material and equipment supplied by the Contractor including necessary arrangements for guarding of store(s) and provision of guards.
- Establishing of a detailed implementation plan in co-operation with the Project Manager
- Establishing of outage plans in co-operation with the Project Manager
- Spare parts

The scope includes also the detailed design studies of tower, soil studies, civil works, specially the determination of tower foundation type (pile or footing), the earthing calculation note, the calculation of reinforcement bars, drawings, bending schedule and bill of quantities.

All components and accessories necessary for safe and efficient operation at site in accordance with sound engineering practice shall be included in the supply.

2.8 LOT 8 (± 600 KV DC LINE IN SUDAN)

The contract of LOT OHL 8 will cover all works necessary to complete the following: route-survey, soil studies, design, supply, construction, testing and commissioning a ± 600 kV bipole DC overhead line between Bohad village (Sudan) and Sudanese / Egyptian Border.

The line is equipped of bipole ± 600 kV two-phase, six sub-conductor CURLEW ACSR (Aluminum Conductors Steel Reinforced) per phase overhead transmission line and one earthwire OPGW on self-supporting horizontal formation galvanized steel towers. Composite Fiber Optic Overhead Ground Wire (OPGW) shall be used for overhead transmission lines to serve dual function as Optical fiber communication link and shielding wire.

The overhead lines shall be terminated on tension towers situated at Bohad village and Sudanese / Egyptian Border. The actual proposed route will be finalized after final survey, to be carried out by the contractor and approved by the Employer / Project Manager.

The Works will comprise the following:

- Final topographical survey, soil investigation, plotting and picketing,
- Calculation and design of all towers (Terminal towers, Angle towers, Suspension towers), calculation and design of foundations, calculation and design of earthing, determination of all equipment and fitting (Insulators, conductor clamps, Earthwires (optical fiber), conductors and fittings, accessories (dampers, clamps, warning signs, etc), calculation of spans and sags, line route profile,
- Manufacture, factory test, supply, shipping, loading and unloading, transport from Docks to Stores and or sites of all equipment, construction of line (site preparation, foundations, tower assembling and erection, line stringing, etc)), setting to work, care and remedying of defects of plant and civil works, testing, site cleaning.
- Access road, civil works, construction/installation, erection, field test, commissioning and maintenance during the product liability period for the supply of steel towers (including the stubs of towers), conductors, OPGW, insulators, hardware and accessories and all works related to transportation and erection.
- The provision of samples, drawings, operation and maintenance manuals as per details in the Specification.
- All machinery, vehicles and office facilities needed for the Contractor's work and his Sub-Contractor's work shall be provided by the Contractor.
- The arrangement, maintenance and care of store(s) for the material and equipment supplied by the Contractor including necessary arrangements for guarding of store(s) and provision of guards.
- Establishing of a detailed implementation plan in co-operation with the Project Manager
- Establishing of outage plans in co-operation with the Project Manager
- Spare parts

The scope includes also the detailed design studies of tower, soil studies, civil works, specially the determination of tower foundation type (pile or footing), the earthing calculation note, the calculation of reinforcement bars, drawings, bending schedule and bill of quantities.

All components and accessories necessary for safe and efficient operation at site in accordance with sound engineering practice shall be included in the supply.

2.9 LOT 9 (± 600 KV DC LINE IN EGYPT)

The contract of LOT OHL 9 will cover all works necessary to complete the following: route-survey, soil studies, design, supply, construction, testing and commissioning a ± 600 kV bipole DC overhead line between Sudanese/Egyptian Border and Nag Hammadi HVDC substation (Egypt) .

The line is equipped of bipole ± 600 kV two-phase, six sub-conductor CURLEW ACSR (Aluminum Conductors Steel Reinforced) per phase overhead transmission line and one earthwire OPGW on self-supporting horizontal formation galvanized steel towers. Composite Fiber Optic Overhead Ground Wire (OPGW) shall be used for overhead transmission lines to serve dual function as optical fiber communication link and shielding wire.

The overhead lines shall be terminated at the incoming gantry structure of Nag Hammadi HVDC substation (Egypt). The actual proposed route will be finalized after final survey, to be carried out by the contractor and approved by the Employer / Project Manager.

The Works will comprise the following:

- Final topographical survey, soil investigation, plotting and picketing,
- Calculation and design of all towers (Terminal towers, Angle towers, Suspension towers), calculation and design of foundations, calculation and design of earthing, determination of all equipment and fitting (Insulators, conductor clamps, Earthwires (optical fiber), conductors and fittings, accessories (dampers, clamps, warning signs, etc), calculation of spans and sags, line route profile,
- Manufacture, factory test, supply, shipping, loading and unloading, transport from Docks to Stores and or sites of all equipment, construction of line (site preparation, foundations, tower assembling and erection, line stringing, etc)), setting to work, care and remedying of defects of plant and civil works, testing, site cleaning.
- Access road, civil works, construction/installation, erection, field test, commissioning and maintenance during the product liability period for the supply of steel towers (including the stubs of towers), conductors, OPGW, insulators, hardware and accessories and all works related to transportation and erection.
- The provision of samples, drawings, operation and maintenance manuals as per details in the Specification.
- All machinery, vehicles and office facilities needed for the Contractor's work and his Sub-Contractor's work shall be provided by the Contractor.
- The arrangement, maintenance and care of store(s) for the material and equipment supplied by the Contractor including necessary arrangements for guarding of store(s) and provision of guards.
- Establishing of a detailed implementation plan in co-operation with the Project Manager
- Establishing of outage plans in co-operation with the Project Manager
- Spare parts

The scope includes also the detailed design studies of tower, soil studies, civil works, specially the determination of tower foundation type (pile or footing), the earthing calculation note, the calculation of reinforcement bars, drawings, bending schedule and bill of quantities.

All components and accessories necessary for safe and efficient operation at site in accordance with sound engineering practice shall be included in the supply.

2.10 Lot 10 (Control Center)

Lot 10 is covering required equipment and works for proper monitoring and control of the whole Interconnection system.

Contractors involved for these particular works will have to provide equipment, software and appropriate training in the purpose of ensuring remote supervision (both monitoring and control) of end to end energy transmission equipment.

- **Monitoring (from local to central):**

  Basic functionality of centralized computerized system should acquire as exhaustively as possible all status and analog measurements for interconnection system. This covers the following stations: Mandaya AC substation (Ethiopia), Kosti HVDC converter station and Kosti AC substation (Sudan), Nag Hammadi HVDC converter station and Nag Hammadi AC substation (Egypt).

  Telecom links with each national TSO, to exchange data useful for border energy transactions.

- **Control (from central to local):**

  The facility must have the capacity to transmit controls to :

  - appropriate disconnecting devices.
  - to be able to adjust active power, voltage, reactive power in critical points of the interconnector to any interconnector DCS system
  - to EN countries TSO dispatching centres to adjust active power or reactive power transmitted by the Interconnector.

- **Telecommunications (for energy systems):**

  An entire telecommunication network will be inserted in transmission lines and power infrastructures. In particular, choice of equipment will implement SDH and PDH functionalities. Optical fiber will be used, to create a loop circuit over the whole Interconnection.

  Telecommunication circuits are essential to proper system operation. Moreover they are at the cross-border to transmission line equipment: optical fiber should use OPGW technique, please refer to previous chapters related to power lines: insertion inside ground wire on overhead line. “booster” technology should be used.

  As an option, emergency transmission system may be provided, in order to avoid single mode factor (in case physical transmission medium outage). This emergency telecommunication means can be implemented through microwave or satellite link.

  Telecommunication circuits for energy system must also transfer voice operation and maintenance phone lines. A private network must be implemented by putting into service appropriate PABX infrastructure.

- **Telecommunications for National Utilities transmission needs:**

  Capability as to be provided to provide a dedicated transfer capacity allowing each of the 3 utilities to communicate with its neighbouring utilities, separately from data flows needed to operate the interconnection.

  These communications will allow data Interchange between the Operator of the interconnection and the three respective TSO (Egypt, Ethiopia, Sudan).

  Provision should be granted at each SCADA/dispatching levels, reflecting appropriately the organisational decisions undertaken before. To implement such capability, hardware servers must be implemented: a particular study must occur to take into account compatibilities. It is advised to use standard protocols such as ICCP protocol, also known as IEC 60870-6/TASE.2.

- **Device coordination and protection supervision, in regard of interfaces with other counterpart networks**:

  Transmission lines and power substations will be equipped with adequate protections according line and power station specifications. They should cover standard functionalities such as over-current protection, automatic reclosure system, synchro-check (particularly at connection points with each national system). Signal transmission must be included in transmission capacity. It is also necessary to endorse DC circuits particular protection needs, along with dedicated inter-conversion stations signals.

- **Control Centre SCADA and Backup Centre hardware equipments:**

Modules M4 and M5 are describing in details hardware architecture for control centres. Please refer to the corresponding documents. Nevertheless here is a brief summary of corresponding hardware:

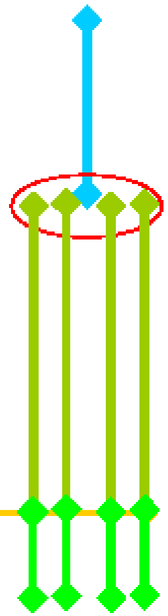
- For Main and Back-up control centre :
  - servers
  - disk array bay
  - main operator console
  - auxiliary stations
  - video wall control,
  - GPS time and frequency clocks,
  - weather station
  - laser printers,
  - redundant LAN switches, and firewalls (for external data links).

3 WORKS SCHEDULE WITHOUT ANTICIPATION

Description	Schema interconnection	2012	2013	2014	2015	2016	2017	2018	2019	2020	2030
Construction of HVDC and electrode station.	NAG HAMMADI						LOT 2	LOT 2	LOT 2		
Connection to Nag Hammadi 500kV substation.									LOT 2		
Construction of one bipole ± 600 kV line Kosti/Rabak to Nag Hammadi and connection to Nag Hammadi HVDC station .	DC 1 (1 Circuit)					LOT 7	LOT 7	LOT 7	LOT 7		
						LOT 8	LOT 8	LOT 8	LOT 8		
						LOT 9	LOT 9	LOT 9	LOT 9		
Construction of AC-DC 500 kV substation.	KOSTI / RABAK							LOT 4	LOT 4		
Construction of HVDC and electrode station.							LOT 2	LOT 2	LOT 2		
Construction of SVC.								LOT 1	LOT 1		
Construction of double line 500 kV double circuits line Mandaya to Kosti/Rabak and connection to Kosti/Rabak 500 kV substation.	AC 1 (4 Circuits)						LOT 5	LOT 5	LOT 5		
	AC 2 (4 Circuits)					LOT 6	LOT 6	LOT 6	LOT 6		
Preparation of the future 500 kV Border substation connection.	BORDER										
Connection of Border HPP to the interconnector without significant shutdown duration of the interconnector.											
Construction of Mandaya 500/400 kV substation	MANDAYA						LOT 3	LOT 3	LOT 3		
Mandaya to Sebbetta connection with a 400 kV double circuit line through Gheddo substation.											
Mandaya HPP to Mandaya 500 kV substation connection.									LOT 3		
Control Center Construction and commissioning					LOT 10	LOT 10	LOT 10	LOT 10			

Table 1 : Works Schedule Without Anticipation

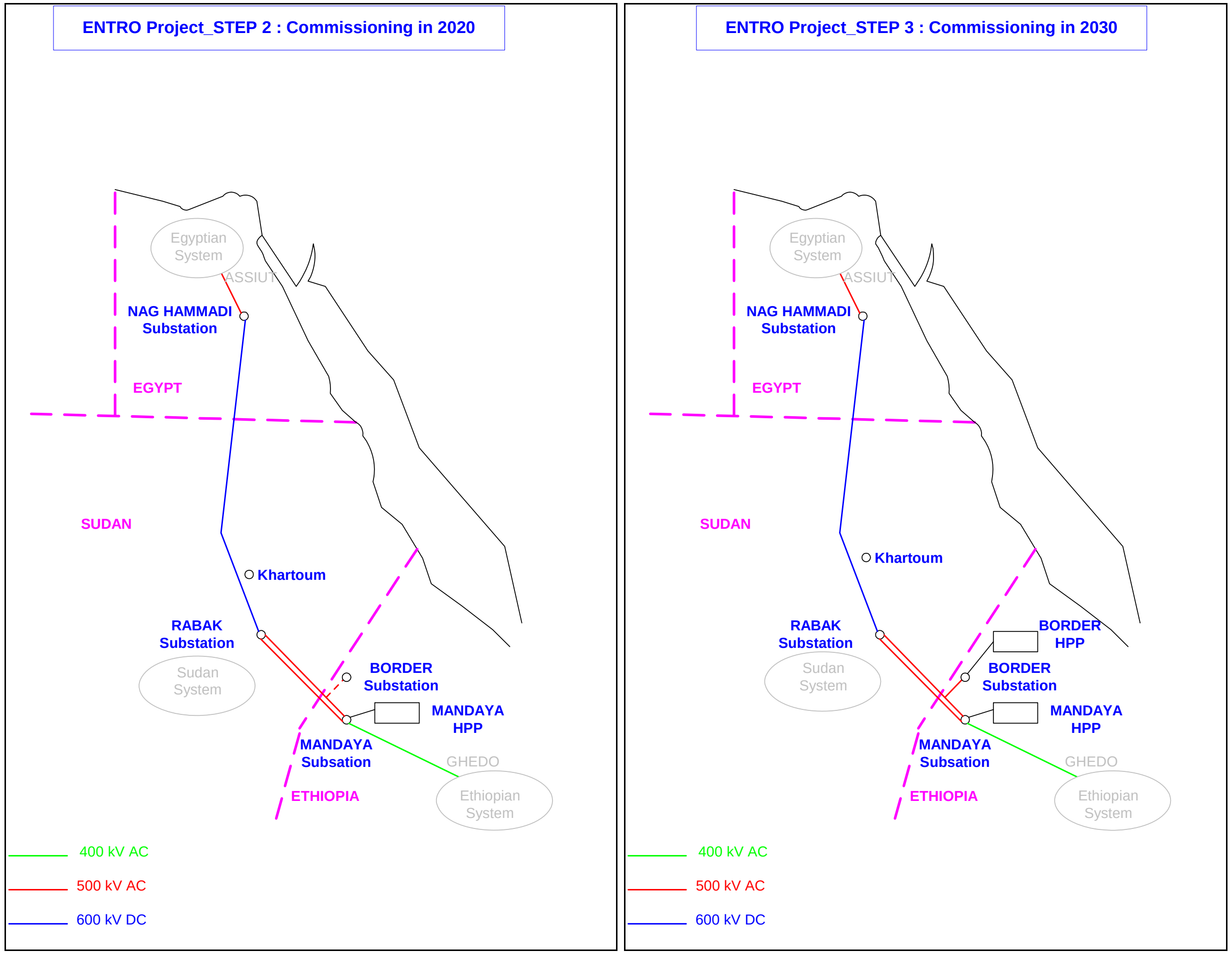
4 WORKS SCHEDULE WITH ANTICIPATION



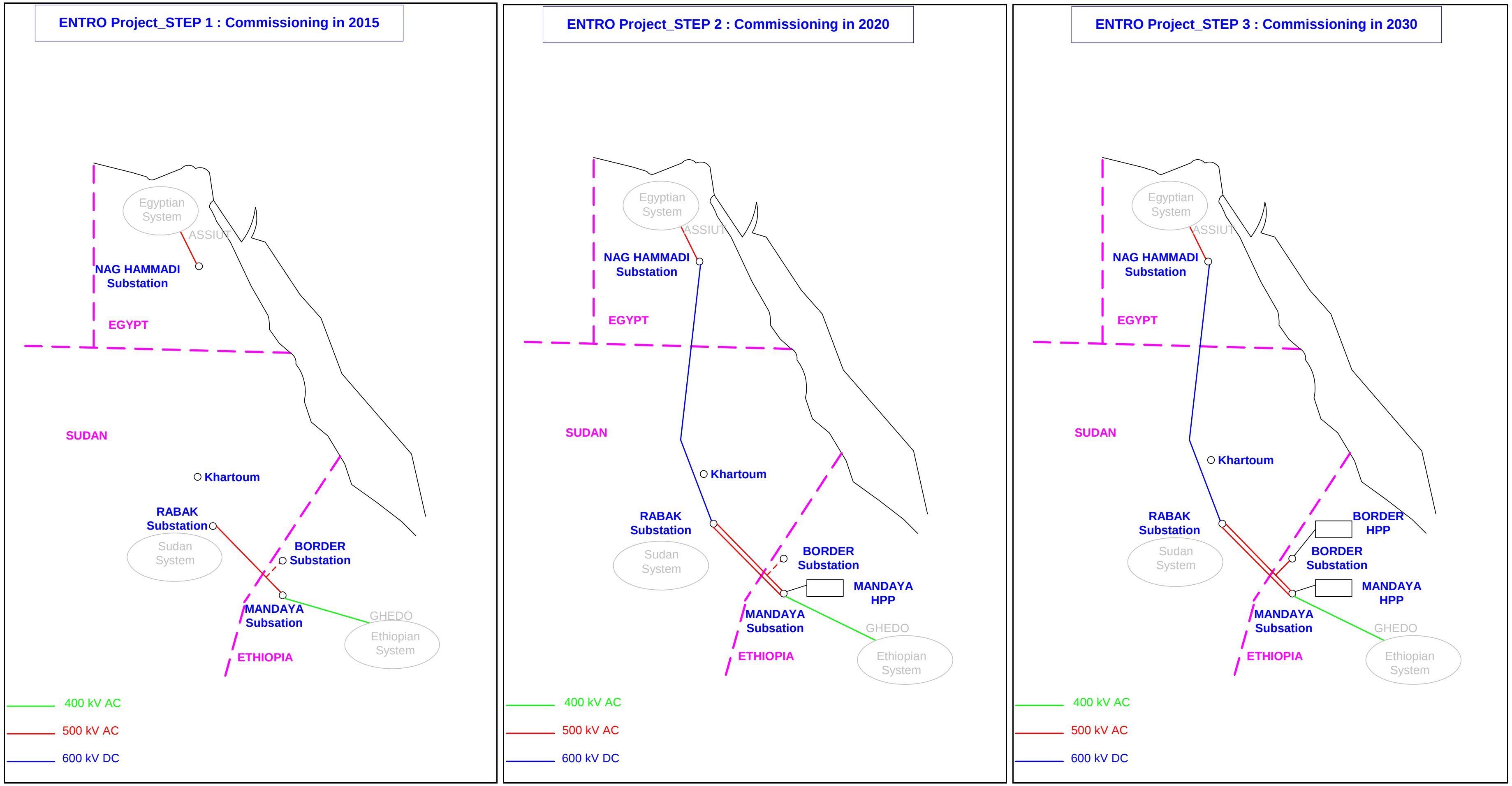
<table>
<tr><th>Description</th><th>Schema interconnection</th><th>2012</th><th>2013</th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2030</th></tr>
<tr><td>Construction of HVDC and electrode station.</td><td>NAG HAMMADI</td><td></td><td></td><td></td><td></td><td></td><td colspan="3">LOT 2</td><td></td><td></td></tr>
<tr><td>Connection to Nag Hammadi 500kV substation.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>LOT 2</td><td></td><td></td></tr>
<tr><td rowspan="3">Construction of one bipole ± 600 kV line Kosti/Rabak to Nag Hammadi and connection to Nag Hammadi HVDC station .</td><td rowspan="3">DC 1 (1 Circuit)</td><td></td><td></td><td></td><td></td><td colspan="4">LOT 7</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">LOT 8</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td colspan="4">LOT 9</td><td></td><td></td></tr>
<tr><td>Construction of AC-DC 500 kV substation.</td><td>KOSTI / RABAK</td><td></td><td colspan="2">LOT 4</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Construction of HVDC and electrode station.</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">LOT 2</td><td></td><td></td></tr>
<tr><td>Construction of SVC.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="2">LOT 1</td><td></td><td></td></tr>
<tr><td rowspan="2">Construction of one line 500 kV double circuits line Mandaya to Kosti/Rabak and connection to Kosti/Rabak 500 kV substation.</td><td>AC 1 (2 Circuits)</td><td></td><td colspan="2">LOT 5</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>AC 2 (2 Circuits)</td><td colspan="3">LOT 6</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Installation of a second 500 kV double circuit line from Mandaya to Kosti/Rabak 500 kV substation.</td><td>AC 1 (2 Circuits)</td><td></td><td></td><td></td><td colspan="2">LOT 5</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>AC 2 (2 Circuits)</td><td></td><td></td><td></td><td colspan="2">LOT 6</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Preparation of the future 500 kV Border substation connection.</td><td rowspan="2">BORDER</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Connection of Border HPP to the interconnector without significant shutdown duration of the interconnector.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Construction of Mandaya 500/400 kV substation</td><td>MANDAYA</td><td colspan="3">LOT 3</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mandaya to Sebbetta connection with a 400 kV double circuit line through Gheddo substation.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mandaya HPP to Mandaya 500 kV substation connection and Installation of complementary 500/400 kV transformers in Mandaya substation.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>LOT 3</td><td></td><td></td></tr>
<tr><td>Control Center Construction and commissioning</td><td></td><td colspan="3">LOT 10</td><td></td><td></td><td></td><td colspan="2">LOT 10</td><td></td><td></td></tr>
</table>

Table 2 : Works Schedule With Anticipation

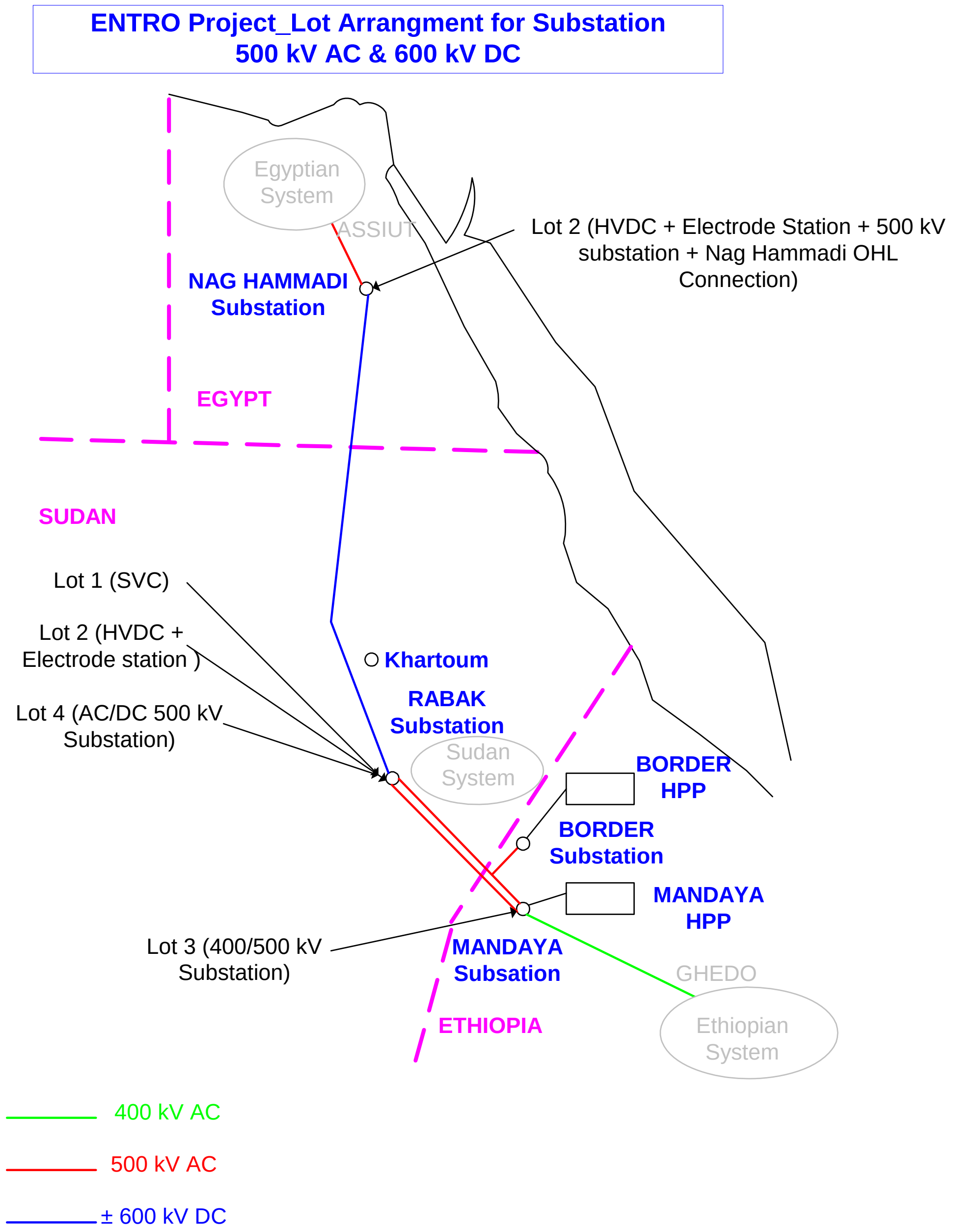
Appendix 1: Scenario Without Anticipation



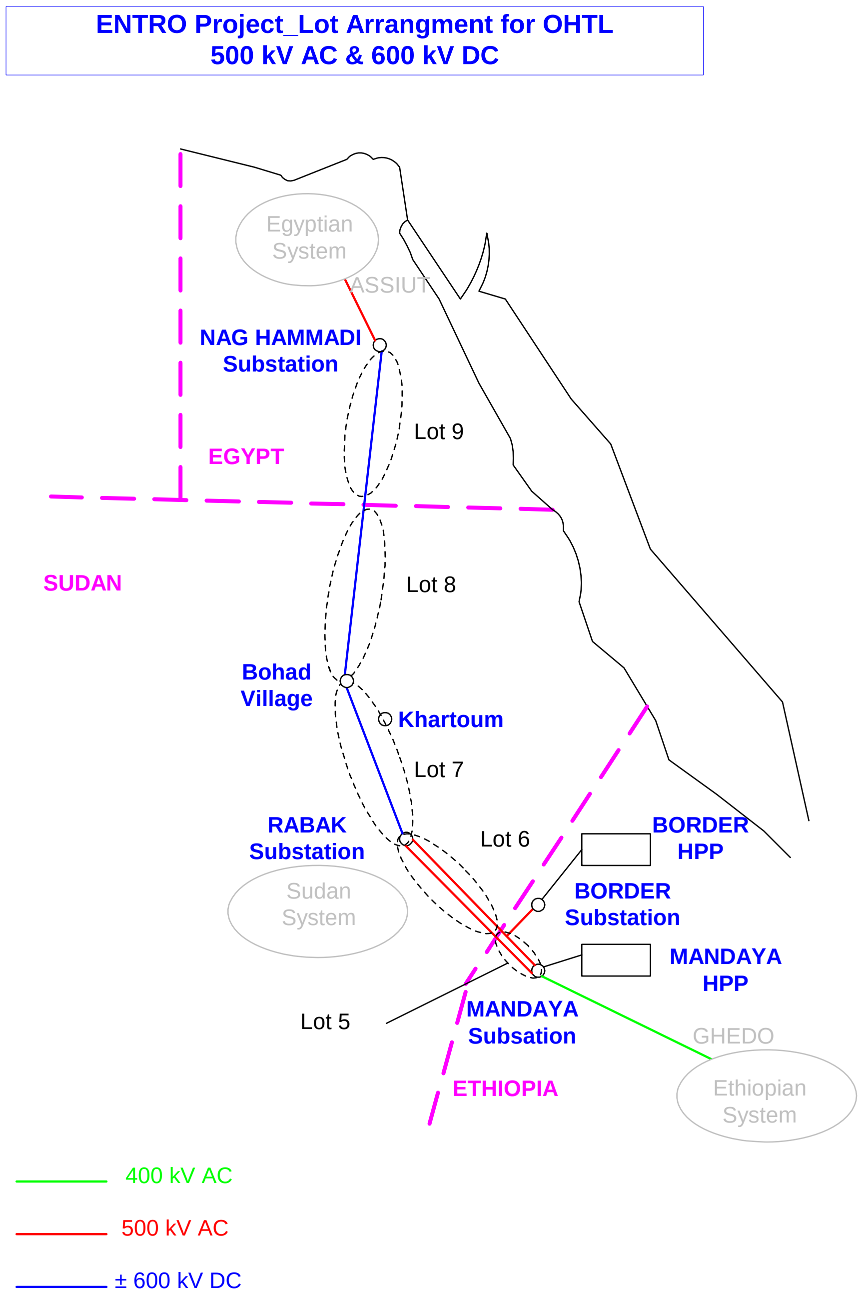
Appendix 2: Scenario With Anticipation



Appendix 3: Lot Arrangement for Substations

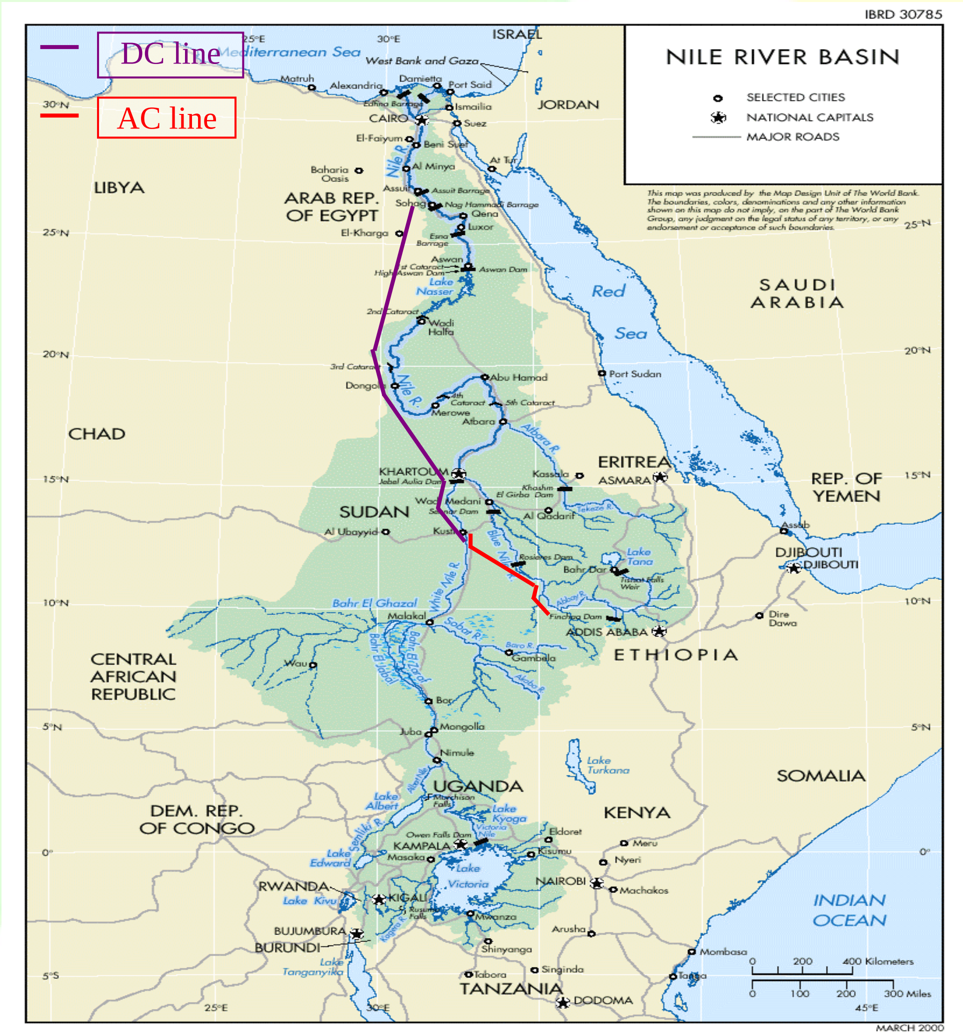


Appendix 4: Lot Arrangement for OHL



Nile Basin Initiative
Eastern Nile Subsidiary Action Program
Eastern Nile Technical Regional Office

EASTERN NILE POWER TRADE PROGRAM STUDY



M7 – INSTITUTIONAL ANALYSIS

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ABBREVIATIONS AND ACRONYMS

AC	Alternative Current
BOO	Build-Own-Operate
BOT	Build Operate Transfer
BTO	Build Transfer Operate
DBF	Design Build Finance
DBO	Design Build Operate
DC	Direct Current
EAPP	Eastern African Power Pool
EEHC	Egyptian Electricity Holding Company
EEPCO	Ethiopian Electric Power Corporation
EETC	Egyptian Electricity Transmission Company
EN	Eastern Nile
ENPTPS	Eastern Nile Power Trade Program Study
ENTRO	Eastern Nile Technical Regional Office
EPCM	Engineering-Procurement-Construction Management
FS	Functional Structure
HV	High Voltage
HVDC	High Voltage Direct Current
HPP	Hydro Power Plants
IRA	Interconnection Regulatory Agency
MFIs	Multilateral financial institutions
MIGA	Multilateral investment Guarantee Agency
MOU	Memorandum Of Understanding
MW/ MWh	MegaWatt / MegaWatt hour
NBI	Nile Basin Initiative
NEC	National Electricity Corporation (Sudan)
OMVS	Organisation pour la mise en valeur du fleuve Sénégal
RPTP	Regional Power Trade Program
SAPP	South African Power Pool
SVC	Static Voltage Compensator
TPA	Third Party Access

TSO	Transmission System Operator
UCTE	Union for the Coordination of Transmission of Electricity
WAPP	Western African Power Pool

EXECUTIVE SUMMARY

This Institutional Analysis report constitutes the module 7 of ENPTPS phase II: Egypt-Sudan-Ethiopian Power Interconnection Feasibility Study.

Following the results of economic studies from phase I, the creation of a suitable institutional framework in which exchanges are encouraged and risks foreclosed is essential. Covering regulatory issues, form of the market organization and establishment of appropriate institutional structures all along the interconnector lifetime is decisive for project feasibility. It remains a prerequisite.

The main objective of this study is "to propose the best power energy organization, in terms of interconnection build, own and operate, suitable to take advantage of the benefits generated by interconnection concept and following phase I validated recommendations".

Such an organization shall obviously carry out the interests of involved companies and states. This analysis adopts essentially a functional approach insisting on proficiencies and responsibilities required without conditioning the organizations that will have to be in charge. The last chapter proposes some key recommendations and methodology to launch the implementation phase of this project.

This analysis is absolutely dedicated to this interconnection project. The regional institutional framework such as Power Pool development is not taken into account.

The way to implement electricity unbundling and opening reforms at a national level are out of scope too.

As a result of this analysis, a global institutional model emphasizing the necessity of a collaborative approach mixing multilateral agreements and multilateral institutions, is proposed so as to finance, build, own and operate the Egypt-Sudan-Ethiopian power interconnection. Institutional key points for a successful integration of this large infrastructure project are detailed. The specificities of the project are taken into account in a risk analysis.

The most suitable scheme turns out to be a functional scheme carried out by transnational entity to be distinct from national Transmission System Operators. A multinational structure, whose capital base is at least shared by the three countries or/and their electricity utilities, shall be in charge of the implementation of each successive step of this interconnection from financing to operating phases.

In addition, the establishment of a multinational Interconnection Regulation Agency shall guarantee a continuous control of the framework development in which exchanges will occur, scrutinizing the compliance with future transparent and non-discriminatory rules. These two keystones of the proposed model, combined with the enactment of agreements, firm contracts and operating guidelines should enable to control major risks making investors confident to launch such a project integration.

The stress is laid on an overall vision of the proficiencies and interactions of a functional structure, with its environment including governments, shareholders, national TSOs, interconnection users and Interconnection Regulatory Agency.

The study also contemplates the energy exchanges conditions. A staged vision of the way to perform exchanges is recommended on the basis of gradual opening, competition and refining.

A road map for implementation, from financing and political agreements to operation in a long-term vision in which exchanges occur in a fully open and competitive market is put forward. It appears in close link with the different contemplated steps of energy exchanges organization but without allocating responsibilities to any existing regional organizations. However, the regional context of this interconnection cannot be ignored and the most suitable way to implement the Egypt-Sudan-Ethiopian power interconnection in this area with the potential support of the existing organizations in Eastern Nile shall be settled. This section provides with recommendations for a project entity should run next steps after the completion of ENPTPS study. The launch process and the methodology to allocate project risks to determine financial as well as institutional schemes are highlighted.

1 BACKGROUND AND MAIN OBJECTIVES

The Eastern Nile Power Trade Program Study is fully funded by the African Development Bank and has the general objective :

"to promote regional power trade between Egypt, Ethiopia and Sudan through creation of an enabling environment, coordinated regional investment planning of power generation and transmission interconnection projects."

The Project is carried out in close contact and co-operation with the three countries Utilities: Egyptian Electric Holding Company (EEHC), Ethiopian Electric Power Corporation (EEPCO) and Sudan National Electricity Company (NEC). In addition, other relevant institutions, in particular the Nile Basin Initiative, the Ministries of Water Resources and Irrigation of the three countries are also intensively involved in the project, with strong support of the local team experts in the three countries.

The Eastern Nile Power Trade Program Study is divided in 2 phases :

- Phase 1: Cooperative Regional Assessment of Power Trade Opportunities between Ethiopia, Egypt and Sudan
- Phase 2 : Feasibility Study of the Power Interconnection between Ethiopia, Egypt and Sudan.

During the ENPTPS phase I, the economic analysis demonstrated that it was very profitable for the three countries to develop the Egypt-Sudan-Ethiopian power interconnection. The lowest capital cost scheme has been selected and validated by the three countries. It is characterized by a mix AC/DC interconnection scheme made up of a 500 kV AC link between Ethiopia and Sudan and a 600 kV DC link between Sudan and Egypt.

This one is presented below.

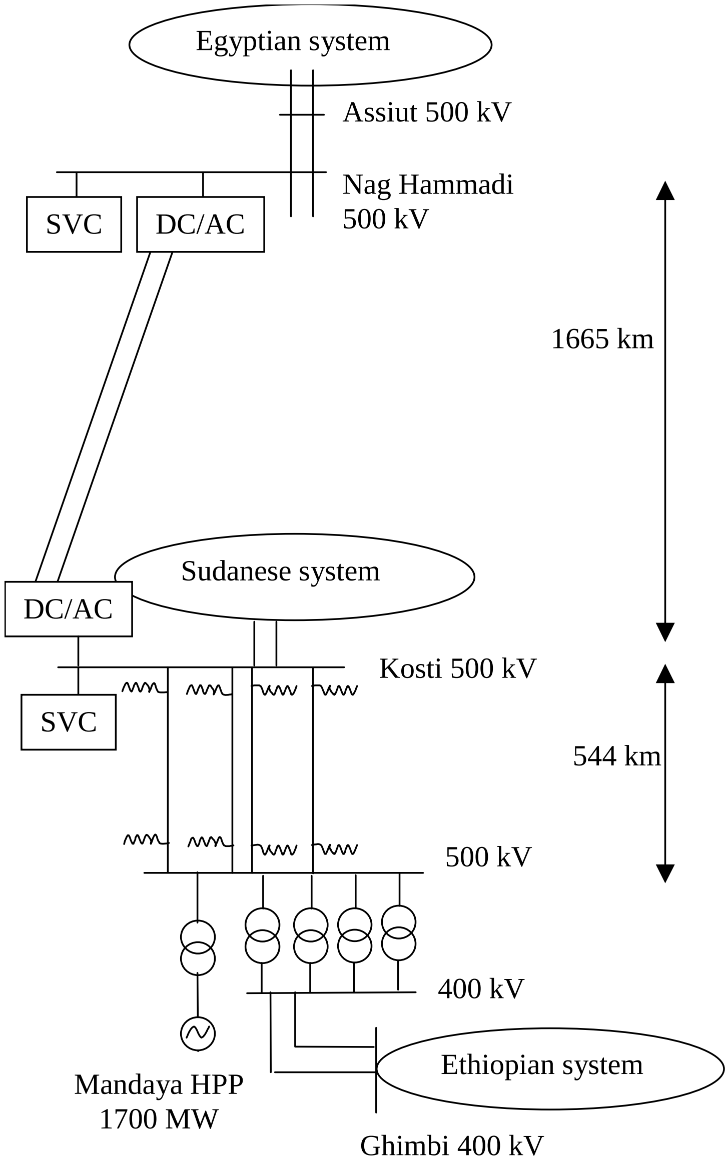

Figure 1. Interconnector scheme

Within this context, the "Institutional Analysis" constitutes the module 7 of the Egypt-Sudan Ethiopian power interconnection feasibility study.

Technically and economically viable interconnection projects may be faced with political, institutional, and financial barriers. Therefore, according to the Terms of Reference and the Inception Report submitted to ENTRO in February 08, the main objective of this module is:

"**to propose best power energy organization, in terms of interconnection build, own and operate, suitable to take advantage of the benefits generated by interconnection concept and following phase I validated recommendations**".

Such an organization shall carry out the interests of involved companies and states.

To be more accurate, this Institutional Analysis aims at giving more details on institutional key conditions to build, own and operate the interconnector consistently with power exchange markets. Proposals of organization models have to be provided for the different phases of the project implementation, from financing to a long-term vision operational phase. These essential conditions are linked among others to regulatory, form of the market and institutions establishment issues.

Therefore, the scope is divided into three major parts:

- Giving more details on institutional and economic requirements for building and operation phases
- Envisaging energy exchange conditions
- Proposing recommendations about institutional framework for implementation and phasing

2 POSITION OF THIS INSTITUTIONAL STUDY IN THE REGIONAL CONTEXT

2.1 AN ANALYSIS OF POLAR IMPORTANCE

Interconnection projects in developing countries assume a symbolic meaning. It is well known that access to energy, and specially electricity, is critical for poverty alleviation and spurring growth. The improvement of the electric power sector is a prerequisite for the other sectors, for overall economic and social development. In the Eastern Nile region, strengthening and facilitating, as appropriate, regional cooperation arrangements for promoting cross border trade, including the interconnection of electricity grids, remains a topic of particular relevance.

Unfortunately, a combination of factors ranging from inability to attract investment linked to the risk perceived in these countries marked by conflicts and political instability, to poor management and maintenance of existing infrastructure, and inadequate and inappropriate tariffs and revenue collection, have all contributed to irregularities and shortages in electricity supply.

These current shortages and irregularities have forced many African countries to contemplate more closely the possibility of supplement supplies with trans-border networks and Power Pools. This step forward collaboration comes up against issues of sovereignty, resistance to power sector reforms and privatization as well as serious capacity constrains. All these items have hampered the development and expansion of trans-border grids and Power Pools in the region. However, a growing demand for electricity, the need to reduce energy costs in a context of dramatic rise of fuel prices, the necessity to provide greater energy supply stability are some of the major factors behind the recent interest in using such interconnections in the African energy context.

The benefits to be expected from these interconnections are huge. For instance :

- The reduction of capital and operating costs through improved coordination among power utilities,
- The reliability optimization with reserve sharing,
- The enhance of security of supply through mutual assistance in emergency cases,
- The improvement of investment climate through pooling risks,
- The increase in inter-countries electricity exchanges,
- The development of a regional market for electricity

Sharing production means and putting demand in common is certainly part of the best way to face up energy management challenges. Africa is fairly endowed with significant energy resources for electricity generation but they are unevenly distributed. Hydropower potential is very high in Ethiopia and bordering countries could enjoy this cheap electricity.

Thus, even if regional electricity trade through the Egypt-Sudan-Ethiopian interconnection in a favorable environment will provide many benefits to the Eastern Nile countries and final consumers, each interconnection requires the creation of a specific and appropriate framework in which exchanges are encouraged and risks foreclosed or at least reasonably taken into account.

The Institutional Analysis takes on there a polar importance and contains a lot of stakes because:

- Technically and economically viable interconnection projects may be faced with political, institutional and financial barriers.

- Benefits from this interconnection can be expected only if an appropriate framework will surround energy exchanges
- The institutional framework shall enable all parties to find both economic and technical interests and to fairly share the benefits
- The organizational model for project implementation combined with the institutional framework shall make stakeholders confident.

2.2 A FUNCTIONAL INSTITUTIONAL ANALYSIS

Unlike phase I, in which existing regional organizations were explicitly quoted and designated to carry out some integration process, and bear some responsibility to develop the regional electricity market, the “ENPTPS phase II Institutional analysis” neither mention nor attribute proficiencies to regional organizations because the Terms of Reference do not specify any.

Therefore, this module settles for carrying out a functional analysis, insisting on proficiencies and responsibilities required without conditioning the entities that will have to be in charge. Yet, the report recommends the creation of functional structures necessary for the different steps of the interconnection lifetime development without foreshadowing their implementation in the regional context. In a few words, these proposed organizations to set up :

- Can be effectively established as new regional entities for the need of this interconnection in the event of no existing institution is likely to take such responsibilities.
- Can lead to the extension of existing institutional structures authority attributing to them a part of the characteristics underlined in this present report.

2.3 AN ANALYSIS CENTERED ON THE EGYPT-SUDAN-ETHIOPIAN POWER INTERCONNECTION

Before entering into the heart of the matter, it is also important to well understand the position of this institutional analysis in the regional context and especially in comparison to the Institutional Analysis carried out in ENPTPS Phase I as well as analysis performed within EAPP or NBI consultancy.

This ENPTPS phase II Institutional Analysis is absolutely dedicated to the Egypt-Sudan-Ethiopian power interconnection and each addressed issue is centered on this power infrastructure. Requirements and proposals are recommended in the light of this interconnection even if, indubitably, the development and the integration of this interconnection will have repercussions both on the national electricity sectors and the regional vision of power trade.

For instance, to move from vertically-integrated monopoly towards a more competitive structure, legal changes at a national are mandatory. The access and pricing policies recommended for this interconnection do not deal with these necessary changes. Moreover, this interconnection may have to be inserted in a more global organization, managing power trade at a regional level. These relevant questions which will have to be discussed are not tackled in this report.

In the same line, generation and expansion questions are out of scope. The usual concepts linked to Power Pool such as Regional Market Coordinator, Regional Energy Broker that have been developed in ENPTPS phase I do not appear in this report.

2.4 LINK WITH OTHER STUDIES

In Eastern Nile region, countries have embarked upon a cooperation path to face up energy challenges. Several regional organizations confirm this collaboration.

The Nile Basin Initiative (NBI) was formally launched in February 1999 by the Council of Ministers of Water Affairs of the Nile Basin States. It provides a forum for the countries of the Nile to move towards a cooperative process, in order to achieve tangible benefits in the Basin, and build a solid foundation of trust and confidence. For this purpose, the Regional Power Trade Project (RPTP) is one of the thematic projects to be implemented basin-wide, so as to help to establish a foundation for trans-boundary regional cooperation and to create an enabling environment conducive for investment and action on the ground, within an agreed basin-wide framework. The RPTP aims at establishing the institutional means to coordinate the development of regional power markets among the Nile Basin countries, through the creation of a power trade framework which can contribute to achieve poverty reduction including expanding access to reliable and low-cost power supply, in an environmentally and sustainable manner.

In parallel, at a more global scale, the establishment of the Eastern African Power Pool (EAPP) in 2005, has been a decisive step. It follows the main goal to make available an affordable and reliable electricity by pooling together all available electrical resources (generation means, transmissions infrastructures, knowledge…) in an optimized and coordinated manner in order to increase the access rate and thereby promote regional integration.

Following the recognition of this necessity for Eastern Nile countries to join their effort to solve out growth and economic development, many regional organizations are working to promote Power Trade. These organizations are studying the better way to establish energy exchanges in the region, including the institutional and regulatory aspects.

This regional integration deals with:

- The creation, under the governance of the governments of the region, of a regional organization responsible, partly or entirely, for the coordination of the actors of the electric power industry, the harmonization of the planning and operating rules, and for the minimization of the overall cost of supply
- The management of power generation and transmission projects that are justified from the perspective of sustainable regional development.

As an example, the current project: “C*onsultancy to develop an institutional, regulatory and cooperative framework model for the Nile basin power trade* ” carried out by MERCADOS ENERGY MARKETS INTERNATIONAL falls within the Regional Power Trade Program framework and provides an analysis.

Several other studies raise power trade integration and are carried out by regional organizations or consultants.

The ENPTPS phase I ”Institutional Settlement Modeling” proposes a power trade strategy strongly linked to the development of EAPP and the establishment of a pool.

The MERCADOS study proposes an approach based on bilateral cross-border trading moving towards multi-parties transactions in the long term. It describes institutional and regulatory needs for each step starting from the harmonization of standards to a competitive operation.

In view of these analysis, despite their specificities, key objectives are:

- To review institutional arrangements adopted by regional power trade organizations, comparing and contrasting the different arrangements in order to perform an informed decision making process.
- To propose a model for developing Regional Power Trade at the Nile sub–basin and basin levels.

Within this approach, the establishment of structures expresses a political vision but does not support an unified vision of concrete realizations. The development of power trade stays limited to conceptual considerations. Some road map, for institutional and regulatory development, is given in these studies but without a clear correlation with existing or future physical interconnections. To be more precise, on-going interconnection feasibility studies, or existing interconnections have some difficulties to find their position in such a conceptual framework.

There is no doubt that this contemplation is useful to analyze the potential barriers to overcome, the changes to implement. However, there is at present time a need to fill the gap between this political desire linked to institutional and regulatory changes and the physical reality of energy exchanges. There is a need to materialize this power trade development whereas the framework seems ready to welcome such cross-border exchanges.

Framework application shall be launched with concrete interconnection projects like the Egypt-Sudan-Ethiopian interconnector.

To sum up, two options can coexist to trade power :

- A global institutional approach consisting in developing a regulatory and cooperative framework for the Nile Basin Trade in a general way as it is done. This framework is aiming at hosting projects, serving as an agreed reference.
- A local institutional approach consisting in developing a regulatory and cooperative framework centered on specific interconnection projects. Focusing on projects needs, the institutional framework is totally built with the objective to better adapt to the specificities of considered projects.

Actually, NBI and EAPP are organizing at regional level the frame in which future power trade will occur. This regional framework looks like an empty box waiting to host real projects.

It is interesting to consider now, how these approaches can be complementary worked out, contemplating the capability for these frameworks to host this interconnection for the best efficiency and interests of all parties. The integration of this interconnection project into a general institutional framework is a question also regarding other interconnection projects.

3 INCONTROVERTIBLE CONDITIONS

For this interconnection involving countries with a specific context, a work prior to the operation of the interconnection has to be carried out. The financial, political and institutional features of the EN countries of the region will mostly determine the challenges faced when integrating the region's electric power system.

Even if some countries are presently interconnected, their experience in interconnection management is limited. Moreover, power trade projects require significant amount of investments for these EN countries that are facing a lack of financing. Important restructurings in the electricity sector are on-going or will be realized, and numerous required structures linked to the interconnection are still inexistent or under development.

This political, economical and institutional context has to be adapted and barriers to profitable trade through this interconnection benefiting equitably to Egypt, Ethiopia and Sudan should be overcome.

Such projects in developing countries are financially and economically risky. Significantly mitigating the perceived risks by a relevant institutional proposal is a key point for fundraising and interconnection profitability.

The elements presented hereafter are incontrovertible conditions to demonstrate the consistency of this interconnection project. A set of essential items are raised linked to the interconnection settlements.

