

# **The Role of Electricity Networks in Supporting Sustainability and Regional Integration**

## **Electrical Interconnection Project Between Egypt, Sudan and Ethiopia**

By  
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## **Electrical Interconnection Project Between Egypt, Sudan and Ethiopia**

### **Objective:**

Promote regional power trade through coordinated planning and development of power generation and transmission interconnection projects and creation of an enabling environment for implementation of the interconnection project.

## Description of the Project

The project composed of two phases:

- **Phase I:** Cooperative Regional Assessment of Power Trade Opportunities including developing a strategy for creating an enabling environment to effect power trade and coordinated planning for regional power generation and transmission interconnection projects.
- **Phase II:** Feasibility Study of Regional Power Interconnection.

## Market and Power Trade Assessment

### Egypt:

- **Generation:**  
Total Installed Capacity: 24,223 MW (2008)  
(20,936 MW thermal, 2,284 MW of hydro and the rest wind)
- **Transmission system:**
  - 500 kV Double circuit from High Dam to Cairo, and a single circuit from Cairo to the interconnection with Jordan.  
An extension of the 500 kV network is currently under construction from Cairo 500 to Sidi Krir in West