3.1 A LONGING FOR POWER COLLABORATION

The first need is obviously a willingness to trade. It has been clearly demonstrated the potential benefits of such a power trade with adequate demand and supply. EN countries, for a few years, have been embarking upon a cooperation path. Yet, it has been shown that the foremost barriers to regional integration were often political ones. Countries may be concerned about self-sufficiency, energy security issues, power penetration, possible asymmetries in the cross border trade of electricity, and by the impact of regional exchanges on the price of the commodity in their domestic market.

In the East Nile region, numerous regional organizations have been created for the last few years and have shown a genuine recognition of the necessity for Egypt, Ethiopia and Sudan to join their efforts in terms of resources management in order to contribute to economic development. There is no doubt that water management and power trade through the interconnection is on the core of this collaboration.

This endorsement has to come true, with the execution of power infrastructures projects, such as the Egypt-Sudan-Ethiopian interconnection linked up to dam building, and with some additional agreements concretizing this political wish.

3.2 A RECOGNITION OF THE EN COUNTRIES SPECIFICITIES

Egypt, Sudan and Ethiopia show a set of characteristics, which will be further described in the next chapter, indispensable to take into account in the different phases of this interconnection project. In a few words:

- Egypt has initiated an unbundling whereas Sudan and Ethiopia have still an electricity sector organized around national vertically integrated utilities
- The assumed evolving, pace at which unbundling and opening reforms will occur, seem proper to each country.

These multiple disparities oblige to propose relevant solutions which can fit all countries regulations and existing organizations.

The implementation of the organization linked to this interconnection can only be achieved if the national regulations of each country evolve in a coordinated way. All implementations during the multiple steps of the interconnection development shall be realized considering meticulously the framework of these three countries in which they will be integrated.

This consideration is particularly touchy for the development of energy exchanges. A gradual and stable approach in the development of a regional electricity market is necessary to avoid decisions that mark a rupture. Looking forward progress must not hinder exchanges.

3.3 A CAREFUL FINANCIAL RISK MANAGEMENT

Interconnecting Egypt, Ethiopia and Sudan over such long distance will require huge amount of investment outlays. However, if conditions were not fulfilled years ago, financing sources and modes now exist for such infrastructures, including government participations, public-private partnership, private sector involvement. Demonstrating the profitability and the consistency of the interconnection management will facilitate to financially secure investments. This is a key point for the project.

Moreover, paying special attention to payments during the interconnection operation will be crucial. Guarantees shall be taken to ensure that the investors will be paid and the interconnection operator will be able to carry out its leading role in the energy exchanges.[1].

Nowadays, the development of banking system fitting with market actors' need is insufficient. Suitable financial and banking services shall support transactions and deal with currency exchange issues.

Finally, taking again experience from OMVS interconnection, financial measures shall be determined to face up with exceptional low hydrology reducing exchanges[2].

The M8 module of ENPTPS phase II entitled "Economic and Financial analysis" will bring findings to both prevent and mitigate this financial risk.

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[1] The feedback for OMVS project consisting in a valorization of Senegal river and leading to energy exchanges through an interconnection has highlighted this consideration. The national utilities involved in trade turned out to be bad payers and accumulated debts between them and above all with the interconnector operator.

[2] In 2007, a and creating wrong anticipation of drought year has involved a reduction of 200GWh obliging the leasing of thermal production units to honor its contracts deficits.

3.4 THE IMPLEMENTATION OF EFFICIENT CONTROL STRUCTURES

Such an interconnection requires all life long adequate structures to successively take in charge the building, the operation but also the regulation of this interconnection.

3.4.1 BEFORE THE INTERCONNECTION COMMISSIONING

This period raises ownership and building issues. The framework, including institutional structures, has to be carefully set up because the future operation of the interconnection is on stake. There is a need to establish:

- A structure taking in charge legal aspects of ownership
- A structure endorsing the financing, involving specialists in close relation with financial institutions but also technical managers.
- A structure managing the construction that will last several years and will implicate a lot of actors, many agreements and procurements. In order not to jeopardize the interconnection profitability, respecting costs and meeting deadlines will be two important challenges to take up.
- A structure supervising the implementation of a suitable framework for exchanges including set of rules, codes, agreements and organizing training.

3.4.2 DURING OPERATIONAL PHASE:

After investment, it is time to reach as soon as possible the profitability threshold. Countries may enjoy the use of this interconnection so as to benefit from the expected energy and see the results of this East Nile co-operation initiated several years ago.

This operational period shall meet several objectives :

- To ensure energy exchanges satisfying market actors and transmission system operators
- To service debts and to cover operational costs.
- To optimize O&M costs
- To look after the optimal tariff

Thus, to encourage trade and achieve win-win outcomes in the created framework, several conditions shall be assembled. They can be decomposed into fundamental functions and associated structures :

- A structure endorsing an “Operation” function dedicated to provide the transmission service through the interconnector linking the three countries. It implies to properly maintain and operate the assets at optimal cost, in compliance with the agreed standards in terms of reliability, security and accessibility.
- A structure endorsing a “Regulation” function dedicated to monitor that interconnection users abide by guidelines and rules, respecting their contracts but also dedicated to monitor operation including budget. Transparency and non-discrimination will be the two major points to target.
- Different structures having successively authority to resolve disputes according to the subsidiary principle.

3.5 STANDARDIZED AGREEMENTS AND PROTOCOL GOVERNING THE INTERCONNECTION

The experience of developed countries shows that trans-national trades are not naturally favored by state owned and controlled electricity utilities. A strong political push needs to be given, either through political organizations or by firm agreements.

In reference to the recent Power Pool establishments such as the Southern, Western or Eastern African Power Pools, similar manners to proceed emerge in order to set up structures and responsibilities. Traditionally, it consists in :

- Founding agreements
- Operational agreements
- Trading agreements

These agreements that could take various forms, make solid a shared vision and are declined so as to implicate successively high representatives from governments, then operational entities.

3.5.1 FOUNDING AGREEMENTS

Countries have to make a common commitment to embark on this project and to make possible the real launch of the next steps leading to the building. An agreement signed by high representatives of the states could express a convergence of will between these three countries, indicating an intended common line of action for the implementation and the operation of this interconnection including the establishment of dedicated institutional structures.

To consider the potential evolution of the interconnection status, these agreements shall bring sufficient flexibility.

3.5.2 OPERATIONAL AGREEMENTS

This global political vision shall lead to an overall vision but detailed operating vision has to be made concrete and applicable by reference agreements that would constitute a kind of “Interconnection Code”. It could be materialized by operating technical guidelines or common “GRID CODE”. This document would set up the firm foundations of an efficient operation in terms of system reliability and safety. It would be designed as a set of rules which would facilitate the operation and the management of power exchanges. Actually, the basic goal of this document would be to define the minimum requirements and procedures so as to ensure reliable operation and secure cross-border energy exchanges because each country has its own requirements concerning electricity quality, operational measures. An harmonization is necessary to regulate the connection access. There is a need to be properly connected to avoid degrading the reliability of the power system. It is crucial to specify the minimum criteria which must be fulfilled by any applicant seeking connection, injection or withdrawal. This common grid code shall cover all usual relevant items ranging from load frequency and voltage control to telecommunications passing through scheduling and accounting.

3.5.3 AGREEMENTS ON THE WAY TO EXCHANGE

Interconnection users have to be well aware of the exchange conditions. A “Trading Code” needs to be created to provide with the general conditions of these energy exchanges between countries, specifying market design and relationship between parties. It would determinate terms that the parties shall enter into for the purchase, sale, delivery and acceptance of electricity. Concretely, it would raise commercial aspects including bilateral trades, short term market, Third Party Access, time frame, invoicing and payment, transmission charges, etc. This instructive document shall be completed by a set of contracts templates materializing these conditions.

The table hereafter summarizes main agreements:

Agreements	Vision Carried out by	Objectives
Founding Agreements		
- Inter Governmental Memorandum Of Understanding	Governments	Common line of actions and definition of the legal and institutional framework
- Inter Utilities Memorandum Of Understanding	Electricity sector	General operating principles
- Shareholders Agreement	Interconnection Owners	Establishment of an entity to carry out the project
« Grid Code » Technical Agreements	National TSOs	Definition of detailed operating guidelines (frequency, voltage, reserves, reactive transfer, SCADA)
« Trading Code » Contractual Agreements	Interconnection users	Definition of relationships between stakeholders Definition of the pricing policy (transmission, wheeling…) Definition of types of exchanged products and way to trade

Figure 2. Standardized Agreements and Protocols

4 INTERCONNECTION SPECIFICITIES

If traditionally, regional electricity cooperation is a long-term process which may be implemented in a stepwise manner, developing countries are confronted with the urgent need to organize the expansion of their power system at regional level[3]. For EN countries, the demand for electricity is expected to explode in the next few years. To face up the new challenges of growth, economic development, passing through the increase of electricity penetration, regional power trade seems to be part of the solution. The corresponding investment to be made is out of reach from the governments' financial capability. Therefore, the development of cross-border energy exchanges is developing quickly with great expectations and the cross-border trade may be integrated on fledgling electricity sectors. Therefore, the recommendation of a suitable model for the building, the ownership and the operation of the interconnection has to incorporate the specificities of the countries and of this project.

The following major specificities of the Egypt-Sudan-Ethiopian interconnection impact the way to proceed for the institutional analysis:

- An interconnection between three countries

Unlike a greatest number of interconnections, this one involves three countries not only two. Therefore, this project cannot be studied as the sum of two separate interconnections (Ethiopia-Egypt on one side and Ethiopia-Sudan on the other side) because Ethiopian-Sudan link is also dedicated for an important part to transmit energy to Egypt. However, the building may be realized in two steps according to an "anticipated scenario" examined in economic studies in ENPTPS phase I and estimated to be more profitable. The first part expected to be commissioned by 2015 will ensure an interconnection between Ethiopia and Sudan for a capacity of about 700MW with two 500kV AC lines. The second lot expected to be commissioned by 2020 will complete the scheme.

This building in two phases could reinforce the trend to dissociate these two parts but they are absolutely linked because their profitability cannot be separated.

- A billion $ interconnection project

This huge infrastructure project has an investment cost nearby 2 billion $ and revamping, O&M over the life time increases this amount. Because of geographical reasons, overhead lines cover more than two thousand kilometers. This project combines also a mix between AC and DC technologies because loss rate was too high with AC lines for such a distance. It implies costly HVDC converter stations.

- An unbalanced equipment allotment

This characteristic may be determining because ownership issues are particularly linked to the payment of equipments. Ethiopia has scarcely any infrastructures on its territory reduced to Mandaya station and a few miles of tie lines. Sudan and Egypt detain most infrastructures (HVDC stations, HVDC lines…) and consequently the greatest investment part. Yet, Sudan is one of the

[3] For the European System, development has gone through exchanges of expertise and information of operation, joint venture, asynchronous interconnection, synchronous interconnection to the full integration of an electricity market. It took time to reach this step.

poorest country in the world and could be unable to finance its part. Public or private investors and institutional financial institutions have to be solicited for them to bring their contribution to the project. Investors or lenders shall feel confident regarding this interconnection project waiting guarantees on their payback with low risk.

- A limited experience in terms of interconnection management

Egypt has been interconnected with Jordan, Libya and Syria since 1999 (EIJLST interconnection). The existing EIJLST cross-border trade is characterized by capacity transactions and interchange of surplus power and energy through yearly bilateral contracts in application of General Interconnection Agreements for the Electrical Interconnection among the concerned countries (Egypt, Jordan, Libya and Syria).

There is an on-going project of interconnection between Ethiopia and Sudan only for 100MW. Despite these two examples, it cannot be considered that these countries have a significant experience to manage such an interconnection with a capacity of 3200MW.

For these interconnections, each party with excess (firm power) shall, at its own option, make available for the other party:

- ❖ a defined firm power and associated energy which it desires to sell for a defined period;
- ❖ at times other than emergencies such surplus power and energy, it may desire to sell.

Therefore, the model is quite simple and coordination is limited.

- An existing and an assumed gap in electricity sector unbundling and opening

The characteristics of the electricity sector in Egypt are:

<u>For domestic aspects</u>:

- ❖ Restructuring of the electricity sector initiated leading to unbundling generation, transmission and distribution.
- ❖ Single Buyer model is adopted and EETC (Egyptian TSO) plays this role
- ❖ Electricity Utility and Consumer Protection Regulatory Agency is an established regulator
- ❖ Investment Law allows IPPs;
- ❖ By 2010, a new law is expected combining competitive (eligible customers HV-EHV) and regulated electricity market (MV and LV)

<u>For cross-border trade:</u>

- ❖ Country interconnected with other countries (EIJLST) and presently exchanging power but these exchanges remain marginal and face some difficulties
- ❖ Interchange of surplus power and energy through yearly bilateral contracts
- ❖ EEHC is the only company which exports/imports electricity (It is not possible for large consumers such as companies to trade directly with a foreign power supplier)

❖ The Ministry of Electricity and Energy controls and supervises the cross-border trade and imports

The characteristics of the electricity sector in Ethiopia are:

For domestic aspects:

❖ National vertically integrated utility EEPCO

❖ Possible restructuring of the electricity sector: unbundling of generation, transmission and distribution of electricity activities;

❖ Ethiopian Electricity Agency is an established regulator

For cross-border trade:

❖ No existing interconnection with the neighbouring countries, only Agreements on Power System Interconnection were signed with Kenya and Djibouti and on-going project to connect Sudan and Ethiopia

❖ EEPCO is the only company that can presently export/import electricity;

The characteristics of the electricity sector in Sudan are:

For domestic aspects:

❖ NEC is responsible for electricity generation, transmission and distribution in Sudan. It is a national vertically integrated utility.

❖ No independent regulator

❖ A High Committee has been formed to study the issue of reforming and restructuring the national electricity sector towards the opening of the sector including privatisation.

For cross-border trade:

❖ NEC is the only company that can presently export/import electricity;

❖ No interconnection with the neighbouring countries, only a MOU on power System Interconnection has been signed with EEPCO and a project connecting Ethiopia and Sudan is on-going.

- A power project inseparable from the Nile water resources requiring a compromise between power generation and irrigation

5 POSSIBLE GLOBAL MODELS AND RISK ANALYSIS

5.1 TWO CONCEIVABLE MODELS

Given other power interconnections developed recently around the world, within the framework of Power Pool integration or just for cross-border trade between countries or entities, two principal options are conceivable.

5.1.1 OPTION 1 : EACH COUNTRY DEVELOPS AND OPERATES THE INFRASTRUCTURE PART LOCATED ON ITS TERRITORY

This option is very common and was implemented in Europe for many years. When an interconnection project is launched following bilateral agreements, the national TSOs from each country are in charge of :

- setting up a whole project and carrying out necessary studies including financial, economical and technical aspects
- managing and supervising the construction of assets which are located in its country
- then operating its side of the interconnector with close collaboration and operating rules with other TSOs (planning, data exchanges, real time actions…) to guarantee security, quality and accessibility standards.

Therefore, the interconnection is not considered as a whole but as two separate parts built, owned and operated by the different national TSOs. Each part located on a specific country is just perceived as a national grid extension.

This organization model has been admitted as a suitable manner to develop interconnection for many projects and it fits particularly when:

- an interconnection between only 2 countries is envisaged

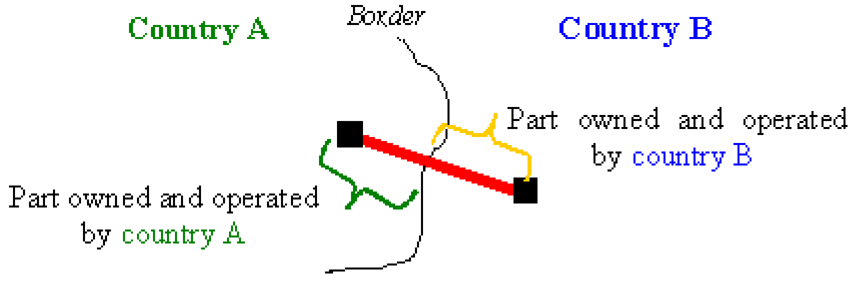


Figure 3. Country-to country approach

- the cost of the interconnection is not high (short distance) and the financing needs do not imply a strong contribution of lenders
- the cost is quite well shared between the two countries

This model can also be contemplated for the Egypt-Sudan-Ethiopian interconnection involving three countries using a country-to-country approach. However, three bilateral agreements are required to define the general line of actions for this interconnection.

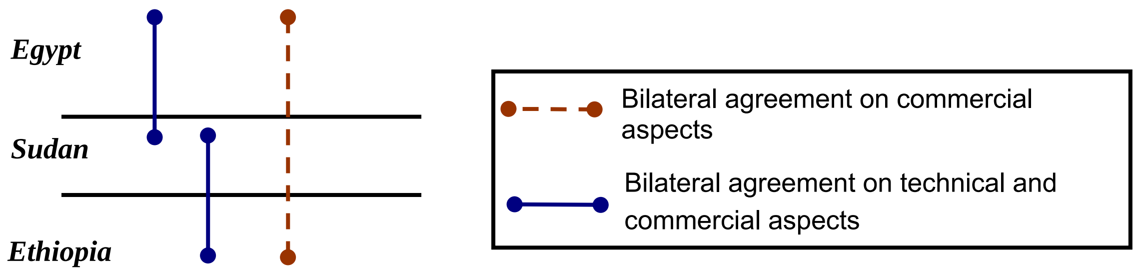


Figure 4. Agreements in a country-to-country approach

5.1.2 OPTION 2: SEVERAL COUNTRIES FORM MULTINALERAL ORGANIZATIONS TO BUILD, OWN AND OPERATE THE INTERCONNECTION

The conditions described above are not always fulfilled and some infrastructure projects are implemented using a collaborative approach with multiple multinational entities. For instance, the Manantali Interconnected network within the frame of the *Organisation pour la Mise en Valeur du Fleuve Sénégal* (OMVS) involving Mali, Mauritania and Senegal has been developed according to this model. The WESTCOR project within the SAPP is another illustration. This project is intended to exploit the hydroelectric energy of the Inga rapids site in the DRC through interconnected lines as follows:

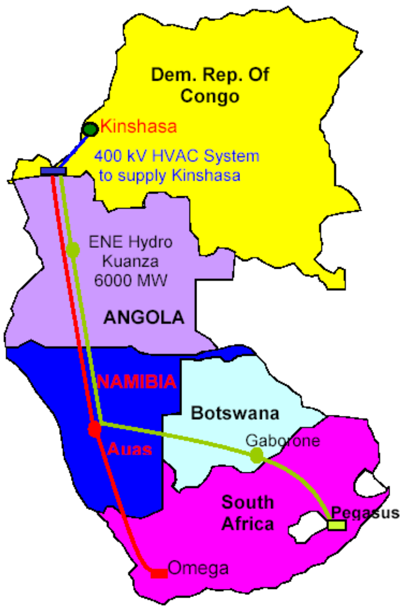


Figure 5. Projected WESTCOR transmission lines

The WESTCOR Joint Venture Company is compounded of the five national utilities from Namibia, South Africa, Angola, RDC and Botswana, each one sharing 20% of the capital. Registered in Botswana, it aims at funding the engineering and financial studies, and at building, owning, and operating the infrastructure should the project prove to be viable.

In general terms, a multilateral entity dedicated to the project is set up with a possible participation countries, national utilities or TSOs, producers, private/public investors. There are a lot of possibilities regarding the capital base, the legal status, but key points are:

- The interconnection is owned and built by a unique multinational entity[4], no matter the number of countries involved.
- A unique entity is also responsible of operation. Nevertheless, it is not unthinkable to entrust the operation of this interconnection to a specific and private specialized organization with a concession agreement on operation management.

In this configuration, only one multilateral agreement is necessary. Decisions and negotiations imply all parties.

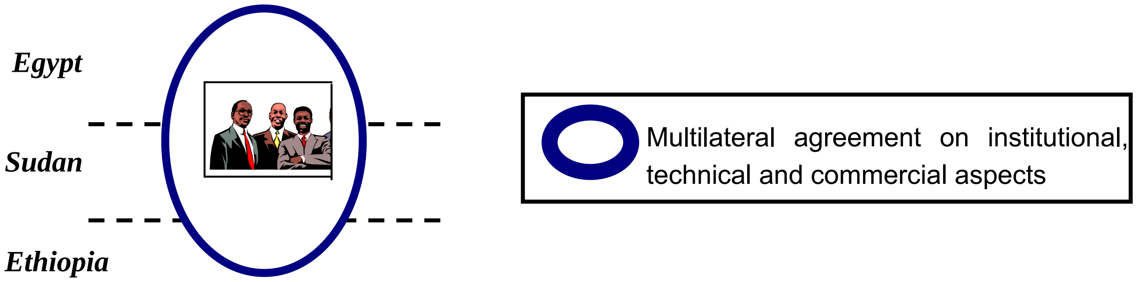


Figure 6. Agreement in a collaborative approach

This collaborative approach can be declined into numerous forms of organizations and schemes to develop the project. Several distinctions are indeed worthy regarding the implication of multilateral organizations and private actors in the successive stages. These different schemes are well known under the name of BOO, BOT, DBO. The last section of the present report proposes a methodology to select the optimal scheme.

[3] This approach is in fact an adaptation to a project of a Power Pool vision developed for regional infrastructures. To illustrate this point, the common and inseparable ownership of dams within the framework of OMVS is significant.

5.2 RISK ANALYSIS

Given the specificities of this project, a first analysis level enables to determine the global approach for this project implementation. The two models presented above, collaborative and country-to-country, have to be compared, weighting their hardiness faced to the foreseeable risks regarding the different steps of this project: financing, building and operation. The proposed model has to avoid most major pitfalls and to mitigate residual obstacles.

This risk analysis is summed up by means of the table presented hereafter. Its purpose is to list the possible risks which may arise during the different phases so as to determine actions to eliminate or mitigate them. The gathering of these actions enable to find the most suitable characteristics of the proposed institutional model.

This table is designed around four major points:

- A breakdown into the fundraising, building and operational steps which constitutes the first column
- An enumeration of the major potential issues is given in the second column. Important questions, demonstrated as keystones, have to be carefully addressed in each interconnection projects. These issues are expressed in terms of general questions.
- A list as exhaustive as possible of major risks constitutes the third column. This part attaches a particular importance to the specificities of the project and describes the risks for this interconnection. Issues are indeed studying in the light of the three countries context to imagine where and why concerns could occur.
- Adapted prevention and mitigation measures to cope with risks constitutes the fourth column. The way to address issues prevents disagreements and misunderstanding. Many actions within reach of these three countries could enable to foreclose risks.

For each identified risk, a few comments are made mentioning further recommendations, considerations taking inspiration from other projects and international organizations.

Phases	Potential Issues	Associated Risks	Prevention and Mitigation measures	Comments
Fundraising	How sharing investment between countries ?	Countries take too much time to reach an agreement	**Forming a group compounded of representatives depending from the Energy Ministry of Egypt, Sudan and Ethiopia having the mission to reach agreement within a deadline**	This sharing investment concern has been expressed in several meetings and workshops and will be is the core of fundraising. In a country-to country approach, Sudan would have to pay for an HVDC station enabling trade between Ethiopia and Egypt…
		Countries do not achieve a common agreement		
		An agreement involving not achievable financial needs is concluded	**Forming a multinational group carrying out a financial project aiming at setting up a common financing plan**	This group could add weight to negotiations with lenders and visibility of a collaboration for international institutions. Such a collaborative approach has bigger chances to succeed.
	How solving ownership issues ?	Reinforcing disagreement on investment	**Having a unique owner for the whole interconnection**	The ownership implies to bear investment but also maintenance costs. The joint tenancy has been used for OMVS infrastructure to avoid debating ownership breakdown.

Phases	Potential Issues	Associated Risks	Prevention and Mitigation measures	Comments
Fundraising	How convincing about the project profitability ?	Lenders are not interested in the project	**Setting up a common financing project integrating legal, political, economic, technical and financial aspects in which parties are absolutely bounded**	For lenders, it is indispensable that the financing should be coordinated between the three countries. For them , the project has to be considered as a whole because exchanges implementation requires the whole interconnection and a loan cannot be granted to one country if there is no insurance that other countries will fulfil their obligations. UN seminars have particularly insisted on this global financing project.

Phases	Potential Issues	Associated Risks	Prevention and Mitigation measures	Comments
Building	How getting the best building?	Costs are too high	**A unique Engineering Procurement Construction Management for the whole interconnection** **Involving :** **Common tenders & specifications** +	A coordination in preparation phase for building, common constructors and suppliers and free phasing would enable to reduce costs.
		Equipments disparities interfere with good future operation	**Common constructors and technologies** +	Buying set of equipments would avoid incompatibility.
		Deadlines are not met	**Optimised phasing regarding the whole building**	In the event of delay, the responsibility is global and centralized. Difficulties faced during construction are handled by all countries.

Phases	Potential Issues	Associated Risks	Prevention and Mitigation measures	Comments
Operation	How solving interconnection access issues?	Non-fair and discriminatory interconnection access	**Studies and capacity allocation realized by a unique organism** + **Implication of an interconnection regulator**	The regulator has make sure that the compliance with these fundamental principles is respected. In addition, a better coordination between TSOs for access could be obtained by a supervisory organism in charge of capacity allocation.
	How sharing benefits?	Parties feel penalized because of unbalanced benefits sharing	**Having clear and non-discriminatory rules about fees charging policy approved by an interconnection regulator**	With a BOO model, only remains the transmission tariff allocation between countries because the whole amount paid to the BOO organism is fairly distributed between shareholders.
	How guaranteeing fair dispute resolution between national TSOs?	Blockages between national TSOs	**Having a neutral interconnection operator** + **Having an Interconnection Regulator**	The neutral metering would bring unmistakable reference and avoid recurrent metering failure pretexts to justify deviations as it is noted for interconnections.
	How controlling physical flows on tie-lines ?	Non-respect of scheduled program or technical constrains (voltage drop, reactive power…)	**Having a unique interconnection operator authorized to control flow on tie lines** + **Compensation mechanism**	When cheap electricity is available, interconnection users are tending to withdraw more than scheduled. In an operation supervised by TSOs, it is quite frequent (OMVS, SAPP…)involving many disputes and non-payments due to the lack of real time corrections. An interconnection operator shall control flows imposing limitations, reducing deviations to their minimum. Moreover, a compensation mechanism has to be set up to cope with deviations, non compliance of standards so as to erase prejudice.

Phases	Potential Issues	Associated Risks	Prevention and Mitigation measures	Comments
Operation	How ensuring the operational financial balance?	O&M costs are higher than scheduled	**Having a unique operator coordinating an only O&M planning for the whole interconnection**	Incentives could be proposed to this operator about losses management, maintenance costs without modifying the availability and reliability standards
		Tariffs are too high (dissuading trading participants) or too low (not cover the real costs)	**Good finance management** + **tariff approval by an Interconnection Regulator**	If each country builds its part, each country will adopt its own tariff policy. It will be certainly less consistent than having an harmonised tariff for the whole interconnection agreed by the three countries and a Regulator.
		Invoices are not paid	**Escalation procedures in the form of penalties, exchange limitations**	
		Lack of water supply reducing revenues	**Hydrological conditions extensively studied at the feasibility stage** + **Provisions made**	Getting a robust estimate of the average annual flow, its distribution over the year and a statistical knowledge of inter-annual variations by means of successive actualisations is fundamental. The interconnection shall constitute an amount usable for dry years. This point is further detailed in the M8 module "financial analysis"
		Currency issues hindering exchanges	**Efficient financial institutions**	

Phases	Potential Issues	Associated Risks	Prevention and Mitigation measures	Comments
Operation	How controlling O&M costs ?	Interest conflicts and confusion between costs interconnection costs and costs related to the national electricity sector	**A unique interconnection operator centralizing all costs**	Determining exact O&M costs is a prerequisite for the calculation of suitable transmission tariffs. With a unique operator, it would be quite easy to estimate expenses and establish a transparent and equitable tariff for the use of this interconnector. The interconnection operator's accounts would be open books controlled by an Interconnection Regulator
	How guarantying the best availability ?	Exchanges cannot take place	**Having a unique responsibility for operation**	The poor availability is generally due to a lack of money for the operator or o a poor management. With a unique operator, in the event of a outage, the responsibility is common. Moreover, the O&M can be more coordinated. For instance, maintenance actions can be optimised to have the shortest cut off.

Figure 7. Risk table analysis

This first risk analysis underlines several crucial issues which could :

- handicap the negotiations between EN countries, principally for financing
- lead to inefficient construction
- lead to unacceptable operation

However, most risks can be prevented adopting measures which are within reach of Egypt, Ethiopia and Sudan.

Concretely, it is noticed that a country-to-country approach presents many risks, important enough to endanger the interconnection preventing both its building and its good operation. If countries do not opt for a unique coordinated project, their guarantees will not be sufficient. How demonstrating for a country the feasibility of this project to banks if it has no guarantee that other countries should bring their project into fruition ?

The ideas developed as prevention and mitigation methods have demonstrated the need :

a) To have a unique owner
b) To have a coordinated owning and financing project implicated all parties and proficiencies (legal, technical, financial and economic)
c) To have a construction of the interconnector considered as a whole
d) To have a unique responsibility for operation (capacity allocation, maintenance, costs centralization…) distinct from national TSOs
e) To have a dedicated interconnection control entity being authorized to take real time measures
f) To have a specific regulation for this interconnection

These conditions that come out of this risk analysis would be gathered with a collaborative approach of this interconnection based on a organizational model carried out by a multilateral organizations mixing representatives from Egypt, Sudan and Ethiopia to own, build and be responsible of operation. As a starting point and adopting a functional point of view, the interconnector would be operated by this organization distinct from national TSOs and the creation of an interconnection regulator would enable to monitor the different phases and the compliance with fair and non-discriminatory practices.

However, the financing project as well as operation activities can be dissociated from this global multinational structures and be allocated to any qualified structures. This point will be developed further in the last section dedicated to implementation road map.

The risk analysis findings underline the necessity and the common interests for these three countries to join their moves to finance, build and operate this interconnection as they have already done at a political level for power trade principles within EAPP or other agreements promoting energy exchanges between neighboring countries. Three countries linked to achieve the same objective would facilitate agreements about potential issues and would give more consistency and visibility to the international community.

For developing countries, the primary incentive to opt for better cooperation, is obviously the lack of money available for economic development. International organizations call for such a collaboration because the commitment of several countries, is a better guarantee for investors than the commitment of an isolated country.

To sum up, the mere fact that countries devise multilateral organizations in order to take in charge this project from financing to operating period can reduce the risks perceived by potential investors. If this desire to face up together energy challenges has been materialized by the creation of African Power Pools, it is consistent to adopt also a collaborative approach run with multilateral institutions, for this interconnection project involving three countries.

Therefore, considering the project specificities and the results of the risk analysis, a collaborative approach appears to be the most suitable option. This approach consists both in the establishment of one or several multinational entities to Build, Own and Operate the interconnection, and in the set up of a regulator in charge.

It is strongly recommended to adopt such a model which displaces most of issues in a possible common ground and which considerably reduces risks.

6 PROPOSED INSTITUTIONAL MODEL

6.1 GENERAL DESCRIPTION

In order to demonstrate the viability of this power interconnection project between Egypt, Ethiopia and Sudan, a consistent institutional model is fundamental. In view of the specific context surrounding this interconnection including as well geopolitical, economic reasons as technical considerations, the following preliminary model is proposed for the form of energy exchanges and institutional structures contributing to the integration of this interconnection. It includes the results of the previous risk analysis.

6.1.1 REASON TO TRADE AND EXPECTED BENEFITS

This interconnector ensuring a link between Egypt-Sudan and Ethiopia relies upon a structural gap in the electricity generation costs of the different countries. Therefore, the only condition to benefit from this interconnection is that price differential between countries should be greater than transaction costs. In fact:

- Ethiopia has huge hydrologic resources with Blue Nile river to build HPP and can produce cheap electricity. An estimated surplus of 30 GW has been pointed up.
- Sudan and Egypt use many thermal power plants burning fossil fuels such as oil or gas and are facing up present fuel price escalation.

The ENPTPS phase I has clearly demonstrated a global benefit/cost ratio ranging from 2.4 to 7 depending on the frame in which cross-border trade will take place. It is assumed that in the short term, Egypt and Sudan will have an importing status whereas Ethiopia will have an exporting status. The energy amounts calculated during the optimization analysis carried out in ENPTPS phase I (2000MW during 6300 hours for Egypt and 1200MW during 7800 hours for Sudan) shall be actualized to look for the best profitability [5].

However, as the interconnection is designed in a totally reversible way, it enables all possible exchanges between countries. This is not simply the construction of lines in order to evacuate power generated by Ethiopian Hydro Power Plants.

In the first operational phase, energy exchanges will be conditioned by three major items:

- The electricity price difference between countries
- The Ethiopian water resources dedicated to power generation. It is important to recall that, even if the Ethiopian network shall inject power on the interconnector and not exclusively HPP stations, the Ethiopian hydrologic potential remains crucial
- A possible minimal energy amount agreed between countries and compulsorily traded to secure the debt service.

[5] Economic studies planed that the HVDC link between France and England would be used to alleviate peak periods using jet lag between these two countries. However between these studies and operation period, economic conditions had changed and the interconnection was exclusively used on an unidirectional way : from France to England.

Both importing and exporting countries would find their interest because:

- Importing countries will save up because imported hydroelectricity (especially hydroelectricity) will be less expensive than generated one.
- Exporting countries will make money selling their available electricity

In addition to these purely economic considerations, this interconnector will provide many technical services in terms of mutual assistance in case of emergency, reserve sharing, coordination in primary reserve for load frequency control, knowledge sharing…

6.1.2 *An Interconnection Model Flowing From Founding Agreements*

Described as an incontrovertible institutional condition, the interconnection integration shall be initiated by a push given by the governments of the three countries. This is a prerequisite confirming the decision to bring this interconnection to fruition and enabling the implementation to all measures required for financing. Several Power Treaties have already been signed within EAPP or general agreements between two countries authorizing and promoting energy exchanges. These treaties shall be filled out, or new treaties be signed, in order to define a common line of actions for the implementation of energy exchanges through this interconnection.

Taking inspiration from the usual agreements, it could consist of:

- **An Inter-Governmental Memorandum of Understanding (IGMOU):**

Signed by the three states, represented for instance by their energy ministers, it would at least express a convergence of will between Egypt, Ethiopia and Sudan. It would show a common line of action for the implementation and the operation of this interconnection. It would offer a guarantee by underlying legally enforceable obligations of the parties and clarifying the role of the impacted entities among which the national TSO, the interconnector operator, interconnection users and multinational organizations.

- **An Inter-Utilities Memorandum of Understanding (IUMOU):**

This multilateral agreement between the interconnection operator and the national utilities or TSOs at least of Egypt, Ethiopia and Sudan shall enable to set up a shared vision of the operation establishing management and operating principles. The general conditions would be settled with a view to achieving the defined quality and reliability standards and enabling technically and economically interconnection of Egypt, Ethiopia and Sudan. It shall announce operating guidelines to define later.

The combination of these three basic multilateral agreements are often used to found a firm foundation for regional trade and interconnection management. It has been already adopted within the framework of Power Pools for SAPP, WAPP and EAPP but also for interconnection projects.

These agreements would be dedicated to the Egypt-Sudan-Ethiopian interconnection while letting the possibility to belong to a more global integrated regional market within Nile Basin or EAPP region. To consider this future evolution these agreements shall bring sufficient flexibility.

6.1.3 A FUNCTIONAL BOO MODEL

The global Model for the Egypt-Sudan-Ethiopian interconnection shall be built on the basis of a functional multinational organization. Independent from national TSOs and absolutely dedicated to the interconnection, this organization gathering all required responsibilities or the project development will:

- Own the interconnector assets
- Build the whole interconnector without any differences between the Ethiopian-Sudan link probably anticipated (scheduled commissioning by 2015) for economic reasons and the Ethiopian-Egypt link built to be operated by 2020
- Define operating guidelines and grid code in collaboration with TSOs and future entities physically connected to the interconnector dealing with but not limited to:
    - Load frequency and voltage control
    - Interchanges scheduling and accounting
    - Transmission coordination
    - Connection requirements
- Define the contractual framework with TSOs and interconnection users dealing with but not limited to :
    - Charges
    - Scheduling and data exchanges
    - Exchanged products
    - Dispute resolution and arbitration
    - Interconnection access, capacity allocation process
- Operate the connector in compliance with approved standards in close collaboration with national TSOs. This organization shall just be a specific transmission operator for the interconnection. It only ensures a transmission service and will not buy or sell energy like a participant to trade (except for losses management).

6.1.4 A FUNCTIONAL STRUCTURE INTERACTING WITH ITS ENVIRONMENT

For financing, building and operating stages, this functional structure (FS) will be in touch with many entities that will constitute its background. These relationships shall be clearly materialized by contracts, agreements and rules defining roles and responsibilities, rights and duties. These contracts shall imply several types of flows which can consist in data exchanges for a close collaboration, physical energy flows as well as payments.

The stakeholders involved in this FS are detailed hereafter with a few comments.

6.1.4.1 Shareholders

Depending on the project scheme chosen, a specific entity shall be established with a specific capital base agreed between all parties likely to contribute to the financing of this interconnection. According to this scheme, investors may go from public and national entities to private investors.

The shareholders will enable the establishment of this entity through the enactment of a Shareholders Agreement. They will constitute the board and will be the ultimate decision makers, having the mission to comply with the general line of actions flowing from agreements. Egypt, Ethiopia and Sudan, represented by high governmental members, shall keep control on this interconnection by driving the board.

In exchange of their participation in the capital base, stocks dividends will be paid to them during the operating period.

6.1.4.2 Financial institutions

The shareholders participation will determine the missing financial needs. The legal status of the interconnection owner and the capital base, will indeed condition the characteristics of the loans to grant. The financial institutions such as international banks or private lenders shall be solicited in order to raise enough funds to initiate the building process. To secure the investment and to make lenders confident, some guarantee agencies may be involved in fundraising. Therefore, loans will have to be obtained and then reimbursed.

6.1.4.3 Constructors and suppliers

During building and operation phase, the FS will have to call for services from constructors, consultants, and/or other resources to help it carry out the construction and O&M actions. Engineering Procurement and Construction contracts may be concluded as well as maintenance contracts. This shall demand a careful follow-up with many potential companies involved and important financial flows.

6.1.4.4 Clients

The clients will be the interconnection users. For them, the interconnection is a service which shall meet their expectations in terms of quality, security, transparency and fair accessibility.

The interconnection users will obviously depend on the implemented transaction process. It is assumed that the form of the market will evolve over the operational lifetime. Therefore, these users may pass from national verticality integrated utilities to economic agents from each country including producers, consumers and traders.

These clients shall have a clear contractual relationship with the Operator of the interconnection about interconnection access, tariffs, energy exchanges scheduling.

6.1.4.5 National TSOs[6] of EN countries

In order to successfully operate the interconnection, a close collaboration shall be required between the Operator of the interconnection and the national TSOs. National TSOs will be the physical users of this interconnection and will be physical intermediates between domestic clients and the interconnector. They will have to abide by operating rules that will regulate operating questions including connection, reserves, scheduling, accounting, data exchanges. A coordination at different time horizons from studies several years-ahead to real time actions shall be determining.

6.1.4.5.1 An interconnection Regulatory Agency (IRA)

IRA is a functional multinational organization independent from national regulators. This is the second keystone of this proposed model. The regulation function is an inevitable condition in the project implementation. Institutional changes, definition of exchange conditions and implementation shall have to be monitored by a regulator. Moreover, a regulation by the market is absolutely insufficient for the operation stage[7]. Therefore, the Operator of the interconnection shall have to be controlled during operation to guarantee its compliance with fair and non-discriminatory methods. In the same line disputes between the Operator and its clients shall be settled by IRA.

6.1.4.5.2 Other regional institutions

The implication of regional institutions is quite woolly and was out of scope. Nevertheless it will certainly be a major point to address in next studies. This interconnection will inevitably be inserted in a regional context and regional structures may play a leading role in this interconnection implementation. This relationship shall have to be meticulously defined and options ranging from an intervention as advisers, observers to a concrete implication as supervisor for building and operation will be decided. It is clear that future integration of this interconnection in a more global framework at the Nile Basin or East African scale seems unavoidable, the uncertainty lies within the time horizon and associated turn of events.

6.1.5 FINANCIAL BALANCE

Depending on the scheme retained, expected profit from the operation may be different. As presented in the financial analysis, the Operator of the interconnection is not designed to make profit. Even if financial arrangements are obviously necessary (provisions, refinancing, tariff optimization …) for a good operation, this operation phase shall enable to achieve year by year a financial equilibrium.

6.1.5.1 Revenues

The interconnection operation will generate receipts. Two sources can be distinguished:

- Firstly, in exchange of the transmission service through the interconnector, interconnection users will have to pay charges. This fee will certainly be cost-based and uppermost

[6] TSO has to be understood in this paragraph as the provider of transmission function. No matter if this function is ensured by independent entity in an unbundled electricity sector or by the national vertically integrated utility.

[7] The creation of the Commission for Energy Regulation in Europe attests to this necessity in liberalized and competitive markets.

regulated to make sure of the financial health of organizations. The mechanism used to calculate this fee, the constitution with fix and variable parts and its allocation between importing/exporting participants will depend on the exchanges model and the market maturity and will be discussed between countries. The Module 8 provides with inputs by analyzing the bill for each country in function of these parameters.

- Secondly, some actors that would not meet their requirements leading to deviations, real time actions on the interconnector, or last time modifications in their program after the related deadlines shall be obliged to financially compensate.

<u>Remarks:</u>

- This interconnection fee is only dedicated to the service consisting in transmitting energy through tie lines. It is absolutely not linked with the national price setting related to the national network use.

- Financial arrangements will be integrated for tariffs to stay in line with the probably movement in costs over the interconnector lifetime (higher tariff at the beginning to service the debt, escalation based on inflation…)

6.1.5.2 Expenses:

Borne expenses can be categorized into several types:

- O&M expenses
- Revamping expenses: some equipments will require important upgrades and replacements to lengthen their lifetime
- Debt costs: loans granted by public/private financial institutions will have to be reimbursed
- Stakeholders remuneration: investors that have contributed to the capital base for the establishment of a multilateral entity owning the interconnection will receive incomes according to their participation in capital base and expectations.
- Expenses resulting from compensation for interconnection users if their scheduled transactions cannot be completed
- Taxes (corporate income tax for instance) if any

It is also important to highlight the polar importance of financial risk anticipation. This financial balance will be attained only if measures are planned to secure revenues.

Moreover, interconnection users could be forced to buy and sell a fixed energy amount during the first operation stage to secure payback period though take or pay contracts for instance.

Remark: If the price difference is as important as currently, there is no reason for clients to deprive themselves of benefiting from such a cheap electricity to sell or to buy.

Provisions could be done saved on the hydrological risk. A sensibility analysis on the traded energy amount assuming a reduction of a few % is performed in the financial analysis. In the event of a bad rainfall season, the lack of revenues may endanger good operation. A reserve fund shall be constituted to make up for this situation as a kind of weather derivative.

6.1.6 AN INTERCONNECTION CONTRIBUTIONG TO TELECOM SERVICES DEVELOPMENT

As done before in other countries, it would be worth considering the opportunity to develop high speed telecommunication services with the implementation of this interconnection. The use of optic fibers is essential to ensure data exchanges between the national TSOs and the Operator of the interconnection for a good operation. A defined number of fibers could be reserved to provide with services for telecom companies benefiting from power towers.

If the interconnection is chosen to support such services :

- The interconnection preliminary design will define the optimized optic fiber capacity and associated performances for telecom services.
- The lease of communication capacities will generate revenues, integrated in the pricing policy in order to reduce access & transmissions fees paid by power importing/exporting companies.

The OMVS feedback is encouraging. EN countries have to think about this opportunity and begin to address the potential legal barrier.

In a nutshell, the Functional Structure's environment is schematically represented hereafter.

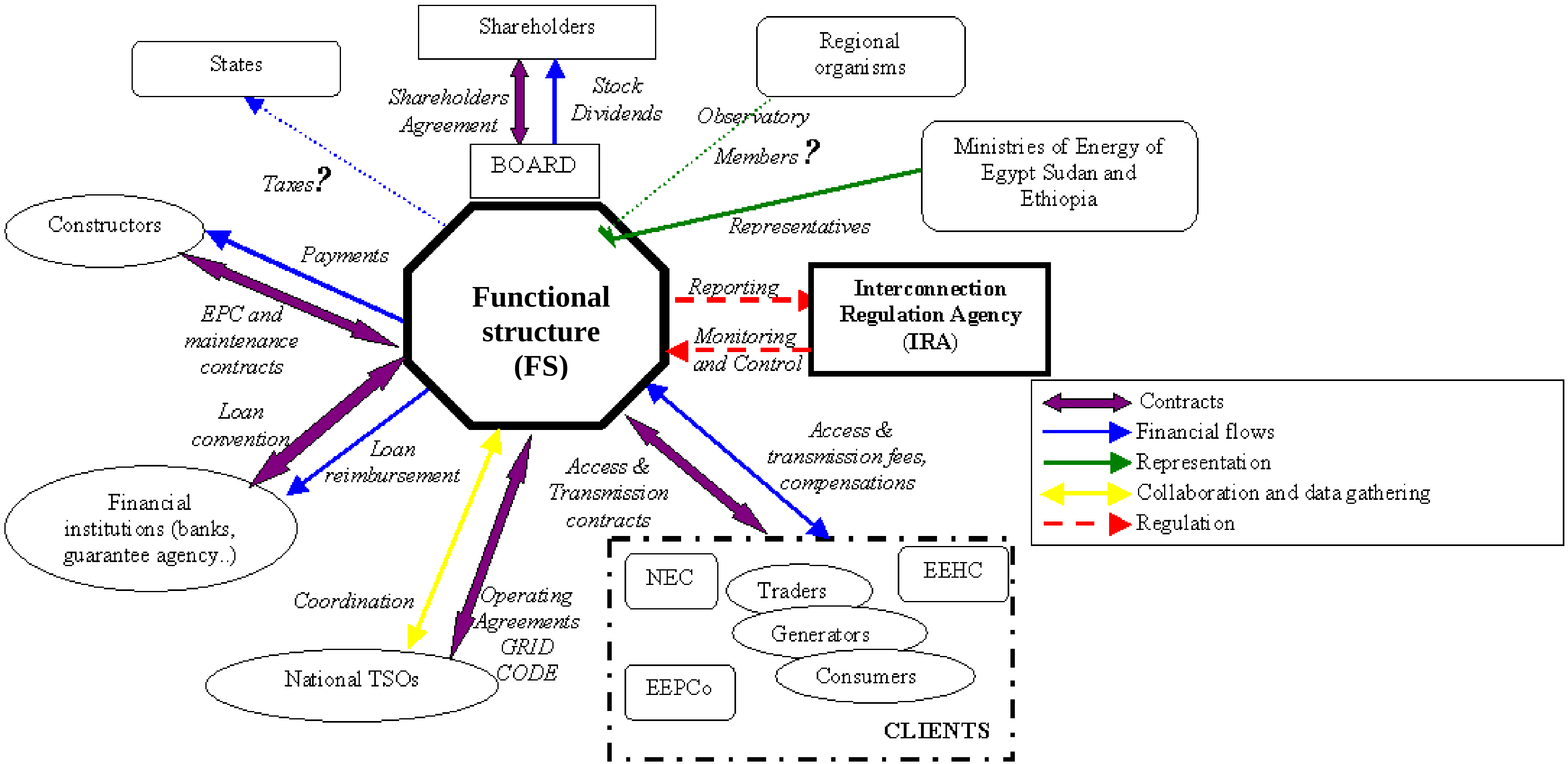


Figure 8. The environment of the FS

6.2 Considerations On Structures And Way To Exchanges

As presented in the Interconnection Global Model, this interconnection implementation goes hand in hand with the settlement of at least two functional institutional structures, a functional structure to carry out the project implementation and operation (FS) and the functional Interconnection Regulatory Agency (IRA).

It is recalled that these multilateral institutions are described in a functionally way, underlining proficiencies, responsibilities and possible organization. It does means that FS and IRA will be necessarily founded. They may constitute an extension of the role of existing regional structures and consist of several entities sharing a part of detailed competences.

6.2.1 Presentations Of Functional Structures To Set Up

6.2.1.1 The Functional Structure

This is a symbolic and functional multilateral entity that gathers proficiencies and responsibilities that effective founded structures will require to Finance, Design, Build, Own and Operate the Egypt-Sudan-Ethiopian interconnection. This FS would also contribute to the creation of the dedicated contractual framework and operating rules.

This key institution will be compounded of a management department supervising a staff, a control center and several departments with specific roles and responsibilities. The main parts of this institution are described hereafter.

It includes a building unit attached to carry out the process from the tenders, the choice of constructors to the commissioning of equipments and usual tests. This unit would monitor the follow-up having in mind costs and delay issues. However, other options like EPCM contracts can be retained.

6.2.1.1.1 The board

This shareholders' assembly will have decision making authority to develop and implement initiatives to develop the project and achieve the successive steps through operation according to IRA approval and taking into account the overall policy directives agreed upon by multilateral Founding Agreements.

6.2.1.1.2 FS Management

It will be the guarantor of the compliance of the FS with its objectives. It will verify the safe, efficient and economical operation of the interconnection. Its missions include:

- The establishment and the supervision of departments including appointments and TOR
- The establishment of the control center and its management
- The promotion of coordination between parties

- The proposal and comments on the issuance of regulations, codes or decisions related to operating conditions on the basis of departments works
- The proposal on prices regulation related to transit fee including the method by which they are evaluated and changed

6.2.1.1.3 Operation

The control center is the compulsory operational and real-time organ for operation. Its purpose is to perform the monitoring and coordination necessary to ensure operation of the interconnector according to the agreed standards. It will ensure that each party is undertaking their duties in accordance with the terms of contracts and enacted operating codes and other rules.

A unit shall take several operating, scheduling, reporting and studies responsibilities as listed hereafter:

- Continuously monitoring the operation of the interconnector system including frequency, voltage at the border and active/reactive flow on the tie-lines and assessing defined operation quality criteria
- Guaranteeing the safe operation of the interconnection during real-time even if each country remains responsible of its own network.
- Monitoring the primary and secondary response as determined as per the agreed code
- Issuing warning to the national TSOs and load dispatch centers (LDCs) of an any abnormal situation noticed and event related to operation of the network
- Issuing warnings in the event of transfer of reactive power without formal agreement
- Issuing warnings to LDCs in the event of an important discrepancy between the scheduled flow and actual flow active power
- Controlling the flow between parties in addition to the assumed control of each party within the use of Automatic Generation Control or Load Frequency Controller for instance. It implies that this control center has the right to adjust flows in real time.

To meet these requirements, the control center needs support and advice on all matters related to collective policy formulation functions for developing, maintaining and updating common "rules of practice" on technical, planning and operational aspects.

6.2.1.1.4 Technical Support

This department shall be dedicated to the management of technical aspects. It includes:

- Initiating and coordinating the writing, revisions and improvement of operational guidelines. In collaboration with TSOs (or national utilities if the unbundling has not yet occurred) it will address:
    - ❖ Load frequency and voltage control
    - ❖ Interchanges scheduling and accounting
    - ❖ Transmission coordination : data exchanges between TSOs and the Operator of the interconnection for good operation

- ❖ Connection requirements to properly connect the interconnector
- ❖ Capacity requirements

- Coordinating the maintenance schedules and activities
- Carrying out technical studies of the interconnector
- Reporting experience feedback and analysis on standards reliability, security following unexpected event and outage

The members of this department shall have sufficient technical background and experience to fully understand and evaluate the technical aspects. In addition to the regular members, representatives or consultants could be invited to provide guidance on policies and regulatory framework .

6.2.1.1.5 Planning

This department shall be in charge of tasks enabling to determine the daily exchanges program. It includes:

- Calculating safe transfer capability limits between two countries according to the adopted reliability and safety criteria in link with TSOs and using technical subcommittee studies
- Supervising the capacity allocation to trading participants
- Collecting information from the TSOs and commercial users for agreed transactions relevant to operate the interconnector (MW, MWh in an hourly basis…)
- Preparing the net interchange schedule for each party
- Collecting the metering information
- Summing the inadvertent energy per period and deducting the corresponding settlement of exchanges schedule
- Managing losses estimations and compensations
- Preparing compensations program if any (choice has to be done between “in-kind” compensation and financial compensation) for “in-kind” return of inadvertent energy during similar period.

6.2.1.1.6 Legal, Economic and Financial Support

These departments shall deal with:

- Defining the contractual framework between the FS in charge of operation and national TSOs and between the FS and interconnection users focusing on :
  - ❖ Exchanged products
  - ❖ Charges
  - ❖ Scheduling and data exchanges
  - ❖ Dispute resolution and arbitration
  - ❖ Interconnection access, capacity allocation process

- Using methods to elaborate transmission tariff actualization
- Taking in charge financial flows including invoicing and payments, compensations

6.2.1.2 The Interconnection Regulatory Agency

The IRA is the second key institution of this interconnection model and shall be a multinational organization independent from national regulators, but coordinated with. It shall be founded or designated by the governments of Egypt, Ethiopia and Sudan to monitor energy exchanges verifying the compliance with transparent and non-discriminatory practices. Its action, defending the interests of all parties, will particularly make sense in a future competitive market.

A major discouragement to the entry of new actors in the electricity sector is a perception of arbitrary and frequent political intervention in the industry in the pursuit of objectives having little to do with electricity. This means that the establishment of regulatory authorities which are independent to day-to-day political intervention, while remaining accountable in a more general way to the political process, is a necessary condition for more competitive behavior in electricity trade. The market regulation is usually shared between the Ministry in charge of Electricity, which has a leading role in defining and implementing the electricity policy as well as in defining and controlling public-service missions, and a Regulatory Agency which is an independent and specialised administrative authority[8].

Its main missions shall consist in:

- Defining the Terms of Reference of operation
- Validating the transmission tariffs and budget
- Monitoring contracts between stakeholders involved in this interconnection project and operation
- Removing monopolistic situations in a competitive market
- Ensuring the compatibility between national laws and regional exchanges
- Proposing interconnector access evolution following both the restructuring in national electricity sectors (unbundling and licensing for foreign trading), and the regional context promoting an opening to other agents from other countries.
- Settling disputes

[8] In Europe, each country has its own energy regulator and the debate is now the creation of a European Regulator to monitor the trans-boundary cooperation for the electricity transmission. At an institutional level, European treaties do not allow the commission of European communities to attribute such powers to an independent agency it does not control. Yet, it is acknowledged that the improvement, even important, at national level is not sufficient to speed up the process leading to an integrated electricity market for a region and the Regional Regulator has to be more than a simple consultative organ . It shall have sufficient power to meet efficiently its mandate.

6.2.2 EXCHANGES OVERVIEW

6.2.2.1 Characteristics of the approach

The long term goal is the establishment of a competitive electricity market but it is important not to forget that the first steps taken are realistic in relation to the current policies and positions of the participating countries. It will be obviously impossible to take measures at a regional level that are further advanced along the path of opening than in the least reformed of each country. The design of exchanges is strongly influenced by the evolving structure of the individual electricity sector organization. There are, and we can reasonably assume there will be, wide variations between the countries in terms of existing and future internal electricity market structures and regulatory environments. Policies and objectives for a future restructuring vary between countries, pace at which reforms may take place as well as the changing demand patterns are unknown. At present time, cross-border trade remains marginal, and so, these countries have a limited experience in terms of interconnection management.

An overview of the different electricity sectors of these EN countries Egypt, Sudan and Ethiopia has been presented. For the moment, domestic markets are not open and electricity sectors are organized around a Single Buyer (the transmission company) or a national vertically integrated utility. Given the specific context in which energy exchanges may be inserted, the proposed approach is based on the following principles:

- Easiness to implement at a first operational stage, to provide with important shared benefits without implying a strong restructuring or harmonization and minimizing obligations

- Will to create the proper framework so as to let the economic interests of the parties be the real drivers for the trade. Only win-win transactions will encourage energy exchanges increase.

Electricity exchanges will indeed only take place if trade is perceived to be in the interests of contracting parties (and possibly an intermediate transit country providing wheeling service). Therefore, the implementation of a new market structure has to remain an opportunity. It has to be done on a voluntary basis for taking an active part in that market, not a requirement to do so. This idea is reinforced by the recent observation that even tight pools has been towards voluntary rather than mandatory markets.

The legal codes and general agreements will not compel any party to undertake any action without their consent. Once a country or utility signs up to the rules of the proposed new market, it will be necessary to observe those rules in any transaction undertaken, but parties will only sign up to new rules if they wish to do so, and will only undertake trade if it is their own interest to participate.

- Enough flexibility to enable each party to find benefits according to its specific need and use.

As a starting point, it cannot be assumed that all countries will have the same need or desire to trade in a similar manner at the time when exchanges are initiated. An essential feature of the exchanges design should be the flexibility which may be required to accommodate the approaches taken in each country in restructuring their electric systems and in the design of their own markets. The model should ideally allow each country maximum flexibility in determining what capacity and energy it may wish to buy or sell and the type of transaction that it may wish to use. Exchanges may be required by the EN countries at different stages in their system development.

This flexibility could refer to time horizons for scheduling, types of contracts, services in addition to bulk energy, or also network operation.

- Application of the cross-border trading regulation limited to the interconnector.

From the interconnection points between countries (Mandaya, Rabak and Nag Hammadi) towards the country's interior places, the national legal and regulatory frameworks prevail.

- Compliance with a phased institutional and market development.

A power exchange with open access to all generators and consumers could only function if each country had already moved to a fully competitive internal market. This objective can only be reached through a phased approach made of steps and reforms.

6.2.2.2 Key points to address for trans-boundary exchanges

There are a number of factors that need to be considered due to the impacts they involve on the structure of energy exchanges. These factors are linked to the limitation or extension of competition in electricity sector but also to the sharing of expected benefits.

6.2.2.2.1 Trading participants

Defining the trading participants having access to the interconnector is one of the first element to consider because the design of exchanges is completely conditioned by this choice. Actually, this point regroups two questions:

- Which countries are involved in energy exchanges through the interconnection ?

This interconnection is designed as a link between Egypt, Sudan and Ethiopia and it seems logical that these three countries benefit from it, above all if they bore the heavy investment. However, this interconnection has to be studied in its regional context with a strong push towards regional power trade at a more global scale. From regional organizations in charge of the development of energy exchanges emerge the will to insert this interconnection in this framework. This implies the opening of this interconnection to other countries than Egypt, Sudan and Ethiopia to enable transactions with Kenya for instance which will be soon interconnected to Ethiopia.

- Which actor(s) in each involved country take(s) part to trade ?

Concerning the domestic market, it is also desirable to reach a multiple buyers and sellers as soon as possible for the competition to develop. A competitive electricity market at the interconnection scale could deliver benefits to all countries and final customers in the form of lower prices and improved products and services. The essential condition that must be satisfied is that a domestic market has been implemented in each country. This requires that electricity trade and prices in the region to be set by supply and demand, clear commercial separation of generation, transmission and distribution functions and finally a division of network operations from the power generation.

This is obviously a global consideration. This decision is up to the countries and closely tied up with the stage of restructuring of their national electricity sectors and licenses given to some agents for importations and exportations. Regional organizations, national policies and the IRA will play a leading role in this determination. However, with only one actor per country currently licensed to import/export, the structure of energy exchanges is fixed.

Therefore three major situations can arise:

- Egypt, Sudan and Ethiopia designate a unique entity to trade (typically the monopolistic entity or the TSO): this is the reference scenario to demonstrate the project viability and profitability
- Egypt, Sudan and Ethiopia and other countries designate a unique entity to trade (typically the monopolistic entity or the TSO)
- Every individual agent from every country can freely make business in a fully competitive market by using the transmission service provided by the interconnection

The recommended evolution towards competitive practice implies that, as multiple sellers and/or buyers appear, the complexity of trade will grow. This sophistication can be managed by a suitable framework enabling to face this complexity in terms of contracts, regulation, scheduling and operation, keeping on providing a fair and efficient transmission service.

6.2.2.2.2 Third Party Access and Congestion Management

This question of Third Party Access (TPA) which means the rules regulating the network access for every entrant, has become central to the debate around the liberalization and unbundling of electricity sectors due to the natural monopoly characteristic of the transmission network. At present time, no TPA exists in EN countries because the electricity sector is still organized around a vertical integrated national utility. Thus, TPA is one of the most important issues to raise in this analysis. The potential impact on the interconnection operation and types of exchanges is crucial. In this context, TPA, is a key instrument in the transition from emerging to developed and mature electricity sector with a view at interconnection and new investment.

This question is not limited to the interconnection access and has to be extended to the domestic markets of each country. For this interconnection, this TPA notion is tied up to a fair and not discriminatory access to the interconnector.

For this interconnection, TPA is also inseparable from congestion management. Congestion occurs when the flow on a tie line is above the maximum power allowed to transit, limit determined by thermal, voltage drop and stability reasons. With the development of competitive markets with many participants wanting access to the interconnector, the notion of congestion management takes on a complex and comprehensive meaning. As soon as trading becomes liquid, cross-border capacity may turn fully utilized.

Congestion management usually refers to two major aspects:

- Allocation of available commercial transmission capacity to participants implying a dedicated mechanism and targeting to avoid discrimination according to TPA.

- Parallel flows and wheeling which are linked to the difference between commercial flows and physical flows conditioned by Kirchhoff's rules.

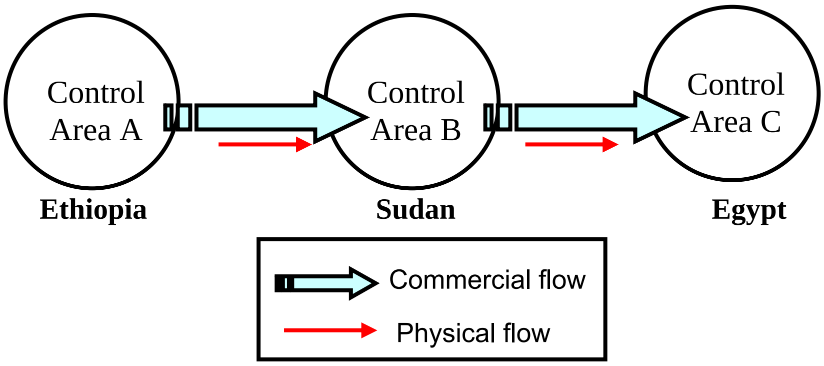


Figure 9. Commercial and physical flows are identical

However, with the entrance of new participants to trade, an other case happens:

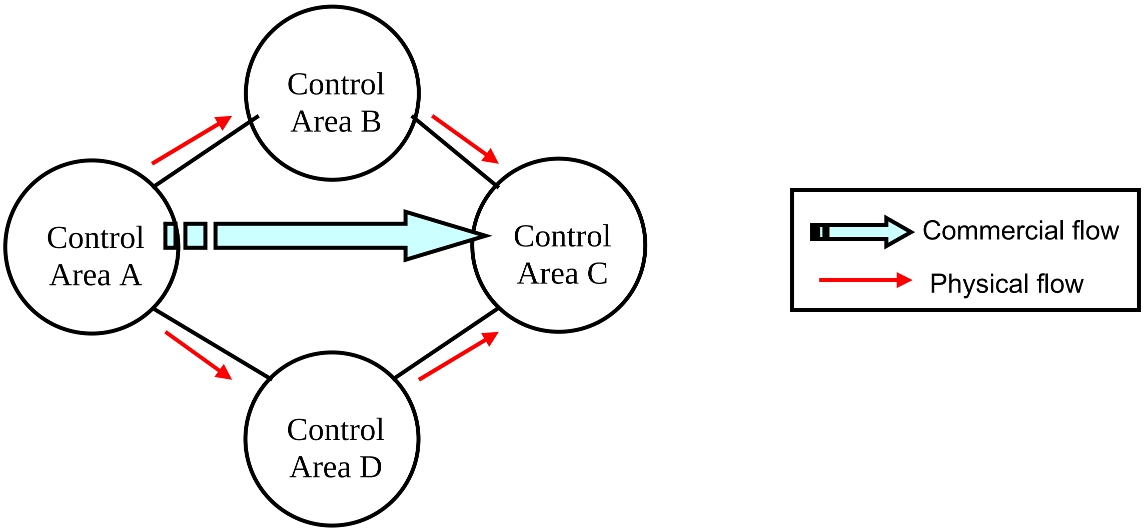


Figure 10. Commercial flows differing from physical flows

Such a phenomenon has been studied in Europe and is characteristic of meshed network. Many interrogations have been raised about the way to allocate charges.

Fortunately for this interconnection, flows are well foreseeable. This interconnection scheme does not directly involve wheeling because the Sudanese network is not crossed when a transaction occurs between Egypt and Sudan.

However, with the possible opening to other countries, wheeling issues shall be addressed and could be harmonized at regional level. Wheeling occurs whenever the transaction passes through a third country's network. Because wheeling introduces a third party to the transaction who is not a beneficiary of the electricity exchange, efficient tariffs are highly important. There is a further question of the allocation of the third party charges.

When such a transaction crosses one or more countries, it becomes necessary to account for the additional congestion and losses within the countries. Finally, for wheeling transactions it is especially important to have established clear rules for the unloading of contracts when third party transmission systems are congested. The rules will need to take into account the firmness of different contracts and will also have obligations for disclosure of relevant information. Therefore, developing a common policy for wheeling charge is decisive in a long term vision for a successful operation.

Congested interconnections have to establish mechanisms that guarantee fair and non-discriminatory access. The right price to connect the network at the connection point (entry or exit fees) is generally determined at national level but extra costs can be due to cross-border congestion management. We can distinguish several transmission rights allocation methods which could be used. Some of them are "based on the market", other not.

- Non "based on the market" methods:
    - ❖ First Come First Served Method: the capacity is allocated as requested until there is no available capacity left. Thus, only the fastest trading participants calling for capacity reservation have the right to transmit energy. Obviously, this method is totally unfair and even if it has been used for a while in Europe, it has been replaced as soon as possible.
    - ❖ Pro rata Method: the bids of trading participants are compiled and at the gate closure, if there is more demand than available capacity, there is a pro rata curtailment of the capacity demanded. As long as the congestion remains occasional, such a mechanism can be convenient and sufficient. It could constitute an intermediate option enabling to define the congestion, with a gradual entrance of new actors, and to define the needs to make fluid exchanges.

In general, these two methods have turned out inefficient when they were introduced in a competitive market and there is an important cheating risk. When it is implemented, the entity in charge of this allocation has to be sharp about the capacity demanded by parties because the pro rata method is sometimes manipulated by parties that demand more than they really need anticipating the reduction following the pro rata.

- "Based on the market" methods:
    - ❖ Explicit Auctions : the available capacity is allocated to the agents who submit the highest bids in an auction. Transmission bids and energy negotiations through market place or bilateral contracts are totally separated. Therefore, this mechanism does not require a centralized market place and the congestion price is the result from the capacity transmission auctions.
    - ❖ Implicit Auctions: the available interconnection capacity is allocated to allow access to an organized electricity market by agents located on the other side of a congested interconnection, whose bids and offers are accepted. In this sense, the capacity is allocated implicitly on the basis of the energy market results. In other terms, there is a simultaneous allocation of energy and transmission capacity. Therefore, the congestion price is the difference between the two energy clear prices.

It exists other more evolved mechanisms but for this interconnection, simple based on the market mechanisms seems appropriate. These more advanced mechanisms enable to better address congestion costs in highly meshed networks. However, loop flows and differences between commercial and physical flows will be limited for this interconnector scheme.

To conclude, a coordinated explicit auction mechanism has proved its efficiency. It requires a dedicated organization responsible for auctions but prices considered as a signal market reflect the interconnection characteristics. It would be a good compromise between non-discrimination, transmission costs and easiness to implement.

6.2.2.2.3 Types of traded products

In developing options for an exchanges model, it is helpful to understand what types of transactions will be possible between parties. This part is determining for the flexibility, announced as a challenge for this approach.

Generally, there are three possible durations of transactions, corresponding to different requirements to balance national energy markets through trading:

- Long-term exchanges for typically more than one year. They answer to a need for cheaper energy in the long-term due to a structural price difference between areas.
- Medium-term seasonal transactions for a month, week or day. They meet some technical reasons to smooth out the load curve economically, to face up maintenance or outages.
- Short term balancing exchanges as in an hourly spot energy market to cope with unexpected situations.

At these different time horizons, several products can be traded and can lead or not to real physical flows on tie-lines:

- Amount of energy
- Capacity reserves and other ancillary services. These services are available and can be mobilized at any moment.
- Price risk hedging products which do not imply any delivery of energy

Lastly, it is useful to distinguish “Over The Counter” products freely negotiated between parties with some flexibility in clauses and auction standardized products available in a spot market, day-ahead or within day. Medium-term transactions shall bring security of supply and the flexibility can also be introduced with more appropriate short-term exchanges even if this can be handled through flexible terms in the contracts. Short term trades can be required by parties when the markets becomes fluid enough.

The advantage of a spot market is that it creates open access to a market and a transparent regional electricity spot price through which trading participants can seek the cheapest way of meeting their short term requirements. This is a quick process adding a lot of possibilities for trading.

6.2.2.2.4 Implication of the Operator of the interconnection in bid match

The role of an Operator in the match between bids is an other interesting point. Two general ways to schedule, confirm and implement energy exchanges through this interconnection can be imagined. Obviously, these schemes are linked to the exchanges complexity and their evolving. These options are the following :

- Mediated trade:

Buyers and sellers reach an agreement about energy exchanges and this becomes a transaction only if the interconnection coordinator validates this agreement and integrates it in a daily schedule. This mediated trade is typically used in the WAPP and the GCCI, where the market coordinator has an approval role:

❖ Parties conclude bilateral agreement and agreed on confidential parts (prices, clauses, options..) generally on the base of templates.

❖ The seller prepares a standardized confirmation sent to the buyer which contains exact conditions including seller and buyer, firmness of transaction, charges allocation, transaction schedule (first date, last date, from time, to time, capacity in MW, quantity in MWh) and delivery point

❖ If it is agreed by the buyer, this one informs the interconnection coordinator for it to determine whether this transaction can be implemented or not.

❖ The interconnection coordinator prepares a registration of the transaction and send it to buyer, seller and national TSOs and integrates this transaction in its scheduled program.

Remark: This method requires a lot of communication to finalize the scheduling process, time and effort may be spoiled if the transaction is not executed. Moreover, trading participants do not have a good visibility. This can be a barrier to exchanges, to flexibility and it is not adapted to competitive access because transparency is delicate.

Therefore, this mediation role is almost certainly unnecessary and a potential barrier to trade. The range and scope of contracts will be highly flexible and matching would be unlikely to be more rapid through a mediator.

- Non mediated trade

This organization lies on two separate phases:

❖ Capacity allocation phase: the Operator, using a specific time management, gives at different time horizons an available capacity for buyers and sellers .

❖ Nomination phase: this second phase follows the first one and parties confirm to the Operator their reservation, scheduling the use of their reserved capacity. This nomination phase and deals only with energy and transit period. Some reserved capacity may be not used.

In this option, trading participants can freely make business without having to refer to the Operator. The Operator does not need to know when and how buyers and sellers agree and the conditions of this agreement to properly transmit energy through the network. Every participant has a transparent view of decisions taken by the Operator and related criteria. This method currently used by European TSOs is strongly recommended for this interconnection and can last with the evolving into a competitive market.

6.2.2.2.5 Fiscal framework

As underlined in the M8 module dedicated to financial analysis, the specification the fiscal framework will have an important impact. It refers to the two following major points:

- The fiscal provisions which will apply to entities implicated in operation since this interconnection will be developed and operated at a regional level. It will have to be determined if VAT or corporate income tax are applicable to multinational organizations taking into account the budgetary and economic challenges but also constraints specific to such regional interconnections. Agreement will have to be reached at what extent the regional electricity market will allow countries the possibility for using tax policy to pursue national objectives for environment and energy policy.
- The custom tax which will possibly apply to cross-border trade. As done in most interconnections and following recommendations of ENPTPS phase I, it seems suitable that trans-boundary exchanges should be exonerated from any importing or exporting taxes. It is proposed to adopt the EU taxation practice where electricity is taxed at the level of output. When electricity is traded between countries, this principle means taxation in the country where the electricity is finally consumed and accordingly, electricity could be traded without tax.

6.2.2.2.6 Deviations

Deviations in cross border electricity exchanges must be understood as a gap between scheduled commercial exchanges and real-time physical exchanges. The scheduling leads to real time expected flows on the different tie lines following confirmation of compiled confirmations by trade participants. Then a global scheme is implemented:

The set of daily cross border transactions among all the participants of the market origin flows in cross border links

- Members of the market must agree how to measure deviations form scheduled flows
- Deviations from schedules (that means from agreed transactions) must be measured and settled.

These deviations can be imputed to buyer/seller, TSOs or the Operator and can be caused by the following reasons:

- Unexpected outage in the interconnection transmission system reducing the interconnection capacity or availability
- Generation failures increasing or reducing flows in a synchronous system
- Intentional deviations contrary to the two previous one that result from physical rules

Therefore, during real time operations, flows on tie lines will inevitably differ from day-ahead schedule. If exchanges have been detailed with a contractual framework it would always have a difference between contractual energy traded and the physical metered flow.

According to the rules, the responsible actor will have to bear financially the cost of deviations arising from non compliance of actual power injection, withdrawal or transmission with the day-ahead schedule.

There are two ways to handle deviations and the choice will depend on transactions complexity:

- An "in-kind" compensation : this physical compensation mechanism consists in integrating deviations in a future schedule to compensate physically by an additive or deductive energy amount.
- A financial compensation : as indicates its name, participants responsible for deviation pay the Interconnection Operator to value the cost involved for managing the deviation and the party that suffered the deviation consequences on their program. For this method, some requirements are needed:
    - ❖ Organized and liquid market
    - ❖ A mechanism to determinate a fair price to compensate properly parties, for the cost incurred to balance the system[9].

6.2.2.2.7 Transmission tariff

Ordinarily, without competitive access to the network, cross-border transactions do not pay for transmission services because a country-to-country approach prevails. At national level, compensation for the use of installations remains within the domain of local regulation. For these bilateral transactions in which each country employs its own system, there is no need to allocate costs.

However, for this interconnection, all contemplated operational phases lead to transmission tariffs depending on periods, tariff structure and potential payers.

- Different periods
    - ❖ For the first operational stages, a regulated transmission tariff is possible. The profitability of this project implies exchanges between Egypt, Ethiopia and Sudan with a regulated tariff calculated to cover O&M expenses and service the debt (loans and shares).

This reference model is useful to demonstrate the viability but it can also be extended to the integration of other countries and national actors if there is no congestion on tie lines.

- ❖ In a medium term vision, a "based-on the market" transmission tariff will take place with TPA and congestion management implementations. So long as a competitive access to the interconnector is set up, a regulated tariff has no sense because the transmission right has to be fixed by market rules such as explicit

[9] This question is on the core of a debate in UCTE and inaccurate compensation could encourage parties to game benefiting from the disproportioned sanction.

auctions. This is a key point to guarantee non-discrimination. If provided, it is at least as profitable as the first phase.

- Different tariff structures

Many options can be imagined for tariff structure tariff. A distribution between a fixed part and a variable part depending on MWh exchanged is often used. Negotiations will have to address which king of costs enter in the fix or variable part, and on which criteria.

For example, shall the tariff cover OPEX and interests charges in a low hydrology scenario?

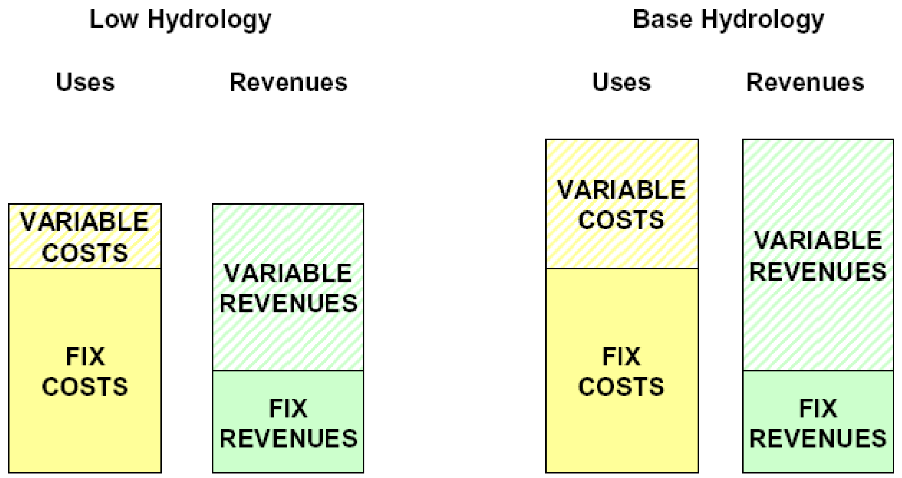


Figure 11. Setting of fixed/variable tariffs

Several tariff modes can be simulated over time:

❖ Instantaneous tariff mode: tariffs are actualized every year to cover cashflow requirements . Though this tariff is financially optimal, it is not operational since extensive and repeated tariff variations would be unacceptable for trading participants

❖ Per period tariff mode: instantaneous tariffs are smoothed per period (usually 5 years)

- Different possible payers

Many options can also be contemplated for the allocation of tariffs between parties. For the first operational stage, when the tariff is regulated and determined according to clear rules, options could have an impact of the cost borne by each country.

❖ Same tariff for every country : this approach gives priority to the collaboration between countries and an equal share of the energy cost during operation. The difference of invoice is simply due to the difference of the traded energy amount. This method used in Europe under the name of “postage stamp” seems quite strange regarding the huge difference of distance between countries.

❖ Differentiated tariff between countries: this approach takes into account the differences between countries to determine an allocation per country. This allocation can rely upon :

- o Capacity disparity:

  Shall only importing countries pay transmission tariffs on a capacity Pro-rata basis (Egypt: 2000 MW; Sudan: 1200 MW) ?

  Shall exporting country (Ethiopia) contribute to the global tariff, and how much?

- o Energy disparity:

  Shall the tariff per delivered MWh be the same? It supposes losses equalization: the geographical location is not up to the countries and so there is no reason for countries to be penalized by the distance separating them.

  Shall the tariff per injected MWh be higher when losses are higher?

  Should exporting country (Ethiopia) contribute to the global tariff and how much?

The determination of a suitable tariff and a fair allocation are incontrovertible conditions.

Transmission tariffs shall meet requirements:

❖ Be determined using costs reflectivity and be sufficiently high to cover the interconnection expenses (equity, loans, O&M, provisions…). The rather high initial investment costs require high revenues in the first ten or fifteen years to satisfy the lenders.

❖ Be considered as transparent and equitable by users

❖ Be calculated taking risks into account (allowance for price escalation, lack of water…)

Each actor should have a clear understanding of which costs may be recovered in the interconnection access fees, and should able to estimate the total transmission fee based on the fee structure, on each affected country (wheeling, transmission from interconnection point to local area…) in order to secure electricity trade without fictitious barriers.

6.2.3 SETTLING DISPUTES

Dispute resolution is fundamental so as to constitute a suitable power trading framework even if the way to exchange is very simple, in a phase where national utilities trade within bilateral contracts for instance. Whenever there are commercial transactions, disagreements may arise between participants, the Operator of the interconnection and TSOs, and must be somehow solved. There is no doubt that it will gain in importance with the sophistication of exchanges. These disagreements may be of very different types (interconnector access, pricing, transit dispute, metering…) and so, the system for settling them must be flexible, and above all credible.

Therefore, general agreements must govern dispute resolution. IRA shall be empowered to play a leading role in dispute resolution. Without a mechanism to quickly and effectively resolve interconnection disputes, energy exchanges may be threatened. New entrants with limited financial means will not commit resources unless they have confidence that their business will be viable, and that they will be able to resolve any disputes in a timely manner.

The dispute resolution shall follow the principles below:

- A party shall attempt to resolve all disputes promptly, equitably, and in a good faith manner.
- Dispute resolution shall be conducted with minimal costs and delay.
- Dispute resolution shall be conducted in a graduate manner implying new means in case on non-settlement according to the principle of subsidiarity
- The dispute resolution costs shall be allocated to the party whose proposal or position is not adopted
- Some agreements (memoranda, operating guidelines, contracts) shall have some real legal force and shall be the basic documents to which reference shall be made at the start of any dispute resolution process.

Once a dispute has risen, efforts should be made by the parties to solve their differences in an amicable way through discussions. Then, a set of rules flowing from general agreements shall indicate a resolution process. It will rely upon the IRA and its authority to return a verdict.

In the event of non-settlement, an arbitration process in compliance with international rules applied in international courts will be necessary. It is important to recognize that international arbitration is a consensual agreement between parties on how disputes are to be resolved. Thus, the requirements regarding the scope and substance of arbitration have to be specified through an agreement between parties approved by the IRA.

7 PROPOSED ROAD MAP FOR IMPLEMENTATION

The previous sections of this "Institutional Analysis Report" were dedicated to global requirements and recommendations regarding the way of carrying out such an interconnection project. Structures to set up were characterized by functional considerations describing them in terms of responsibilities and proficiencies without dealing with the implementation process and their possible establishment.

This last section adopts an other point of view highlight what could be the next steps to undertake for a successful project development. Recommendations are more practical to stick to the reality of the implementation.

Therefore, this section insists particularly on the measures required after the completion of ENPTPS phase II to bring this interconnection project into fruition, for financing and institutional issues.

7.1 ESTABLISHMENT OF A PROJECT STRUCTURE

ENPTPS phase II has demonstrated the technical feasibility of the Egypt-Sudan-Ethiopian interconnection project. Real stakes reside now in financing and institutions settlements.

After a previous phase using consultancy services, a significant step lies in the capability of EN countries to run efficiently next steps towards infrastructure construction.

The phase going from the end of feasibility studies to the financial closure and institutional framework has indeed to be considered as a full-fledged project.

Therefore, the first step of this implementation phase is to set up a project structure supported by governments in order to move forward the project. This structure has to be recognized by the three countries as rightful to take decisions regarding the whole interconnection. Thus, in order to get this legitimacy, a "Convention" prior to any Interconnection Agreement has to be signed between Egypt, Ethiopia and Sudan. It is a prerequisite to formalize the desire of EN countries to see this interconnection come into the light and give this project structure the means to take up this challenge.

7.1.1 A CONVENTION TO ESTABLISH THE PROJECT STRUCTURE

The "Convention" is a prerequisite for EN commitment and this agreement has to insist on the following key points:

- Defining tasks using a project approach with care of delays and budgets
- Make clear the implication of the three countries Egypt, Ethiopia and Sudan in the interconnection implementation project
- Clarify the decision regarding the responsibility of financing this project structure
- Define accurately the tasks assigned to this structure

- Finalize the financing
- Finalize the project scheme
- Propose institutional measures to be taken
- Reach an agreement on outstanding negotiations issues
- Define and Elaborate, on the basis of project structure results, an “Egypt-Sudan-Ethiopian Interconnection Treaty” (or possible IGMOU) the interconnection will be subjected to

- Showing a clear acceptance by all countries of powers conferred to this structure
- Define the necessary conditions to break this structure up in order to go further and to found a Project Company through a Shareholders Agreement. This Project Company is devoted to carry out the implementation function of the FS described in figure 8. These conditions could be simply written in terms of agreements between states on outstanding questions, guarantees on a defined % for the financing plan, bid process launched successfully…

7.1.2 An Overview of Project Structure Organization

This chapter does not aim at defining exactly this project structure. However, some pitfalls can be highlighted taking experience from other projects so as to help this structure to hold its leading role.

The representativeness will be a fundamental question to be solved. This point refers to different levels of representation and visibility:

- representation regarding the environment of this project structure
- representation inside the project structure:
  - between countries
  - between representatives from EN countries and potential advisors and consultants who could be implicated

It is highly recommended to have an organization as simple as possible avoiding political interferences. This structure has to privilege practical aspects and as an example, it is unnecessary having a board.

In the same line, few people would facilitate negotiations and would avoid dispersions and a little structure has to be preferred.

As an indication an organization based on only two levels could perfectly suit:

- an “ad hoc committee” compounded of a high representative from each country endowed with power delegation on key points and referring periodically to its government
- a workgroup compounded of a team regional experts and/or international advisors and acting as a taskforce.

In order to bring to fruition this implementation project, this structure shall gather the following proficiencies and experts :

- Financial experts : competent in financial terms, loans characteristics and above all familiar with financial institutions to run investment road show.
- Legal experts : competent in risk assessment, legal status and contractual schemes. The establishment of institutions, the ownership of this interconnection assets, fiscal concerns will generate lots of legal issues to settle for.
- Economic experts: economic conclusions on expected benefits provided in previous studies could be put into questions with possible economic changes in the next few years. Several studies will have to be performed again to update results and efficiently demonstrate the project profitability.
- Technical experts: even if the main project negotiations will refer to financing and responsibilities of existing of future organizations dedicated to the interconnection, this has not to elude the technical part of this project with for instance the supervision or the writing of technical specifications.

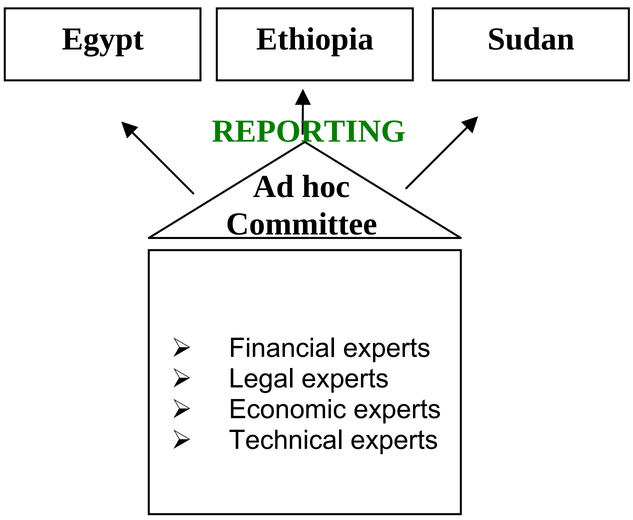


Figure 12. Project Structure Organization

7.1.3 PROJECT STRUCTURE ROLE IN FINANCIAL CLOSURE

A crucial role of this project structure will be to set up the financing plan. The team in charge shall go through financing feasibility phases with the solicitation of financial institutions, investment guarantee agencies and potential investors likely to contribute to this project. To face up this issue, all funding sources have to be contemplated, whether public or private, and all means that could ease the financial burden explored. It will be necessary to arrange in an iterative way the financing round in close link with validations on institutional project scheme. This step up process will require all competencies available in the project structure.

This financing project shall be initiated as soon as possible following UN's recommendations about Electricity Interconnections.

Steps	Output
1. Commitment from decision-makers	"Convention" signed and strong support from governments to the financing project
2. Project definition	Update of hydrological and economic studies, tenders preparation, planning management
3. Risk analysis	Detailed prevention and mitigation measures with allocation to stakeholders
4. Seeking international interest and support	Road show leading to select investors
5. Financial and operational structures	Draft of TORs for organizations involved in the financial scheme
6. Legal environment	Definition of legal status of organizations
7. Independent review of the project	Report review
8. Information memorandum	
9. Assessing investors/lenders interest	Update of financial studies
10. Debt and equity proposals	Contribution of shareholders proposed and lenders solicited
11. Negotiations and contractual agreements	Consensus on key negotiation points
12. Meeting disbursement conditions	**FINANCIAL CLOSURE**

Table 1. Financing Closure Steps

Even if the proposed organizational model based on a collaborative approach enables to reduce considerably many risks, some of them can be prevented. Therefore, those risks must be taken on by key stakeholders, including:

- The host governments, which are chiefly responsible for creating the proper legal and institutional environment in which developers will feel reasonably protected (political risks, force majeure…)
- The Multilateral Financing Institutions (MFIs) and especially the World Bank Group or the African Development Bank, which can help in different ways

- The private sector with the determination of the final project scheme depending of this implication of the private sector in the successive phases of the project such as the design, the construction or the operation.

The MFIs have an essential role to play in providing risk mitigation. They could finance an important part of this project acting for social and economic growth of three African developing countries and at least stimulating the involvement of other capitals in countries with perceived high risks, thanks to their presence. Their commitment in promoting cooperation and trans-boundary power exchanges is real.

For this project MFIs should contribute to solve this financial challenge and risk responsibility by:

- Helping to create a reassuring investment climate by taking on political risk and setting the tone for other lenders and mobilizing international co-financing
- Providing loans which attune with the creation of long-term infrastructure assets
- Providing insurance and guarantees for risks that neither the private sector nor the government can handle. MFIs dispose of two major means: Partial Risk Guarantee products and risk insurance cover (from MIGA for instance)
- Providing refinancing facilities to allow commercial banks to extend loan tenors
- Providing with legal advisors
- Assisting government authorities in raising their share of equity

7.1.4 PROJECT STRUCTURE ROLE IN INSTITUTIONAL AND LEGAL PROCEDURES PERTAINING TO THE SET-UP OF THE INVESTMENT PROJECT

The leading role of the project structure in financing closure is inseparable from the settlement and refinement of legal and institutional remaining issues. This Institutional Analysis has initiated discussion on the best organization and environment hosting the interconnection. However, organizational model needs more definition to determine the final project scheme and contractual framework for the interconnection development.

At this stage:

- There is no sufficient visibility on main factors impacting the decision process and it is too premature to have a clear picture of involved stakeholders.
- this project scheme can only be determined in compliance with the results of the financing plan elaboration
- it is the logical and procedural result of an analysis
- this decision has to imply political decision makers
- this responsibility has to be carried out by the EN countries because it represents a strong symbol of their appropriation of the interconnection project.

Given that, next chapters provide with a methodology for the project structure, explaining the different phases and objectives.

7.1.4.1 Methodology Objectives

The key objectives that subtend the methodology are the following:

- **Common interests and rights for the participants**:

Within the frame of this interconnection project, the three EN member states have agreed to combine some elements of their sovereign rights in order that the work enabling to achieve construction and operation can be carried out with the least possible delay and in the most suitable conditions.

The geographical layout of the project could have allowed each of the three states to exercise their rights on a stage of the work (part of the work will take place in each of the participating states.) With this approach, as the technical characteristics of the project would be pre-defined, each of the states would manage their own finance, construction and operational issues.

However, given that this project is different from others in that it requires perfect co-ordination and risk-management, a segmentation of this type could cause more problems then it would solve. This is particularly true with regards to the carrying out of the construction work and the operation of the interconnection.

As a result, it has been proposed that the member states work as a single entity from the planning stage, right through to the operational stage of the project.

In order to make this a reality, the three EN countries shall be prepared to work as a single united body, which does not prioritise the policies of any single participating state.

- **Ensuring project efficiency and maximizing practical effectiveness**

This search for efficiency is, at technical level, a major reason having led the three EN countries to realize a common infrastructure and to share the operational benefits. This approach will mean an optimal integration of this new interconnection into the combined electricity network of the three states, and this from both a financial and economic standpoint.

Beyond this first decision, project efficiency will be an important factor in the planning, finance, conception, construction, and introduction phases of the project.

Project efficiency must also be continuously offset against practical effectiveness. For example, a more costly solution can be used, should it afford a greater adherence to deadlines, and the effectiveness/cost balance can be averaged out.

- **Effective Risk Management**

This item is predominant in a project development. It is properly a risk analysis which enabled to recommend a collaborative approach to lead this interconnection project.

This risk analysis preformed in section 5 of the present report constituted a first level of analysis. Two levels of risk analysis have indeed to be distinguished.

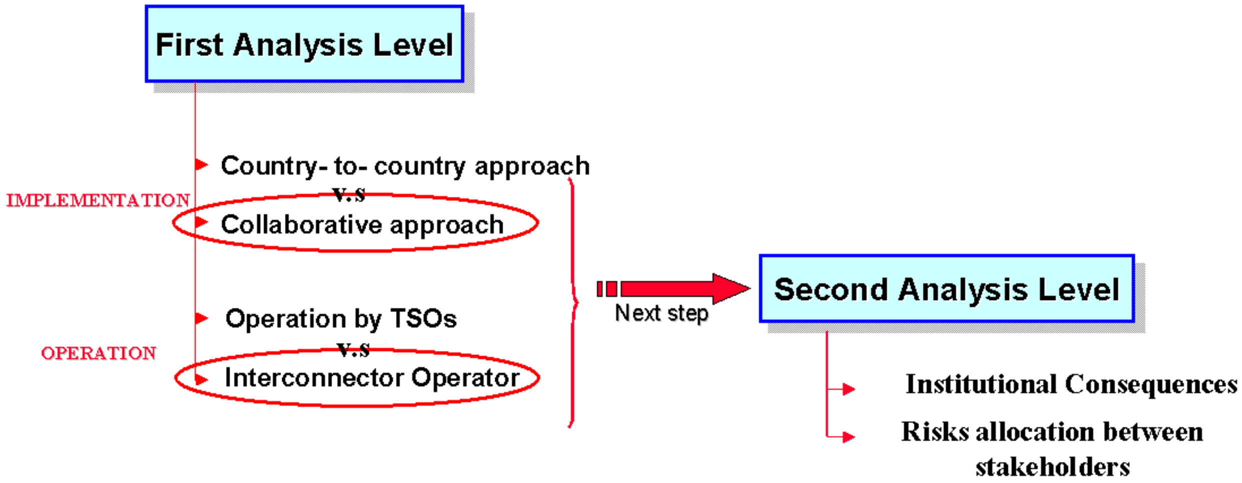


Figure 13. Risk Analysis Levels

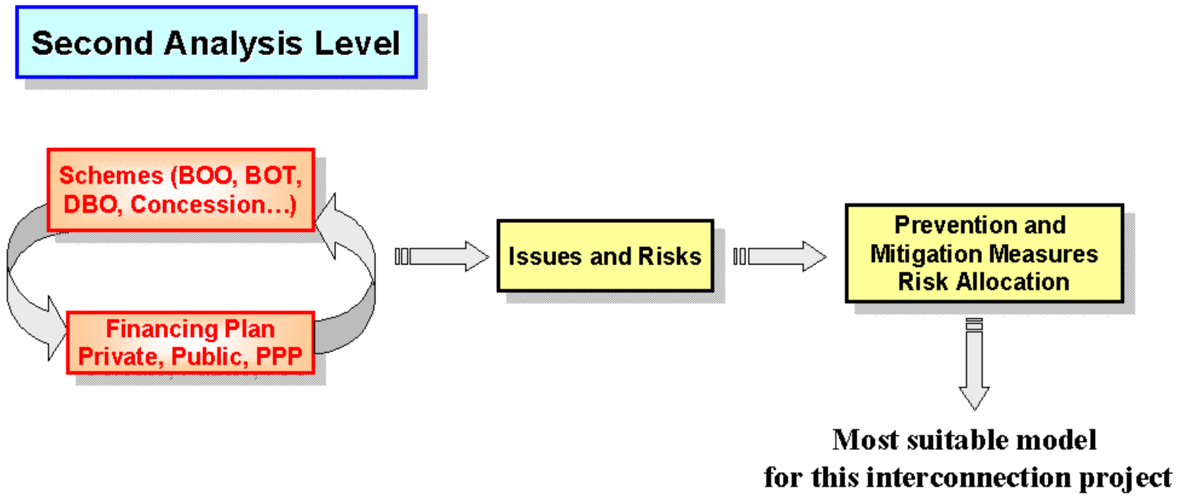


Figure 14. Second Risk Analysis Level to be carried out by the project structure

The methodology introduced in the following chapters develop further the risk management and give general recommendations.

7.1.4.2 Proposed Plan for Approach Application

All of the above objectives shall be considered simultaneously and in an iterative process, in order that their effect on the project as a whole (possible structural solutions, work procedures, effective development of solutions) can be accounted for.

7.1.4.2.1 First stage of application : Rights and Prerogative Allocation

So that the interests of all parties involved are respected, it is important that a well structured approach is adopted with regard to:

- The nature of the Agreement to be finalised between EN countries
- The status of assets forming the interconnection

The first key principle mentioned above should lead EN countries to accept the concept of exercising their own rights, whilst being part of a common mechanism and/or a common structure.

Possible Solution for first stage

It is fundamental to go beyond national rights to enable states to exercise their own rights within the frame of a common mechanism and/or common structure. An internationally-minded plan is necessary in order to facilitate such an operation, in which multiple countries exercise their own rights as part of a collective entity. As part of an International Interconnection Treaty, including a certain number of appendices, the three EN countries must decide on the following characteristics of the Project Company:

- Objectives
- Structural Organization
- Competencies
- Legal management of assets
- Fiscal applicable system
- Customs procedures
- Privileges and immunities to be enjoyed by this multilateral organization and its staff as part of this plan.

The use of such a plan will also dictate the structure of the organization(s) charged with carrying out both the feasibility studies and practical work on the project.

The scheme according which the interconnection could be divided into different “segments”, pertaining to each of the three states, and within which each state will exercise their own rights and prerogatives is now excluded.

The consequence of this relates to the ownership of the assets which will make up the infrastructure as whole. The member states must organize themselves in such a way as to effectively manage their collective assets, which include:

- Control of the works
- Rights of ownership

- Rights of use
- Right to consent to delegation or guarantee.

EN countries must evaluate the quality and attributes of undivided owners, and more precisely co-owners.

To exercise this undivided ownership the two following will be essential:

- Recognition of possible unequal rights over the interconnection, which could be linked, for example, to an inequality in financial contributions.
- Willingness to honor the purpose of the international Interconnection Treaty (upon which the project will be based) and the skilled organizations which are taking part in the project.

This willingness must, of course, be accompanied by a continuous striving to achieve project efficiency along with excellent risk management.

These key objectives also include better management of rights and responsibilities generated by the construction and the operation, as well as being able to delegate the exercising of these rights contracted out has to be taken into account.

In order to achieve this, it would be possible to incorporate into the International Interconnection Treaty, a legal entity : the Project Company, which would assume the role of owner of the infrastructure – and who would share the rights to the relevant assets based on the contribution made by each of the three participating countries.

7.1.4.2.2 Second Stage of application : Final Design and Construction

At this stage, project efficiency and effective risk management mean that choices will be made at each stage of the project, in respect of the technical, financial and legal framework of the project.

An example of risk assessment to carry out at every stage of the project is given below.

The global objective is to foreclose step by step the risks linked to the project as illustrated in the following curve for the first implementation phases.

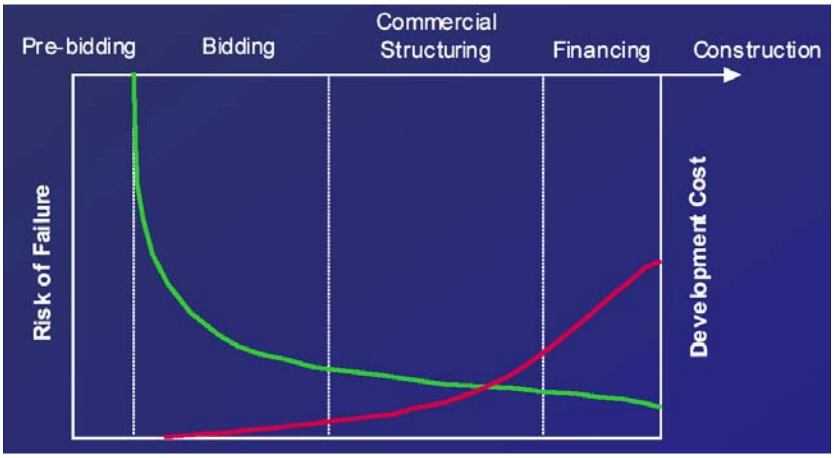


Figure 15. Risk Curve

Final Design and Planning

Two opposite scenarios are conceivable.

- EN countries decide to give project structure responsibility to execute the interconnection design. The project structure is supported by EN power utilities professionals with sub-contractors collaboration. This is the “architect-engineer” model.

  The risk is the possible lack of skills and means to carry out the work in a timely manner. This interconnection resorts to high technologies with a unusual 600kV DC link and EN countries may not dispose of an entire competence regarding these equipments.

- EN countries decide to give project structure the responsibility to buy design specifications and tenders.

  An externalization of the design process with the recourse to the experience professional design agencies could be a huge benefit. It is certainly a way to gain time and money in the future steps. However, this externalization raises the necessary control on design. The specialized companies may increase the cost of this design stage.

For each step, a compromise has to be found between do and make do by private actors.

Construction

At this stage, a policy whereby tasks are allocated shall be adopted:

- on the basis of their impact on short and long term project efficiency,
- on the basis of the skills which are on offer (public organizations, private sector…)

In the following table, some significant risks are raised and will have to be allocated either to public or private stakeholders.

Nature of Risks	Public	Private
Taking out loans		
Debt Service for Loans		
Risk of change for Loans		
Inflation		
Contracting Owner		
Planning		
Infrastructure Construction		
Construction Management		
Non-Conformity		
Force Majeure		

Table 2. Risk Matrix for Construction Phase

Operation & Maintenance

A similar approach to that of the construction stage of the project needs to be renewed, in terms of ensuring that certain requirements are fulfilled when the interconnection is put into operation.

Nature of Risks	Public	Private
Choice of method of operation		
Responsibility for practise of operation		
Responsibility for operation interruptions		
Responsibility for operation incidents		
Responsibility for achieving operational measurable performance		

Responsibility for the quality of operation		
Maintenance of infrastructure		
Legal change		
Revamping of infrastructure		
Responsibility for client complaints		
Credit for Renovation works		
Financial and Age Depreciation		
Business and staff Costs		
Operation Fiscal concerns		
Contractual Penalties		
Operation Deficit		
Unpaid Invoices…		

Table 3. Risk Matrix for O&M phase

These risks are introduced linked to specific phases (design, construction and O&M…) but should not be studied separately due to benefits generated by activity project integration.

For instance in a project scheme where the construction and operation refers to the same responsibility, the Operator of the interconnection cannot turn against the constructor charging him in case of failure or delay. It prevents dispute regarding operability, construction cost overrun penalizing operation. It could be a way to attain high performance but it unfortunately reduces the project configurations and the number of potential bidders.

This reasoning will have to be extended to the different combinations as a complementary study of risk matrix analysis.

Possible Solutions for second stage

Risk allocation between stakeholders of this infrastructure project is commonly done by means of a Risk Matrix. It will be determinant to define roles and responsibilities of each side, particularly determining the implication level of private sector in project phases.

The figure below proposes an illustration of risk allocation on a typical infrastructure project.

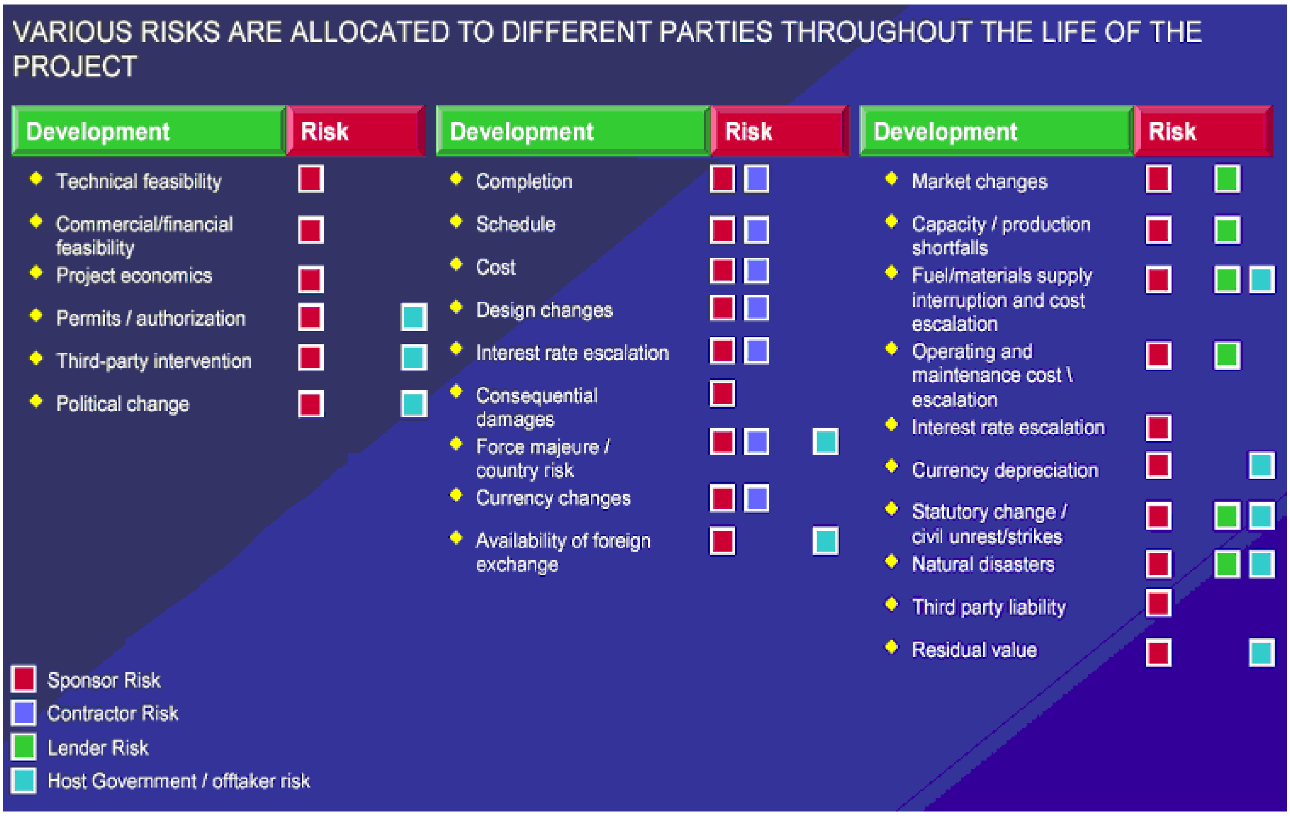


Figure 16. Result of Risk Matrix Analysis

It is necessary to invite reputable external companies or operators who have international proven expertise. These companies must be highly skilled in managing complex projects and large networks, as well as dealing with high-end technology.

In the case study, recourse to the options offered by the public-private partnership PPP must also form part of the project efficiency and risk management strategy.

Interconnection projects are historically of a public nature. Electricity transmission remains associated to public service and it has not been favored by the private sector. Countries want keep their position to control issues of national interests. The recommended traditional model of a utility (either public or closely regulated) managing the various project life cycle is indeed still used. In view of all interconnection projects, private investors have not stepped in yet. In all cases, whatever the shareholders are, a strong regulation ensuring fair service relying on market mechanisms has to be set up.

Given that, the involvement of any private agent can only be justified where they can demonstrate a clear benefit to the project, in terms of cost-effectiveness and practical contributions. They can also be considered if they are proven to be able to manage risks to a higher degree than their competitors, public and/or private.

Through following and combining the steps outlined above, it is possible to identify the different project schemes depending on feasibility of public-private partnerships, particularly with Operators potentially interested in a project.

Moreover, through following the approach highlighted there, it is the suitable way to make procedural decisions such as BOO, BTO – or other decisions relating to the involvement of private companies in any stage of the project implementation, such as *Design Build and Operate(DBO)* and *Design, Build and Finance (DBF).*

As a result, project schemes cannot be selected one by one and then studied. It is an efficient risk allocation process mixed with the output of financing round and interested stakeholders that shall lead to the determination of the optimal project scheme.

Obviously this choice has also important consequences on the cost of the project, on the contractual structure and on the way to envision operation. As an example, the most suitable financing plan, regarding cost of equity and debts, is an implication of only public actors drawing on multilateral or bilateral aids. Then, the average cost of capital is low whereas this average cost of capital could be three times higher with a private financing. The combination of public and private funds can also lead to a win to win situation sharing risks. Therefore, the consequences are huge because the regulated transmission tariff calculated to cover private financing costs could be at least twice as much as the one calculated to cover public financing costs.

7.1.5 THE PROJECT STRUCTURE IN THE CORE OF NEGOTIATIONS

This period during which the project structure should finalize the way to proceed to build, own and operate this interconnection, will be used to address some significant questions and initiate the negotiations between stakeholders. EN countries, national utilities, regional organizations and other potential actors such as private investors will have to settle remaining issues.

Numerous points to be sorted out by this project structure will indeed be cause of negotiation. Apart from the project scheme and financing plan, other items shall call for concerted effort and mutual trust and are related but not limited to the following items.

7.1.5.1.1 Contribution of each shareholder in capital base

The risk analysis has shown that ownership and investment sharing are the main issues. The proposed collaborative organizational model avoids allocating costs depending on the location of equipments, but the contribution of each country in the capital remains a delicate subject. The operation period will enable to investors to get back their money.

The interest is to centre the debate around reasons different from geographical aspects to find a common ground with all potential actors involved, including private sector.

7.1.5.1.2 Shareholder Rights

Shareholder rights allocation will be an important step.

Two principles are indeed conceivable and are respectively based on :

- Equality principle **:** no matter how much they contribute to the capital of the Project Company, shareholders enjoy the same power : " one country one vote". However, it can also be perceived as a negation of financial participation granted to develop the project.
- Inequality principle : countries or companies which have contributed more than other benefit from some privileges and bigger power on infrastructures. Africa has develop many projects structured on this principle. The feedback shows that it can also be a source of cyclic frustration because each decision is the outcome of a coalition of interests. This desire for a shareholder to hold for its sole use a part of interconnection capacity could lead him to propose to take more shares.

Generally, the first principle demonstrates the wish to embark upon a cooperation pathway. The second is more adapted to an existing market infrastructure.

7.1.5.1.3 Location of Control Centre

In this feasibility study, the interconnection has been designed so as to be operated from any place, due to remote telecommunications, metering, command and control systems. Regarding operational aspects, the sub-module M4 dedicated to control systems provide recommendations to choose the most suitable location.

No matter the Operator selected for the interconnection, it will have to be attached to a legal country and set up on a specific country. This decision takes on a political importance due to the symbolic power of detaining the Control Center on its territory.

7.1.5.1.4 Management of interconnection entities

The nominations of CEO of the different key multinational organizations managing the interconnection such as the Regulator IRA, the Project Company or the future Operator. The global management shall be negotiated. A turn-over enabling to all EN countries to ensure chairmanship could be installed.

To conclude on these negotiation points, common agreements have to be reached with the imperative following golden rule : a joint project can only be successful if a stable solution is found that convinces every participant that his particular effort is worthwhile.

7.2 ENACTMENT OF AN INTERCONNECTION TREATY : A FOUNDING AGREEMENT

This Founding Agreement shall be the concretisation of the work undertaken by the project structure. Once the project structure has acquired approval of the three states, commitment of future investors, financial institutions and governments on main issues developed a political agreement will have to be signed between Egypt, Ethiopia and Sudan.

This Agreement will host the interconnection and will insist on general principles :

- efficiency
- perpetual pursuit search for private/public partnership

In the proposed model, this founding agreement takes on a decisive role, confirming the decision to bring this interconnection to fruition and enabling future implementations. The development of transparent arrangements for transmission and transit of power between countries is the most critical single area to be resolved in setting up electricity market arrangements.

The political agreement will create a favorable environment for this interconnection meeting international standards. Particularly, political agreements shall:

- Define the equitable, stable and transparent conditions for investment
- Defining deadlines for next steps until the commissioning
- Describe global exchange principles with the objective to eventually achieve the creation of an effective open, competitive and non-discriminatory market with provisions related to freedom to transit and open access to interconnection. Transits would have to be facilitated and not interrupted in the event of dispute.
- Announce the creation of a Project Company and its legal status
- Announce the establishment of a Regulation carried out by a Regulatory Agency dedicated to the interconnection and defining the global dispute resolution process.
- Announce agreements to come especially technical rules

It could consist in enacting Inter-Governmental MOU and Inter-utilities MOU as explained or in adapting existing agreements of power trade.

7.3 ESTABLISHMENT OF INTERCONNECTION ORGANIZATIONS

The founding agreement shall enable to set up in a proper way:

- A project Company. Project Company responsibilities and scope will depend on the definition process ran previously by the project structure. This scope will range from sole owner model conceding construction and operation to a BOO model in which the Project Company assumes all responsibilities defined in the Functional Structure (FS).
- A Regulator in charge of this interconnection (IRA).

These key multilateral institutions established as soon as possible, will be able to run and monitor the following steps of the implementation process.

The enactment of a Shareholders Agreement shall concretize the establishment of this project Company and the capital sharing brought by shareholders according to the outputs of the financing and owning results of the project structure.

7.4 DEFINITION OF TECHNICAL STANDARDS

Afterwards, under IRA initiatives, the Project Company, the future Operator of the interconnection and national TSOs shall agree technical standards for this interconnection aiming at achieving criteria compliant to usual requirements in terms of availability, reliability, quality and accessibility.

This common grid code that may not applied in national networks depending on countries will, shall cover but will not be limited to the following:

- Load frequency control: since Ethiopia and Sudan constitute a synchronous area, frequency deviations will be unavoidable in case of unbalance between generation and demand and it may generate cross-border flow deviations. This notion refers to operating reserves, primary, secondary, tertiary control and monitoring equipment
- Scheduling interchanges: rules are necessary to address the issues concerning the determination of the capacity of the interconnection, arranging, confirming and implementing cross-border trade
- Accounting interchanges: accurate real time observation of power flows is crucial for a good operation and to account unintentional deviations.
- Transmission and system coordination
- Metering and telecommunication: data transfer and data processing systems shall ensure that the Operator and national dispatch load centers have continuously supplied with information on the operating condition of the power stations, the transformers, compensation equipments, the active and reactive power, the voltage in the transmission lines….
- Emergency cases, protection and restoration procedures

The Project Company, the Operator and national TSOs shall acquire sufficient skills and experience to manage the future operational steps. For instance, the increasing sophistication of Control Centre with regards to control equipment, instrumentation, data presentation techniques and the interconnection of adjacent systems, requires new skills to develop. Moreover, the capacity allocation process, scheduling and implementation of cross-border trade could be improved in regards to European standards. Thus, there is a need to a coordinated training program initiating close cooperation and deepening proficiencies on competitive markets and associated operating rules between the Operator of the interconnection and the three TSOs.

7.5 DEFINITION OF CONTRACTUAL FRAMEWORK

The contractual framework to establish refers to two main aspects:

- the project implementation

Even if at this feasibility stage it is too early to specify the contractual architecture, depending on the selected project scheme, several multilateral organizations and/or private companies will carry out some project stages and a solid contractual relationship will be required. Financing will also generate a lot of contracts linked to the granted loans as well as guarantees offers by states or MIGA.

- the operation of the interconnection

Given the uncertainty regarding the project scheme this chapter will insist on contracts directly linked to operation.

The “Trading Code” notion refers to a general agreement that will govern the general conditions of the energy exchanges between trading participants. Used in the GCCI for instance, it clarifies the market design chosen and relationship between parties. It determinates commercial terms that the parties shall enter into for the purchase, sale, delivery and acceptance of electricity. Concretely, it raises commercial aspects of trading including but not limited to the following :

- Interconnection access method and congestion management
- Framework and current types of energy exchanges (long-term interchange, short-term interchange, operating reserve, emergency support…) with their characteristics
- Commercial aspects of energy exchange scheduling (way to conclude bilateral contracts, registration and confirmation of a notified exchange, time frame)
- Taxes and charges for each party
- Invoicing and payment
- Dispute resolution procedure and arbitration
- Confidentiality

However, this agreement has just an informative purpose and commercial aspects have to be clearly addressed in contracts. It is considered that the realization of the economic benefits of a trans-boundary exchanges requires the establishment of a broad and consistent contractual framework determining the relationships between market participants and contracts templates could be proposed.

7.5.1.1 Contracts between trading participants

Most part of exchanges shall be performed by bilateral contracts freely negotiated between two interconnection users and not involving any third party in the contractual relationship. These contracts implemented at different stages of operation can comprise different types.

7.5.1.1.1 Physical bilateral contracts

At present time, similar bilateral contracts already exist between EIJLST member countries although there is no common set of rules. It is indeed the most common and simple alternative for cross-border trade. These physical contracts concluded between two parties can deal with:

- Energy exchanges: consisting in a delivery of a defined energy amount during a defined time window, it will represent the most part of contracts. In the first step, trade will be implemented with supply contracts in which national utilities or single buyers exchange energy through the interconnection. There is a commitment to supply a defined amount of energy and available capacity, but this is not linked to any particular plant. In the interconnection market design, Ethiopian electricity utility would provide electricity determining the origin of this energy and contracts with producers limited to national debate.

- A set of ancillary services: since the beginning, it was dealt with energy exchanges but the interconnection can lead to many transaction types which do not imply necessarily physical exchanges. In order to fulfill these energy requirement at specific time horizons but also other services, transactions can be also implemented within :

    - ❖ Reactive power supply and voltage control
    - ❖ Different types of operating reserve which are available generation capacity. For instance, each country shall have to maintain operating reserves deemed necessary for its own power system but a national authority may arrange to get operating reserve from the other parties. The contract shall be defined as capacity (MW) and buyer would include this capacity in its operating reserve, seller would subtract it to its own.

- Emergency energy supplied to a party who experiences outages. This does not include support by way of primary reserve deployment during disturbance. This support, met for numerous interconnections where exchanges occur between national utilities, is available for a period of a few hours less than 5 or 6 starting from the beginning of the occurrence of the emergency situation. After time, the party has to obtain other type of service, load shedding in case the shortage should continue. This free transferred energy is returned in kind. The interruption of exchange asked by the receiver can intervene at any moment without any cancellation charge.

Generally, bilateral contracts are associated to a medium-term vision and "structural price differential". Bilateral trade in energy or capacity should continue to be agreed between any two parties and constitute the basis of trade used to supply agreed amounts of energy or capacity at specified times (e.g. one month, one season, one year, peak times, base load).

It is recommended, given the evolving of the trading participants and exchanges rules, not to adopt a too long-term contracts. These contracts would necessarily be modified or nullified causing some problems.

7.5.1.1.2 Financial bilateral contracts:

Financial contracts are for transactions which do not result in any delivery of electricity, but are designed to determinate predictable and stable prices for one party while placing the price risk on the counter-party. The most common form of financial contract is a contract for differences. This more sophisticated trade consists in a price risk hedging product. The settlement price for electricity (strike price) at a future date is fixed. If the actual price (e.g. a spot market price) varies from the settlement price, the parties settle the difference between them. Financial contracts, therefore, normally require a spot market with a common clearing price against which to hedge the contract. Although two parties may devise financial contracts, it is likely that these could not be used until a liquid regional spot market had been developed.

These contracts are flexible in that a financial contract can be signed with any party, not only someone who is involved in the physical transaction.

Concretely :

The seller compensates the buyer when spot price (SP) is greater than contract price (CP). The compensation amount is fixed at :

Compensation = (SP-CP)*energy exchanged

The buyer compensates the seller when spot price is lower than contract price (CP). The compensation amount is fixed at:

Compensation = (CP-SP)*energy exchanged

These contracts have to allocate clearly responsibilities, define the prices and their possible evolving. A set of templates could be proposed on the basis of on-going contracts in other regions. However, it is up to trading participants and it does not regard other parties.

7.5.1.2 Contracts between the Operator of the interconnection and users

The Operator and interconnection users shall have to be contractually linked regarding access to the interconnection. Either competitive or not, the two parties have to agree on methods and tariffs regulating this access. In the event of based on the market process, interconnection users accept the defined rules and coordination with the Operator.

In the same line, contracts have to settle pricing, explaining in details criteria taken into account in transmission tariffs including losses, compensations or others penalties for non-compliance to the terms of contracts.

These contracts have also to address responsibilities for scheduling and nominations, with clear deadlines, right and duties of users and the Operator to enable flexibility and safety.

Moreover, in order to manage losses and face unexpected outages, the Operator shall have to contract with producers to dispose of available energy, with consumers accepting to be cut off in exchange of compensations.

7.5.1.3 Contracts between the Operator and national TSOs

Such an interconnection operated by an unique multilateral Operator distinct from national TSOs requires a strong collaboration but also a firm allocation of responsibilities and duties of each party. This has to be materialized by official documents. Beyond the contracts, this relationship is dictated by some general operational agreements which shall be an IUMOU followed by operating guidelines or common grid code.

These contracts have to detail the contents of this cooperation regarding scheduling and real-time actions. They have also to define precisely compensations mechanisms and their implementation if they imply in-kind returns. Lastly, contracts could be concluded to cover mutual services to make maintenance easier for instance.

7.5.1.4 Contracts regarding spot market

- Contracts between the interconnection users and the market place supervisor

Interconnection users will have to contract the market place supervisor to be authorized to take part in the spot market, proposing bids and accepting offers.

- Contracts between the Operator and the market place supervisor

When a spot market is implemented, a new relationship is established between the Operator and the market place supervisor. The contractual relationship:

- ❖ Imposes the market place supervisor to communicate market results (energy amounts per time slice and per member) to the Operator
- ❖ Obliges the Operator to implement exchanges traded in spot market in return

The question on the status of operating agreements both technical and trading codes is important. It is proposed that there will be two levels of such documents.

First there will general agreements signed by every participant, framed in general terms and designed to be long lasting. It would therefore have some real legal force and would be the basic document to which reference would be made at the start of any dispute resolution process.

Second, there will need to be a set of much more detailed documentation that outlines the operational characteristics of the market at any one moment. This would itself have two main components: a grid code for physical operation, harmonised and integrated into individual national grid codes, and a trading code developing particularly pricing policy and contractual framework specifying the way in which tariffs and payments are to be organised and settled. This second level of documentation on grid, pricing and settlement rules would be designed to be open to very frequent change. All experience with electricity market development in recent history suggests that as markets evolve, they must be subject to significant and sometimes almost continuous changes of rules and conventions. While these second level rules are to be enforced at any given moment, they would need to be designed not only to allow, but positively to encourage, rule changes as these prove necessary. Hence, the importance of having both founding agreements to which all parties can be expected to adhere over relatively long periods, and a second level designed to be as flexible as possible as needs change.

7.5.1.5 Likely contract between the Project Company and an Interconnection Operator

As evoked in the present report and by EN countries, an external Operator is possible.

The contractual arrangement will be decisive regarding the good course of operation.

Two types of operation management are conceivable:

- a running at “own risk “ for Operator: this risk refers particularly to generated revenues. The Operator collects directly wheeling fees and pays a rent to the Project Company which is not function to these revenues.

- a public service concession in which the Operator operates the interconnection according to EN countries rules and does not directly receive payments. The operator is indeed paid by the owner to provide the operational service.

7.6 BUILDING

7.6.1.1 Appealing to EPCM contracts

Over the past decade, there has been a definite trend to move towards EPCM-type contracts (Engineering - Procurement - Construction - Management), where most risks associated with design and construction are under a single point of responsibility, namely the EPC contractor.

Such an arrangement is almost standard for privately developed projects, since it is often required by the lenders in an attempt to reach maximum clarity in the allocation of responsibilities. But EPCM contracts have also been considered by some public owners, especially after experiencing delays and cost overruns on previous projects. Indeed, it can be quite tempting for any owner to give to the contractor the construction risks and full responsibility for overall construction management. But this should not delude the owner about the fact that:

- Any serious and reputable contractor will only accept to bear the risks that he can actually manage or be insured for.
- The contractor will include in his price a provision for risk, which will have to be paid for, no matter if the project is constructed smoothly without significant risk materializing.
- Only financially strong contractors will be able to take such risks. That may not be the case for local contractors, who would be in the best position to construct the project, especially the civil works, with payments in local currency. Large international equipment suppliers are often reluctant to take a joint and several liabilities with such local civil contractors.

However, the owner can generally find its own interest by retaining some construction risks, including for instance, political or social turmoil during construction or natural events…The EPCM approach is not necessarily the best suitable option and has to be studied. If the Project Company feels able to manage the construction with the necessary financial strength, substantial savings can be obtained by accepting to bear the risk of overall completion by coordinating a number of construction packages, possibly at the cost of giving up the project financing approach.

7.6.1.2 Key points to strive for

- Reducing costs by a rigorous preparation

  ❖ Development costs can be reduced if standard documentation is developed and a rational step-by-step approach is adopted. Excellent project preparation, including proper site investigations, imaginative design and value engineering are important factors in reducing construction costs and uncertainties.

  ❖ It should be stressed again than EPCM or turnkey contracts may not always be the cheapest contractual approach. In most cases, however ensuring fair and transparent competition among contractors and equipment suppliers, as well as top of the line project management can help minimize the final construction cost.

- Local involvement in construction

The funds needed for construction should ideally be borrowed in the same currency as the future revenue stream in order to minimize devaluation concern. In turn, it means that there is a clear advantage in utilizing local or regional resources for the construction of the project. In particular local or regional contractors can be mobilized at an attractive price for the construction of the civil works, yard installation or access roads for instance, possibly as partners or subcontractors of larger international firms.

7.7 *PHASED OPERATIONAL APPROACH*

Following the characteristics of the approach for energy exchanges conditions, a phased approach is proposed hereafter in a chronological order with recommended options related to operation including interconnection access, congestion and losses management, scheduling, or deviations settlement.

For the sake of consistency of project feasibility, a reference scenario has to be established so as to show that this interconnection is viable and profitable. Assuming a collaboration between only Egypt, Sudan and Ethiopia which is a prerequisite, the two first phases express a configuration enabling to countries to benefit from this interconnection and investors to be confident. However, these phases are not to be perceived as mandatory steps. An opening to other countries, after a first operational step can be contemplated provided that it seems more advantageous.

7.7.1.1 Potential phase I: energy exchanges between EEPCo ad NEC from 2015 to 2020

The most profitable scenario studied in phase I forecasts the commissioning of a 700MW link between Ethiopia and Sudan by 2015. If this scenario called “with anticipation” is retained, this phase will constitute the first operational model and will contribute to validate exchanges principles in terms of scheduling, deviations management ,and transmission tariffs. The major features of this phase shall be:

- Exchanges are implementing within bilateral agreements (medium term energy blocks, reserve, emergency support…)
- The interconnection users are the two national electricity utilities NEC and EEPCo: only one actor per country is licensed to buy and sell power to a foreign entity
- NEC and EEPCo pay back a regulated tariff typically compounded of a fixed ($/MW) and a variable ($/MWh) parts.

7.7.1.2 Reference scenario: energy exchanges between national utilities and/or TSOs from 2020

This way of exchanges is the reference case no matter if this phase will constitute an operational phase, or if it will be the first or second phase. The major features of this phase shall be:

- Exchanges are implementing within bilateral agreements (medium term energy blocks, reserve, emergency support…)

- The interconnection users are national electricity utilities or national TSO in the event of partial unbundling (like in Egypt): only one actor per country is licensed to buy and sell power to a foreign entity
- Energy exchanges scheduling could rely upon an actualization of economic results based on hydrologic, demand pattern and costs forecasts to secure payback period and make investors more confident.

The following figure schematically presents the features of trading where exchanges only occur between Egypt, Sudan and Ethiopia.

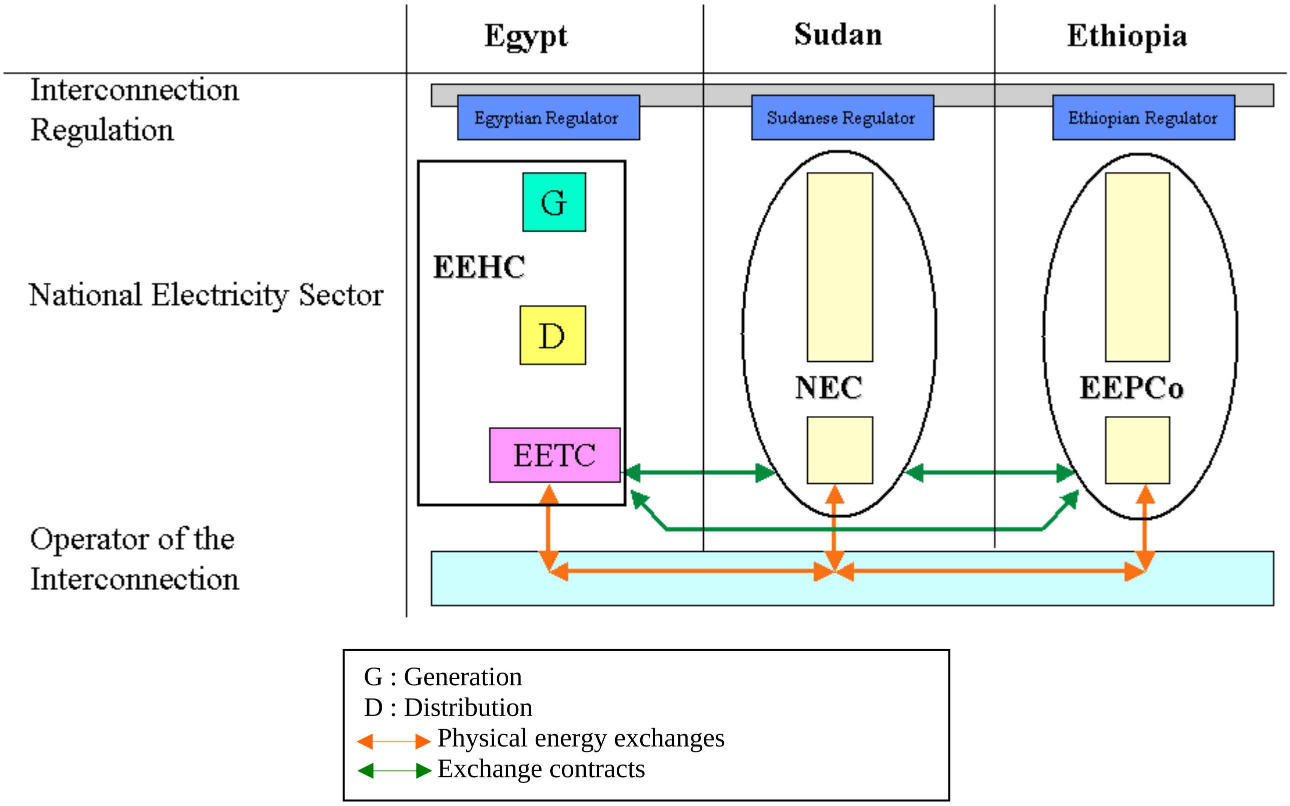


Figure 17. Exchanges model in the first stage: trade between NEC, EEPCO and EETC

In order to describe more accurately this model, it is useful to consider the following relevant aspects:

- Interconnection access

This phase is assumed non-competitive and the access question is trivial. Indeed, the 3 interconnection users share the whole capacity of the interconnector only depending on technical limitations. Ethiopia will have at least 3200MW to export, Sudan 1200 to import and Egypt 2000MW to import. This phase constitutes a derogation to the TPA principle that could be justified by the fact that:

- Countries that have taken risks by financing the interconnection want to keep the benefits for a while
- This enables to begin operation with a limited complexity

- Scheduling

Taking inspiration from UCTE practice, the scheduling shall follow this standardized method hereafter. It enables a better understanding for interconnection users and implication of TSOs:

- The Operator of the interconnection determines the available capacity to trade carrying out studies in collaboration with national TSOs and broadcast these results via a website or other communication means.
- The three interconnection users indicate their will to use the transmission service for a defined capacity and time period. Some flexibility shall be integrate to enable the Operator to adjust its forecast and users to adjust their nominations regarding capacity or time slice.
- A deadline has to be set after which each modification will be accounted as a deviation. The final nominations are compiled and integrate in the daily program beamed to national TSOs and users.

- Deviation management

As long as the interconnection is reserved to a unique actor per country playing a single buyer role, it is consistent to consider an “in-kind” readjustment mechanism based on inverse physical flows avoiding useless financial compensations. However, deviations have not the same consequences depending on when they happen. Therefore, there is a need to define the reference period during which it is equal to compensate a deviation. It is necessary to take into account the fact that some period are more crucial than another in terms of reliability and costs such as peak, off-peak, season, Week-end, etc…

Moreover, the Operator and national TSOs have to ensure that the deviations keep at a minimum. It implies that each national utility shall have enough power under secondary or tertiary control to balance its generation and interchange schedules to the demand of its area. It involves also that the Operator should have authority to control flows on tie lines and reduce deviations down to mandatory limits.

The emergency cases are obviously scarce and have to be treated differently.

- Transmission tariff

The national utilities and/or national TSOs pay back a regulated tariff typically compounded of a fixed ($/MW) and a variable ($/MWh) parts. This tariff results from a calculation enabling to achieve financial balance with foreseen exchanges. The allocation must have been clearly agreed by the three countries and approved by the IRA.

- Losses management

The exporting country supplies an equivalent amount to losses to guarantee the specified energy at the delivery points according projected calculations. This energy can then be invoiced by this country to the Operator.

7.7.1.3 Phase III: Intermediate phase

The move towards the next phases will be initiated when a significant change in the national electricity sector or in the regional context will occur, obliging to reconsider energy exchanges organization at the request of the IRA. Thus, the phase II will be suitable until:

- An unbundling will happen and individual agents (consumers, producers…) in a country will be licensed to import/export electricity due to reforms in the national electricity sector regulation extending their participation to regional trade.
- Other countries than Egypt, Sudan and Ethiopia call for the interconnection use in the name of regional power trade and energy collaboration. The regional context may certainly play a leading role in the evolution of this interconnection model looking forward more competition and opening.

This phase has to be understood as an intermediate phase marking the transition from a monopolistic system of energy exchanges to an interconnector opening to multiple agents : other countries and individual national agents.

As it is supposed that the content of reforms and the pace at which they may be implemented will vary between countries, this phase shall serve as a buffer phase waiting for the future competitive exchanges and enabling countries with different organizations to fit this way to trade.

This intermediate phase could be initiated by transactions performed on a “agent to agent basis” and not only on a “country to country vision”. Other countries could also be implicated in cross-border exchanges.

Key issues to solve for future operation shall be tested during this phase :

- Third Party Access and congestion management
- Wheeling issue for countries only offering the service consisting in transmitting energy in their network to enable exchanges between non-bordering countries.
- Preparation of structures to welcome a fully competitive market for instance institutions able to ensure auctions linked to the development of financial services.

Between the two well identified phase II (exchanges between three national utilities and/or TSO) and phase IV (fully competitive market), we can imagine different scenarios depending on choices made by countries about their electricity sector reforms, the pressure of a integration in a more global frame influencing the vision expressed by IRA. This interconnection can either be integrated in a more global frame with a practice and rules harmonization through a power pool for instance or keep its specificity.

7.7.1.4 Phase IV: fully competitive energy exchanges between economic agents

Afterwards, when each country has performed reforms enabling all potential actors to participate to trade the last step shall be set up. The major characteristics of this phase shall be :

- Transactions are possible between national power sector agents meeting entrance conditions and there is potential opportunity for multilateral transactions involving more than contiguous countries
- Exchanges are implementing both through bilateral agreements and through an established spot market
- There is a competitive Third Party Access to the interconnector with a transparent and non-discriminatory transmission capacity allocation mechanism.

The following figure schematically presents the features of trading in this stage.

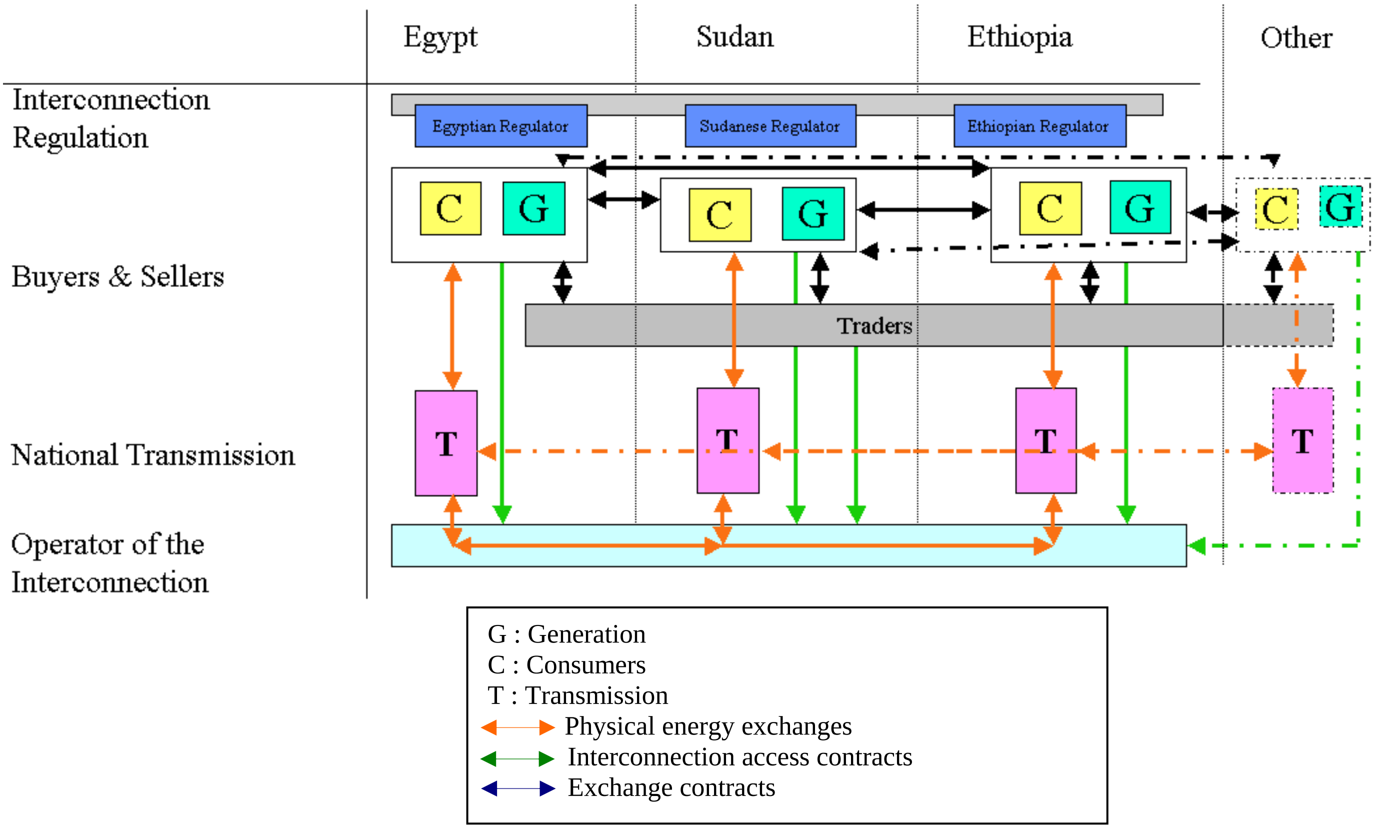


Figure 18. Exchanges model: fully competitive market

7.7.1.4.1 Interconnection access

Many actors have a legitimate right to access this interconnection. Many proposals regarding TPA have been made to allocate limited capacity in a competitive market. To grant fair and non-discriminatory access, the most suitable option for this interconnection is explicit auctions in which traded products are a physical transmission right. It involves that a dedicated structure shall be in charge of auctions. However, several questions shall be address to precise this method and make a link with scheduling.

- A distinction between Egypt-Sudan and Ethiopia-Sudan links

For the moment, expected energy exchanges enable to consider the Egypt-Sudan link as a continuity of a part of the Ethiopia-Sudan link. Indeed energy from Ethiopia to Egypt will follow this path. However, when a TPA is implemented for this interconnection in a more or less far away future, economic and energy conditions may have changed and transactions could be concluded between Sudan and Egypt. In such an event, there is no reason for the interconnection to be considered as a whole. Ethiopia may have to buy the right to use the Egypt-Sudan link.

- The auction type

Two methods currently coexist. The first one is called "pay as clear" or "marginal pricing" principle. It is characterised by a unique price for all market actors for the available capacity. This "marginal price" is determined by the "bid curve" in function of the interconnection available commercial capacity. It implies that each actor, having made a bid at a higher price than this marginal price, has acquired its interconnection access. This method is particularly interesting because it constitutes a unique market signal that can be very useful when a "secondary capacity market" (trading of unallocated or non-used capacity) is implemented to maximize exchanges or when financial contracts appear.

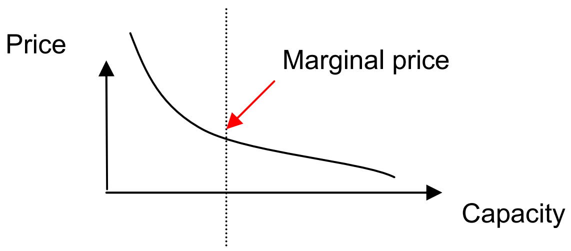


Figure 19. Determination of clear price thanks to bid curve

The second one is called "**pay as bid**" and each market actor pays its bidding price if it is higher than the minimum marginal price determined thanks to bid curve and available commercial capacity to allocate.

- Auction products

In order to encourage trade, auction products shall be close to users' needs. It is important to carefully study the firmness, the time and the capacity slicing. Different time horizons are necessary to well foreseen capacity allocation and several types of time horizons could be set up: annual, quarterly, monthly and daily auctions. The standardised capacity slices (20MW, 50MW, 1000MW…) for each auction, the allocation term (strips, fractionated parts, …) shall play a leading role. For instance in Europe, short-term blocks are allocated hour per hour whereas long-term blocks are allocated in some strips. Moreover, in addition to these blocks, in day-ahead auctions, products can be also a profile to fill the gap with the available capacity curve.

It is important to have in mind that these auctions products have to be correlated to production means characteristics and national network in addition to users' will.

- Unused capacity

Obviously, the un-reserved capacity at the gate closure of the auction process is automatically reallocated at the forthcoming auction. However, it is relevant to wonder:

  - Whether the capacity allocated to a party is definitely unavoidable for other parties. That is to say that if this party does not use this capacity, it is simply lost. This method is called Use It Or Lose It (UIOLI)
  - Or the party noticing that it will not use its capacity will be authorize to reallocate it. Several options are conceivable depending if the capacity is given back to the Operator in exchange of money (Use It Or Get Paid To It) or if parties are authorized to conclude bilateral contracts to sell their transmission right (Use It Or Sell It). These mechanisms avoid to spoil capacity but require a lot of means and an efficient organization.

It is also crucial to anticipate the major consequences that may have the integration of a competitive interconnection access on the current energy exchanges structure. The integration in the energy exchanges model represents an important step which could disrupt power trade patterns. Such a modification in the way to schedule and perform exchanges, the proliferation of actors and the complexification of contractual interactions may lead to an adjustment phase.

- Continuity of long-term agreements

In the first operating phase, long-term contracts may have been signed be signed to protect parties from future uncertainties such as generation costs escalation. These historical contracts assuming a free access to the whole capacity may be a serious issue as they have been in Europe a few years ago with the new European Energy Directive.

Indeed, historical contracts cannot be revised, redistributing for instance the capacity between market actors because it would prevent future entrances. In Europe, it has been admitted to start again from scratch abolishing all reserved access contracts. It unavoidably creates a bigger uncertainty on interconnection profitability for users because they may be reluctant to make long-term commitment if they do not precisely know the future market rules. Negotiated contracts after this period may be less economically interesting.

Therefore, historical contracts and former privileges shall disappear. It is the best way to clear previous mechanism and to set up a new efficient competitive market with transparent and non-discriminatory rules. Actually, these considerations depend only on national policies and commercial actors but is quite independent from the interconnection operation because access and transmission fees would stay unchanged. Even if this transition often leads to a price increase for consumers, the interconnection gets more profitable.

- A possible reduction of energy exchanges

Each big change in organization is often perceived as a risk and trading participants are used to mark a distance for a while to consider the new situation. This phenomenon has been observed for most European interconnections[10].

[10] For instance, for the HVDC link between France and England, new access rules implied a lack of significant exchanges during nearly six months.

- A definition of entrance criteria

In the same time, criteria shall be defined to authorize or not actors to participate to trade. If interconnection access is fully open, some requirements must be met particularly regarding the financial aspects.

7.7.1.4.2 Scheduling

Unlike the two first phases, a clear distinction in scheduling has to be made between capacity and energy. The method recommended is an extension of phase II. It shall follow the scheme hereafter:

- The Operator of the interconnection determines the available capacity to trade carrying out studies in collaboration with national TSOs.
- The Operator organizes at specific dates capacity allocation auctions between participants. Buyer and/or sellers reserve capacity for their transactions already agreed or not. The capacity non traded is automatically integrated in the future auction as available capacity.
- A nomination phase enables parties to readjust and confirm a delivery schedule integrated in the Operator daily program and communicate to parties and national TSOs.

7.7.1.4.3 Deviations

An “in-kind” compensation is no longer reasonable considering the assumed sophistication of exchanges and above all the entrance of traders that have nothing to do with physical flows. Therefore, a financial compensation mechanism has to be implemented to deal with deviations.

However, contrary to usual compensations mechanisms, the Operator only controls flows on tie-lines and for this organization, national networks are perceived as black-boxes. The deviations can only be accounted at a national level. The Operator shall compensate the national TSO which shall be responsible to compensate the users. Indeed, only national TSOs are able to know if a deviation on tie line has been caused by reasons attributable to TSOs or producers, consumers.

7.7.1.4.4 Transmission tariff

Participants to trade through the interconnector pay back for the use of the interconnection according to the auctions imposed by the capacity allocation mechanism and eventually to an injection/withdrawal charge. The transmission tariff shall follow market rules. According to UCTE experience, capacity allocation seems very profitable and the use of auctions extra-revenues must have to be agreed. It could be used to lower transmission tariffs for the next period.

7.7.1.4.5 Losses management

Losses management can no longer be performed like in phase II. Losses shall be buy by the Operator and could be compensated at a national level by TSOs and then TSOs could set up a more complex compensation mechanism in which they buy the required energy on market. This implies a careful estimation of these losses on the national network and a fair invoicing.

An other vision could consist in letting the Operator contracting with providers to compensate these losses. Actually, these losses are still reflected and finally borne by interconnection users.

To sum up, this phase IV will be marked by a sophistication of trade and of interactions between buyers, sellers, the Operator of the interconnection and the national TSOs. It coincides with the apparition of new practice regarding the type of exchange with financial transactions, the way to exchange with interconnection access, wheeling and spot market but also the contractual framework.

To complete the major points mentioned above, it is significant to recall that support services enabling a good operation shall be more solicited and a special care shall be brought to communication equipments and data exchanges as well as metering and accounting. The redundancy principle shall be applied to prevent contestations. Moreover, due to the proliferation of actors, the contractual framework has to be exhaustive and consistent, defining all responsibilities between actors. Third Party access, congestion management and wheeling shall be determining for this phase. Finally, financial transaction management shall guarantee that the increase of trade does not imply the increase of debts and non-payments. The fluidity of energy exchanges and above all associated financial transactions for compensations, auctions for sport market and access shall require strength financial institutions which do not exist yet.

The implementation of the proposed model requires a lot of means and steps which have been presented with an overall vision. The milestones are recapitulated on the pattern below even though this crucial part needs to be gone into further details.

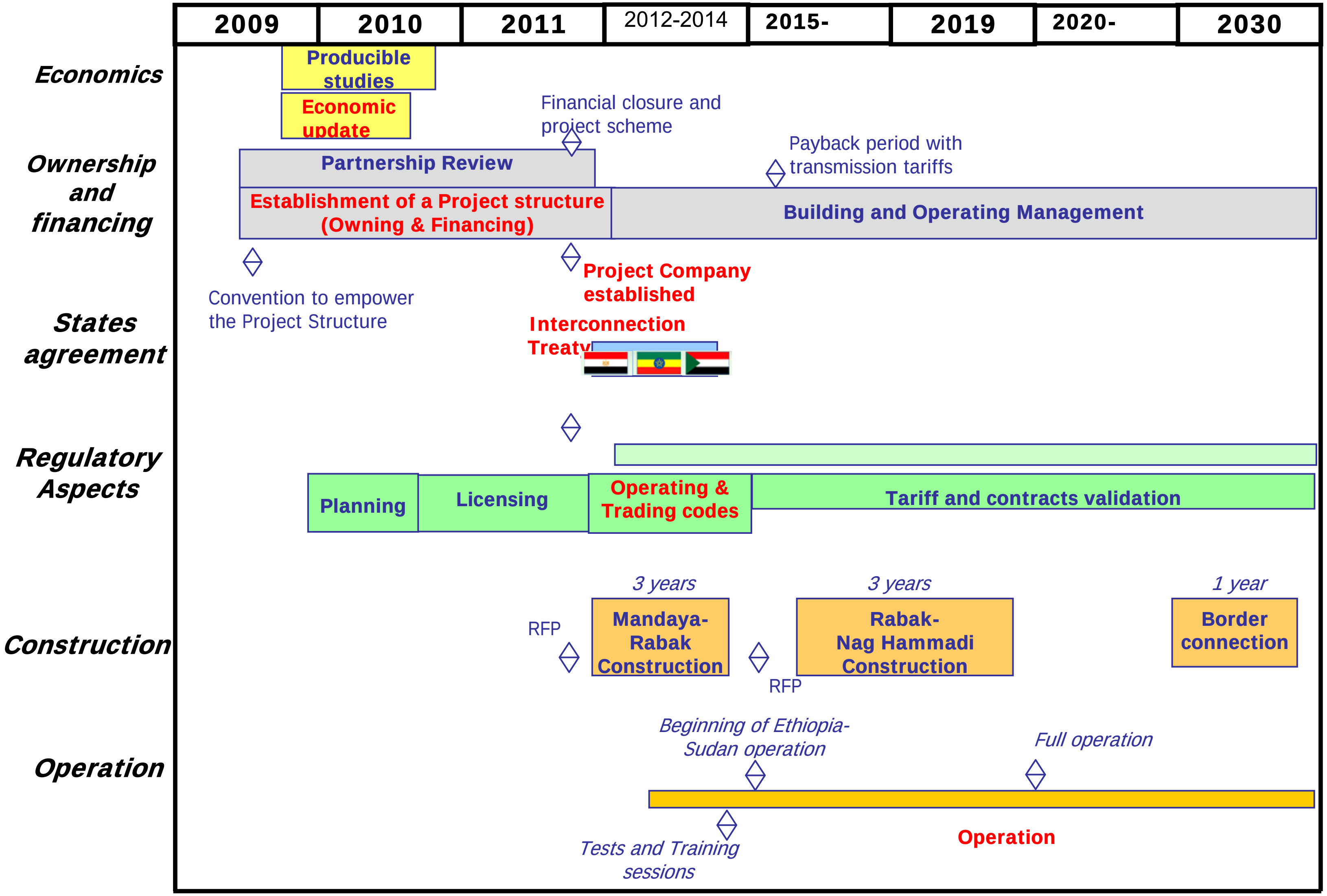
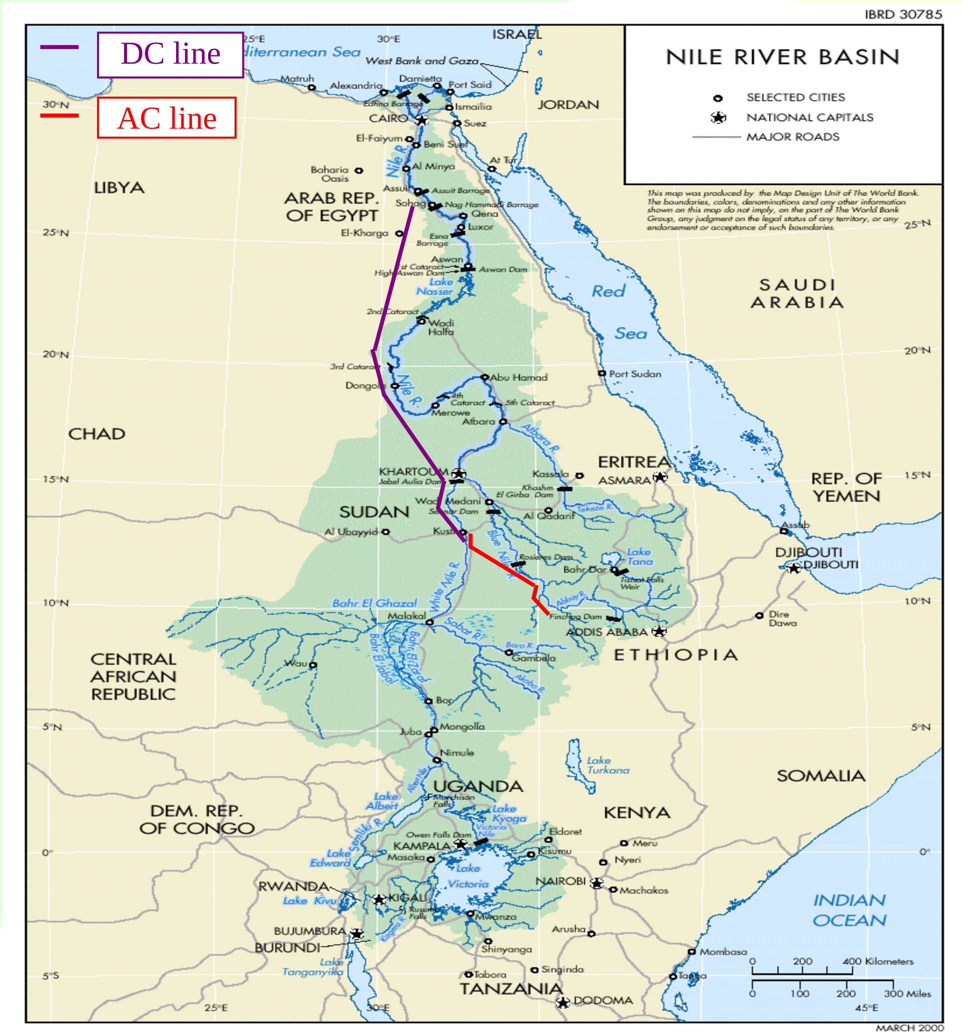


Figure 20. Road map for implementation

Nile Basin Initiative
Eastern Nile Subsidiary Action Program
Eastern Nile Technical Regional Office

EASTERN NILE POWER TRADE PROGRAM STUDY



M8 - FINANCIAL AND ECONOMIC ANALYSIS

Electrical Power Systems
Engineering Company

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ABBREVIATIONS AND ACRONYMS

AC	Alternative Current
ADB	African Development Bank
ADF	African Development Fund
BCR	Benefits to Costs Ratio
BOT	Build, Operate, Transfer
CAPEX	Capital Expenditure
DC	Direct Current
EEHC	Egyptian Electricity Holding Company
EEPCO	Ethiopian Electric Power Corporation
EHV	Extra High Voltage
EIRR	Economic Internal Rate of Return
EN	Eastern Nile
ENTRO	Eastern Nile Technical Regional Office
ESIA	Environmental and Social Impact Assessment
FIRR	Financial Internal Rate of Return
GEP	Generation Expansion Plan
HPP	Hydro Power Plant
HV	High Voltage
HVDC	High Voltage Direct Current
NEC	National Electricity Corporation (Sudan)
NPV	Net Present Value
O&M	Operations and Maintenance
OPEX	Operational Expenditure
PC	Project Company
PPA	Power Purchase Agreement
PBP	Pay Back Period
ROW	Right Of Way
SC	Steering Committee
SW	Scott Wilson

TPP	Thermal Power Plant
UA	Unit of Account
UCTE	Union for the Co-ordination of Transmission of Electricity
WB	World Bank

DEFINITION OF STANDARD FINANCIAL RATIOS

DSCR (Debt Service Coverage Ratio)

Cash-flows available for debt service / Debt service.

LLCR (Loan Life Coverage Ratio)

Net Present Value of the Cash-flows available for debt service during the debt service period, actualized at the average interest rate of the outstanding loans, divided by the loans outstanding balance.

Calculated at the maximum loans outstanding balance.

PLCR (Project Life Coverage Ratio)

Net Present Value of the Cash-flows available for debt service during the concession period, actualized at the average interest rate of the outstanding loans, divided by the loans outstanding balance.

Calculated at the maximum loans outstanding balance.

Project IRR

Internal rate of return calculated on the basis of the Project Cash-flows:

- Investments (installation and revamping) excluding VAT
- Operating Cash-flows (EBIDTA minus working capital requirements).

Financing IRR ("net cost of financing")

Internal rate of return calculated on the basis of the Financing Cash-flows:

- Capital added and removed (including investment and refinancing loans, equity capital, subsidizing)
- Cost of capital (interest, dividends before tax).

Financial IRR

Internal rate of return calculated on the basis of the total Cash-flows:

- Project Cash-flows (see above)
- Financing Cash-flows (see above)
- Interests on cash balance
- Corporate income tax

Executive Summary

The Eastern Nile Power Trade Program Study

The Eastern Nile Power Trade Program Study is fully funded by the African Development Bank with the general objective of promoting regional power trade between Egypt, Ethiopia and Sudan through creation of an enabling environment, coordinated regional investment planning of power generation and transmission interconnection projects.

The Eastern Nile Power Trade Program Study is divided in 2 phases:

- Phase 1: Cooperative Regional Assessment of Power Trade Opportunities between Ethiopia, Egypt and Sudan:
- Phase 2: Feasibility Study of the Power Interconnection between Ethiopia, Egypt and Sudan:

The Phase 1 concluded on the economic profitability of the Egypt-Ethiopia-Sudan power interconnection. The project is characterized economically by a good profitability, a short payback period and a high benefit to cost ratio under a large range of hypothesis.

Scope and objectives of the financial and economic feasibility study

The overall objective of the financial study consists in analyzing the conditions of the Eastern Nile Regional Power Interconnection's financial profitability and viability given:

- Project income (kWh transmitted, transmission tariff)
- Project costs (investment, O&M, corporate income tax…)
- Financial costs (cost of equity and debt, etc)

The final objective is to design a financial scheme and recommend tariff mechanisms that secure shareholder investments (loan reimbursement and interests, dividends) and end-users' expectations (available interconnection to export or import a cheaper hydraulic electricity).

The financial study was carried out under the institutional assumption that the interconnection will be developed under the classic Project Company scheme, with a single company in charge of the interconnection development, building and financing as part of a "concession" type contract, and potentially subcontracting the technical and commercial operation and maintenance to an external Operator.

This financial and economic module of the feasibility studies constitutes the first phase of the Project Financing cycle. Thus the financial analysis is intended to be updated and developed throughout the project life, whether through discussions with potential investors, through contractual negotiation or through monitoring the financial performance of the interconnection. Therefore, at this stage of the feasibility study, the financial analysis aims to provide recommendation on a financial and tariff framework attractive to potential investors and mitigating the risks inherent in this type of project. The purpose of the study is thus to lead to a financing strategy that will build trust with shareholders by reducing their perception of the level of risk involved in the operation, in order to get best financing conditions during the Project Financing Implementation phase, with a positive impact on the transmission tariff.

Financing plan for the Eastern Nile Power Trade Program Study

The financing plan is the key element of the financial analysis as it conditions the "cost of money" to be raised to commission and maintain the Eastern Nile Regional Power Interconnection.

Unfortunately, at the feasibility study stage, it is difficult to anticipate the amounts and financial terms and conditions of potential investors, as well as the capacity of each stakeholder country for budgetary commitment into the project.

However, the review of similar regional interconnections (within the framework of the OMVS, OMVG, West-African Power Pool and South-African Power Pool interconnected networks) indicates that such multilateral, highly capital-intensive infrastructures, with a long amortization period, are generally developed under a public financing scheme, with a majority of concessional loans, interest-free loans or donations, with a corresponding weighted average cost of capital (WACC) ranging from 2.5% (subsidized projects) to 5% (non-subsidized projects).

Preliminary tariff analysis

Setting pricing for transmission system is a complex issue for which there is currently no universal method, though experience gathered from the main interconnected networks and from the European network (UCTE) provides indications on “best practices”:

Two key methods for pricing electrical power transmission can be considered for networks such as the Eastern Nile Regional Power Interconnection:

- The most commonly method for transmission pricing is the “postage stamp” system, with a cost per MWh transmitted regardless of the distance between the injection point and the withdrawal point.
- Tariffs are split between a “capacity tariff”' (fixed tariff per MW) and an “energy tariff” (variable tariff per MWh). The proportion between fixed and variable tariffs is correlated with the strategic allocation of commercial risks between the Project Company and interconnection stakeholders (for example hydrologic risk).
- The “postage stamp” can be applied per MWh delivered (which implies a geographical equalization of transmission losses) or per the corresponding MWh injected (the resulting tariff per MWh delivered being proportional to transmission losses). In the second option, Egypt would be charged an 8.5% higher variable tariff than Sudan. Part of the fixed and variable tariffs can also be billed to the exporting country (Ethiopia). The decision of setting a tariff applied per MWh delivered or injected, as well as of billing a part of the transmission tariff to the exporting country Ethiopia, will have to be guided by the economic strategy and policies adopted by the three stakeholder countries.
- Tariffs can be constant over time, or be adjusted on a quinquennial basis in order to generate revenues meeting with the Project Company’s quinquennial cash requirements, which is financially optimal and yield to a lower average tariff.
- Tariffs are indexed to inflation through an “escalation formula” in order to guarantee the viability of the interconnection in an inflationary environment.

Results and key-learning of the financial and tariff modeling

Under the latest technical and macroeconomic assumption, for the technical scenario with anticipation, a quinquennial tariff mode, a public financing and corporate income tax exoneration, the optimal transmission tariff to ensure the interconnection financial profitability and viability is **USD 10.6 / MWh excluding tax** in 2010 USD (equivalent to USD 7.6 / MWh in 2006 USD).

The variant without anticipation is less attractive than the base scenario with anticipation, requiring a 13% higher average transmission tariff. Under a technical scenario without anticipation, the tariff is **USD 12.0 / MWh excluding tax** in 2010 USD (equivalent to USD 8.6 / MWh in 2006 USD). Assuming a low Ethipian demand, the average price will raise to 2010 USD 18.5 (2006 USD 13.3).

The adoption of a constant tariff would lead to a 12% higher transmission tariff compared to the average optimal tariff under a quinquennial tariff mode (**USD 11.8 / MWh excluding tax** in 2010 USD, equivalent to USD 8.5 / MWh in 2006 USD). A quinquennial tariff also consistently improves the Project Company's financial robustness (minimal refinancing, improved debt ratios and debt service coverage ratios…).

Transmission tariff is highly sensitive to the proportion of private financing in the financing plan. The average tariff would double under a private financing scheme (**USD 21.2 / MWh excluding tax** in 2010 USD, equivalent to USD 15.2 / MWh in 2006 USD) compared with the base public financing scheme. The financing strategy will therefore have to focus on raising the maximum amount of public resources from stakeholder countries' national budgets, and marketing the project to development aid partners in order to negotiate optimal concessional terms for long-term loans.

Regarding hydrologic risk mitigation, it is recommended to set tariffs for the first 10 years at a level around 5% higher than the equilibrium for the base hydrology scenario, at around **USD 11.1 / MWh** (equivalent to USD 8.0 / MWh in 2006 USD). It is also recommended to set a tariff adjustment mechanism in order to pass on tariffs a potential additional demand, as well as a sustainable favorable hydrology.

Regarding sensitivity on financing plan, the financial and tariff modeling shows that the financing strategy will have to take into account both long-term optimization (which incites to maximize public participation through non-remunerated equity and, preferably, subsidies) and the capacity for the stakeholders' states to raise fund from public budget. Regarding loan negotiation with lenders, the strategy will also have to conciliate long-term optimization (which incites to shorten loan duration and grace period), and the maximum admissible transmission tariff during the debt service period (which incites to extend loan duration).

The introduction of a 30% corporate income tax has a limited impact under public financing (+ 2% on average tariffs) but a stronger impact under a private financing (+25%) as profit have to be generated, and therefore taxed, to pay out shareholders. Nevertheless, the decision to exempt the Project Company from corporate income tax or not shall depend of an economic "arbitrage" between the additional cost of electricity transmission and the revenue generated by this taxation.

Updating of economic analysis

The updating of the economic analysis carried out in Phase I confirms the good profitability of the Eastern Nile Regional Power Interconnection project:

- The payback period is reached after 7 full years of operation for the first scenario (medium Ethiopian demand), and 8 full years of operation for the second scenario (low Ethiopian demand).
- Net present value of the project is positive for the both demand scenarios (low and medium Ethiopian demand). For a 10% discount rate, the NPV is between 1 810 MSD_{2006} to 2 210 MSD_{2006}. About 160 MUD to 320 MUSD must be added to NPVs if this project is eligible to Clean Development Mechanism.
- The benefit to Cost ratio (BCR) of the both scenarios are above 3 for a 10% discount rate, and remains superior to 2 for 8% and 12% discount rates.
- Both scenarios have high Economic Internal Rate of Return (EIRR), respectively 18% and 17%.
- The sensitivity analysis runs for a low Ethiopian demand on fuel prices, shows that the variant with anticipation is even more profitable, with a BCR of 4.9. High fuel prices assumption enhances the interest of the Eastern Nile Regional Power Interconnection project, with a BCR as high as 8.1.

1 DEFINITION AND SCOPE OF THE STUDY

1.1 THE EASTERN NILE POWER TRADE PROGRAM

The Eastern Nile Power Trade Program Study is fully funded by the African Development Bank with the general objective of promoting regional power trade between Egypt, Ethiopia and Sudan through creation of an enabling environment, coordinated regional investment planning of power generation and transmission interconnection projects.

The Project is carried out in close contact and co-operation with the three countries Utilities: EEHC, EEPCO, NEC. In addition, other relevant institutions, in particular the Nile Basin Initiative, the Ministry of Water Resources and Irrigation of Egypt, the Ministry of Water Resources of Ethiopia, the Ministry of Irrigation & Water Resources of Sudan are intensively involved in the project, with strong support of the local team experts in the three countries.

The Eastern Nile Power Trade Program Study is divided in 2 phases:

- Phase 1: Cooperative Regional Assessment of Power Trade Opportunities between Ethiopia, Egypt and Sudan:
- Phase 2: Feasibility Study of the Power Interconnection between Ethiopia, Egypt and Sudan:

The kick-off meeting led by ENTRO took place on 20 October 2006. The project duration is about 21 months up to the end of December 2008. The decision to proceed to Phase 2 has been taken by ENTRO in December 2007, on the basis of the findings of Phase1.

1.2 ECONOMIC AND TECHNICAL ASSESSMENT OF PHASE 1

The Phase 1 concluded on the economic profitability of the Egypt-Ethiopia-Sudan power interconnection (Phase 1 – task M6). The project is characterized economically by a good profitability, a short payback period and a high benefit to cost ratio under a large range of hypothesis.

Several capacities, designs and line routes have been analyzed during the Phase 1.

From the economic point of view, an export capacity of 1 200 MW to Sudan, and 700 MW or 2 000 MW to Egypt, are the most promising options. The 700 MW export capacity to Egypt may be more cost effective (BRC ratio). However, going up to 2 000 MW capacity to Egypt would still be very profitable for the region (benefit to cost ratio = 2.7 with the medium fuel price projection, up to 4.0 for the high price projection, payback period < 10 years), and would give more freedom and flexibility for future expansion of the power market to the South (Kenya and SAPP) and to the North.

1.3 VALIDATED INTERCONNECTION SCHEME FOR THE PHASE II OF FEASIBILITY STUDY

The phase II feasibility study is executed for an interconnection scheme of 1 200 MW capacity from Ethiopia to Sudan and of 2 000 MW capacity from Ethiopia to Egypt, as follows:

- Ethiopia exports 3200 MW to Sudan, including 2000 MW for Egypt.

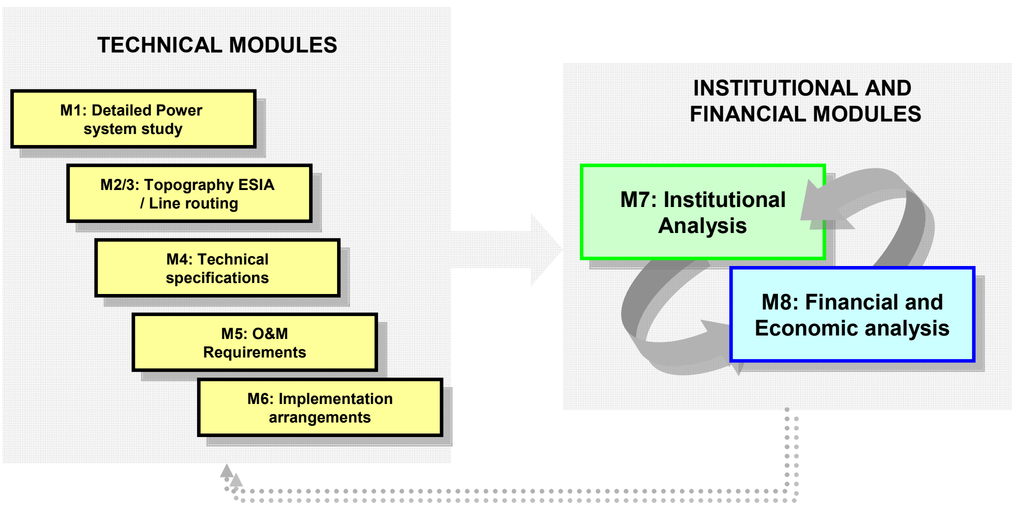
- 500/400 kV substation located on Mandaya HPP site, equipped with four 500/400 kV 510 MVA transformers.
- Four 500 kV AC circuits between Mandaya HPP and Kosti 500 kV substations, about 544 km).
- AC/DC 2 x 1075MW converter station located at Kosti substation in Sudan, and a SVC.
- 600 kV DC bipolar line, between Kosti and Nag Hammadi. The total length of the line is about 1 665 km.
- DC/AC 2 x 1010 MW converter station located in Nag Hammadi in Egypt.
- A SVC in Nag Hammadi to sustain reactive power in Egypt

The design of the interconnection (AC link between Ethiopia and Sudan, AC or DC link up to Egypt) gives some flexibility in the phasing. A commissioning in two phases will be studied: connection to Sudan in 2015 (earliest possible date considering duration of technical studies, tender process, construction), followed by a connection to Egypt in 2020 (earliest possible date when large amount of hydro power will be available from Ethiopian Blue Nile HPP projects).

1.4 OBJECTIVES OF THE FINANCIAL AND ECONOMIC STUDY

The feasibility study consists in 8 modules as listed in the below diagram. The financial and economic study makes up Module 8.

Figure 1. Feasibility study modules



The overall objective of the financial study consists in analyzing the conditions of the Eastern Nile Regional Power Interconnection's financial profitability and viability given:

- Project income (kWh transmitted, transmission tariff)
- Project costs (investment, O&M, corporate income tax…)

- Financial costs (cost of equity and debt, etc)

The final objective is to design a financial scheme and recommend tariff mechanisms that secure shareholder investments (loan reimbursement and interests, dividends) and end-users' expectations (available interconnection to export or import a cheaper hydraulic electricity).

To this end, the financial study shall determine the optimal level of transmission tariffs under different configurations of financing and pricing, and carry out an exhaustive sensitivity analysis based on key technical and financial parameters.

Regarding the economic analysis, a Costs / Benefits analysis has already been carried out in Phase 1 – Task M6. The "economic" component of this module M8 will therefore consist in:

- Actualization of operating and capital expenditure (amounts and schedule);
- Integration of transmission costs;
- Integration of environmental and social costs / benefits (Task M3)
- Initiate Project financing and Project marketing

This financial study constitutes the first step of the global Project Financing cycle and Project Marketing (see below).

1.5 LINKS WITH TASK 7 - INSTITUTIONAL STUDY

Task 7 deals with the institutional and organizational framework of the Eastern Nile regional power interconnection.

As represented in the above diagram, the institutional and financial studies are interdependent insofar as the choice of an organizational structure (public company / concession / DBO / BOT / BOOT…) has a direct impact on the types of financing that can be raised (public or private equity, private or concessional loans…), and thus the tariff levels required to ensure the interconnection's profitability and viability. Conversely, the economic acceptability of the interconnection tariff could guide the decision-makers of the Eastern Nile Power Trade Program towards a particular institutional and organizational structure.

For the purposes of this study, and without prejudging the future organizational framework for the development and management of the interconnection, the model was design under the classic Project Company scheme, with a single company in charge of the interconnection development, building and financing as part of a "concession" type contract, and potentially subcontracting the technical and commercial operation and maintenance to an external Operator for this interconnection. With regard to the present analysis, the interconnection operator will be assimilated to a single "consolidated" entity, the "Project Company" (PC).

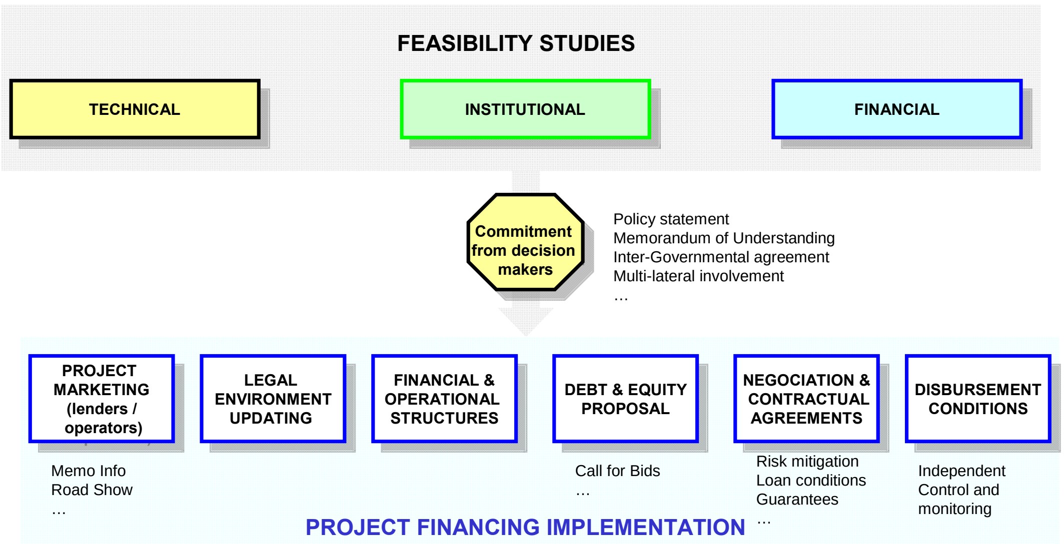
Under this scheme, the Project Company only charges a "transmission tariff" per transmitted MWh, regardless of the selling price set between the buyer and the seller in the Power Purchase Agreement (PPA); in other word, the Project Company does not buy energy to the production entity to sell it at the buying entity with an extra transmission fee: it only measures transiting energy flows and bills them at a given transmission tariff, to the seller and / or the buyer, according to pricing rules in effect.

The financial analysis will however provide data for the institutional analyses of module M7, by comparing tariff levels and state budgetary commitments for a small number of financing plan scenarios, representative of public or private financing schemes.

1.6 FOLLOW-UPS OF THE FINANCIAL STUDY – PROJECT FINANCING STEPS

This financial and economic module of the feasibility studies constitutes the first phase of the Project Financing cycle illustrated in the diagram below. Thus the financial analysis is intended to be updated and developed throughout the project life, whether through discussions with potential investors, through contractual negotiation or through monitoring the financial performance of the interconnection.

Figure 2. Project financing implementation



Therefore, at this stage of the feasibility study, the financial analysis aims to provide recommendation on a financial and tariff framework attractive to potential investors and mitigating the risks inherent in this type of project. The purpose of the study is thus to lead to a financing strategy that will build trust with shareholders by reducing their perception of the level of risk involved in the operation, in order to get best financing conditions during the Project Financing Implementation phase, with a positive impact on the transmission tariff.

2 FINANCING PLAN FOR THE EASTERN NILE REGIONAL POWER INTERCONNECTION

2.1 DEFINITION AND IMPACT OF THE FINANCING PLAN

The financing plan is the key element of the financial analysis as it conditions the "cost of money" to be raised to commission and maintain the Eastern Nile Regional Power Interconnection.

A financial plan includes several levels:

- Types of available financing: equity capital (from private or public shareholders), loans (from commercial banks or aid agencies such as World Bank, Islamic Development Bank…), investment subsidies, or self-financing resources generated by operating cash-flows;
- Financing terms: for equity capital: expected RoE; for loans: duration, grace period, interest rate…
- Financing mix: contribution of each of these resources to finance investments.

A given financing plan yields to a given "cost of money" usually computed as the Weighted Average Cost of Capital (WACC). For example, if an infrastructure is financed by 1/3 of private equity provided by shareholders expecting a 15% RoE, and by 2/3 of loans with an average interest rate of 6%, the WACC will be equal to 1/3 x 15% + 2/3 x 6%, i.e. 9%[1]. The corresponding financial cost taking into account in the Project Company's income statement through interest charges or dividends will therefore be equal to the WACC multiplied by the amount of capital.

Though loans duration and grace period do not have a direct impact on the cost of capital as expressed by the WACC method, they do however impact on the Project Company's cashflow balance and can generate refinancing requirements that carry an additional financial cost.

Ultimately, the cost of capital - and more generally the financing terms – has a direct impact on the overall Project Company's cost, and thus on the level of tariff ensuring its financial equilibrium and viability. As an example, between a "public financing" scenario (subsidies or public capital with no expected return on equity, concessional loans provided by development banks...) and a "private financing" scenario (equity capital with expected RoE, commercial loans…), the WACC before tax can vary between 3-5% and 12-15% depending on the financing terms and the company tax rate. Capital charges can accordingly vary from 1 to 3, with an impact on tariff depending on how capital-intensive the project is, but potentially as high as 1 to 2 as illustrated in the Table 1 below.

[1] With a 25% corporate income tax rate, the cost of equity capital before tax would actually be 15% / (1-25%), i.e. 20%, and the WACC before tax will be 1/3 x 20% + 2/3 x 6%, i.e. 10,7%.

Table 1. Illustration of the impact of the cost of capital on the tariff level

	PUBLIC	PRIVATE
EQUITY	20%	30%
RoE	0%	15%
Income Tax	25%	25%
LOAN	80%	70%
Interets	5%	10%
WACC	**4.0%**	**13.0%**
OPEX	1.0	1.0
CAPEX	2.0	2.0
Cost of capital	2.0	6.5
TARIFF	**5.0**	**9.5**

This tariff sensitivity to the cost of capital, i.e. to the financial plan, is even more significant for projects that are highly capital-intensive (in other words for projects where the CAPEX is much higher than the OPEX). As regional interconnections such as the Eastern Nile Regional Power Interconnection fall in this category, designing a realistic financing plan (financing mix and terms) is the key to a reliable financial analysis aiming at forecasting Project Company's future transmission tariff.

Unfortunately, at the feasibility study stage, it is difficult to anticipate the amounts and financial terms and conditions of potential investors. Indeed, it is only at the Project Financing stage that development partners, commercial banks or private investors will be contacted in order to market the project and that the terms and conditions of their participation will be discussed. Moreover, it is at this stage not possible to anticipate the capacity of each stakeholder country for budgetary commitment into the project, when the level of public funding is a crucial parameter for establishing the cost of capital and thus the transmission tariff. As a consequence, it is not possible at this stage to anticipate the financing strategy that will, in close coordination with the M7 institutional module, be chosen by the authorities and, in particular, the participation of private sector into the interconnection financing. Thus, for the purpose of this financial study, it will only be possible to elaborate a set of reasonable, coherent "standard" financing scenarios (base case and variants) and determine the corresponding required transmission tariff.

2.2 EXAMPLE FOR THE FINANCING OF REGIONAL INTERCONNECTIONS

At this stage, it is useful to review the financial plans of similar regional power transmission lines. The following examples will be briefly analyzed:

- The OMVS interconnected network (Mali, Mauritania, Senegal)
- The OMVG interconnected network (Gambia, Guinea, Guinea-Bissau, Senegal)
- The North Togo – North Benin interconnection (WAPP – West African Power Pool)
- The Nigeria – Ivory Coast interconnection (WAPP)
- The Malawi – Mozambique interconnection (SAPP – Southern African Power Pool)

2.2.1 *THE OMVS INTERCONNECTED NETWORK (MALI, MAURITANIA, SENEGAL)*

The OMVS interconnected network connects the Manantali hydroelectric power plant in Mali to the interconnected networks of Mali, Mauritania and Senegal, via 1,000 km of 225 kV lines. 71% of the interconnection was financed from concessional loans and 27% from subsidies (mainly from the KFW and the European Union), broken down as follows:

Table 2. OMVS Financing plan

Investments	
Lot	**M FCFA**
Senegal Line	85,747
Mali Line	18,428
Dispatching center	5,026
TOTAL	**109,201**

Financings				
Source	**%**	**Duration**	**Grace**	**Rate**
Loans	71%	21	6	3.42%
Subsidizing	27%			
Public Equity	2%			
	100%	**21**	**6**	**2.43%**

Loans	%	Duration	Grace	Interest
BOAD	7%	17	5	6.80%
FADES	15%	20	5	7.00%
IDA	13%	20	5	7.00%
FAD	12%	20	5	0.75%
AFD	30%	22	8	1.50%
BEI	13%	18	5	3.00%
BID	9%	25	7	
Total	**100%**	**21**	**6**	**3.42%**

The average loan interest rate was 3.42%. Based on these elements, the corresponding WACC of this financial plan was 2.43%.

2.2.2 *THE OMVG INTERCONNECTED NETWORK (GAMBIA, GUINEA, GUINEA-BISSAU, SENEGAL)*

The OMVG state members decided to build a 225 kV interconnected network of about 1,700 km, powered by the hydroelectric facilities of Sambangalou in Guinea and Kaleta in Senegal. The estimated investment given by the detailed preliminary study came to approximately 25.5 billion CFA francs.

Based on a comparative tariff analysis, the financial study recommended a public financing scheme (eventually validated by OMVG), resulting in a 2.45% WACC.

Table 3. Projected financing plan – OMVG

Investments	
Lot	**M FCFA**
Interconnexion	254,590
Total	**254,590**

Financings				
Source	**%**	**Duration**	**Grace**	**Rate**
Public Equity	10%			
Subsidizing	20%			
Concessional loan	70%	20	5	3.50%
	100%	**20**	**5**	**2.45%**

2.2.3 *THE NORTH TOGO – NORTH BENIN INTERCONNECTION (WAPP)*

This interconnection between the North Togo and North Benin networks is implemented by the CEB (Electric Community of Benin, a binational company with the exclusivity for the purchase and transmission of electricity in Togo and Benin) as part of the West African Power Pool (WAPP).

The key characteristics of the project are as follows:

- 692 kilometers of 161 kV line

- A 33.6 million CFA franc investment.

The financing plan for this project is as follows:

Table 4. Financing plan – North Togo-North Benin interconnection

Investments	
Lot	**M FCFA**
Togo Station	5.3
Benin Station	4.5
Togo line	7.2
Benin line	4.1
Nati. + Bemb. Station + Line	5.4
Dapaong-Mango Station + Line	2.7
Supervision and environment	4.4
TOTAL	**33.6**

Financings				
Source	**%**	**Duration**	**Grace**	**Rate**
Governmental bond	16%	7	4	6.50%
EIB	13%	10	3	6.50%
Governmental bond	21%	7	4	6.50%
IDA	11%	25	20	
Autofinancing	1%			
NDF	16%	25	20	
Governmental bond	8%	7	4	6.50%
IDA	13%	25	20	
	100%	**15**	**10**	**3.80%**

Based on the breakdown of the different sources of financing and the corresponding interest rates, the WACC is 3.8%. The average duration of financing was 15 years, including an average 10 years grace period.

2.2.4 NIGERIA – BENIN – TOGO – GHANA – IVORY COAST INTERCONNECTION (WAPP COASTAL TRANSMISSION BACKBONE)

This interconnection project consists in commissioning a 330 kV line linking the Nigeria network to the Ivory Coast network through the CEB (Togo – Benin) and VRA (Ghana) networks.

The provisional financing plan is as followed:

Table 5. Financing plan – WAPP coastal transmission backbone

Investments	
Lot	**M USD**
Interconnexion	287.5
Total	**287.5**

Financings				
Source	**%**	**Duration**	**Grace**	**Rate**
IDA	35%	20	5	4.50%
AfDB	28%	No data available	No data available	No data available
BOAD	14%			
IDB	7%			
EBID	7%			
KFAED	6%			
EIB	3%			

Financing from the IDA is a 40-years loan to the governments of Benin and Ghana, with a 10-year grace period, retroceded to the CEB and the VRA under the terms outlined in the previous table.

Without data on the financing terms of other shareholders, it is not possible to determine the provisional WACC of the operation. However, since this other shareholders are mainly development agencies offering concessional or interest-free loans, it can be assumed that the WACC will be between 3% to 5%.

2.2.5 THE MALAWI – MOZAMBIQUE INTERCONNECTION (SAPP)

The interconnection project between Malawi and Mozambique, and beyond that the South African Power Pool (SAPP) interconnection network, consists in a 210 km, 220 kV line for an investment of approximately USD 91 million. The financing comes mainly from IDA concessional loans, leading to a WACC of 4.22%.

Table 6. Financing plan – Malawi-Mozambique interconnection

Investments		Financings				
Lot	**M USD**	**Source**	**%**	**Duration**	**Grace**	**Rate**
Interconnexion	90.6	ESCOM / EDM	16%			
		IDA	84%	20	5	5.00%
Total	**90.6**			**20**	**5**	**4.22%**

2.2.6 SUMMARY

In conclusion to this brief case study, we can state that regional interconnection such as the Eastern Nile Regional Power Interconnection are generally developed under a public financing scheme, with a majority of concessional loans, interest-free loans or donations. The cost of capital for these operations approximately ranges from 2.5% (subsidized projects) to 5% (non-subsidized projects).

Table 7. Financing plan – Summary

Line	WACC
OMVS	2,43%
OMVG	2,45%
North Togo – North Benin (WAPP)	3,80%
Nigeria – Ivory Coast (WAPP)	3 - 5 %
Malawi – Mozambique (SAPP)	4,22%

2.3 TEMPTATIVE FINANCING PLAN FOR THE EASTERN NILE REGIONAL POWER INTERCONNECTION

2.3.1 BASE FINANCIAL PLAN

Based on the benchmarking analysis of several similar regional interconnections, a cost of capital around 3.5% can reasonably be assumed for the base financial scenario.

More precisely, a base public financing scenario has been chosen as follows:

Table 8. Financial plan – base case – public financing

Public financing				
Source	**%**	**Duration**	**Grace**	**Rate**
Public equity	20%			
Concessional loan	80%	20	5	4,50%
	100%			**3,60%**

It is assumed in this base case that the public equity capital is not remunerated (nil RoE), public shareholders (governments or national utilities) not expecting dividends from this interconnection. The remuneration of public equity will be discussed in sensitivity analysis.

It is also assumed that concessional loans are repaid at constant principal.

2.3.2 VARIANTS

For the purpose of this study, two alternative financial plans have been simulated in order to illustrate the impact of the cost of capital on the transmission tariff.

a) The first variant is a BOT / BOOT private financing scheme:

Table 9. Financial plan – variant – private financing

Financings				
Source	**%**	**Duration**	**Grace**	**Rate**
Private equity	30%			14.00%
Commercial loan	70%	15	4	10.00%
	100%			**11.20%**

The target RoE is in real terms (constant money terms excluding inflation) and after tax.

The Project Company (and its potential subcontractor ISO) is also assumed to be exonerated from corporate income tax (for a corporate income tax rate of 30%, the cost of equity capital before tax would increase from 14% to 20% and the corresponding WACC from 11.2% to 13% in real terms before tax).

It is also assumed here that the commercial loans are repaid at constant principal.

b) The second variant is a "mixed" scenario that combines private and public financing resources (Public Private Partnership or PPP):

Table 10. Financial plan – variant – public private partnership

Financings				
Source	**%**	**Duration**	**Grace**	**Rate**
Private equity	12.5%			14.00%
Public equity	12.5%			
Commercial loan	37.5%	15	5	10.00%
Concessional loan	37.5%	20	5	4.50%
	100%			**7.19%**

As an indication, for a 30% corporate income tax, the WACC for this public/private variant would rise to 7.94% (real terms before tax).

Nevertheless, it has to be emphasized that if private participation can be an option for hydroelectric facilities (for example the Nam Theung hydroelectric power plant in Laos, yielding to a 10% WACC), it is extremely unusual for transmission network, highly capital-intensive and with a long amortization period (in fact, we do not have example of such private financing for similar regional power interconnections in the sub-region).

3 PRELIMINARY TARIFF STUDY

3.1 OBJECTIVES AND CONTENTS OF THE TARIFF STUDY

Price setting for electricity-related services (production, transmission, distribution and retail) follows a number of general principles that are traditionally applied for large interconnected networks as well as local and national networks.

This section is a brief introduction to the most widely used pricing methods for transmission networks, with the purpose of defining the different configurations that will be analyzed in the financial model, and eventually submitting a number of recommendations regarding the Eastern Nile Regional Power Interconnection.

3.2 PRICING OF POWER INTERCONNECTION

Setting pricing for transmission system is a complex issue for which there is currently no universal method, though experience gathered from the large interconnected networks and from the European network (UCTE) provides indications on "best practices".

3.2.1 NATURE OF FLOWS

It should be stated first of all that flows across the transmission network differ in their commercial nature and therefore they theoretically require different price setting methods. The main flow categories are as follows:

- Energy flows from the power plants towards the member countries;
- Trades between EN countries;
- Trades with other countries;
- Pure transit (energy crosses the network without being injected or withdrawn by a member country).

In the Eastern Nile Regional Power Interconnection first phase, only trades between two countries are planned through Power Purchase Agreements (PPA) concluded between an exporting country (Ethiopia) and an importing country (Sudan, then Egypt).

In the second phase, the interconnection should be opened to third party operators (independent producers, eligible customers...), though it is not possible yet to foresee what type of contractual and commercial arrangement will be applied, nor the volumes involved.

Thus, at this stage of the feasibility study, the financial analysis will only take into account trades between the 3 EN countries; the possibility of generating additional revenue by allowing capacities to third party operators will be examined in the sensitivity study.

3.2.2 PRICING PRINCIPLES

Two key methods for pricing electrical power transmission can be considered for networks such as the Eastern Nile Regional Power Interconnection:

3.2.2.1 The "Postage Stamp" Method

This method consists in setting a "fee" for every MWh transmitted, regardless of the distance between the injection point and the withdrawal point. This simple method was adopted by France, by the member countries of the European interconnected network (UCTE), and by the member countries of the OMVS and the OMVG.

The postage stamp is divided into two parts:

- An "injection stamp" paid by the producer to deliver its energy to a grid connection point;
- A "take-off stamp" paid by the consumer for being supplied at a grid connection point.

There is no definitive rule to decide how the postage stamp tariff is shared between the producer and the buyer, the topic being still debated among state-members of the European interconnected network.

3.2.2.2 The "Contract Path" Method

This method consists in a cost per kilometer based on a fictitious path followed by the electrical current between a production plant and a delivery point. The distance can be determined either at a zonal level[2] or using a "line by line" approach.

Though this method is more strictly in accordance with market rules, it raises a number of operational difficulties:

- It is difficult to establish the actual path traveled by electricity, as this could differ widely from the "fictitious path" due to KIRCHHOFF's laws and loop flow phenomena.
- High transaction costs (determination of the "contract path", possible renegotiation or request for compensation when an interconnected operator argues that the actual flow path differs from the contract path…).

For purposes of comparison, in the gas sector, operators currently favor zonal tariffs due to the high cost of transmission. Indeed, this method of pricing is an incentive to limit long-distance gas exchanges by promoting "swap" mechanisms (trading of gas between operators, based on their proximity to one another).

3.2.2.3 Conclusions

At this stage of the study, it would be premature to decide on one or other of the two methods. However, most interconnected networks currently operate according to the postage-stamp method: this is the case for France (RTE), the European interconnected network (UCTE), and the OMVS interconnected network. This solution was also recommended for the OMVG network.

This method may be less strictly in accordance with market rules (according to which users must pay the real cost of the service provided to them, and therefore the real cost of electricity transmission), given the fact that it implies a geographical equalization between zones close to the

[2] This is the case for the South African Power Pool (SAPP), where the transmission costs are calculated in the following way: 7.5% of the cost of the energy transmitted per country traversed, with a maximum of 15% notwithstanding the number of countries traversed (in other words, the energy transmitted from one country to another without an intermediary would not generate any additional cost, but the fact of traveling through two countries between the supplier and the user would generate an additional charge of 15%). This system must however be replaced in the long-term by a cost per kilometer.

production plants and more distant zones, the latter being charged a higher transmission tariff under the contractual path method. Moreover, production facilities distant from the main consumption areas are not penalized with a comparative surcharge (this explains why the "per kilometer" method was challenged in Panama, because it tended to penalize hydroelectric power plants).

In addition, the "contractual path" method was eventually dismissed by the European Commission[3] on the reason that its implementation would be excessively complex. Moreover, its economic adequacy was questioned since "the losses generated by a transaction have very little to do with the distance between the producer and the consumer."

It could, however, be argued that in the case of a simple linear grid like that of the Eastern Nile Regional Power Interconnection, it would be relatively easy to establish the "fictitious path" (the shortest distance between the injection point and the delivery point) compared with a more complex meshed grid like the UCTE. However, because of the considerable length of the line, this tariff system would lead to a significantly higher transmission tariff for Egypt than for Sudan.

It should also be stated that the postage-stamp method has two variants depending on whether the stamp is applied to the withdrawn electricity or the injected electricity (see below). The first method implies a loss perequation between buyers, whereas under the second method each country pays for the real losses generated by its consumption, which de facto leads to a higher tariff for the most distant country. Thus, applying the postage-stamp method to the injected MWh could be a solution to take into account on a real basis, in economically and politically more acceptable proportions (see below), the distance, and therefore the losses, between the importing and exporting countries.

Eventually, for the purpose of the financial study, tariffs will be set according to the "postage stamp" method.

3.2.3 TARIFF FORMULA FOR THE POSTAGE STAMP

3.2.3.1 Fixed Tariff and Variable Tariff

Electricity transmission pricing generally includes a fixed charge for grid access, dependent on the voltage range and the contractual power capacity, and a variable charge based on the number of MWh transmitted and also on the voltage range.

Tariff formulas usually take the following form:

$$\textbf{Bill} = a_1 + a_2.Ps + b\,\tau^{c}\,Ps \qquad (1)$$

Where:

a_1, a_2, b and c are parameters that depend on the voltage range

P_s is the contractual power capacity

τ is the "rate of consumption" calculated as the ratio between the real withdrawn energy E_s **and the "contractual withdrawn energy"** (8760 x P_s)**:**

$$\tau = \frac{Es}{8760 \times Ps}$$

[3] Report by Mr. Haubrich, professor at the University of Aix-la-Chapelle, April 1999

The c parameter, which is less than 1, leads to a "concave" formula according to which the marginal cost of the withdrawn MWh diminishes as the real withdrawn energy get nearer to the contractual withdrawn energy.

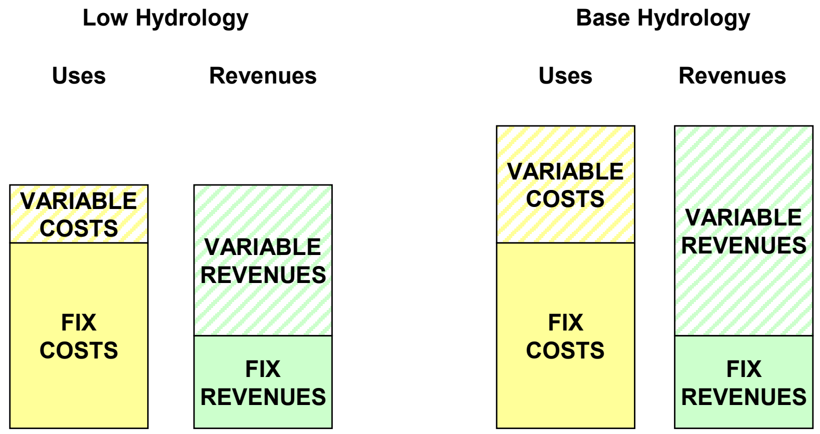
Other parameters can affect tariff formulas, notably weighting coefficient for energy and power according to the period (peak hours / off-peak hours, day/night, summer/winter, dry season/wet season, etc.) as well as over-withdrawal factors.

For a preliminary tariff study relating to a simplified power grid, the formula can usually be simplified in the following way:

PC bill (USD) = FT x Capacity (MW) + VT x Energy (MWh)   (2)

Generally, the breakdown between capacity tariffs (USD / MW) and energy tariffs (USD / MWh) is based on an analysis of Project Company's fixed costs and variable costs for a low demand scenario (in this case a low hydrology scenario) and a base demand scenario. The fixed and variable revenues are set to cover the costs in both cases, as illustrated in the following charts.

Figure 3. Setting of fixed / variable revenues



The ratio between the fixed and variable revenues verifies the following formulas:

$$\mathbf{FC + VC_L = FR + VR_L = FR + VT \times D_L \qquad (1)}$$

$$\mathbf{FC + VC_B = FR + VR_B = FR + VT \times D_B \qquad (2)}$$

With:

FC: fixed costs

VC_L / VC_B: variable costs for the low / base hydrology scenarios

FR: fixed revenue

D_L / D_B: demand (MWh) for the low / base hydrology scenarios

Then (2) – (1) implies:

$$\mathbf{VC_B - VC_L = VT \times (D_B - D_L)}$$

$$\mathbf{VT} = \frac{\mathbf{VC_B - VC_L}}{\mathbf{D_B - D_L}} \quad \mathbf{(3)}$$

For example, in the specific case where variable charges are proportional to demand (if D_L = k x D_B, VC_L = k x VC_B), (3) implies that the variable tariff will be equal to the ratio between VC_B and D_B, which is the level of variable charges per MWh. In this case, therefore, variable revenues are equal to the variable charges and the fixed revenues to the fixed charges.

However, for the specific case of the Eastern Nile Regional Power Interconnection, variable charges account for only a small part of OPEX, which in turn account for a small part of the overall costs. Variable costs remain finally so marginal that the classic methodology described above is inappropriate. The proportion between fixed and variable revenues can therefore only be fixed arbitrarily with regard to the level of fixed / variable costs, while correlated to the strategic allocation of risk between the Project Company and interconnection stakeholders (for example, a "pure" variable tariff with no fixed tariff would allocate the full hydrology risk to the Project Company, whereas a "pure" fixed tariff would transfer this risk on the sole stakeholders, which would pay the same transportation bill whatever the electricity actually transferred). For the purpose of this financial study, an option with a 50% fixed revenue will be analyzed.

3.2.3.2 Taking Grid Losses into Account

The variable tariff is applied to the withdrawn energy, and therefore is a "tariff at delivery point". Nevertheless, this tariff can be calculated either based on the withdrawn energy $\mathbf{E_S}$, or based on the corresponding energy injected into the grid $\mathbf{E_I}$, with by definition:

$$\mathbf{E_S = E_I \times (1 - P_k)} \quad \mathbf{(3)}$$

Where $\mathbf{P_k}$ is the loss rate for importing country **k**.

The first method leads to a variable tariff at delivery points $\mathbf{T_V}$ identical for all importing countries, regardless of how far they are from the production plants. The second method leads to a variable tariff at injection point identical for all importing countries, but a variable tariff at delivery point depending on the distance from the plant. For a given country k:

$$\mathbf{R_{V,k} = T_{V,K} \times E_{S,k} = T_{VI} \times E_{I,k}} \quad \mathbf{(4)}$$

Where:

$\mathbf{R_{V,k}}$ = PC's variable revenue billed to country k

$\mathbf{T_{V,k}}$ = Variable tariff per MWh withdrawn by country k

$\mathbf{E_{S,k}}$ = Energy withdrawn by country k

$\mathbf{T_{VI}}$ = Variable tariff per MWh injected into the grid, identical regardless of country k

$\mathbf{E_{I,k}}$ = Energy injected into the grid for country k

So, given the relationship between the energy injected and the energy withdrawn (3):

$$\mathbf{T_{V,k}} = \frac{\mathbf{T_{VI}}}{\mathbf{1 - P_k}} \quad \mathbf{(4)}$$

So, for two countries 1 and 2:

$$T_{V,1} = \frac{T_{VI}}{1 - P_1} \text{ and } T_{V,2} = \frac{T_{VI}}{1 - P_2}$$

Or:

$$T_{V,2} = T_{V,1} \times \frac{1 - P_1}{1 - P_2} \quad (5)$$

As an example, if the loss rate is 5% for country 1 and 10% for country 2, the variable tariff per withdrawn MWh for country 2 will be 5.6% higher than variable tariff per withdrawn MWh for country 1. In the case of the Eastern Nile Regional Power Interconnection, loss rate are assumed to be 6% for Sudan and 12% for Egypt, which leads to a variable tariff per MWh delivered to Egypt around 7% higher than the variable tariff per MWh delivered to Sudan.

This method can be considered as more satisfying from a technical and economic point of view, since the importing country only pays for the amount of energy actually delivered (whereas in the first method it is also charged with the energy lost along the transmission network). It does however tend to introduce a disadvantage to countries and regions that are furthest from the power plant by charging them a higher price per MWh delivered. It would also introduce a higher level of complexity in the case of a buyer having multiple delivery points with different loss rates (even though it is possible to apply "grouping" methods for establishing an "average loss rate " per buyer in order to set a unique tariff per country...).

3.2.3.3 Billing the Exporting Country

The issue here is to determine the extent to which the exporrting country contributes to the interconnection revenues. When it is the case, the billing method applied to the exporting country is generally similar to that applied to the importing countries, with a fixed revenue for capacity disposal and a variable revenue depending on the energy injected into the grid.

3.2.4 TARIFF MODE

Several tariff modes can be simulated over time:

3.2.4.1 “Instantaneous” Tariff Mode

Tariffs are calculated annually to cover the Project Company’s cashflow requirements on a yearly basis (including a minimal normative cash balance; debt coverage service ratio and progressive reconstitution of equity capital in order to have cash at the end of the concession to allow shareholders to recover this capital).

This theoretical pricing method leads to higher tariffs during debt service periods or during periods of extensive revamping. Though this instantaneous mode is financially optimal, it is not operational since extensive and repeated tariff variations would be unacceptable for interconnection users. It is though generally calculated to serve as a basis, through smoothing, for calculating periodic modes.

3.2.4.2 Per Period Tariff Mode

The instantaneous tariffs calculated previously are "smoothed” per period (usually five years). Tariff then takes the shape of descending "steps” before stabilizing once debt has been fully repaid.

3.2.4.3 Constant Tariff Mode

The tariff level is constant over the whole period. This results in cash-flow deficits during the debt service period, which leads to refinancing requirements (which financial cost will require additional revenues for the Project Company, therefore higher tariffs) and to defer payment of shareholder dividends (which in turn rises the cost of equity, and therefore tariffs, at an actualization rate equal to the target RoE). This constant mode is therefore not financially optimal and leads to a higher average tariff than the quinquennial mode.

3.2.4.4 "Semi-Constant" Tariff Mode:

For this project, since the interconnection is being commissioned in two phases (2015-2019: Sudan interconnection; from 2020 onwards: Sudan and Egypt interconnection), it can be useful to analyze a tariff mode with two levels of constant tariffs for these two phases.

At this stage it is recommended to adopt a quinquennial pricing. This method is very close from financial optimal (instantaneous method) as it generates revenues meeting with the Project Company's quinquennial cash requirements, and therefore limits refinancing requirements as well as dividends deferring. In addition, such a tariff structure can easily be inserted into contracts including provisions for periodic review, generally on a quinquennial basis. Lastly, it is more flexible and contributes to mitigate risk, especially hydrological risk: a first tariff level is calculated for the first 5-year period according to the latest forecasts, then can be adjusted every 5 years to take into account the real hydrology, or any other technical or macroeconomic factors which variation might impact the financial equilibrium of the interconnection.

Results from the financial analysis detailed clearly confirms that the quinquennial tariff mode is optimal, whereas a constant tariff mode jeopardized the interconnection financial viability and results in a 17.5% higher average transmission tariff. For the purpose of the financial and tariffs study, the following analysis will be carried out under the assumption of a quinquennial tariff mode.

3.2.5 TARIFF INDEXATION FORMULA

In order to guarantee the viability of the interconnection – in other words the Project Company's financial balance and profitability – in an inflationary environment, it is highly recommended to index tariffs to inflation through an "escalation formula". Such formula generally takes the following form:

$$\mathbf{T_n = A + B_l \times I_{l,n} + B_e \times I_{e,n} + C \times P_n + C \times P_n + D \times R_n}$$

With:

$\mathbf{T_n}$	=	Indexation coefficient for year n
A	=	Weighting coefficient of non-indexed charges
$\mathbf{B_l}$	=	Weighting coefficient of charges indexed to local inflation (personnel, outsourcing...)
$\mathbf{B_e}$	=	Weighting coefficient of charges indexed to capital goods inflation
C	=	Weighting coefficient of interest charges on debt
D	=	Weighting coefficient of shareholder remuneration

I_l = Variation of the local inflation index

I_e = Variation of the capital goods index

P_n = Variation of the average exchange rate of the basket of debt currencies

R_n = Variation of shareholder remuneration

3.3 CONCLUSION - APPLICATION TO MODELING

In the model base case, the transmission tariff will be calculated as a unique postage-stamp per MWh delivered and billed to the importing countries, with no fix tariff, and according to a quinquennial mode.

The impact of the following variants on the yearly invoices of the 3 countries and on the average cost per MWh transmitted will additionally be analyzed:

- Constant or semi-constant tariff modes;
- Fixed tariff for 50% of the Project Company's revenues;
- Variable tariff taking losses into account;
- 50% of the fixed and variable tariff charged to the exporting country.

At this stage, the tariff analysis will remain succinct, with the objective to illustrate pricing issues relating to the viability and profitability of the Eastern Nile Regional Power Interconnection.

4 FINANCIAL AND TARIFF MODELING

4.1 METHODOLOGY

4.1.1 GENERAL APPROACH – MODEL BUILDING

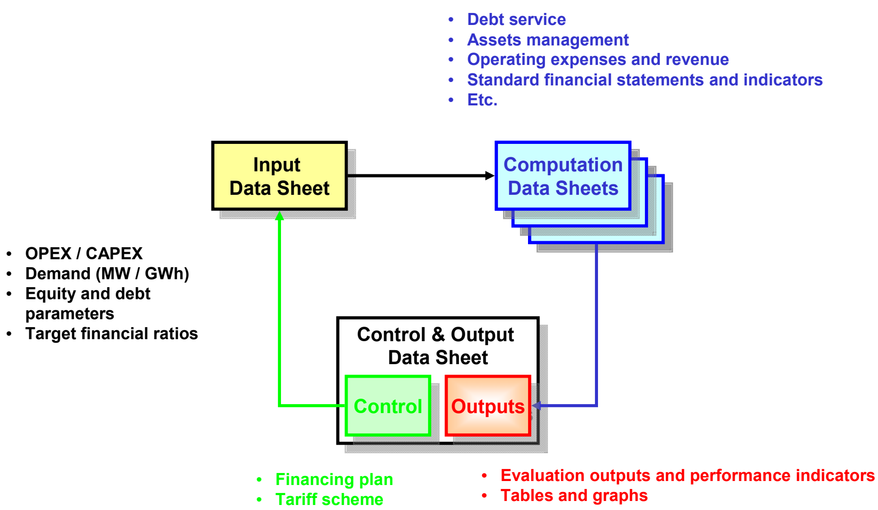
Carrying out a financial study primarily requires to develop a robust and dynamic modeling tool able to coherently simulate different technical or financial scenarios and to perform a wide range of sensitivity tests on the main technical, macroeconomic and financial parameters.

Such model must be easy to parameterize and update throughout the Project Financing cycle. The model for this particular study was designed in a commonly used mathematical calculator software with an intuitive and user-friendly control interface with scrolling menus for selecting key scenarios and parameters. On the same screen are also displayed the main results for the current configuration through summary tables and graphs.

The structure of the model is presented in the Figure 4 below. It includes three categories of data sheets:

- An input data sheet which includes all of the model's technical, financial and macroeconomic parameters;
- Intermediate computation data sheets to simulate the standard financial statements for the interconnection (income statement, cashflow sources and uses, balance sheet, the usual financial ratios);
- A control and output data sheet that allows you to view the model's main output indicators.

Figure 4. Model building



The model calculates the following indicators for the evaluation of the Project Company's financial performance:

- Operating Margin (EBITDA / Turnover);
- IRR - Internal Rate of Return (based on Project Cash-flows);
- FRR - Financial Rate of Return (based on Free Cash-flows);
- RoA - Return on Assets (Net income / Assets);
- RoE - Return on Equity (Net income / Shareholders equity);
- Debt on Equity ratio;
- DSCR - Debt Service Coverage Ratio;
- LLCR / PLCR - Loan Life / Project Life Coverage Ratio.

These indicators are of direct interest to potential investors as they allow them to evaluate the soundness of the financial plan (safety margin, capacity to absorb performance shortfalls in comparison to initial forecasts without impacting investors...).

4.1.2 MODEL PROCESSING

The model is used according to the following procedure:

- Setting of technical (OPEX / CAPEX…) and financial parameters (financing plan parameters...) in the Input Data sheet;
- Programming of technical (technical variants…) and financial (public financing, private financing…) scenarios;
- Selection of technical and financial scenario on the Control Data sheet);
- Calculation of the tariff level required to reach financial equilibrium during the modeled period.

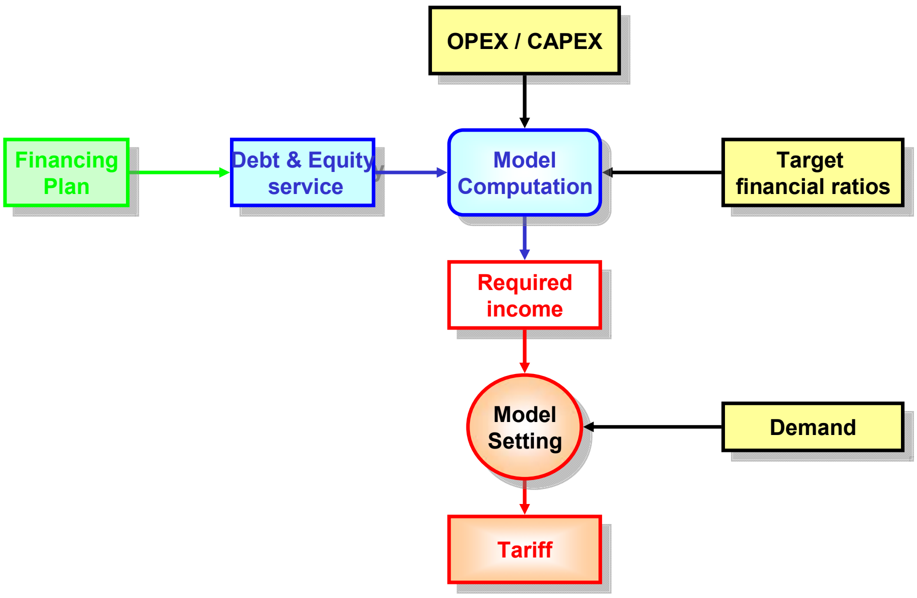
The model's financial equilibrium is set by calculating the tariff level generating the revenue required to cover the Project Company's various costs, while respecting a number of target financial ratios (DSCR, financial leverage...). These costs fall under three types:

- Operational Expenditures (OPEX, including 0&M, taxes…);
- Capital Expenditure (CAPEX, capital raised to finance investments and revamping): in terms of cash-flows, CAPEX is equal to the amount of initial investment in equipment plus revamping, after deduction of any investment subsidies granted to the operator (this amount being equal, by definition, to the sum total of the capital invested by Shareholders through Equity capital, Loans and Self-financing); in terms of income statement, CAPEX is reflected in depreciation and renewal provisions, the total amount deducted during the concession period being equal to this invested capital in order to reconstitute this capital over the period (refer to the accounting and tax assumptions section below).
- Cost of capital (interest on loans and cost of equity / dividends).

More precisely, for any given financing scenario, the model is balanced using a “macro” activated via a button on the control data sheet. Developed with a commonly used structured programming language, the macro enables to set the level of income by using the "Goalseek" function in order to tune the resulting shareholder RoE at the target RoE configured in the financing plan.

Once the level of income for reaching the Project Company's equilibrium is set, transmission tariffs are calculated by dividing income by power capacity or energy (in MW and/or MWh).

Figure 5. Model processing



4.2 PARAMETERS AND ASSUMPTIONS

4.2.1 TECHNICAL DATA

4.2.1.1 Technical Scenarios

As detailed in the modules M1 to M6, two options have been studied for the development of the Eastern Nile Regional Power Interconnection:

Base option:

The entire interconnection (double AC line between Ethiopia and Sudan, DC line between Sudan and Egypt) is commissioned between 2015 and 2019 and is fully operational in 2020; no electricity transfer occurs before 2020.

Variant with anticipation:

A first AC line between Ethiopia and Sudan is commissioned between 2012 and 2014, and is operational in 2015; electricity exchanges take place between Ethiopia and Sudan between 2015 and 2019, when the AC line is doubled and the DC line between Sudan and Egypt built. This anticipation of the first AC line between Ethiopia and Sudan enables the Project Company to generate earlier revenues between 2015 and 2019, with an expected positive impact on tariff.

4.2.1.2 Demand

There are two types of information relating to demand:

- Capacity allocated to each country (MW)
- Anticipated energy trades (GWh): amount of energy withdrawn by each importing country, and corresponding energy injected in the network by the exporting country (the difference being equal to losses during transmission).

This data is defined for a Base scenario, both for the configuration with and without anticipation, the later with two sub-scenarios:

- Base sub-scenario (BASE – Low) with low Ethiopian demand;
- Alternative sub-scenario (BASE – Medium) with medium Ethiopian demand, resulting in a lower amount of surplus flowing through the interconnection.

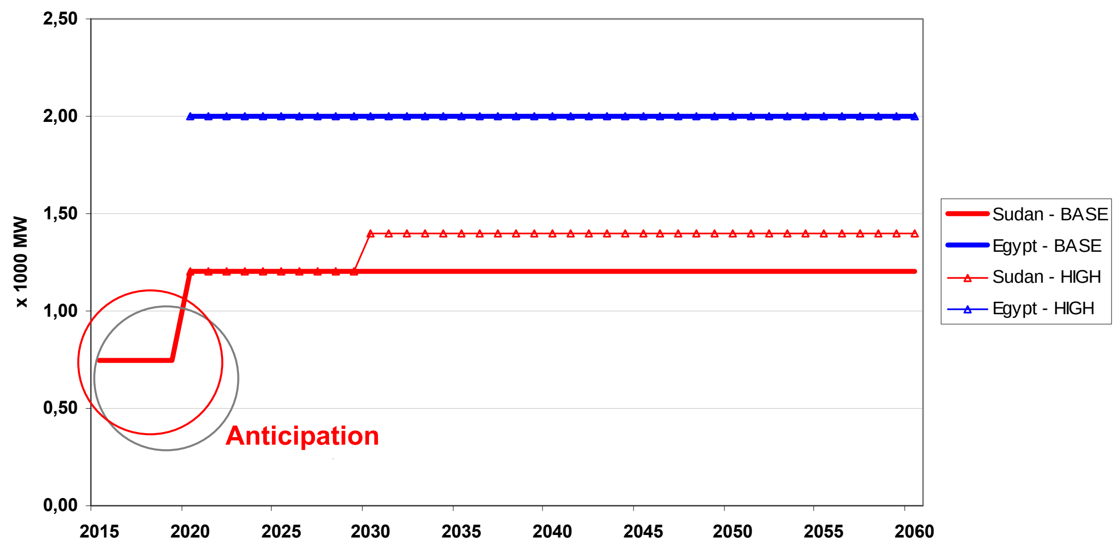
Additionally, two sensitivity analyses will be carried out for the scenario with anticipation:

- Low demand scenario (reduction by 5% of the amount of electricity available for export from the power plants after 2020) corresponding to an unfavorable hydrology and / or, after 2030, a reduction of the hydropower surplus due to a higher domestic demand in Ehiopia.
- High demand scenario (additional 5% of transmitted electricity after 2030), enabled by a better network stability following the commissioning of the border station, either through a favorable hydrology or by connecting new production capacities to the interconnected network.

The demand forecasts used in the financial study are as follows:

<u>**Capacity**</u>

Figure 6. Assumed capacity for importations (MW) - Scenario with anticipation



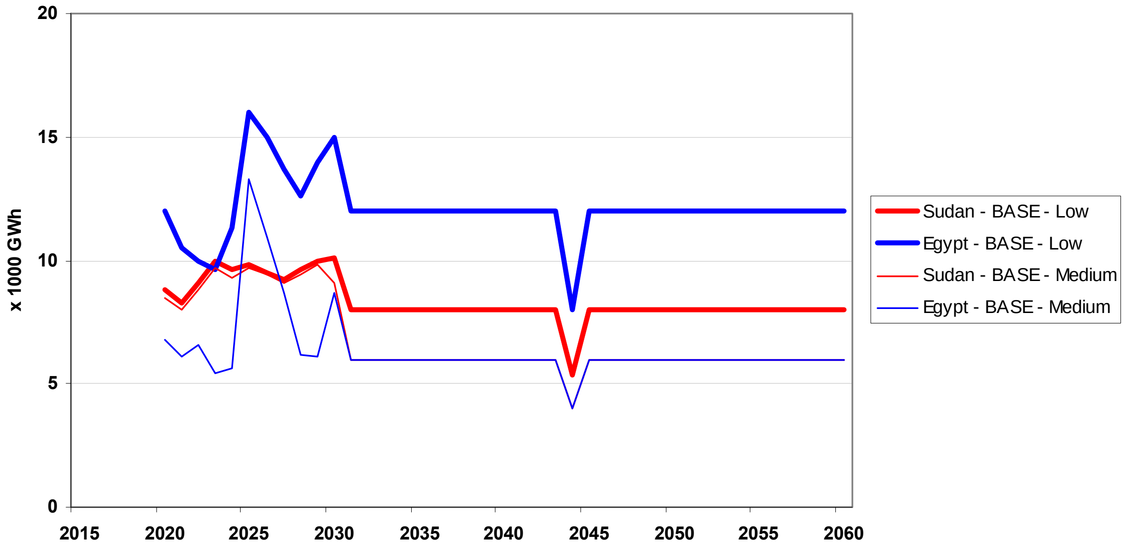
During the first phase, in the anticipated scenario, the capacity allocated to Sudan is 750 MW.

During the second phase, the capacity allocated to Sudan is 1,200 MW and the capacity allocated to Egypt is 2,000 MW. In the high scenario, Sudan is expected to benefit from an additional capacity of 200 MW. Capacities remain unchanged in the low scenario.

Traded electricity

Until 2030, trades are based on hydrological cycle forecasts determined in phase I on the basis of the EN countries master plans. Regarding the lack of generation input data, beyond 2030 trades are assumed to be constant except in 2044, due to interconnector outage for important renewal of DC power station electronic equipment, with a conservative estimated consequent 2/3 drop of trades.

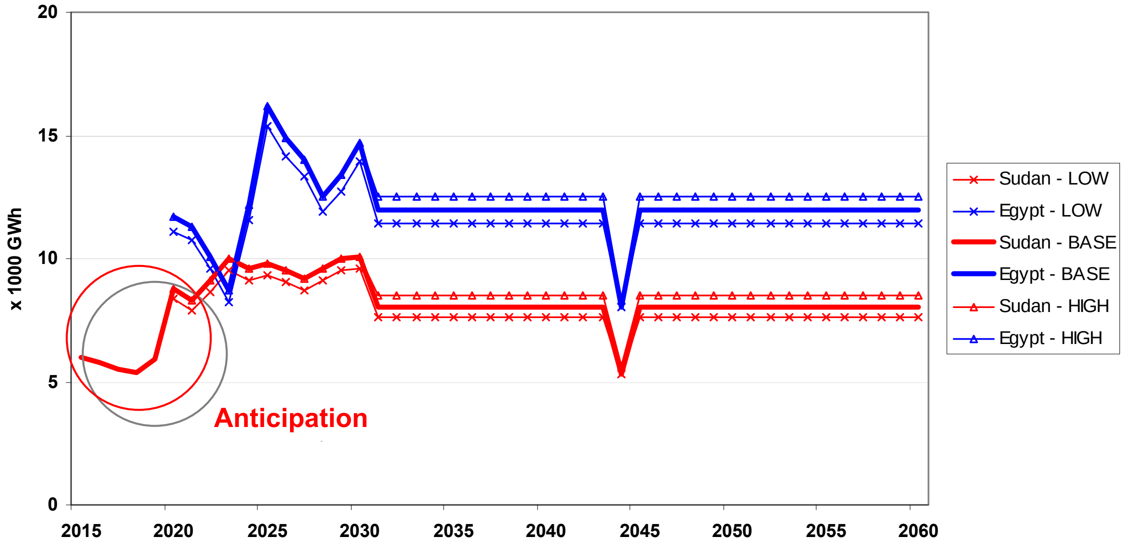
Figure 7. Assumed cross-border trades - Scenario without anticipation



It is assumed here that in the high and low scenarios, Egypt and Sudan split the surplus or deficit of available electricity in proportion to their assumed consumption in the base scenario.

The loss rates taken into account in the model vary slightly along time according to the grid load. Average values over the whole period are 5.5% for trades between Ethiopia and Sudan, and 12.3% for trades between Ethiopia and Egypt (the average value being 9.5%).

Figure 8. Assumed cross-border trades – Scenario with anticipation



Results from the financial analysis clearly shows that the scenario with anticipation is more attractive than the scenario without anticipation, allowing a nearly 10% lower average transmission tariff. For the purpose of the financial and tariffs study, the following analysis will be carried out for the scenario with anticipation.

4.2.1.3 Investment Costs

Two types of investments are taken into account in the financial model:

- Installation investments, required to commission infrastructures.
- Revamping investments, required to expand infrastructure lifetime.

These investments are broken down into infrastructure elements (stations, AC/DC lines, control centers…) then into asset classes (buildings, AC equipment, DC equipment, line equipment…) according to their life duration (LD).

Installation investments

The overall installation investments are USD 1,864 million (in 2006 money terms) exclusive of tax, broken down as follows:

- Phase 1+2 (Egypt + Sudan interconnection): USD 1,841 million;
- Phase 3 (Border substations and connection): USD 23 million.

With anticipation, the cost of Phase 1 (Ethiopia – Sudan AC line) is USD 359 million, while the cost of Phase 2 (doubling of Ethiopia – Sudan AC line, Sudan – Egypt DC line) is USD 1,482 million. The Border dam connection is still USD 23 million.

Table 11. Installation investments (USD million 2006 excluding tax) – no anticipation

		Phase 1			Phase 2					Border	
INVESTMENTS	**LD**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2030**	**TOTAL**
Engineering & control	25				6	17	56	29	19	2	129
Yard installation	5					2	3	7	7	2	21
Access roads	50				8	8	30	34	35	3	118
Buildings	50				19		84	42	48	3	229
Equipments AC	50						65	221	118	5	410
Power electronics equipments	25					32	17	57	16		90
Equipments CC	15				2	3	14	36	1		54
Line Equipments	50				51	51	232	232	237	9	813
TOTAL					**86**	**113**	**502**	**658**	**482**	**23**	**1 864**

Table 12. Installation investments (USD million 2006 excluding tax) – anticipation

		Phase 1			Phase 2					Border	
INVESTMENTS	**LD**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2030**	**TOTAL**
Engineering & control	25	4	16	7			60	23	18	2	129
Yard installation	5	0	6	5			5	1	2	2	21
Access roads	50	5	11	10			27	30	32	3	118
Buildings	50	13	19	20			90	40	43	3	229
Equipments AC	50	9	38	48				231	79	5	410
Power electronics equipments	25		3	4				71	12		90
Equipments CC	15	2	3	2				47	1		54
Line Equipments	50	31	48	53			212	230	230	9	813
TOTAL		**65**	**144**	**149**			**394**	**673**	**415**	**23**	**1 864**

Table 13. Revamping investments (USD million 2006 excluding tax) – no anticipation

REVAMPING	LD	< 2033	2033	2034	2035/42	2043	2044	2045/47	2048	2049	> 2049	TOTAL
Engineering & control	25			2	0		4			3		9
Yard installation	5											
Access roads	50											
Buildings	50				1							1
Equipments AC	50									46		46
Power electronics equipments	25					21	60					81
Equipments CC	15		14	32	1	0		0	14	32	1	95
Line Equipments	50											
TOTAL			**14**	**34**	**3**	**21**	**63**	**0**	**14**	**82**	**1**	**231**

Table 14. Revamping investments (USD million 2006 excluding tax) – anticipation

REVAMPING	LD	< 2033	2033	2034	2035/42	2043	2044	2045/47	2048	2049	> 2049	TOTAL
Engineering & control	25	0		2			4			3		9
Yard installation	5											
Access roads	50											
Buildings	50	1										1
Equipments AC	50									46		46
Power electronics equipments	25					21	60					81
Equipments CC	15	1	14	32	1			0	14	32	1	95
Line Equipments	50											
TOTAL		**2**	**14**	**34**	**1**	**21**	**63**	**0**	**14**	**82**	**1**	**232**

Revamping investments

The interconnection maintenance plan includes 3 major revamping phases:

- 2033/34: replacing DC station and control centre CC equipment (47,5 M USD);
- 2043/44: replacing DC stations' power electronic equipment (84 M USD);
- 2048/49: second replacement of DC station and control centre CC equipment (96 M USD).

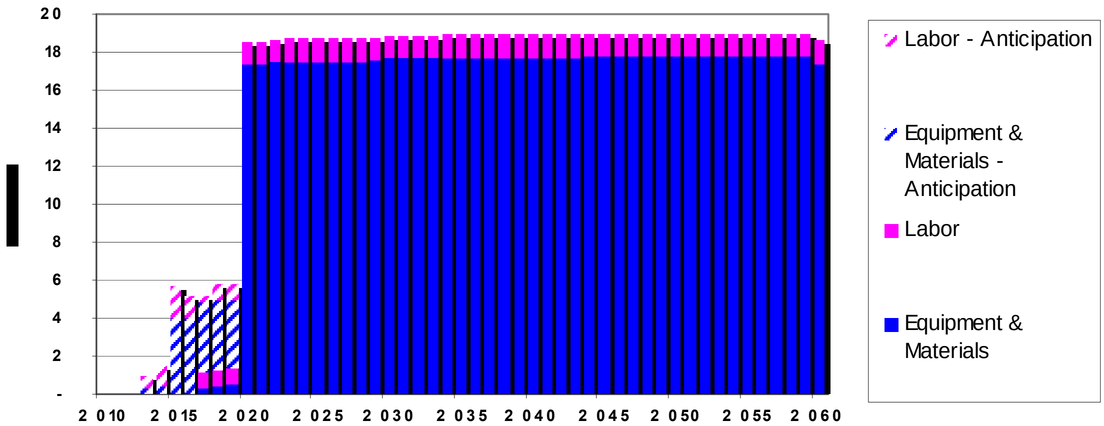
The total cost of revamping is around USD 230 million (2006) excluding tax for the base scenario (no anticipation).

4.2.1.4 O&M Costs

O&M costs include purchase of maintenance equipment and materials and the cost of the interconnection staff. It is assumed in the present study that O&M costs would remain unchanged under subcontracting to a System Operator (ISO).

The assumptions are as follows:

Figure 9. O&M costs (kUSD 2006 excluding tax)



O&M costs are around USD 18.5 million (2006) excluding tax per year; for the scenario with anticipation, O&M costs average at USD 5.5 million in phase I.

4.2.2 FINANCIAL PARAMETERS

4.2.2.1 Refinancing Parameters

During debt service periods, refinancing consists in borrowing in the medium term to cover potential cash-flows deficiency to cover interest and principal of the long-term debt. Such refinancing takes the form of "junior" (or "mezzanine") debt, usually raised from local commercial banks. Refinancing need can also appear a year of extensive revamping operations.

Refinancing requirements are calculated each year in order to cover uses and guaranty a normative level of minimal cash balance. In periods of long-term debt repayment, refinancing calculations also take into account the need to respect the target DSCR.

Financial terms for junior debt in this model are as follows:

Table 15. Financial plan – junior debt refinancing

Refinancing				
Source	**%**	**Duration**	**Grace**	**Rate**
Commercial loan	100.0%	10	3	8.00%

Junior debt repayment is also assumed to be at constant principal.

4.2.2.2 Debt Ratios

In order to secure their investments, shareholders have standard financial conditions that the borrowing entity has to meet.

Lenders will typically look at two classic ratios:

- Financial leverage: ratio between the amount of loans raised from institutional or commercial banks, and the equity capital provided by the borrower. For example, a financial leverage of 3 means that the borrower is expected to bring 25% of funds in order to borrow the remaining 75% from banks;
- Debt Service Coverage Ratio (DSCR): ratio between the cashflow available for debt servicing (interest plus principal) and the debt service, calculated each year during the period of debt repayment. Lenders will require a “safety margin” to guaranty that the company will be in a position to reimburse its debt and pay interest charges even if there is a downturn in revenues or an increase in operating costs. For example, a DSCR of 1.2 means that the lenders will expect the Project Company's business plan to generate each year an available cash-flows equal to 1.2 time the debt service.

It is assumed here that commercial banks will have a stronger requirement in term of leverage ratio and DSCR. For the 3 scenarios described previously, the values of these ratios are as follows:

Table 16. Target debt ratios

	PUBLIC	**MIXTE**	**PRIVATE**
Debt	20%	25%	30%
Equity	80%	75%	70%
Leverage	**4.0**	**3.0**	**2.3**
DSCR	**1.2**	**1.3**	**1.4**

4.2.2.3 Working Capital Management Parameters

These parameters are used to simulate the delay between a charge or revenue in the income statement, and the corresponding cash-flow disbursement or collection in the sources and uses statement.

Within the framework of this financial model, the following parameters are set:

- Collection rate: 100%
- Average collection period: 60 days

- Normative stock level: 3 months of equipment and materials purchases
- Average payment period to Equipment and Material suppliers: 60 days
- Average payment period to staff: 30 days
- Average payment period for income tax: 1 year (income tax paid out the year following the end of the fiscal year).

4.2.2.4 Cash flow Management Parameters

The following parameters are set in the model:

- Normative level of available cash: 3 months of OPEX;
- Cost of bank overdraft refinancing: 8%;
- Return on cash surplus: 3%.

4.2.3 MACROECONOMIC PARAMETERS – INFLATION RATES

The model is built on nominal terms, all costs and revenues taking into account inflation.

Investment and O&M costs, given in USD 2006, are calculated in current values by applying:

- The real or estimated inflation rates for 2006, 2007 and 2008 (based on the Retail Price Index - RPI – and the historic exchange rates between USD and local currencies for local inflation, and the Cambridge University's upstream capital costs index - IHS-CERA - for the cost of capital goods in USD);
- IMF local inflation forecasts for 2009 to 2013;
- The assumption of a progressive decrease of local inflation and capital goods inflation, with target values set for 2030 and 2060.

Meanwhile, the nominal expected RoE is computed from the real expected RoE assuming a 3% normative actualization rate. The nominal rate corresponding to the 14.00% real rate is therefore of 17.42%.

Figure 10. Inflation assumptions

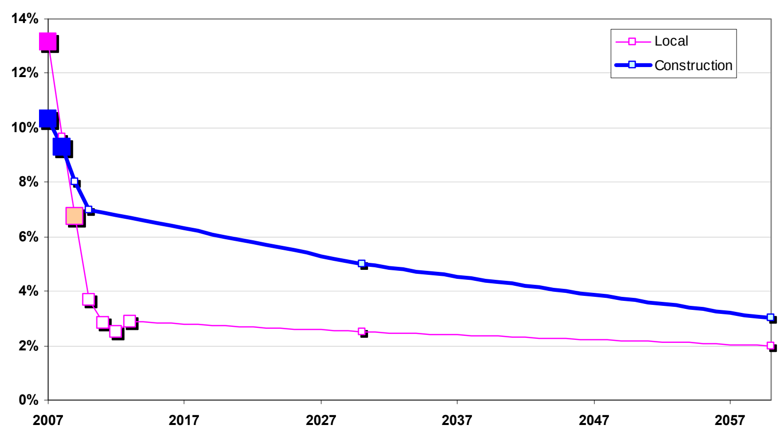


Table 17. Inflation assumptions

	2006	2007	2008	2009	2010	2011	2012	2013	2030	2060
			Est. FMI	Prév. FMI	Prév. FMI	Prév. FMI	Prév. FMI	Prév. FMI		
Inflation IPC (base 100 en 2000)										
Ethiopia	132	154	185	209	235	263	289	311		
Sudan	154	167	180	191	199	207	216	224		
Egypt	133	147	160	174	188	201	215	229		
Inflation IPC (annual rate in %)										
Ethiopia		17.0%	20.1%	12.9%	12.6%	11.8%	9.8%	7.8%		
Sudan		8.0%	8.0%	6.0%	4.5%	4.0%	4.0%	4.0%		
Egypt		11.0%	8.8%	8.8%	7.7%	7.2%	6.7%	6.7%		
Exchange rates										
Ethiopia (ETB)	8.68	8.80	9.48	10.43	11.26	12.16	13.14	13.93		
Sudan (SDG)	2.17	2.02	2.00	2.00	2.00	2.00	2.00	2.00		
Egypt (EGP)	5.75	5.72	5.67	5.73	5.98	6.27	6.56	6.82		
Evolution of exchange rates										
Ethiopia		1.3%	7.8%	10.0%	8.0%	8.0%	8.0%	6.0%		
Sudan		-7.2%	-0.8%	0.0%	0.0%	0.0%	0.0%	0.0%		
Egypt		-0.6%	-0.8%	1.1%	4.4%	4.8%	4.6%	4.0%		
Inflation IPC (annual rate in %) - USD										
Ethiopia		15.5%	11.4%	2.6%	4.2%	3.5%	1.6%	1.7%		
Sudan		16.3%	8.9%	6.0%	4.5%	4.0%	4.0%	4.0%		
Egypt		11.7%	9.7%	7.7%	3.2%	2.2%	2.0%	2.6%		
Gross domestic product, current prices (billions USD)										
Ethiopia		19.431	23.534	25.694	28.588	31.759	34.733	38.029		
Sudan		46.155	53.95	68.605	77.611	86.378	95.864	101.879		
Egypt		127.93	151.258	175.452	194.208	213.323	234.257	259.335		
Weighted regional average inflation IPC		**13.2%**	**9.7%**	**6.8%**	**3.7%**	**2.8%**	**2.5%**	**2.9%**	**2.5%**	**2.0%**

	2006	2007	2008	2009	2010				2030	2060
Power capital costs index (IHS-CERA)	155	171	187							
PCCI annual rate (%)		**10.3%**	**9.3%**	**8.0%**	**7.0%**				**5.0%**	**3.0%**

4.2.4 ACCOUNTING AND FISCAL FRAMEWORKS

4.2.4.1 Accounting Framework

The accounting rules used for this modeling are based on usually used accounting system for public service concessions. The fundamental principle consists in replenishing the capital invested by the Project Company's shareholders. By definition, this invested capital is equal to the total installation and revamping investments, after deduction of any investment subsidies the operator might have been granted.

The replenishment principle implies to accrue in the income statement an equal amount of capital expenditures (CAPEX). Within this framework, 3 types of CAPEX are taken into account:

- Depreciation: the classic economic depreciation of fixed assets, calculated according the straightline method over their economic life. Under the concession accounting rules, the operator only accrues depreciation in the income statement for renewable assets (i.e. assets expected to be revamped during the concession). Depreciation of non-renewable assets is directly written in the balance sheet in a specific equity item ("Authority's right").
- Lapsed depreciation: this depreciation is also calculated according to the straightline method over the duration of the concession, for a total amount equal to the assets installation investments after deduction of investment subsidies. The objective of this depreciation is to compensate the fact that installation are handled over without compensation to the public authority at the end of the contract. This lapsed depreciation is also written in the "Authority's right" item.
- Renewal provisions: these provisions allow the operator to replenish the additional capital require to revamp assets in an inflationary environment. The provision is recognized during the asset economic life on a straight-line base, for a total amount equal to the difference between the asset's replacement cost and installation cost. Provisions are written off in a specific debt item (financial reserves). The year the asset is replaced, the cumulated renewal provision is reversed directly in the balance sheet by transferring the corresponding reserve to the "Authority's right" item.

Under these accounting rules, over the duration of the concession:

- Cumulated lapsed depreciation = initial installation investments minus investment subsidies;
- Cumulated depreciation of renewable assets = revamping investments minus cumulated renewal provisions

The sum of these 3 CAPEX is thus equal to overall capital invested by the operator for installation and revamping, after deduction of investment subsidies, which guaranty capital replenishment.

Additionally, the application of these accounting rules implies that:

- The cumulated net earnings are equal to the cumulated dividends paid to shareholders (i.e. retained earnings is equal to zero at the end of the concession);
- At the end of the concession, after closing short-term receivables and liabilities, the closing cash balance is equal to the equity capital to be repaid to shareholders;

- At the end of the concession, the "Authority's right" on the "liabilities and equities" side is equal to the net value of assets on the "assets" side, coherent with the fact that assets belong to the conceding authority at the end of the concession period.

Thus such concession accounting rules guaranty that: on the one hand, the Operator will not claim tax allowance for assets they do not have financed (subsidized assets); on the other hand, it will have the cash necessary to reimburse loans and to repay shareholder's capital equity at the end of the concession.

4.2.4.2 Fiscal Framework

Since the Eastern Nile Regional Power Interconnection will be developed and operated at a regional level, it will be necessary to specify which fiscal provisions will apply to the Project Company and potentially the Operator, especially regarding VAT, customs tax and corporate income tax, taking into account the budgetary and economic challenges and constraints specific to such regional interconnections.

For the purposes of the present financial study, the following assumptions will be made:

VAT

Project Company and Operator are assumed to be exempted from VAT.

Customs tax

The interconnection is assumed to be exempted from customs taxes and duties.

Corporate income tax

The interconnection is assumed to be exempted from corporate income tax.

In the sensitivity section, the impact on tariffs of a 30% corporate income tax will be analyzed under the following assumption:

- Lapsed depreciation and renewal provisions are tax-deductible;
- Deficits can be deferred over a limited duration (3 years); however, any depreciation recognized in the income statement during a deficit period can be deferred forward without time limit ("deferred depreciation" mechanism). Such an interconnection is highly capital-intensive, CAPEX depreciation representing the bulk of operating costs, this mechanism practically implies a full deferment of deficit.

4.2.5 MISCELLANEOUS PARAMETERS AND ASSUMPTIONS

The simulation covers the 2010 – 2060 period to be consistent with the 50 years assumed interconnection lifetime.

The equity capital is repaid to shareholders at the end of this period (the lapsed depreciation principle guarantying that the company will have the necessary cash available at this time).

Tariffs given in 2010 USD are "desinflated" from the nominal values on a 2010 basis using the tariff index given by the application of the price escalation formula.

4.3 RESULTS OF THE FINANCIAL AND TARIFF MODELING

4.3.1 BASE CASE

The main assumptions for the base case are as follows:

- Anticipation
- Development under public financing
- Single tariff billed to the importing countries (Egypt and Sudan) as a "wheeling fee" per MWh delivered
- Quinquennial tariff
- Project Company granted exemption from VAT, custom and corporate income taxes.

4.3.1.1 Tariff Level

The transmission tariffs for the 3 countries in 2010 USD (excluding tax) are displayed in the Table 18.

According to the base case assumption, no energy exchanges occur before 2020, no fixed tariff is charged, Ethiopia does not participate to the Project Company's revenues, and Egypt and Sudan pay the same tariff per MWh delivered.

The transmission tariff for the base case, under a "public" financing scheme and for quinquennial tariff, is USD 10.6 / MWh excluding tax in 2010 USD (corresponding to USD 7.6 / MWh in 2006 USD).

Due to the high part of non-indexed costs (interest and principal repayment), tariff index slowly increases during the debt service period, then increases at a higher rate starting from 2040 onward (at an average 2,3% / year, see Table 19).

The Table 20 displays the resulting quinquennial bills per country in current USD (taking into account inflation) based on the energy demand profile for each country.

Table 18. Tariff per country – Base case – 2010 USD

USD 2010		2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Fix tariff / MW	Soudan										
	Egypt										
	Ethiopia										
Variable tariff / MWh delivered	Soudan	11,0	10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
	Egypt		10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
	Ethiopia										
Average tariff / MWh delivered	Soudan	11,0	10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
	Egypt		10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
	Ethiopia										
Average		**11,0**	**10,6**	**14,9**	**17,3**	**11,5**	**10,8**	**10,2**	**4,3**	**4,8**	**10,6**

Table 19. Tariff per country – Base case – current USD

USD current		2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Fix tariff / MW	Soudan										
	Egypt										
	Ethiopia										
Variable tariff / MWh delivered	Soudan	11,6	11,9	17,4	21,5	15,4	16,8	19,3	9,8	12,9	15,3
	Egypt		11,9	17,4	21,6	15,4	16,8	19,3	9,8	12,9	15,7
	Ethiopia										
Average tariff / MWh delivered	Soudan	11,6	11,9	17,4	21,5	15,4	16,8	19,3	9,8	12,9	15,3
	Egypt		11,9	17,4	21,6	15,4	16,8	19,3	9,8	12,9	15,7
	Ethiopia										
Average		**11,6**	**11,9**	**17,4**	**21,6**	**15,4**	**16,8**	**19,3**	**9,8**	**12,9**	**15,5**

Price index (base 2010)	1,1	1,1	1,2	1,2	1,3	1,6	1,9	2,3	2,7	
Average tariff inflation per year		1,1%	0,9%	1,2%	1,5%	3,0%	4,1%	3,6%	3,3%	2,3%

Table 20. Quinquennial bills per country – Base case – Current USD

M USD current		**2015/19**	**2020/24**	**2025/29**	**2030/34**	**2035/39**	**2040/44**	**2045/49**	**2050/54**	**2055/59**
Bill fix part	Soudan									
	Egypt									
	Ethiopia									
Bill variable part	Soudan	333	544	839	907	617	627	771	392	516
	Egypt		640	1 237	1 351	926	941	1 157	588	774
	Ethiopia									
Total bill	Soudan	333	544	839	907	617	627	771	392	516
	Egypt		640	1 237	1 351	926	941	1 157	588	774
	Ethiopia									

4.3.1.2 Financial Statements and Ratios

The following graphs and tables present the profile of the Project Company's income statement and cash-flows in current USD, as well as the main ratios.

Detailed financial statements are reproduced in Appendix 1.

Financial statements

The quinquennial tariff mode generates an adequate level of cash-flows during the debt service period, with a minimal level of refinancing.

This tariff profile also allows to constitute a cash reserve to finance revamping investments of years 2042/43 and 2048/49 without refinancing.

The Project Company generates profits as earlier as 2025, cumulated earnings being positive after 2032.

Debt ratios

The maturity of the long-term debt, which depends on the disbursement profile, the duration period (PBP) and the grace period, is 13.9 years. The average interest rate is 4.5%, which corresponds to the concessional interest rate.

By definition, the Debt / Equity Capital ratio remains below the target leverage ratio (4 in the case of public financing). Similarly, the average debt ratio remained at an acceptable 73%, with a peak at 98% in 2024. The amount of equity capital is sufficient to absorb losses; the ratio of net equity to equity capital remains positive, with a minimum of 0.02 in 2024 at the end of the first quinquennial period of Phase 2 (this level of equity, however, could justify an occasional and limited need for recapitalization).

It can be noticed that financial losses also depends on the accounting rules for lapsed depreciation and renewal provision. As an indication, cumulated losses could be reduced starting lapsed depreciation after the last revamping of a given asset instead of its initial commissioning.

Figure 11. Income statement – Base case

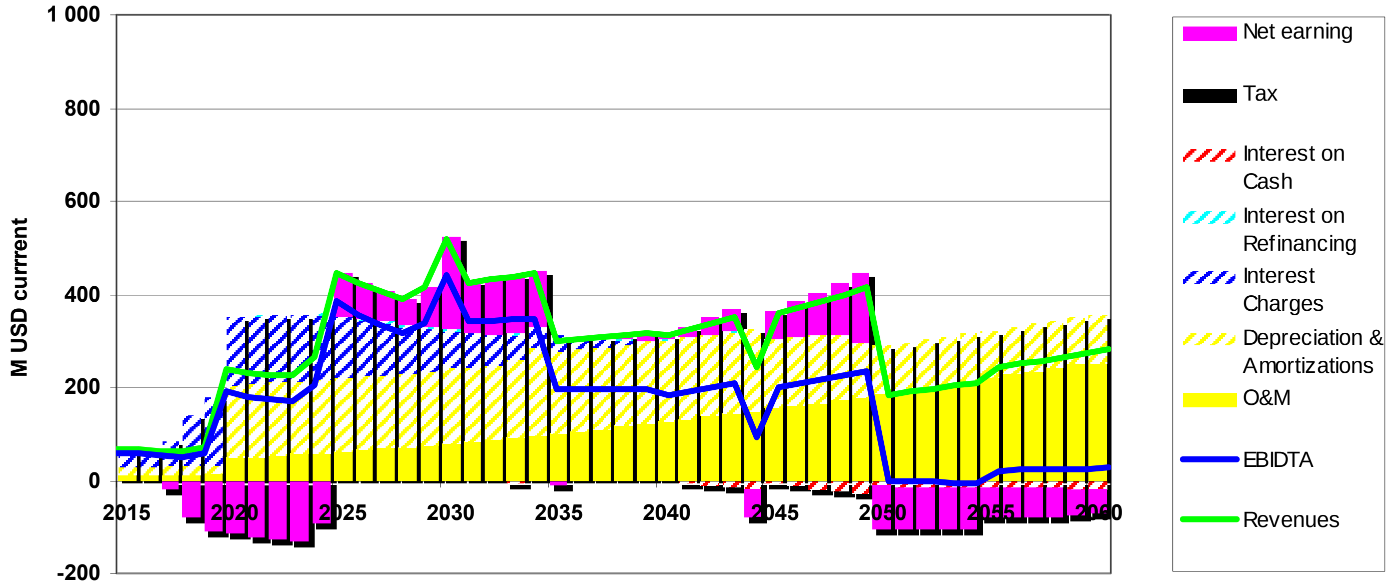


Figure 12. Cashflow profile – Base case

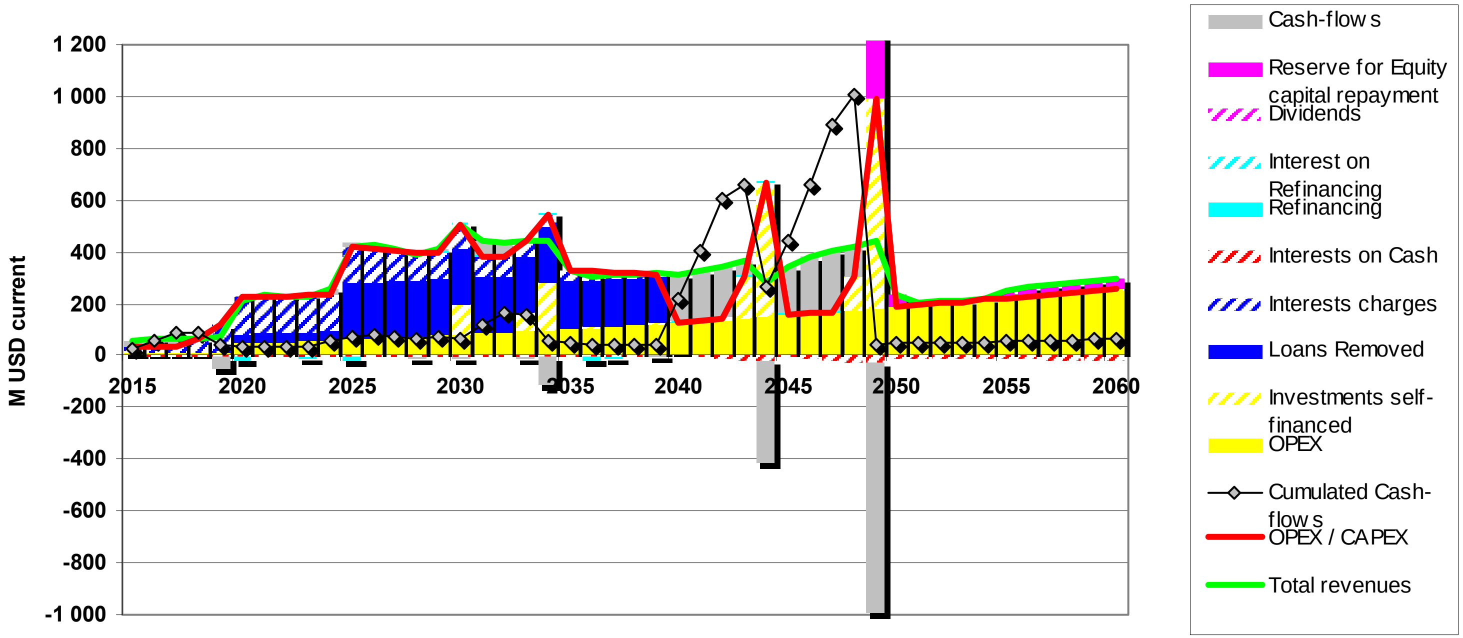


Table 21. Ratios – Base case

Operating ratios		BASE
EBIDTA / Turnover		**58,1%**
Project IRR before tax		**3,0%**

Debt ratios		BASE
LT Loan maturation		**13,9**
LT Loan interest rate		**4,5%**
Debt / Debt + Equity	max	**98%**
	weighted average	**73%**
Debt / Equity Capital	max	**4,00**
Equity / Equity Capital	min	**0,02**

Debt coverage ratios		BASE
DSCR	min	**1,20**
LLCR	max debt	**1,25**
PLCR	max debt	**2,16**
MT Loan Refinancing	% LT loan	**1%**

Financial ratios	BASE
Net Earnings / Revenues	
RoA (Net earning / Net assets)	0,0%
RoE (Net earning / Equity)	0,0%
Financial IRR	

Cost of capital	BASE
Cost of LT Loan	4,5%
% of LT Loan	80,0%
Cost of remunerated Equity (real term after tax)	14,0%
Cost of remunerated Equity (real term before tax)	14,0%
Cost of remunerated Equity (nominal term before tax)	17,4%
% of Remunerated Equity	
WACC (nominal term before tax)	**3,6%**
Net Cost of financing (nominal term before tax)	**2,9%**

Debt service coverage

The DSCR is by definition equal to or greater than the target DSCR (1.20 in the case of public financing).

While the LLCR remained at a relatively moderate 1.25 during the debt service period (with limited refinancing needs around 1% of the long-term debt), the 2.16 PLCR provide a strong security for lenders that the concession will generate enough cash-flows to reimburse debt and pay interests.

Cost of capital

There are several ways to quantify the cost of capital:

- The most widely used is the WACC. In the base scenario, the WACC is equal to 3.6%. This indicator does not however take into account the duration of the loans and their grace period, or any possible refinancing requirements that these generate, and only give a rough indication on the “cost of money”;

- The net cost of financing, calculated as the financing IRR. This indicator, which contrary to the WACC takes into account loan duration and grace period, gives a more accurate picture of the real cost of capital (2.9%), to be compared to the project IR: indeed, once tariffs are set in order to reach financial equilibrium, the net cost of financing is equal, or very close, to the project IRR (here 3.0%, see below).

Operating ratios

In the base case, the operating ratio is equal to 58%; the project IRR before tax is equal to 3.0%.

Financial ratios

In the case of a public financing, under the assumption that public equity is not remunerated, the Project Company does not pay dividends and therefore does not need to generate profit. The cumulated net earnings are thus equal to zero, which explains why the different ratios below are equal to zero.

The financial IRR (internal rate of return calculated on financial cash-flows) is by definition equal to zero, since cumulated cash-flows are equal to zero (closing cash balance equal to zero by construction, see section 4.2.4 on accounting framework). Since is coherent with the fact that at equilibrium the Project IRR is equal to the Financing IRR.

4.3.1.3 Breakdown of Tariff per MWh Transmitted

The breakdown of the current transmission tariffs per quinquenial period and for the whole concession is displayed on the Table 22 .

This breakdown confirms that this type of major power transmission projects is highly capital-intensive as the CAPEX and the cost of capital account for 65% of the overall costs.

The cumulated net earnings being equal to zero over the whole concession, the average earning per MWh is equal to zero in current USD.

4.3.2 TECHNICAL VARIANT WITHOUT ANTICIPATION

The Table 23 below displays the quinquennial and average tariffs for the scenario without anticipation.

This table confirms that the scenario with anticipation is more attractive by generating additional energy transfer and corresponding revenues in Phase 1 which more than compensate the higher level of investments. The scenario without anticipation results in a 13% higher average tariff under the assumption of a low Ethiopian demand (2010 USD 12.0 against USD 10.6, or 2006 USD 8.6 against 7.6); in case of a medium Ethiopian demand, the additional increase of the average tariff is nearly 55% (2010 USD 18.5, equivalent to 2006 USD 13.3).

Table 22. Breakdown of transmission tariff - Base case

USD	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Transportation tarif - USD 2010	**11,0**	**10,6**	**14,9**	**17,3**	**11,5**	**10,8**	**10,2**	**4,3**	**4,8**	**10,6**
Transportation tarif - USD current	**11,6**	**11,9**	**17,4**	**21,6**	**15,4**	**16,8**	**19,3**	**9,8**	**12,9**	**15,5**
OPEX	**2,0**	**2,7**	**2,9**	**4,3**	**5,6**	**7,4**	**8,4**	**10,0**	**11,8**	**6,5**
CAPEX	**3,4**	**7,9**	**6,6**	**8,0**	**8,7**	**9,3**	**6,9**	**5,1**	**5,0**	**7,0**
Cost of capital	**6,3**	**1,3**	**7,9**	**9,3**	**1,1**	**0,1**	**4,0**	**-5,3**	**-3,9**	**2,0**
Cost of LT loans	12,5	7,1	4,6	2,9	0,8					2,4
Cost of refinancing		0,1	0,1	0,1	0,1	0,1	0,0			0,1
Interets on Cash	-0,3	0,0	-0,1	-0,1	0,0	-0,6	-0,9	-0,7	-0,8	-0,4
Net earnings before tax	-5,9	-5,9	3,2	6,4	0,2	0,6	4,9	-4,6	-3,1	

Figure 13. Breakdown of transmission tariff - Base case (USD 2010)

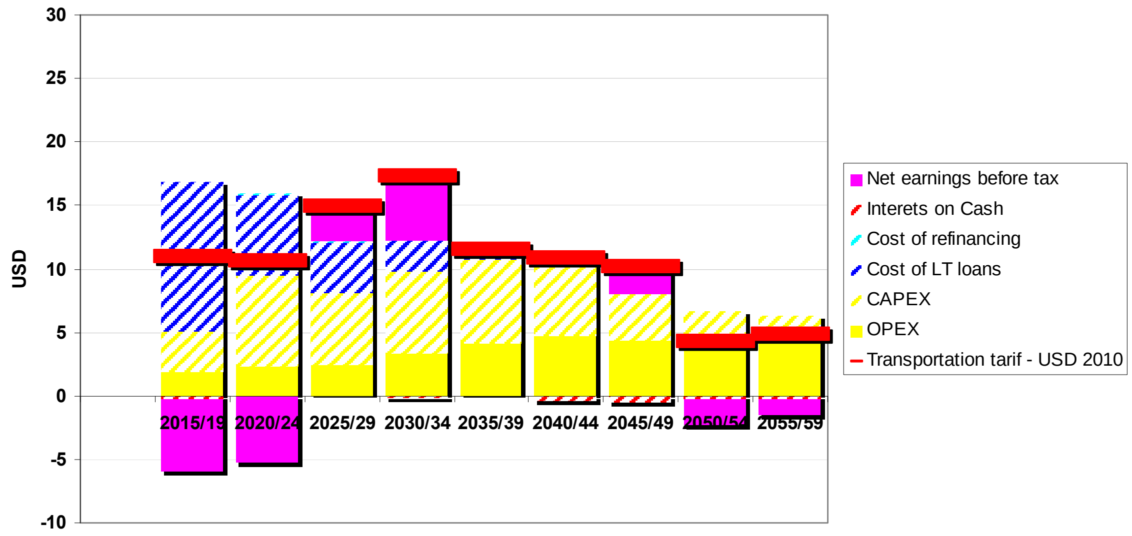


Table 23. Tariff – No anticipation – 2010 USD

USD 2010	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Base case	11,0	10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
No anticipation - Low Ethiopian demand		10,8	17,3	19,7	15,0	11,8	11,1	4,7	5,3	12,0
No anticipation - Medium Ethiopian demand		14,3	22,5	31,3	24,9	19,5	18,5	7,9	8,8	18,5

Table 24. Tariff – Tariff mode options – 2010 USD

USD 2010	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Annual	11,0	10,6	14,9	17,4	11,5	10,8	10,2	4,3	4,8	10,5
Quinquennal	11,0	10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
Semi-constant	12,4	11,8	11,8	11,8	11,8	11,8	11,8	11,8	11,8	11,8
Constant	11,8	11,8	11,8	11,8	11,8	11,8	11,8	11,8	11,8	11,8

4.3.3 VARIANTS BY TARIFF MODE

The following comparative study is carried out in the base case (public financing with anticipation).

4.3.3.1 Tariff Level

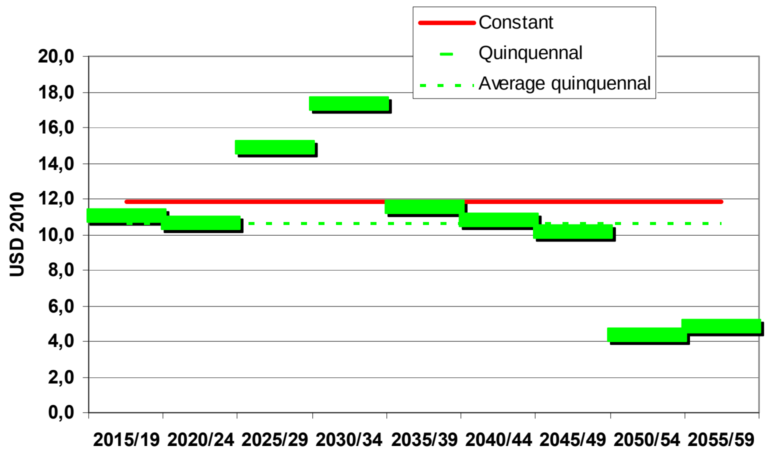
The transmission tariffs for the three countries in 2010 money terms that allow the Project Company to achieve financial equilibrium are displayed in the Figure 14.

Adopting a progressive tariff mode enables to reduce the average cost per MWh, which goes from USD 11.8 in constant mode to USD 10.5 in instantaneous mode.

The quinquennial mode proves to be extremely close to the financial optimum, levels per quinquennial period being almost identical to the quinquennial average of the instantaneous tariff mode (USD 10.6 / USD 10.5).

With a constant tariff for every phase (in real term), the semi-constant mode almost results in the same average tariff than the constant tariff mode (USD 11.8 / MWh).

Figure 14. Tariff per quinquennial period – Tariff modes - 2010 USD



4.3.3.2 Financial Statements and Ratios

The following graphs and tables present the profile of the Project Company's income statement and cash-flows in current USD, as well as the main ratios, for the quinquennal and constant tariff modes.

Financial statements

The financial statements (income statement and cash-flows statement) are reproduced in the form of graphs on the following page for the constant and quinquennial tariff modes.

During the first operating years, the constant tariff mode does not allow to generate the level of cash-flows necessary to reimburse loans (the green line “Total revenues” being inferior to the red line “OPEX / CAPEX”), leading to significant refinancing requirements (over 70% of the long-term debt, see below). Likewise, this tariff pattern generates significant deficits in the first ten years, leading to an extremely deteriorated financial situation with negative equity.

The cash-flows generated during the last 5 years of the concession enable to progressively constitute the cash reserve necessary to repay equity capital to shareholders at the end of the concession (in year 61).

Meanwhile, the quinquennial tariff mode generates an adequate level of cash-flows during the debt service period, with a minimal level of refinancing (refinancing being nil for the instantaneous mode). This tariff profile also allows to constitute a cash reserve to finance revamping investments of years 2042/43 and 2048/49 without refinancing.

Contrary to the constant tariff mode, profits are generated during the debt service period; after the debt has been fully repaid (2040).

Figure 15. Financial statements – Tariff variants

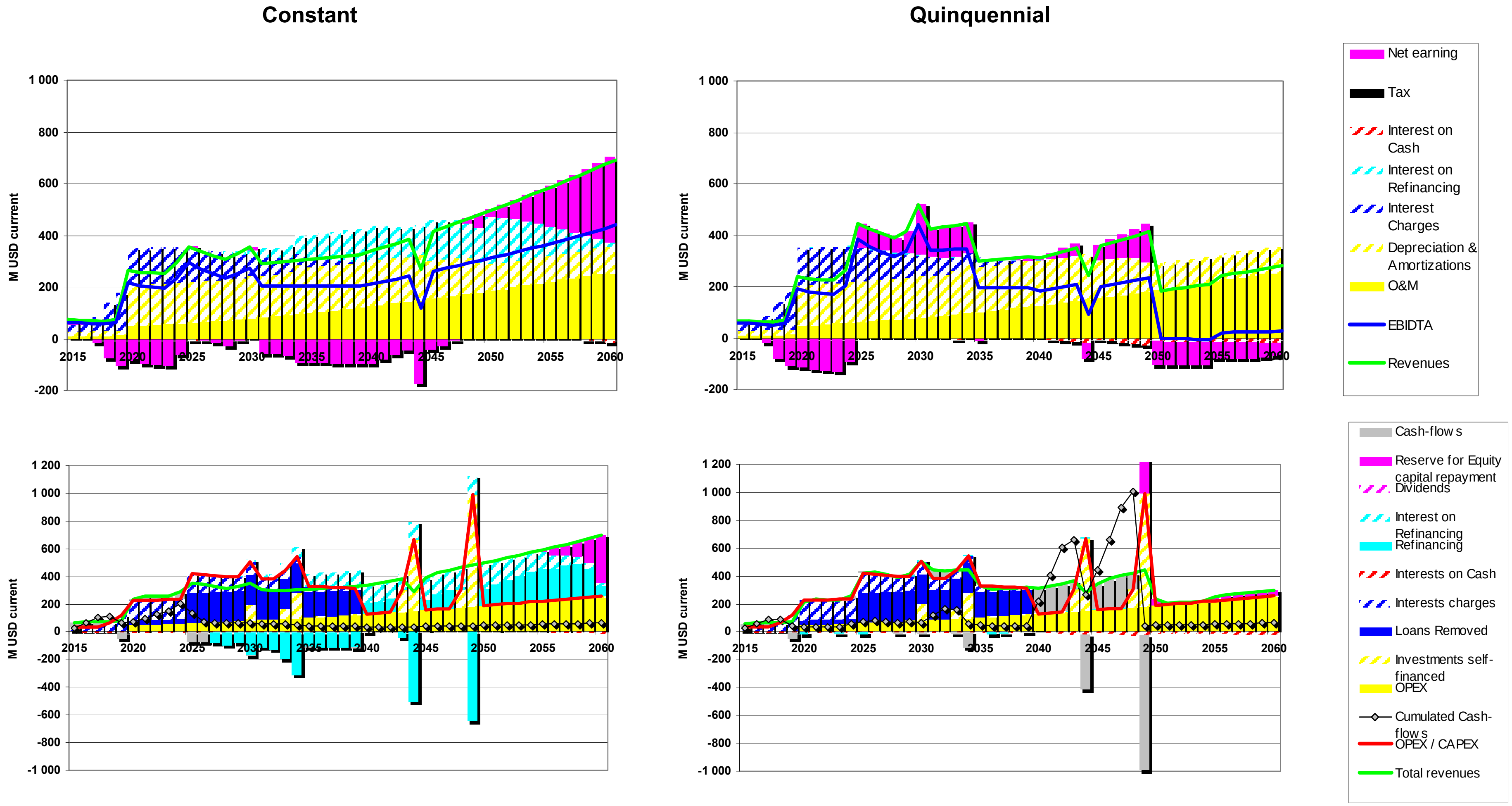


Table 25. Ratios – Tariff variants

Operating ratios		**QUINQ**	**CST**
EBIDTA / Turnover		**58,1%**	**66,8%**
Project IRR before tax		**3,0%**	**4,2%**

Debt ratios		**QUINQ**	**CST**
LT Loan maturation		**13,9**	**13,9**
LT Loan interest rate		**4,5%**	**4,5%**
Debt / Debt + Equity	max	**98%**	**113%**
	weighted average	**73%**	**89%**
Debt / Equity Capital	max	**4,00**	**4,00**
Equity / Equity Capital	min	**0,02**	**-1,36**

Debt coverage ratios		**QUINQ**	**CST**
DSCR	min	**1,20**	**1,20**
LLCR	max debt	**1,25**	**1,33**
PLCR	max debt	**2,16**	**1,49**
MT Loan Refinancing	% LT loan	**1%**	**70%**

Financial ratios	**QUINQ**	**CST**
Net Earnings / Revenues		
RoA (Net earning / Net assets)	0,0%	0,0%
RoE (Net earning / Equity)	0,0%	0,0%
Financial IRR		

Cost of capital	**QUINQ**	**CST**
Cost of LT Loan	4,5%	4,5%
% of LT Loan	80,0%	80,0%
Cost of remunerated Equity (real term after tax)	14,0%	14,0%
Cost of remunerated Equity (real term before tax)	14,0%	14,0%
Cost of remunerated Equity (nominal term before tax)	17,4%	17,4%
% of Remunerated Equity		
WACC (nominal term before tax)	**3,6%**	**3,6%**
Net Cost of financing (nominal term before tax)	**2,9%**	**4,1%**

Debt service coverage

The closest the tariff profile is from required expenses, the less refinancing needs are. At the extreme, the instantaneous tariff mode enable to generate each year the exact cash-flows required to cover debt service in compliance with the DSCR, so that no refinancing is required. The quinquennial mode is extremely close to the optimum as it only generates limited refinancing requirements (1% of long-term debt, compared with 70% in constant tariff mode).

By definition of refinancing, the DSCR remains constantly equal or greater than the target DSCR; as the long-term debt service is refinanced if needed, LLCR is comparable under constant and quinquennial tariff modes. However PLCR is much higher for the quinquennial mode (2.16 against 1.49), indicating a stronger security for lenders that the concession will generate enough cash-flows to reimburse debt and pay interests.

Debt ratios

By definition, the Debt / Equity Capital ratio remains below the target leverage ratio (4 in the case of public financing) in the constant tariff mode. However, the cumulated deficits deteriorate the debt ratio (Debt / Debt + Equity), which average weighted value exceeds 89% with a peak at 113% in 2042, which corresponds to a situation of negative equity: this same year, the cumulated deficits represent as high as 2.4 time the equity capital, with a corresponding negative equity (i.e. equity capital plus cumulated earnings) representing 1.4 time the equity capital, which is unacceptably close from a situation of bankruptcy.

These results indicate that this tariff mode is not optimal and leads to significant refinancing requirements, and even to a recapitalization requirement to secure the financial stability of the company. For such tariff mode, a leverage ratio of 4 turns out to be financially unsustainable, requiring a higher level of participation from states. Sensitivity analysis shows that the level of public equity required to absorb cumulated losses (i.e. equity positive during the whole concession) would be around 45% of installation investments (corresponding to a leverage ratio of 1.2).

Cost of capital

If the WACC is independent from the tariff mode, a more progressive tariff profile lowers the net cost of financing from 4.1% in constant tariff mode to 2.9% in quinquennial tariff mode, due to a lower level of refinancing (1% against 70%).

4.3.3.3 Breakdown of the Cost of Each MWh Transmitted

Analysis of the cost structure per transmitted MWh confirms the above analyses:

- Costs relating to O&M, CAPEX and financial charges on long-term loans remain constant;
- On the other hand the cost of refinancing is dramatically increased (from USD 0.1 to 3.8), and the financial cost is furthermore reduced by a lower level of interests earned on cash placements. Eventually, the average financial cost per MWh is increased from USD 2.0 in quinquennial tariff mode to USD 6.1 in constant tariff mode.

Due to the high capital-intensity of the Eastern Nile Regional Power Interconnection, the impact of the non-financially optimal constant tariff is significant, the average price per MWh in 2010 USD being increased by 12% (USD 11.8 against USD 10.6 in quinquennial mode).

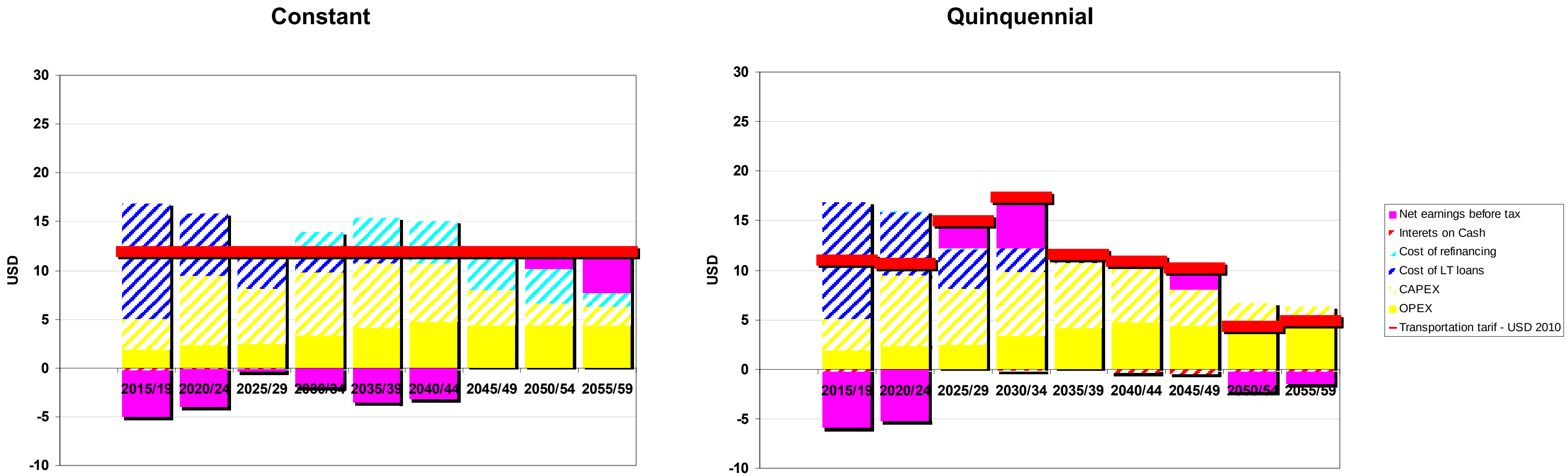
Table 26. Breakdown of transmission tariff – Constant / Quinquennial tariff mode

	QUINQ	CST
Transportation tarif - USD 2006	**10,6**	**11,8**
Transportation tarif - USD current	**15,5**	**19,6**
O&M	**6,5**	**6,5**
CAPEX	**7,0**	**7,0**
Cost of capital	**2,0**	**6,1**
Cost of LT loans	2,4	2,4
Cost of refinancing	0,1	3,8
Interets on Cash	-0,4	-0,1
Net earnings before tax		

Table 27. Breakdown of transmission tariff – Constant tariff mode

USD	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Transportation tarif - USD 2010	**11,8**	**11,8**	**11,8**	**11,8**	**11,8**	**11,8**	**11,8**	**11,8**	**11,8**	**11,8**
Transportation tarif - USD current	**12,5**	**13,2**	**13,9**	**14,7**	**15,9**	**18,4**	**22,5**	**26,9**	**31,6**	**19,6**
OPEX	**2,0**	**2,7**	**2,9**	**4,3**	**5,6**	**7,4**	**8,4**	**10,0**	**11,8**	**6,5**
CAPEX	**3,4**	**7,9**	**6,6**	**8,0**	**8,7**	**9,3**	**6,9**	**5,1**	**5,0**	**7,0**
Cost of capital	**7,1**	**2,7**	**4,3**	**2,5**	**1,5**	**1,7**	**7,2**	**11,8**	**14,8**	**6,1**
Cost of LT loans	12,5	7,1	4,6	2,9	0,8					2,4
Cost of refinancing			0,2	2,1	5,5	6,7	7,2	7,9	3,7	3,8
Interets on Cash	-0,3	-0,1	-0,1	-0,1	0,0	0,0		0,0	-0,1	-0,1
Net earnings before tax	-5,0	-4,3	-0,3	-2,4	-4,8	-4,9	0,0	3,9	11,2	

Figure 16. Breakdown of transmission tariff - Base case - Tariff variants (USD 2010)



4.3.3.4 Conclusion of Variants by Tariff Mode

This tariff analysis confirms that the quinquennial option is close from financial optimum, while a constant tariff generates additional financing costs and results in a 12% higher average tariff (USD 11.8 / MWh in USD 2010, corresponding to USD 8.5 / MWh in USD 2006).

The financial analysis therefore leads to recommending the adoption of a quinquennial tariff mode.

For the purpose of the financial analysis, the following analysis will be carried out under the quinquennial tariff mode.

4.3.4 OTHER TARIFF VARIANTS

4.3.4.1 Introduction of a 50% Fixed Tariff

As outlined in the introduction section, the following formula is classically used to determine the tariff variable part per MWh:

$$\mathbf{VT} = \frac{\mathbf{VC_B - VC_L}}{\mathbf{D_B - D_L}}$$

In the case of the Eastern Nile Regional Power Interconnection, however, the portion of variable costs is marginal and not taken into account in the simulations. The standard method would thus lead to a nil variable tariff, the full yearly bill consisting in a capacity tariff (USD / MW) regardless of the transmitted energy. In such situations, another method consists in dimensioning the fixed and variable tariffs so as to ensure that they cover a number of charges in unfavorable hydrological scenarios. This method was for example adopted for the OMVS and OMVG tariff studies.

In the reference case with a nil fixed tariff, the level of income is directly proportional to the demand (for example, in this case, a 5% drop in the base hydrology productive capacity would lead to only covering 95% of costs). For this financial study, the fixed tariff has been calculated so that fixed revenues represent 50% of the Project Company's revenue.

The Table 28 below details the quinquennial tariffs for each country. Since the allocation of capacities and energy between Sudan and Egypt are not proportional, identical fixed and variable tariffs result in a slightly higher average tariff per MWh for Egypt (USD 10.9 compared with USD 10.2 for Sudan).

For information only, the Table 29 indicates tariff levels in the case of a nil variable tariff (100% fixed part). The USD 10.5 / MWh average variable tariff is therefore equivalent to an average fixed tariff of around USD 65 / MW.

These tariff options have no impact on financial ratios, since the average quinquennial tariff per MWh remains identical to the base case. We can however notice that a higher fix tariff tends to lower the average tariff per MWh paid by Sudan, while increasing the average tariff for Egypt.

Table 28. Quinquennial tariffs per country – With 50% fixed part

USD 2010		2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Fix tariff / MW	Soudan	42,0	33,1	55,5	56,8	36,1	31,6	31,8	13,5	15,1	34,3
	Egypt		33,1	55,5	56,8	36,1	31,6	31,8	13,5	15,1	33,7
	Ethiopia										
Variable tariff / MWh delivered	Soudan	5,5	5,3	7,4	8,7	5,8	5,4	5,1	2,2	2,4	5,3
	Egypt		5,3	7,4	8,7	5,8	5,4	5,1	2,2	2,4	5,3
	Ethiopia										
Average tariff / MWh delivered	Soudan	11,0	9,7	14,4	16,8	11,2	10,5	9,9	4,2	4,7	10,2
	Egypt		11,4	15,3	17,7	11,8	11,0	10,4	4,4	4,9	10,9
	Ethiopia										
Average		**11,0**	**10,6**	**14,9**	**17,4**	**11,5**	**10,8**	**10,2**	**4,3**	**4,8**	**10,6**

Table 29. Quinquennial tariffs per country – With 100% fixed part

USD 2010		2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Fix tariff / MW	Soudan	84,1	66,3	111,2	113,8	72,2	63,2	63,6	27,1	30,3	68,7
	Egypt		66,3	111,2	113,8	72,2	63,2	63,6	27,1	30,3	67,5
	Ethiopia										
Variable tariff / MWh delivered	Soudan										
	Egypt										
	Ethiopia										
Average tariff / MWh delivered	Soudan	11,0	8,7	13,9	16,2	10,8	10,2	9,5	4,1	4,5	9,8
	Egypt		12,3	15,7	18,2	12,0	11,3	10,6	4,5	5,0	11,2
	Ethiopia										
Average		**11,0**	**10,6**	**14,9**	**17,4**	**11,6**	**10,8**	**10,2**	**4,3**	**4,8**	**10,6**

4.3.4.2 Differential Allocation of Losses

This option consists in taking into account the higher rate of losses on electricity imported by Egypt due to the higher distance from the generation sites.

As explained in detail in the introduction, applying an identical tariff at injection points rather than at withdrawal points – as in the base case – leads to a variable tariff for Egypt 7% higher than for Sudan (2010 USD 10.9 against USD 10.2 for loss rates at 12% and 6% respectively).

Table 30 details the quinquennial tariffs for each country, under the assumption of a 100% variable tariff.

4.3.4.3 Contribution of Ethiopia to the Transmission Tariff

Table 30 shows the quinquennial tariffs and bills in the case where 50% of the Project Company required revenue is billed to Ethiopia, under the assumption of a 100% variable tariff and a bill based on the delivered energy.

Table 30. Quinquennial tariffs per country – Losses allocation

USD 2010		2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Fix tariff / MW	Soudan										
	Egypt										
	Ethiopia										
Variable tariff / MWh delivered	Soudan	11,0	10,1	14,3	16,6	11,0	10,3	9,7	4,1	4,6	10,2
	Egypt		11,0	15,3	17,8	11,9	11,1	10,5	4,4	5,0	10,9
	Ethiopia										
Average tariff / MWh delivered	Soudan	11,0	10,1	14,3	16,6	11,0	10,3	9,7	4,1	4,6	10,2
	Egypt		11,0	15,3	17,8	11,9	11,1	10,5	4,4	5,0	10,9
	Ethiopia										
Average		**11,0**	**10,6**	**14,9**	**17,3**	**11,5**	**10,8**	**10,2**	**4,3**	**4,8**	**10,6**

Table 31. Quinquennial tariffs and bills per country – Contribution of Ethiopia

USD 2010		2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Fix tariff / MW	Soudan										
	Egypt										
	Ethiopia										
Variable tariff / MWh delivered	Soudan	5,5	5,3	7,4	8,7	5,8	5,4	5,1	2,2	2,4	5,3
	Egypt		5,3	7,4	8,7	5,8	5,4	5,1	2,2	2,4	5,3
	Ethiopia	5,5	5,3	7,4	8,7	5,8	5,4	5,1	2,2	2,4	5,3
Average tariff / MWh delivered	Soudan	5,5	5,3	7,4	8,7	5,8	5,4	5,1	2,2	2,4	5,3
	Egypt		5,3	7,4	8,7	5,8	5,4	5,1	2,2	2,4	5,3
	Ethiopia	5,5	5,3	7,4	8,7	5,8	5,4	5,1	2,2	2,4	5,3
Average		**11,0**	**10,6**	**14,9**	**17,3**	**11,5**	**10,8**	**10,2**	**4,3**	**4,8**	**10,6**

M USD current		2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59
Bill fix part	Soudan									
	Egypt									
	Ethiopia									
Bill variable part	Soudan	166	272	419	454	309	314	386	196	258
	Egypt		320	618	676	463	470	578	294	387
	Ethiopia	166	592	1 038	1 129	772	784	964	490	645
Total bill	Soudan	166	272	419	454	309	314	386	196	258
	Egypt		320	618	676	463	470	578	294	387
	Ethiopia	166	592	1 038	1 129	772	784	964	490	645

4.3.4.4 Conclusion

In conclusion, though these tariff options have an impact on how the Project Company's required revenues are split between the three countries, they do not impact on the average transmission tariff per MWh.

The opportunity to introduce a fixed tariff, as well as the determination of its level, shall therefore be derived from a strategic risk allocation between the Project Company and the interconnection's "clients" (exporting and / or importing countries).

The decision of setting a tariff applied per MWh delivered or injected, as well as of billing a part of the transmission tariff to the exporting country Ethiopia, will have to be guided by the economic strategy and policies adopted by the three stakeholder countries.

4.3.5 FINANCING PLAN VARIANTS – PRIVATE SECTOR PARTICIPATION

The financial variants below are analyzed in the following configuration:

- Option with anticipation;
- Quinquennial tariff mode;
- Tariff as a single, uniform tariff per MWh delivered, with no fixed part, billed exclusively to the importing countries.

4.3.5.1 Shareholder Remuneration

When financing is partially or completely sought from the private sector, under concession or BOO schemes, the dividends paid to equity shareholders each year are calculated in the following way:

- The amount to be distributed is less than or equal to the net income of the previous year, plus the current retained earnings (cumulative net earnings minus cumulative dividends), if this amount is positive;
- The amount actually distributed is limited by the cash-flows available (prior to refinancing), after taking into account the allocation of part of these cash-flows to fund reserves;
- Repayment of equity capital at the concession closing.

4.3.5.2 Tariff Level

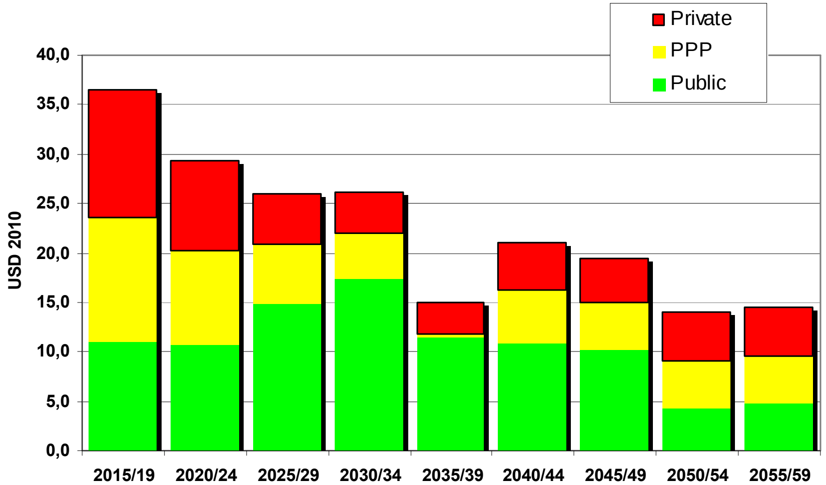
Private sector participation leads to a substantial increase in transmission tariffs, which increase on average from USD 10.6 / MWh with public financing to USD 15.9 / MWh with a PPP (+50%) and USD 21.2 / MWh with private financing (+100%).

As suggested previously, private financing plan leads to a doubling tariff compared with the base public financing plan.

Table 32. Quinquennial tariff - Financing plan variants

USD 2010	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Public	11,0	10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
PPP	23,7	20,3	20,9	22,0	11,8	16,2	15,0	9,0	9,5	15,9
Private	36,5	29,4	26,0	26,1	14,9	21,0	19,5	14,0	14,5	21,2

Figure 17. Quinquennial tariff - Financing plan variants – 2010 USD



4.3.5.3 Financial Statements and Ratios

The following graphs and tables present the profile of the Project Company's income statement and cash-flows in current USD, as well as the main ratios, for the financing options.

Financial statements

The financial statements (income statement and cash-flows) are displayed in the form of graphs on the Figure 18 for the public and private scenarios.

The introduction of private shareholders in the financing plan requires the Project Company to generate profits in order to pay dividends ensuring a RoE in line with shareholders' expectations. In addition, the less favorable loan conditions (lower financial leverage, higher DSCR and interest rates, shorter duration and grace period) lead to higher interest charges during debt service periods.

Debt ratios

The less favorable loan duration and grace period in private financing result in a shorter debt maturity (from 14 years to 11 years); similarly, the average interest rate increases from 4.5% (concessional rate) to 10% (commercial rate).

On the other hand, the debt ratio is lower under private financing due to a lower financial leverage (2.33 with private financing and 3.00 with PPP compared with 4.00 with public financing). Likewise, the level of cumulated losses does not exceed 40% of equity capital in private financing.

Cost of capital

The nominal WACC increases from 3.6% with public financing to 7.6% with PPP and to 12.2% with private financing. Similarly, the net cost of financing increases from 2.9% with public financing to 13.4% with private financing.

Financial ratios

Under public financing, since no profits were needed to remunerate shareholders, the financial profitability ratios were nil.

The average values of these ratios for the private financing scenarios are presented in the table below. The sum of cash-flows being by definition nil (cash accounts on closing equal to zero), the financial IRR is still equal to zero.

Figure 18. Financial statements - Financing plan variants

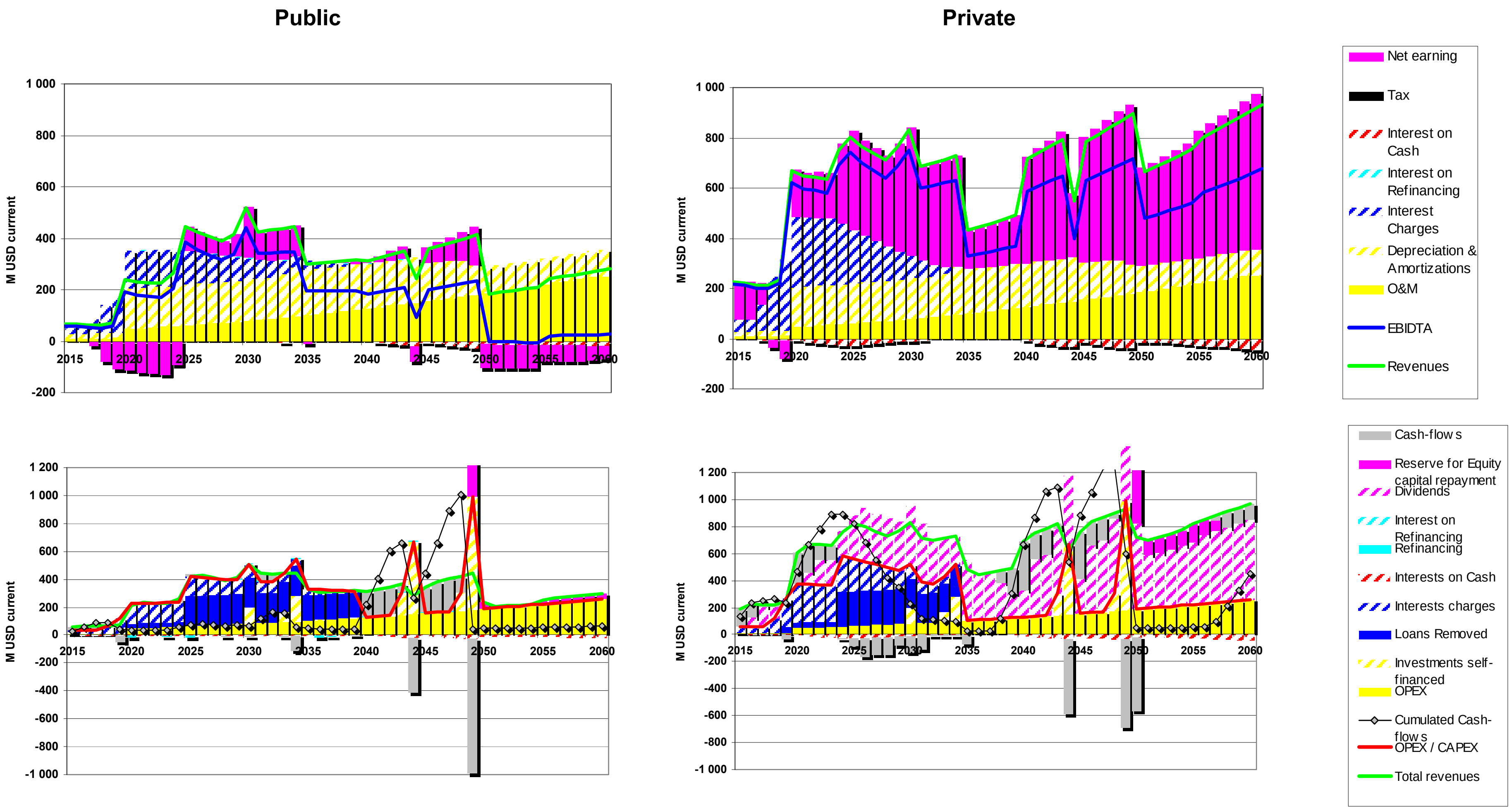


Table 33. Ratios – Financing variants

Operating ratios		PUBLIC	PPP	PRIVATE
EBIDTA / Turnover		58,1%	73,9%	81,6%
Project IRR before tax		3,0%	9,5%	14,9%

Debt ratios		PUBLIC	PPP	PRIVATE
LT Loan maturation		13,9	12,4	10,9
LT Loan interest rate		4,5%	6,9%	10,0%
Debt / Debt + Equity	max	98%	78%	72%
	weighted average	73%	58%	50%
Debt / Equity Capital	max	4,00	3,00	2,33
Equity / Equity Capital	min	0,02	0,61	0,58

Debt coverage ratios		PUBLIC	PPP	PRIVATE
DSCR	min	1,20	1,30	1,40
LLCR	max debt	1,25	2,33	2,46
PLCR	max debt	2,16	2,75	2,87
MT Loan Refinancing	% LT loan	1%		

Financial ratios	PUBLIC	PPP	PRIVATE
Net Earnings / Revenues		35,9%	54,3%
RoA (Net earning / Net assets)	0,0%	6,7%	14,4%
RoE (Net earning / Equity)	0,0%	9,4%	16,5%
Financial IRR		0,0%	0,0%

Cost of capital	PUBLIC	PPP	PRIVATE
Cost of LT Loan	4,5%	7,3%	10,0%
% of LT Loan	80,0%	75,0%	70,0%
Cost of remunerated Equity (real term after tax)	14,0%	14,0%	14,0%
Cost of remunerated Equity (real term before tax)	14,0%	14,0%	14,0%
Cost of remunerated Equity (nominal term before tax)	17,4%	17,4%	17,4%
% of Remunerated Equity		12,5%	30,0%
WACC (nominal term before tax)	3,6%	7,6%	12,2%
Net Cost of financing (nominal term before tax)	2,9%	8,8%	13,4%

4.3.5.4 Cost Breakdown of each MWh Transmitted

As shown previously, the cost of capital per MWh is much higher under private financing (USD 21.9) than under public financing (USD 2.0), due to the cumulative impact of a higher cost of debt (USD 3.5 compared with USD 2.4) and the cost of dividends (USD 19.4).

At constant O&M and CAPEX, this higher cost of capital results an average nominal tariff of USD 35.5 / MWh for private financing compared to USD 15.5 / MWh under public financing, and an average tariff in 2010 USD doubling from USD 10.6 / MWh to USD 21.2 / MWh (USD 15.2 / MWh in 2006 USD).

Table 34. Breakdown of the transmission tariff – Financing plan variants

	PUBLIC	PPP	PRIVATE
Transportation tarif - USD 2010	**10,6**	**15,9**	**21,2**
Transportation tarif - USD current	**15,5**	**24,9**	**35,5**
O&M	**6,5**	**6,5**	**6,5**
CAPEX	**7,0**	**7,0**	**7,0**
Cost of capital	**2,0**	**11,4**	**21,9**
Cost of LT loans	2,4	3,0	3,5
Cost of refinancing	0,1		
Interets on Cash	-0,4	-0,6	-0,9
Net earnings before tax		9,0	19,4

Table 35. Breakdown of the transmission tariff – Private financing

USD	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Transportation tarif - USD 2010	**36,5**	**29,4**	**26,0**	**26,1**	**14,9**	**21,0**	**19,5**	**14,0**	**14,5**	**21,2**
Transportation tarif - USD current	**38,7**	**33,5**	**31,8**	**34,9**	**23,0**	**38,2**	**42,0**	**35,4**	**42,6**	**35,5**
OPEX	**2,0**	**2,7**	**2,9**	**4,3**	**5,6**	**7,4**	**8,4**	**10,0**	**11,8**	**6,5**
CAPEX	**3,4**	**7,9**	**6,6**	**8,0**	**8,7**	**9,3**	**6,9**	**5,1**	**5,0**	**7,0**
Cost of capital	**33,3**	**22,9**	**22,2**	**22,6**	**8,7**	**21,5**	**26,7**	**20,4**	**25,8**	**21,9**
Cost of LT loans	24,3	13,3	6,8	2,1						3,5
Cost of refinancing										
Interets on Cash	-0,9	-0,9	-0,8	-0,2	0,0	-1,2	-1,4	-0,9	-1,7	-0,9
Dividends before tax	9,9	10,5	16,3	20,8	8,7	22,7	28,2	21,3	27,5	19,4

4.3.5.5 Conclusion of the Financial Variants

The comparative analysis of financial variants confirms that the tariff level is highly sensitive to the proportion of private financing in the financing plan. As suggested previously, the average tariff in 2010 USD would double under a private financing scheme compared with the base public financing scheme.

The financing strategy will therefore have to focus on raising the maximum amount of public resources from stakeholder countries' national budgets, and marketing the project to development aid partners in order to negotiate optimal concessional terms for long-term loans.

4.4 SENSITIVITY ANALYSIS

The sensitivity analysis is carried out under the following configuration:

- Development under public financing
- Project Company granted exemption from corporate income tax
- Tariff billed to the importing countries (Egypt and Sudan) as a uniform "wheeling fee" per MWh delivered
- Quinquennial tariff.

4.4.1 DEMAND

4.4.1.1 Low Scenario – Risk Mitigation

No fixed tariff

In the case of a low hydrology and / or high Ethiopian demand (assuming a 5% drop in the production surplus of the Ethiopian power plants starting in 2020), the tariffs reaching the Project Company's equilibrium are displayed in the Table 36.

A 5% drop in the amount of electricity transmitted from 2020 onwards results in a 4.8% drop in the total electricity transmitted over the period, which requires a correspondent 4.8% tariff increase to ensure the interconnection's financial viability.

An adequate strategy for hydrological risk mitigation would therefore consists in anticipating a potential low scenario by planning a tariff level for the phase one (2015 - 2019) that would be around 4.8% - 5.0% higher than the base hydrology scenario, in order to build up an "hydrological reserve" that could be used to cover expenses in the event of a low hydrology. As a precaution, the same 5.0% margin should be planned in the first quinquennial period of the second phase (2020 – 2024).

Tariffs could then be adjusted for the following quinquennial periods considering the actual hydrology; in the event of a sustainable favorable hydrology, the hydrological reserve built during the first 10 years through this "tariff surtax" could eventually be progressively amortized, with a corresponding tariff reduction).

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Table 36. Tariffs – Low demand – no fixed tariff

USD 2010	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Demand - BASE (x 1000 GWh)	28,6	99,8	119,1	104,8	100,0	93,3	100,0	100,0	100,0	845,6
Demand - LOW (x 1000 GWh)	28,6	94,8	113,1	99,6	95,0	89,3	95,0	95,0	95,0	805,4
Var		-5,0%	-5,0%	-5,0%	-5,0%	-4,3%	-5,0%	-5,0%	-5,0%	-4,8%
Tariff - BASE (USD / MWh)	11,0	10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
Tariff - LOW (USD / MWh)	11,5	11,1	15,6	18,2	12,1	11,3	10,6	4,5	5,1	11,1
Var	4,8%	4,8%	4,8%	4,8%	4,8%	4,8%	4,8%	4,8%	4,8%	4,8%

Table 37. Tariffs – Low demand – 50% tariff

USD 2010		2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59
Demand - BASE	‹ tariff / MW	42,0	33,1	55,5	56,8	36,1	31,6	31,8	13,5	15,1
	tariff / MWh	5,5	5,3	7,4	8,7	5,8	5,4	5,1	2,2	2,4
Demand - LOW	‹ tariff / MW	43,0	33,9	56,8	58,2	36,9	32,3	32,5	13,8	15,5
	tariff / MWh	5,6	5,4	7,6	8,9	5,9	5,5	5,2	2,2	2,5
Var	‹ tariff / MW	2,4%	2,4%	2,4%	2,4%	2,4%	2,4%	2,4%	2,4%	2,4%
	tariff / MWh	2,4%	2,4%	2,4%	2,4%	2,4%	2,4%	2,4%	2,4%	2,4%

Table 38. Tariffs – High demand – no fixed tariff

USD / MWh delivered	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
Demand - BASE (x 1000 GWh)	28,6	99,8	119,1	104,8	100,0	93,3	100,0	100,0	100,0	845,6
Demand - LOW (x 1000 GWh)	28,6	99,8	119,1	108,8	105,0	98,0	105,0	105,0	105,0	874,3
Var				3,8%	5,0%	5,0%	5,0%	5,0%	5,0%	3,4%
Tariff - BASE (USD / MWh)	11,0	10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
Tariff - LOW (USD / MWh)	10,8	10,4	14,6	17,0	11,3	10,6	9,9	4,2	4,7	10,3
Var	-2,1%	-2,1%	-2,1%	-2,1%	-2,1%	-2,1%	-2,1%	-2,1%	-2,1%	-2,4%

Impact of a fixed tariff

In the case of a 50% fix tariff, the simulation results are as in the Table 37.

These results indicate that the introduction of a fixed tariff limits the preventive tariff "surtax" to be applied during the first two quinquennial periods (2.4% for a 50% fixed tariff compared to 4.8% previously).

With a 100% fixed tariff, the Project Company revenues being independent of the real transmitted energy, the level of fixed tariff would remain unchanged.

4.4.1.2 High Demand Scenario

No fixed tariff

The high demand scenario consists in simulating the impact on tariff levels of an additional production surplus available for exportation through the Easter Nile Regional Power Interconnection from 2031 onwards.

In theory, this higher level of transmitted energy (and available capacity for Sudan) could allow to lower tariffs by 2.1%, for an overall 2.4% lower average tariff (since the additional electricity would be transmitted in years when tariffs are below the average tariff).

Nevertheless, as a precautionary measure, it is recommended not to speculate on these possible additional transits and not to apply these tariff reductions during the first years of operation.

It is, however, recommended to plan a tariff adjustment mechanism that would enable to pass on the following quinquennial period such extra revenues, with the effect of reducing tariffs.

Impact of a fixed tariff

Similarly to the low hydrology analysis, introducing a fixed tariff limits the sensitivity of tariffs to demand. In the extreme case of a tariff based exclusively on capacity, additional electricity transmission would not generate any additional revenues for the Project Company, except for the increase in the capacity available for Sudan from 2030 onwards (from 1.2 MW to 1.4), with the effect of reducing by approximately 17% the fix tariff per MW applied to Sudan.

It is therefore recommended to set tariffs for the first 10 years at a level around 5% higher than the equilibrium for the base hydrology scenario, at around USD 11.1 / MWh in 2010 USD (USD 8.0 / MWh in 2006 USD), in order to mitigate the hydrological risk.

It is also recommended to set a tariff adjustment mechanism in order to pass on tariffs a potential additional demand, as well as a sustainable favorable hydrology.

4.4.2 INVESTMENT COSTS

Table 39. Breakdown of the transmission tariff – sensitivity – investments

	BASE	10%	-10%	ε
Transportation tarif - USD 2010	**10,6**	**11,4**	**9,7**	**0,8**
Transportation tarif - USD current	**15,5**	**16,4**	**14,6**	**0,6**
O&M	**6,5**	**6,5**	**6,5**	
CAPEX	**7,0**	**7,7**	**6,3**	**1,0**
Cost of capital	**2,0**	**2,2**	**1,8**	**0,9**
Cost of LT loans	2,4	2,6	2,1	1,0
Cost of refinancing	0,1	0,1	0,1	0,3
Interets on Cash	-0,4	-0,5	-0,4	1,2
Net earnings before tax				

A variation of more or less 10% in the cost of investments is reflected in the CAPEX and the cost of long term loans with an elasticity (**ε**) of 1. Depending on the proportion of CAPEX and cost of capital in the cost of MWh transmitted, the final investment elasticity of average tariff is 0.6 (0.8 for tariff in 2010 USD as the impact is stronger on the first quinquennial periods of debt service).

This sensitivity illustrates the highly capital-intensive character of such an interconnection project.

4.4.3 O&M COSTS

Table 40. Breakdown of the transmission tariff – sensitivity – O&M

	BASE	10%	-10%	ε
Transportation tarif - USD 2010	**10,6**	**9,8**	**11,3**	**-0,7**
Transportation tarif - USD current	**15,5**	**15,0**	**16,1**	**-0,3**
O&M	**6,5**	**6,5**	**6,5**	
CAPEX	**7,0**	**7,0**	**7,0**	
Cost of capital	**2,0**	**1,5**	**2,5**	**-2,6**
Cost of LT loans	2,4	1,8	2,9	-2,2
Cost of refinancing	0,1	0,1	0,1	-0,7
Interets on Cash	-0,4	-0,4	-0,4	-0,1
Net earnings before tax				

Similarly, a variation of more or less 10% in the cost of O&M is reflected in OPEX with an elasticity of 1 and, depending on the proportion of OPEX in the cost of MWh transmitted, with an elasticity of 0.4 in the equilibrium tariff (but only 0.2 in USD 2010 as the proportion of O&M costs in lower during the first quinquennial periods of debt service).

As expected, since this interconnection project is capital-intensive, the elasticity to OPEX is much lower than the elasticity to CAPEX.

4.4.4 FINANCING TERMS

4.4.4.1 Loans Duration and Grace Period

Paradoxically, under the quinquennial tariff mode, extending loan duration has a negative impact on the average tariff, whereas shortening them reduce this average tariff, with an elasticity of with an elasticity of 0.2 (including a 1.2 elasticity for the cost of capital).

Table 41. Breakdown of the transmission tariff – sensitivity – loan duration

	20 yrs	15 yrs	25 yrs	ε
Transportation tarif - USD 2010	**10,6**	**9,9**	**10,9**	**0,2**
Transportation tarif - USD current	**15,5**	**14,9**	**16,0**	**0,2**
O&M	**6,5**	**6,5**	**6,5**	
CAPEX	**7,0**	**7,0**	**7,0**	
Cost of capital	**2,0**	**1,3**	**2,5**	**1,2**
Cost of LT loans	2,4	1,9	2,8	0,7
Cost of refinancing	0,1	0,0	0,1	2,1
Interets on Cash	-0,4	-0,6	-0,3	-1,3
Net earnings before tax				

This is due to the fact that shortening loan duration reduces the burden of interest charges and thus the net cost of debt. A shorter loan duration also enables to reduce the Project Company's debt burden, from an average 73% to 69% (but 80% for a 25-year term).

Table 42. Debt and cost of capital – sensitivity – loan duration

Debt ratios		20 yrs	15 yrs	25 yrs	ε
LT Loan maturation		**13,9**	**11,4**	**16,4**	**0,7**
LT Loan interest rate		**4,5%**	**4,5%**	**4,5%**	
Debt / Debt + Equity	max	**98%**	**93%**	**99%**	**0,1**
	weighted average	**73%**	**66%**	**80%**	**0,4**
Debt / Equity Capital	max	**4,00**	**4,00**	**4,00**	
Net capital / Equity Capital	min	**0,02**	**0,21**	**-0,04**	**-24,4**

WACC	20 yrs	15 yrs	25 yrs	ε
WACC (nominal term before tax)	**3,6%**	**3,6%**	**3,6%**	
Net Cost of financing (nominal term before tax)	**2,9%**	**2,7%**	**3,1%**	**0,2**

However, this paradoxical positive impact is due to the fact that, under the quinquennial tariff mode, the level of tariff is automatically adjusted to the level of required expenses; therefore, whatever loan conditions are, the Project Company will always generates enough revenues to cover the debt service.

Therefore, a more adequate benchmark indicator for this sensitivity should rather be the maximum level of tariffs during the debt service period, which would significantly increase for a shorten debt duration. Indeed, as displayed in the Table 43, negotiating a longer loan duration would reduce the tariff peak during the debt service from USD 18.6 / MWh for a 15-year loan to USD 15.8 / MWh for a 25-year loan (USD 17.3 for a 20-year loan).

Table 43. Tariffs – sensitivity – loan duration

USD 2010	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
15 years	11,0	11,4	18,6	18,3	4,2	9,4	8,7	3,6	4,1	9,9
20 years	11,0	10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
25 years	11,0	10,2	13,0	15,8	11,8	15,7	11,2	5,0	5,4	10,9

Table 44. Tariffs – sensitivity – loan grace period

USD 2010	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
3 years	13,2	13,9	13,1	16,1	10,6	10,8	10,1	4,3	4,8	10,5
5 years	11,0	10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
7 years	10,9	10,2	13,6	18,8	12,6	10,7	10,2	4,3	4,8	10,6

Table 45. Tariffs – sensitivity – loan interest rate

USD 2010	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
3,50%	8,9	9,0	13,6	16,2	11,0	10,5	9,8	4,2	4,7	9,8
4,50%	11,0	10,6	14,9	17,3	11,5	10,8	10,2	4,3	4,8	10,6
5,50%	13,2	12,3	16,1	18,3	12,0	11,1	10,4	4,4	5,0	11,3

For the same reason, extending the grace period tends to increase the cost of debt, with a slightly negative impact on the average tariff, while shortening it slightly reduces the average tariff; however, the elasticity remains close to zero.

Table 46. Breakdown of the transmission tariff – sensitivity – loan grace period

	5 yrs	3 yrs	7 yrs	ε
Transportation tarif - USD 2010	**10,6**	**10,5**	**10,6**	**0,0**
Transportation tarif - USD current	**15,5**	**15,3**	**15,6**	**0,0**
O&M	**6,5**	**6,5**	**6,5**	
CAPEX	**7,0**	**7,0**	**7,0**	
Cost of capital	**2,0**	**1,7**	**2,1**	**0,2**
Cost of LT loans	2,4	2,2	2,5	0,2
Cost of refinancing	0,1	0,0	0,0	0,2
Interets on Cash	-0,4	-0,4	-0,4	0,0
Net earnings before tax				

Extending the grace period also result in a higher tariff peak during the debt service period (USD 18.8 / MWh for a 7-year grace period compared with USD 16.1 / MWh for a 3-year grace period, see Table 44). This result can be explained by the fact that a grace period is financially optimal in the event of a progressive increase of revenues, which is not the case in the present situation since the interconnection will be fully operating at the beginning of the second phase (2020).

4.4.4.2 Loan Interest Rates

The variation of the debt interest rate is reflected in the cost of capital, both the WACC and the net cost of financing, with an elasticity of 1.

Table 47. Cost of capital – sensitivity – interest on loans

WACC	4,5%	3,5%	5,5%	ε
WACC (nominal term before tax)	**3,6%**	**2,8%**	**4,4%**	**1,0**
Net Cost of financing (nominal term before tax)	**2,9%**	**2,2%**	**3,7%**	**1,1**

As expected, a lower interest rate results in a lower average tariff, whereas a higher interest rates requires higher tariffs, with an elasticity of 1 on the cost of long-term loans, 1.2 on the cost of capital (due to additional refinancing requirements), and 0.2 on the cost per MWh transmitted (0.3 in 2010 USD as interest charges are higher during the first quinquennial periods).

Table 48. Breakdown of the transmission tariff – sensitivity – interest on loans

	4,5%	3,5%	5,5%	ε
Transportation tarif - USD 2010	**10,6**	**9,8**	**11,3**	**0,3**
Transportation tarif - USD current	**15,5**	**15,0**	**16,1**	**0,2**
O&M	**6,5**	**6,5**	**6,5**	
CAPEX	**7,0**	**7,0**	**7,0**	
Cost of capital	**2,0**	**1,5**	**2,5**	**1,2**
Cost of LT loans	2,4	1,8	2,9	1,0
Cost of refinancing	0,1	0,1	0,1	0,3
Interets on Cash	-0,4	-0,4	-0,4	0,1
Net earnings before tax				

4.4.4.3 Financial Leverage

In the case of a public financing scheme, a reduction in the leverage effect leads to substitute concessional debt by non-remunerated equity capital, and thus to reduce the cost of capital, with a downward effect on tariff.

Table 49. Debt and cost of capital – sensitivity – financial leverage

WACC	4,5%	3,0	2,3	ε
Cost of LT Loan	4,5%	4,5%	4,5%	
% of LT Loan	80,0%	75,0%	70,0%	0,3
Cost of remunerated Equity (real term after tax)	14,0%	14,0%	14,0%	
Cost of remunerated Equity (real term before tax)	14,0%	14,0%	14,0%	
Cost of remunerated Equity (nominal term before t	17,4%	17,4%	17,4%	
% of Remunerated Equity				
WACC (nominal term before tax)	**3,6%**	**3,4%**	**3,2%**	**0,3**
Net Cost of financing (nominal term before tax)	**2,9%**	**2,6%**	**2,3%**	**0,5**

Table 50. Breakdown of the transmission tariff – sensitivity - leverage

	4,0	3,0	2,3	ε
Transportation tarif - USD 2010	**10,6**	**10,2**	**9,9**	**0,0**
Transportation tarif - USD current	**15,5**	**15,3**	**15,1**	**0,1**
O&M	**6,5**	**6,5**	**6,5**	
CAPEX	**7,0**	**7,0**	**7,0**	
Cost of capital	**2,0**	**1,8**	**1,6**	**0,5**
Cost of LT loans	2,4	2,2	2,1	0,3
Cost of refinancing	0,1	0,1	0,1	0,1
Interets on Cash	-0,4	-0,5	-0,5	-0,7
Net earnings before tax				

Of course, the impact would be opposite under a private financing scheme, where private loan would be replaced by a more expensive remunerated equity capital.

4.4.4.4 Remuneration of Public Equity

The remuneration of public equity (assuming an expected RoE of 14% in real term, similar to private equity) significantly increases the cost of capital from USD 2.0 per MWh to USD 17.1 per MWH due to dividend payment to public shareholders. Eventually, the average tariff per MWh in USD 2010 is increased by 2/3 (USD 17.7 against USD 10.6 for non remunerated public equity), and around 11% above the average tariff under a PPP financing scheme.

Table 51. Breakdown of the transmission tariff – sensitivity – public funding

	NRmt Eq.	Rmt. Eq
Transportation tarif - USD 2010	**10,6**	**17,7**
Transportation tarif - USD current	**15,5**	**30,6**
O&M	**6,5**	**6,5**
CAPEX	**7,0**	**7,0**
Cost of capital	**2,0**	**17,1**
Cost of LT loans	2,4	2,4
Cost of refinancing	0,1	
Interets on Cash	-0,4	-0,6
Dividends		15,4

The financing strategy will thus have to take into account both long-term optimization (which incites to maximize public participation through non-remunerated equity and the capacity for the stakeholders' states to raise fund from public budget.

Regarding loan negotiation with lenders, the strategy will also have to conciliate long-term optimization (which incites to shorten loan duration and grace period), and the maximum admissible transmission tariff during the debt service period (which incites to extend loan duration). In any case, the strategy should tend to lower the average interest rate (for example through subsidies from states or institutional lenders).

4.4.5 CORPORATE INCOME TAX

Under public financing, since the cumulated profits are nil over the concession (no dividends to be pay to shareholders), the impact of corporate income tax remains moderate (due to the mechanism of deferred deficit, there would even be no impact for the constant tariff mode, where cumulated earnings remained inferior or equal to zero during the whole concession, so that no corporate income tax has to be paid).

For example, in the case of an indicative 30% corporate income tax, the cost of tax (USD 0.3 / MWh) would raise the average transmission tariff from USD 15.5 / MWh to USD 15.9 / MWh, or from USD 10.6 / MWh to USD 10.8 / MWh in 2010 USD (+ 2%).

Table 52. Breakdown of transmission tariff – sensitivity - Income tax – Public financing

	NO	30%
Transportation tarif - USD 2010	**10,6**	**10,8**
Transportation tarif - USD current	**15,5**	**15,9**
O&M	**6,5**	**6,5**
CAPEX	**7,0**	**7,0**
Cost of capital	**2,0**	**2,4**
Cost of LT loans	2,4	2,4
Cost of refinancing	0,1	0,1
Interets on Cash	-0,4	-0,4
Net earnings before tax		0,3

Of course the impact of corporate income tax would be much higher in case of private financing (+25% of the average transmission tariff in 2010 USD) since profits have to be generated, and therefore taxed, to pay dividends (the level of dividends before tax being raised by 50%).

The cost of equity before tax would increase proportionally to the income tax rate according to the formulae:

Cost of equity before tax = Cost of equity after tax (target) / (1 – tax rate)

The impact of corporate income tax on tariff is therefore significant under private financing, since it is automatically passed through in tariffs.

Table 53. Breakdown of transmission tariff – sensitivity - Income tax – Private financing

	NO	30%
Transportation tarif - USD 2010	**21,2**	**26,5**
Transportation tarif - USD current	**35,5**	**45,1**
O&M	**6,5**	**6,5**
CAPEX	**7,0**	**7,0**
Cost of capital	**21,9**	**31,6**
Cost of LT loans	3,5	3,6
Cost of refinancing		
Interets on Cash	-0,9	-1,1
Dividends before tax	19,4	29,2

Table 54. Cost of capital – sensitivity – Corporate income tax – Private financing

WACC	**NO**	**30%**
Cost of LT Loan	10,0%	10,0%
% of LT Loan	70,0%	70,0%
Cost of remunerated Equity (real term after tax)	14,0%	14,0%
Cost of remunerated Equity (real term before tax)	14,0%	20,0%
Cost of remunerated Equity (nominal term before t	17,4%	23,6%
% of Remunerated Equity	30,0%	30,0%
WACC (nominal term before tax)	**12,2%**	**14,1%**
Net Cost of financing (nominal term before tax)	**13,4%**	**15,7%**

Nevertheless, the decision to exempt the Project Company from corporate income tax or not shall depend of an economic "arbitrage" between the additional cost of electricity transmission and the revenue generated by this taxation.

4.4.6 INFLATION

The impact of long-term inflation has a direct impact on the level of transmission tariff in current USD through the tariff indexation mechanism. For example, a 50% higher inflation at the horizon 2030 (3.8% instead of 2.5% for local inflation, 7.5% instead of 5% for capital good inflation) and 2060 (3% instead of 2% for local inflation, 4.5% for capital goods inflation instead of 3%) results in a doubling tariff for the last quinquennial period (USD 26.8 instead of USD 12.9) and an average 40% higher tariff over the period (USD 22.4 / 15.5), whereas a 50% lower inflation result in a half-reduced tariff for the last quinquennial period (USD 6.4) for an average 33% lower tariff (USD 11.7).

Table 55. Transmission tariffs – sensitivity – inflation

Average yearly inflation	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
-50%		0,9%	0,6%	0,5%	0,6%	1,4%	2,0%	1,8%	1,6%	1,2%
BASE		1,1%	0,9%	1,2%	1,5%	3,0%	4,1%	3,6%	3,3%	2,3%
50%		1,4%	1,3%	2,0%	2,7%	4,7%	6,1%	5,5%	5,0%	3,6%

USD current	2015/19	2020/24	2025/29	2030/34	2035/39	2040/44	2045/49	2050/54	2055/59	Average
-50%	11,3	11,3	16,4	18,9	13,2	10,5	11,1	5,4	6,4	11,7
BASE	11,6	11,9	17,4	21,6	15,4	16,8	19,3	9,8	12,9	15,5
50%	11,9	12,5	18,6	24,9	18,7	27,0	34,2	18,5	26,8	22,4

4.5 CONCLUSIONS OF THE FINANCIAL AND TARIFF MODELING

The financial and tariff modelling introduced above leads to the following conclusions and recommendations:

4.5.1 FINANCIAL STRATEGY

Tariff level is highly sensitive to the proportion of private financing, as the average tariff would double under private financing.

The financing strategy will therefore have to:

- Focus on raising the maximum amount of public resources from stakeholder countries' national budgets,
- And market the project to development aid partners in order to negotiate optimal concessional terms for long-term loans and, if possible, subsidies.

4.5.2 PRICING STRATEGY

The financial and tariff study strongly recommends to adopt a quinquennial tariff mode in order to adjust the Project Company's revenues to OPEX and CAPEX requirements.

The recommended pricing strategy would therefore consist in setting the first quinquennial tariff:

- After project financing implementation, when the financing scheme is designed and equity and capital terms and conditions negotiated with shareholders and lenders;
- According to the revenues required for the coming period;
- Taking into account a +5% risk mitigation premium.

During the first quinquennial period, additional modeling and analysis will be carried out in order to set the tariff for the next quinquennial period.

Finally, the concession contract should include a periodic tariff adjustment mechanism (typically through escalation formula), preferably on a yearly, or even quarterly basis.

The overall financing and pricing strategy should both take into account the long-term financial optimization, which incites to adjust tariff to the required OPEX / CAPEX, and short-term tariff acceptability, which could justify a ceiling for the maximum tariff per quinquennial period.

5 ECONOMIC STUDY UPDATE

5.1 OBJECTIVES AND CONTENTS OF THE ECONOMIC STUDY UPDATE

5.1.1 OBJECTIVES AND CONTENTS

The economic analysis consists in comparing the net balance between:

- The "cost of the interconnection", including the costs of the environmental and social impact mitigation measures
- The "benefits" provided by the interconnection: generation cost savings and CO_2 emission savings if any. Generation cost savings mean the result of the deduction of the overcost due to hydropower plant anticipation from total fuel savings.

The economic study is based on the classic economic criteria: Net Present value, Benefit to Cost ratio, Payback Period and EIRR (Economic Internal Rate of Return). These ratios are calculated at a regional scale: Egypt + Sudan + Ethiopia.

The detailed economic study has been carried in phase 1 (Report M6 – volume 2) and has covered all the initially envisaged scenarios: tight pool model vs. Loose pool model, medium and low demand forecasts for Ethiopia, low, medium and high fuel price projections and several interconnection options in terms of capacity.

The updated economic analysis carried out in phase 2 is focused on the selected scenarios studied in the second phase of the project (see below) until the year 2040.

The discount rates remain unchanged for the economic calculations (comparative to phase I): 8%, 10% and 12% and result are discounted 2008.

5.1.2 REFERENCE SITUATION

The reference situation – used for the calculation of the generation savings – remains unchanged in the updated economic analysis:

- commissioning of the 200 MW Ethiopia-Sudan interconnection in 2010[4],
- generation expansion plans of Egypt, Ethiopia and Sudan identical to those determined without any interconnection.

5.1.3 SCENARIOS STUDIED IN THE ECONOMIC STUDY UPDATE

As reminded in the paragraph 1.3, the phase II feasibility study (and therefore the economic study update) is executed for an interconnection scheme of 1 200 MW commercial capacity from Ethiopia to Sudan and of 2 000 MW commercial capacity from Ethiopia to Egypt. The commissioning of the interconnection is scheduled in 2020.

The Scenarios studied in the updating are as follows:

- Scenario 1: Tight Pool Model - Medium Fuel Price Projection - Medium Ethiopian Demand - Interconnection not anticipated,

[4] This 200 MW Sudan-Ethiopia interconnection project is already commissioned.

- Scenario 2: Tight Pool Model - Medium Fuel Price Projection - Low Ethiopian Demand - Interconnection not anticipated.

A sensitivity analysis is carried out on the scenario 2 by considering the anticipation of the interconnection project in a low Ethiopian demand scenario with two variants on the combustible costs (medium and low fuel price projections).

5.1.4 MITIGATION COSTS

Mitigation and enhancement measures are studied in the M3 report of ENPTPS phase II (Environmental and Social Impact Assessment). The following measures have been estimated:

- Compensation and resettlement,
- Livelihood enhancement programs,
- Public health (workers and local people) enhancement programs,
- Vegetation restoration and replanting programs,
- Soils conservation and erosion prevention measures,
- Institutional capacity building,
- Community benefit programs,
- Community Health and environmental awareness programs.

5.2 RESULTS OF THE ECONOMIC ANALYSIS UPDATE

The results of this updated economic analysis are summarized in the Table 56 below.

Like in phase I, Generation Savings include fuel savings, i.e. fuel cost reduction from substitution of thermal power by hydro[5]. Moreover, even if the anticipation for Ethiopian HPP commissioning (in comparison with the reference situation) generates an extra cost for the project, it is not counting in cost heading but as a reduction of fuel savings.

Therefore, costs include the mitigation costs plus the interconnection costs (capital expenditure, revamping and operating and maintenance costs) until 2040.

[5] CO_2 savings are note included in the calculation.

Table 56. Main results of the updated economic analysis

MUSD 2006	SCENARIO 1: medium Ethiopian demand			SCENARIO 2: low Ethiopian demand		
	8%	*10%*	*12%*	*8%*	*10%*	*12%*
Generation savings	**4 035**	**2 620**	**1 685**	**4 821**	**3 018**	**1 846**
Fuel savings	4 869	3 441	2 468	6 339	4 468	3 199
HPP anticipation costs	834	821	783	1 518	1 450	1 353
Costs	**977**	**806**	**670**	**977**	**806**	**670**
Mitigation costs	10	9	8	10	9	8
Interconnection costs	967	797	662	967	797	662
NPV Net present value	**3 058**	**1 813**	**1 014**	**3 844**	**2 212**	**1 175**
BCR Benefits to cost ratio	**4,1**	**3,2**	**2,5**	**4,9**	**3,7**	**2,8**
Payback period	**7 years (2026)**			**8 years (2027)**		
EIRR	**18%**			**17%**		

Net Present Value[6]:

Net present value of the interconnection is positive for the both scenarios whatever the value of the discount rate between 8% and 12%. For the reference discount rate of 10% these values are about 2000 MUSD $_{2006}$

As demonstrated in the economic analysis carried out in phase I, this interconnection project allows to substitute hydro generation from Ethiopia to thermal generation in Egypt (gas-fired CCGT) and Sudan (gas oil-fired CCGT and crude-oil fired STPP). If this project is eligible to Clean Development Mechanism (CDM), an additional present worth value would have to be included in the benefits of the interconnection.

For the reference scenario 1, these benefits could come to 160 MUSD $_{2006}$ for 10% discount rate and a valorization of 5 USD/t CO_2 . With a valorization of 10 USD/t CO_2 emission savings could lead to a total NPV increased of 320 MUSD $_{2006}$ which represents a bonus of 15% .

As a rough guide, CO_2 quotas are currently negotiated around 15 EUR/ tCO_2 and prices are expected to rise about 20 or 25 EUR/ tCO_2

Benefit to cost ratio:

The Benefit to Cost Ratio (BCR) is equal to the Net Present Value of the benefits ("generation savings") divided by the Net Present Value of the costs. A value greater than one means the benefits outbalance the cost of the project that may therefore be judged profitable.

The BCRs of the both scenarios are above 3 and almost comes up to 4 in scenario 2 (for a 10% discount rate).

The BCR remains superior to 2 for 12% discount rates.

[6] Reference year 2008 expressed in constant USD 2006

Payback period:

The payback period is reached when cumulative savings (from the beginning of the project) equal to cumulative costs.

For the first scenario, the payback period is reached at the end of the year 2026, i.e. after 7 full years of operation.

For the second scenario, the payback period is reached at the end of the year 2027, i.e. after 8 full years of operation.

EIRR (Economic internal rate of return):

The EIRR is the discount rate that makes the net present value (NPV) of savings and costs equal to zero.

For both scenarios 1 and 2, the EIRR are quite high: respectively 18% and 17%.

5.2.1 SENSITIVITY ANALYSIS

The sensitivity analysis is based on the second scenario, i.e. with low Ethiopian demand forecasts, and taking into account:

- revised medium and high fuel price projections (Table 57 and Table 58),
- anticipated interconnection exchanges (Figure 19) and corresponding expansion plan in Ethiopia (Table 59) and interconnection costs (see paragraph 4.2.1 of financial study above).

Table 57. Medium fuel price projection (update September 2008)

	Low sulfur crude oil USD2006/bbl	Natural gas USD2006/Mbtu	Coal USD2006/t	Low sulfur crude oil USD2006/t	HFO USD2006/t	Diesel USD2006/t	Gasoil USD2006/t
2009	77.0	8.07	63.0	561.8	382.0	702.3	842.7
2010	74.0	7.8	63.0	540.4	367.5	675.6	810.7
2011	71.2	7.8	63.0	519.8	353.5	649.7	779.7
2012	68.4	7.7	63.0	499.2	339.4	623.9	748.7
2013	65.6	7.7	63.0	479.0	325.7	598.7	718.5
2014	62.7	7.7	63.0	457.8	311.3	572.3	686.8
2015	59.9	7.6	63.0	436.9	297.1	546.1	655.4
2016	57.0	7.7	63.0	415.8	282.7	519.7	623.7
2017	57.1	7.7	63.0	416.9	283.5	521.2	625.4
2018	58.0	7.8	63.0	423.3	287.8	529.1	635.0
2019	58.9	7.8	63.0	430.0	292.4	537.5	645.0
2020	59.7	7.9	63.0	435.8	296.3	544.7	653.7
2021	60.6	8.0	63.0	442.1	300.6	552.6	663.1
2022	61.5	8.1	63.0	448.7	305.1	560.9	673.1
2023	62.4	8.2	63.0	455.7	309.9	569.6	683.6
2024	63.4	8.4	63.0	463.1	314.9	578.9	694.6
2025	64.5	8.5	63.0	470.8	320.1	588.4	706.1
2026	65.6	8.6	63.0	478.9	325.6	598.6	718.3
2027	66.8	8.7	63.0	487.9	331.8	609.9	731.8
2028	68.0	8.8	63.0	496.6	337.7	620.8	744.9
2029	69.2	8.9	63.0	505.5	343.7	631.9	758.3
2030	70.4	9.0	63.0	514.3	349.7	642.8	771.4

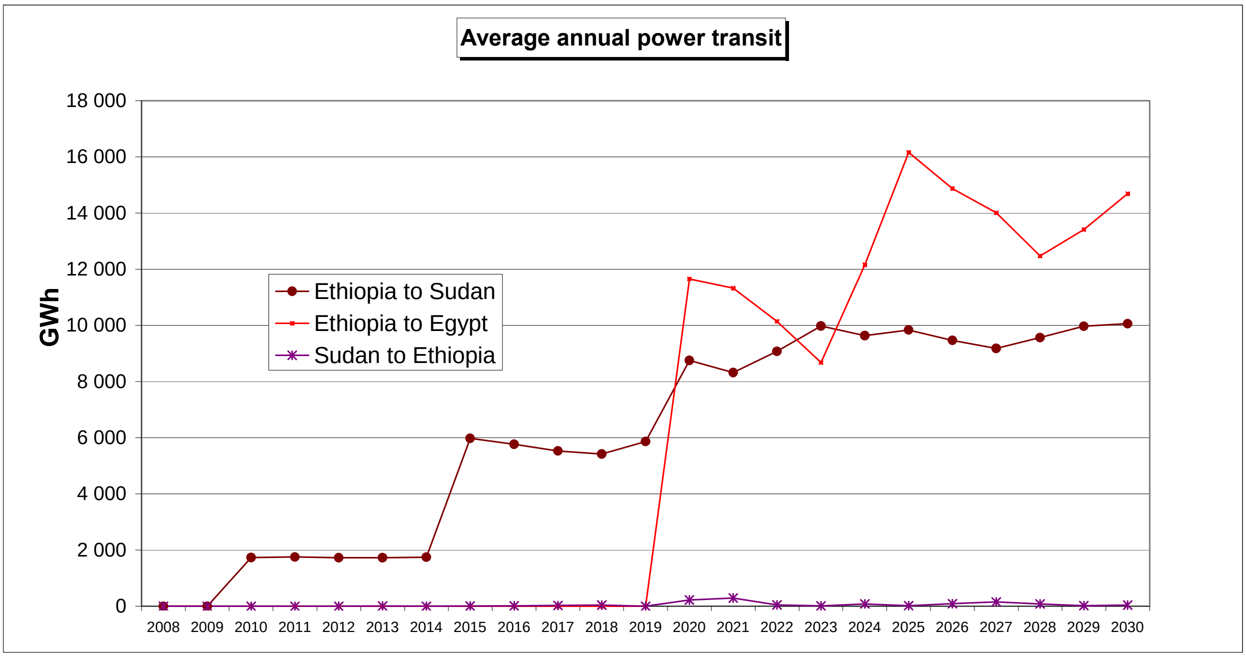
Table 58. High fuel price projection (update September 2008)

	Low sulfur crude oil USD2006/bbl	Natural gas USD2006/Mbtu	Coal USD2006/t	Low sulfur crude oil USD2006/t	HFO USD2006/t	Diesel USD2006/t	Gasoil USD2006/t
2009	77.0	8.56	63.0	561.8	382.0	702.3	842.7
2010	79.0	8.5	63.0	576.8	392.2	721.0	865.3
2011	81.2	8.7	63.0	592.7	403.1	740.9	889.1
2012	83.5	8.8	63.0	609.7	414.6	762.1	914.5
2013	85.9	9.0	63.0	626.7	426.2	783.4	940.1
2014	88.1	9.1	63.0	643.0	437.2	803.7	964.5
2015	90.4	9.3	63.0	660.0	448.8	825.0	990.0
2016	92.5	9.4	63.0	675.5	459.4	844.4	1013.3
2017	95.6	9.5	63.0	698.2	474.8	872.8	1047.3
2018	97.2	9.6	63.0	709.8	482.6	887.2	1064.7
2019	99.7	9.7	63.0	727.6	494.8	909.5	1091.4
2020	102.1	9.8	63.0	745.1	506.7	931.4	1117.7
2021	105.3	9.9	63.0	768.9	522.9	961.2	1153.4
2022	106.6	10.1	63.0	777.8	528.9	972.3	1166.7
2023	107.7	10.3	63.0	786.3	534.7	982.9	1179.5
2024	109.1	10.4	63.0	796.6	541.7	995.8	1194.9
2025	109.2	10.6	63.0	797.5	542.3	996.9	1196.2
2026	110.9	10.8	63.0	809.5	550.5	1011.9	1214.2
2027	112.6	11.0	63.0	821.8	558.8	1027.2	1232.7
2028	114.6	11.2	63.0	836.4	568.7	1045.5	1254.6
2029	116.6	11.4	63.0	851.2	578.8	1064.0	1276.8
2030	118.7	11.6	63.0	866.2	589.0	1082.7	1299.2

Table 59. Generation expansion plan of Ethiopia with anticipated power exchanges

Commisioning Date	Hydro Project	Capacity MW	Average Generation GWh
2008	Gibe II	420	1 600
	Tekeze	300	1 200
2009	Beles	420	2 000
2010	Neshe	97	225
2011	Gibe III (I)		
2012	Gibe III (II)	1 870	6 240
2014			
2015			
2016			
2018			
2019	Halele Worabesa	420	2 245
2020	Baro I + II + Gengi + Mandaya	2 700	16 509
	Geba I + II	368	1 788
	Chemoga Yeda + Genale III	534	2 415
2021	Genale VI	256	1 000
2022			
2023			
2024			
2025	Karadobi	1 600	8 600
2026			
2027	Gogeb	153	520
2028	Aleltu E&W	451	1 850
2029			
2030	Border	1 200	6 000
Total		10 789	52 192

Figure 19. Average annual power exchanges (anticipated interconnection)



The results of the sensitivity analysis are summarized in the Table 60 below for a 10% discount rate.

Table 60. Results of the sensitivity analysis (updated economic study)

	SENSITIVITY ANALYSIS	
MUSD 2006	Medium fuel price projections	High fuel price projections
Generation savings	4 320	7 090
Costs	878	
Mitigation costs	10	
Interconnection costs	868	
Net present value	3 442	6 212
Benefits to cost ratio	4.9	8.1

The NPV of the project remains positive and the BCR greater than 1. NPV and BCR are higher in these variants than in the scenarios 1 and 2.

Although the NPV and BCR are better in the anticipated interconnection variant, one should remind that the technical feasibility of this anticipation will raise important issues regarding the commissioning (see M1 Detailed Power studies report).

APPENDIX 1 – Financial Statements for the Base Case

INCOME STATEMENT (k USD current)

Table 61. Income statement – base case

2010 – 2019

INCOME STATEMENT	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019
Revenue						68 463	66 841	64 007	63 452	69 988
O&M				-1 395	-2 325	-10 311	-10 149	-10 721	-12 319	-13 100
EBIDTA				**-1 395**	**-2 325**	**58 152**	**56 692**	**53 286**	**51 132**	**56 888**
Depreciations and provisions						-19 429	-19 429	-19 429	-19 429	-19 429
EBID				**-1 395**	**-2 325**	**38 723**	**37 263**	**33 857**	**31 703**	**37 459**
Interest charges on LT Loan			-3 736	-12 723	-22 994	-22 994	-22 994	-53 875	-109 952	-146 685
Interest on refinancing										
Interest on cash							633	1 662	2 629	2 617
Pre-tax Result			**-3 736**	**-14 118**	**-25 318**	**15 729**	**14 902**	**-18 357**	**-75 620**	**-106 610**
Pre-tax Result - with report										
Tax										
Net Earnings			**-3 736**	**-14 118**	**-25 318**	**15 729**	**14 902**	**-18 357**	**-75 620**	**-106 610**

2020 - 2029

INCOME STATEMENT	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029
Revenue	237 452	229 785	227 785	224 458	264 687	446 037	422 061	404 571	388 468	414 543
O&M	-47 335	-50 059	-53 185	-56 302	-59 386	-62 584	-65 894	-69 318	-72 854	-76 712
EBIDTA	**190 117**	**179 726**	**174 599**	**168 156**	**205 300**	**383 454**	**356 166**	**335 253**	**315 614**	**337 830**
Depreciations and provisions	-158 058	-158 058	-158 058	-158 058	-158 058	-158 058	-158 058	-158 058	-158 058	-158 058
EBID	**32 058**	**21 668**	**16 541**	**10 097**	**47 242**	**225 395**	**198 108**	**177 195**	**157 555**	**179 772**
Interest charges on LT Loan	-145 152	-143 619	-142 086	-140 554	-139 021	-129 242	-119 463	-109 684	-99 905	-90 126
Interest on refinancing		-1 286	-1 286	-1 547	-2 209	-2 025	-3 612	-3 391	-3 075	-3 094
Interest on cash	1 063	729	700	667	635	1 210	1 669	1 902	1 745	1 416
Pre-tax Result	**-112 030**	**-122 508**	**-126 132**	**-131 336**	**-93 353**	**95 339**	**76 702**	**66 022**	**56 321**	**87 969**
Pre-tax Result - with report										
Tax										
Net Earnings	**-112 030**	**-122 508**	**-126 132**	**-131 336**	**-93 353**	**95 339**	**76 702**	**66 022**	**56 321**	**87 969**

2030 - 2039

INCOME STATEMENT	2 030	2 031	2 032	2 033	2 034	2 035	2 036	2 037	2 038	2 039
Revenue	519 792	425 393	431 606	437 823	444 044	299 687	304 183	308 680	313 178	317 673
O&M	-81 011	-84 940	-89 005	-93 209	-97 819	-102 315	-106 952	-111 732	-116 653	-121 717
EBIDTA	**438 781**	**340 453**	**342 601**	**344 615**	**346 225**	**197 372**	**197 230**	**196 949**	**196 524**	**195 956**
Depreciations and provisions	-160 466	-160 088	-160 207	-168 805	-190 018	-174 795	-174 938	-174 938	-174 938	-175 182
EBID	**278 314**	**180 365**	**182 394**	**175 810**	**156 207**	**22 578**	**22 293**	**22 011**	**21 587**	**20 774**
Interest charges on LT Loan	-80 347	-70 568	-60 789	-51 009	-41 230	-32 984	-24 738	-16 492	-8 246	
Interest on refinancing	-2 525	-1 957	-1 572	-1 139	-744	-444	-143	-1 478	-2 397	-2 771
Interest on cash	1 604	1 359	2 907	4 327	4 084	897	652	495	410	324
Pre-tax Result	**197 047**	**109 200**	**122 940**	**127 988**	**118 317**	**-9 953**	**-1 936**	**4 536**	**11 354**	**18 326**
Pre-tax Result - with report			13 052	127 988	118 317				3 999	18 326
Tax										
Net Earnings	**197 047**	**109 200**	**122 940**	**127 988**	**118 317**	**-9 953**	**-1 936**	**4 536**	**11 354**	**18 326**

2040 - 2049

INCOME STATEMENT	2 040	2 041	2 042	2 043	2 044	2 045	2 046	2 047	2 048	2 049
Revenue	310 845	324 021	337 541	351 402	243 734	357 122	371 094	385 367	399 934	414 789
O&M	-126 922	-132 269	-137 756	-143 381	-149 349	-155 256	-161 295	-167 465	-173 763	-180 185
EBIDTA	**183 923**	**191 751**	**199 785**	**208 021**	**94 385**	**201 867**	**209 799**	**217 902**	**226 171**	**234 604**
Depreciations and provisions	-173 295	-173 295	-173 433	-173 433	-173 433	-146 116	-146 116	-145 997	-137 399	-116 257
EBID	**10 628**	**18 457**	**26 352**	**34 588**	**-79 048**	**55 751**	**63 683**	**71 905**	**88 772**	**118 347**
Interest charges on LT Loan										
Interest on refinancing	-2 771	-2 574	-2 238	-1 842	-1 446	-1 050	-654	-259	-60	
Interest on cash	252	5 602	11 202	17 161	18 699	6 778	12 189	18 552	25 432	28 868
Pre-tax Result	**8 109**	**21 486**	**35 316**	**49 907**	**-61 796**	**61 479**	**75 217**	**90 198**	**114 144**	**147 215**
Pre-tax Result - with report	8 109	21 486	35 316	49 907			74 900	90 198	114 144	147 215
Tax										
Net Earnings	**8 109**	**21 486**	**35 316**	**49 907**	**-61 796**	**61 479**	**75 217**	**90 198**	**114 144**	**147 215**

2050 - 2060

INCOME STATEMENT	2 050	2 051	2 052	2 053	2 054	2 055	2 056	2 057	2 058	2 059	2 060
Revenue	182 810	189 329	195 957	202 688	209 517	242 048	249 891	257 824	265 840	273 931	282 091
O&M	-186 727	-193 385	-200 155	-207 032	-213 833	-220 901	-228 059	-235 299	-242 616	-250 002	-252 816
EBIDTA	**-3 917**	**-4 056**	**-4 199**	**-4 344**	**-4 316**	**21 147**	**21 833**	**22 525**	**23 224**	**23 929**	**29 275**
Depreciations and provisions	-101 451	-101 308	-101 308	-101 308	-101 064	-100 991	-100 991	-100 853	-100 853	-100 782	-100 574
EBID	**-105 368**	**-105 364**	**-105 507**	**-105 652**	**-105 380**	**-79 844**	**-79 159**	**-78 328**	**-77 629**	**-76 853**	**-71 300**
Interest charges on LT Loan											
Interest on refinancing											
Interest on cash	12 293	13 624	13 749	13 936	14 123	14 210	15 040	16 037	17 025	18 121	19 269
Pre-tax Result	**-93 075**	**-91 741**	**-91 758**	**-91 716**	**-91 257**	**-65 634**	**-64 119**	**-62 291**	**-60 604**	**-58 733**	**-52 031**
Pre-tax Result - with report											
Tax											
Net Earnings	**-93 075**	**-91 741**	**-91 758**	**-91 716**	**-91 257**	**-65 634**	**-64 119**	**-62 291**	**-60 604**	**-58 733**	**-52 031**

CASH-FLOWS (k USD current)

Table 62. Cash-flows – base case

2010 - 2019

Projet Cash-Flows	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019
Investments			-103 783	-244 543	-270 293			-857 819	-1 557 697	-1 020 357
Revenue						57 209	67 108	64 473	63 543	68 914
O&M				-1 344	-2 295	-10 530	-10 507	-10 758	-12 305	-13 154
Tax										
Project Cash-Flows			**-103 783**	**-245 887**	**-272 588**	**46 679**	**56 600**	**-804 104**	**-1 506 459**	**-964 597**

Financial Cash-Flows	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019
Capital Added			20 757	49 925	57 062			171 564	311 539	204 071
Principal Added			83 027	199 698	228 249			686 255	1 246 158	816 286
Subsidizing Added										
Capital removed										
Principal Removed										
Interests charges				-3 736	-12 723	-22 994	-22 994	-22 994	-53 875	-109 952
Interests on Cash							633	1 662	2 629	2 617
Dividends										
Refinancing - removed										
Refinancing - interests										
Refinancing - added										
Financial Cash-Flows			**103 783**	**245 887**	**272 588**	**-22 994**	**-22 361**	**836 487**	**1 506 451**	**913 021**

	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019
Cash-Flows						**23 685**	**34 240**	**32 383**	**-8**	**-51 576**
Opening Balance							**23 685**	**57 925**	**90 307**	**90 299**
Closing Balance						**23 685**	**57 925**	**90 307**	**90 299**	**38 723**

2020 - 2029

Projet Cash-Flows	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029
Investments										
Revenue	209 924	231 046	228 114	225 005	258 074	416 226	426 002	407 446	391 115	410 256
O&M	-48 881	-51 583	-53 416	-56 549	-59 631	-62 832	-66 151	-69 584	-73 129	-77 005
Tax										
Project Cash-Flows	**161 043**	**179 463**	**174 697**	**168 456**	**198 443**	**353 395**	**359 850**	**337 862**	**317 985**	**333 251**
Financial Cash-Flows	**2 020**	**2 021**	**2 022**	**2 023**	**2 024**	**2 025**	**2 026**	**2 027**	**2 028**	**2 029**
Capital Added										
Principal Added										
Subsidizing Added										
Capital removed										
Principal Removed	-34 065	-34 065	-34 065	-34 065	-34 065	-217 311	-217 311	-217 311	-217 311	-217 311
Interests charges	-146 685	-145 152	-143 619	-142 086	-140 554	-139 021	-129 242	-119 463	-109 684	-99 905
Interests on Cash	1 063	729	700	667	635	1 210	1 669	1 902	1 745	1 416
Dividends										
Refinancing - removed					-2 296	-2 296	-2 763	-3 944	-3 944	-7 106
Refinancing - interests		-1 286	-1 286	-1 547	-2 209	-2 025	-3 612	-3 391	-3 075	-3 094
Refinancing - added	16 071	4	3 267	8 269		22 131			4 172	
Financial Cash-Flows	**-163 616**	**-179 769**	**-175 004**	**-168 762**	**-178 489**	**-337 313**	**-351 260**	**-342 208**	**-328 097**	**-326 000**
Cash-Flows	**-2 573**	**-307**	**-307**	**-307**	**19 954**	**16 082**	**8 591**	**-4 346**	**-10 112**	**7 251**
Opening Balance	**38 723**	**36 150**	**35 843**	**35 537**	**35 230**	**55 184**	**71 266**	**79 857**	**75 511**	**65 399**
Closing Balance	**36 150**	**35 843**	**35 537**	**35 230**	**55 184**	**71 266**	**79 857**	**75 511**	**65 399**	**72 650**

2030 - 2039

Projet Cash-Flows	2 030	2 031	2 032	2 033	2 034	2 035	2 036	2 037	2 038	2 039
Investments	-112 790		-974	-70 430	-181 203		-1 170			-2 002
Revenue	502 491	440 910	430 584	436 801	443 021	323 417	303 444	307 941	312 438	316 934
O&M	-81 335	-85 266	-89 322	-93 537	-98 169	-102 677	-107 315	-112 106	-117 039	-122 115
Tax										
Project Cash-Flows	**308 365**	**355 644**	**340 288**	**272 834**	**163 649**	**220 740**	**194 958**	**195 835**	**195 399**	**192 818**

Financial Cash-Flows	2 030	2 031	2 032	2 033	2 034	2 035	2 036	2 037	2 038	2 039
Capital Added										
Principal Added										
Subsidizing Added										
Capital removed										
Principal Removed	-217 311	-217 311	-217 311	-217 311	-217 311	-183 247	-183 247	-183 247	-183 247	-183 247
Interests charges	-90 126	-80 347	-70 568	-60 789	-51 009	-41 230	-32 984	-24 738	-16 492	-8 246
Interests on Cash	1 604	1 359	2 907	4 327	4 084	897	652	495	410	324
Dividends										
Refinancing - removed	-7 106	-4 810	-5 406	-4 939	-3 758	-3 758	-596	-596	-596	
Refinancing - interests	-2 525	-1 957	-1 572	-1 139	-744	-444	-143	-1 478	-2 397	-2 771
Refinancing - added							17 286	12 080	5 274	
Financial Cash-Flows	**-315 464**	**-303 066**	**-291 950**	**-279 852**	**-268 738**	**-227 781**	**-199 032**	**-197 484**	**-197 048**	**-193 940**

Cash-Flows	**-7 099**	**52 578**	**48 339**	**-7 017**	**-105 089**	**-7 041**	**-4 074**	**-1 649**	**-1 649**	**-1 122**

Opening Balance	**72 650**	**65 551**	**118 129**	**166 468**	**159 451**	**54 361**	**47 320**	**43 246**	**41 597**	**39 948**
Closing Balance	**65 551**	**118 129**	**166 468**	**159 451**	**54 361**	**47 320**	**43 246**	**41 597**	**39 948**	**38 826**

2040 - 2049

Projet Cash-Flows	2 040	2 041	2 042	2 043	2 044	2 045	2 046	2 047	2 048	2 049
Investments			-1 134	-163 018	-519 780	-1 705			-131 800	-811 409
Revenue	311 968	321 855	335 318	349 123	261 433	338 483	368 797	383 021	397 540	412 347
O&M	-127 331	-132 689	-138 188	-143 824	-149 812	-155 729	-161 772	-167 953	-174 261	-180 693
Tax										
Project Cash-Flows	**184 636**	**189 165**	**195 996**	**42 281**	**-408 159**	**181 049**	**207 025**	**215 068**	**91 479**	**-579 755**

Financial Cash-Flows	2 040	2 041	2 042	2 043	2 044	2 045	2 046	2 047	2 048	2 049
Capital Added										
Principal Added										
Subsidizing Added										
Capital removed										
Principal Removed										
Interests charges										
Interests on Cash	252	5 602	11 202	17 161	18 699	6 778	12 189	18 552	25 432	28 868
Dividends										
Refinancing - removed	-2 469	-4 195	-4 948	-4 948	-4 948	-4 948	-4 948	-2 479	-753	
Refinancing - interests	-2 771	-2 574	-2 238	-1 842	-1 446	-1 050	-654	-259	-60	
Refinancing - added										
Financial Cash-Flows	**-4 989**	**-1 166**	**4 016**	**10 371**	**12 304**	**779**	**6 586**	**15 814**	**24 618**	**28 868**

Cash-Flows	**179 648**	**187 999**	**200 012**	**52 652**	**-395 855**	**181 829**	**213 611**	**230 882**	**116 097**	**-550 887**

Opening Balance	**38 826**	**218 473**	**406 472**	**606 484**	**659 136**	**263 281**	**445 110**	**658 721**	**889 604**	**1 005 701**
Closing Balance	**218 473**	**406 472**	**606 484**	**659 136**	**263 281**	**445 110**	**658 721**	**889 604**	**1 005 701**	**454 814**

2050 - 2061

Projet Cash-Flows	**2 050**	**2 051**	**2 052**	**2 053**	**2 054**	**2 055**	**2 056**	**2 057**	**2 058**	**2 059**	**2 060**	**2 061**
Investments		-2 128			-3 536			-1 947			-2 842	
Revenue	220 944	188 258	194 867	201 581	208 395	236 701	248 602	256 520	264 522	272 601	280 749	46 371
O&M	-187 244	-193 912	-200 691	-207 577	-214 379	-221 455	-228 627	-235 874	-243 197	-250 589	-253 215	19 781
Tax												
Project Cash-Flows	**33 699**	**-7 783**	**-5 824**	**-5 996**	**-9 520**	**15 246**	**19 975**	**18 699**	**21 325**	**22 012**	**24 692**	**66 152**
Financial Cash-Flows	**2 050**	**2 051**	**2 052**	**2 053**	**2 054**	**2 055**	**2 056**	**2 057**	**2 058**	**2 059**	**2 060**	**2 061**
Capital Added												
Principal Added												
Subsidizing Added												
Capital removed												-814 918
Principal Removed												
Interests charges												
Interests on Cash	12 293	13 624	13 749	13 936	14 123	14 210	15 040	16 037	17 025	18 121	19 269	
Dividends												
Refinancing - removed												
Refinancing - interests												
Refinancing - added												
Financial Cash-Flows	**12 293**	**13 624**	**13 749**	**13 936**	**14 123**	**14 210**	**15 040**	**16 037**	**17 025**	**18 121**	**19 269**	**-814 918**
Cash-Flows	**45 992**	**5 841**	**7 925**	**7 940**	**4 602**	**29 456**	**35 016**	**34 736**	**38 350**	**40 133**	**43 961**	**-748 766**
Opening Balance	**454 814**	**500 806**	**506 647**	**514 572**	**522 512**	**527 115**	**556 570**	**591 586**	**626 322**	**664 672**	**704 805**	**748 766**
Closing Balance	**500 806**	**506 647**	**514 572**	**522 512**	**527 115**	**556 570**	**591 586**	**626 322**	**664 672**	**704 805**	**748 766**	**0**

BALANCE SHEET (k USD current)

Table 63. Balance sheet – base case with anticipation and quinquennial tariff

2010 - 2019

ASSETS	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019
Assets Net Value			103 783	348 326	618 619	600 861	583 103	1 423 164	2 963 103	3 965 702
Current assets						11 254	10 988	10 522	10 430	11 505
Stocks				126	178	1 905	2 027	2 155	2 346	2 519
Cash						23 685	57 925	90 307	90 299	38 723
TOTAL ASSETS			**103 783**	**348 452**	**618 798**	**637 705**	**654 042**	**1 526 148**	**3 066 178**	**4 018 449**

EQUITIES AND LIABILITIES	2 010	2 011	2 012	2 013	2 014	2 015	2 016	2 017	2 018	2 019
Equity Capital			20 757	70 681	127 743	127 743	127 743	299 307	610 847	814 918
Retained earnings				-3 736	-17 854	-43 172	-27 443	-12 540	-30 897	-106 518
Net earning			-3 736	-14 118	-25 318	15 729	14 902	-18 357	-75 620	-106 610
Subsidizing Authority Right						-2 945	-5 891	-8 836	-11 781	-14 726
LT Loan			83 027	282 725	510 974	510 974	510 974	1 197 229	2 443 387	3 259 672
MT Loan										
Provisions						4 616	9 233	13 849	18 465	23 082
Current liabilities			3 736	12 900	23 253	24 760	24 524	55 496	111 778	148 630
TOTAL E&L			**103 783**	**348 452**	**618 798**	**637 705**	**654 042**	**1 526 148**	**3 066 178**	**4 018 449**

2020 - 2029

ASSETS	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029
Assets Net Value	3 866 542	3 767 382	3 668 221	3 569 061	3 469 901	3 374 328	3 278 755	3 183 182	3 087 609	2 992 036
Current assets	39 033	37 773	37 444	36 897	43 510	73 321	69 380	66 505	63 858	68 144
Stocks	11 142	11 799	12 555	13 309	14 054	14 827	15 628	16 456	17 312	18 247
Cash	36 150	35 843	35 537	35 230	55 184	71 266	79 857	75 511	65 399	72 650
TOTAL ASSETS	**3 952 867**	**3 852 797**	**3 753 758**	**3 654 498**	**3 582 650**	**3 533 743**	**3 443 620**	**3 341 654**	**3 234 178**	**3 151 077**

EQUITIES AND LIABILITIES	2 020	2 021	2 022	2 023	2 024	2 025	2 026	2 027	2 028	2 029
Equity Capital	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918
Retained earnings	-213 127	-325 158	-447 665	-573 797	-705 133	-798 486	-703 147	-626 445	-560 424	-504 103
Net earning	-112 030	-122 508	-126 132	-131 336	-93 353	95 339	76 702	66 022	56 321	87 969
Subsidizing Authority Right	917	16 561	32 204	47 848	63 491	82 722	101 953	121 184	140 415	159 645
LT Loan	3 225 607	3 191 543	3 157 478	3 123 413	3 089 348	2 872 036	2 654 725	2 437 413	2 220 102	2 002 790
MT Loan	16 071	16 075	19 342	27 611	25 315	45 150	42 387	38 442	38 670	31 564
Provisions	66 336	109 591	152 845	196 100	239 354	282 609	325 863	369 118	412 372	455 627
Current liabilities	154 174	151 775	150 767	149 741	148 709	139 455	130 219	121 002	111 804	102 667
TOTAL E&L	**3 952 867**	**3 852 797**	**3 753 758**	**3 654 498**	**3 582 650**	**3 533 743**	**3 443 620**	**3 341 654**	**3 234 178**	**3 151 077**

2030 - 2039

ASSETS	2 030	2 031	2 032	2 033	2 034	2 035	2 036	2 037	2 038	2 039
Assets Net Value	3 006 167	2 907 508	2 809 759	2 776 770	2 842 687	2 736 127	2 630 660	2 524 023	2 417 385	2 312 615
Current assets	85 445	69 928	70 949	71 971	72 994	49 264	50 003	50 742	51 481	52 220
Stocks	19 290	20 242	21 227	22 245	23 364	24 455	25 580	26 739	27 934	29 163
Cash	65 551	118 129	166 468	159 451	54 361	47 320	43 246	41 597	39 948	38 826
TOTAL ASSETS	**3 176 453**	**3 115 807**	**3 068 402**	**3 030 437**	**2 993 406**	**2 857 166**	**2 749 489**	**2 643 101**	**2 536 747**	**2 432 824**

EQUITIES AND LIABILITIES	2 030	2 031	2 032	2 033	2 034	2 035	2 036	2 037	2 038	2 039
Equity Capital	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918
Retained earnings	-416 135	-219 088	-109 888	13 052	141 040	259 357	249 404	247 468	252 003	263 357
Net earning	197 047	109 200	122 940	127 988	118 317	-9 953	-1 936	4 536	11 354	18 326
Subsidizing Authority Right	185 859	204 849	224 314	277 685	386 169	404 700	423 802	442 328	460 853	480 356
LT Loan	1 785 479	1 568 167	1 350 856	1 133 544	916 233	732 986	549 740	366 493	183 247	
MT Loan	24 458	19 648	14 242	9 303	5 546	1 788	18 478	29 962	34 639	34 639
Provisions	491 221	533 660	575 678	587 692	553 941	603 645	652 843	702 617	752 392	801 300
Current liabilities	93 606	84 452	75 341	66 253	57 242	49 725	42 240	34 779	27 342	19 927
TOTAL E&L	**3 176 453**	**3 115 807**	**3 068 402**	**3 030 437**	**2 993 406**	**2 857 166**	**2 749 489**	**2 643 101**	**2 536 747**	**2 432 824**

2040 - 2049

ASSETS	2 040	2 041	2 042	2 043	2 044	2 045	2 046	2 047	2 048	2 049
Assets Net Value	2 208 155	2 103 694	2 000 292	2 052 253	2 440 185	2 327 033	2 212 177	2 097 385	2 110 303	2 782 493
Current assets	51 098	53 264	55 486	57 765	40 066	58 705	61 002	63 348	65 743	68 184
Stocks	30 426	31 725	33 057	34 423	35 874	37 309	38 776	40 275	41 806	43 367
Cash	218 473	406 472	606 484	659 136	263 281	445 110	658 721	889 604	1 005 701	454 814
TOTAL ASSETS	**2 508 152**	**2 595 154**	**2 695 319**	**2 803 577**	**2 779 406**	**2 868 157**	**2 970 676**	**3 090 612**	**3 223 552**	**3 348 858**

EQUITIES AND LIABILITIES	2 040	2 041	2 042	2 043	2 044	2 045	2 046	2 047	2 048	2 049
Equity Capital	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918
Retained earnings	281 683	289 792	311 278	346 593	396 500	334 705	396 183	471 400	561 598	675 742
Net earning	8 109	21 486	35 316	49 907	-61 796	61 479	75 217	90 198	114 144	147 215
Subsidizing Authority Right	500 593	520 830	541 621	667 027	1 016 401	1 018 514	1 019 786	1 021 062	1 078 866	1 679 057
LT Loan										
MT Loan	32 170	27 975	23 026	18 078	13 129	8 181	3 232	753		
Provisions	849 897	898 494	946 600	883 570	575 781	604 928	634 916	664 845	625 557	2 404
Current liabilities	20 782	21 660	22 560	23 484	24 472	25 433	26 424	27 436	28 469	29 522
TOTAL E&L	**2 508 152**	**2 595 154**	**2 695 319**	**2 803 577**	**2 779 406**	**2 868 157**	**2 970 676**	**3 090 612**	**3 223 552**	**3 348 858**

2050 - 2061

ASSETS	2 050	2 051	2 052	2 053	2 054	2 055	2 056	2 057	2 058	2 059	2 060	FIN
Assets Net Value	2 643 275	2 506 120	2 366 837	2 227 555	2 091 705	1 952 650	1 813 595	1 676 433	1 537 324	1 398 535	1 262 513	1 262 513
Current assets	30 051	31 123	32 212	33 319	34 441	39 789	41 078	42 382	43 700	45 030	46 371	
Stocks	44 957	46 575	48 221	49 893	51 545	53 263	55 003	56 764	58 542	60 337	61 005	
Cash	500 806	506 647	514 572	522 512	527 115	556 570	591 586	626 322	664 672	704 805	748 766	0
TOTAL ASSETS	**3 219 088**	**3 090 465**	**2 961 842**	**2 833 278**	**2 704 806**	**2 602 273**	**2 501 262**	**2 401 901**	**2 304 238**	**2 208 707**	**2 118 656**	**1 262 513**

EQUITIES AND LIABILITIES	2 050	2 051	2 052	2 053	2 054	2 055	2 056	2 057	2 058	2 059	2 060	
Equity Capital	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918	814 918	
Retained earnings	822 957	729 882	638 142	546 384	454 668	363 411	297 776	233 658	171 367	110 763	52 031	0
Net earning	-93 075	-91 741	-91 758	-91 716	-91 257	-65 634	-64 119	-62 291	-60 604	-58 733	-52 031	
Subsidizing Authority Right	1 640 828	1 603 512	1 565 147	1 526 782	1 489 934	1 451 650	1 413 367	1 375 918	1 337 511	1 299 402	1 262 513	1 262 513
LT Loan												
MT Loan												
Provisions	2 865	2 206	2 597	2 988	1 515	1 735	1 955	1 147	1 299	1 401		
Current liabilities	30 594	31 686	32 795	33 922	35 029	36 193	37 365	38 550	39 747	40 956	41 224	
TOTAL E&L	**3 219 088**	**3 090 465**	**2 961 842**	**2 833 278**	**2 704 806**	**2 602 273**	**2 501 262**	**2 401 901**	**2 304 238**	**2 208 707**	**2 118 656**	**1 262 513**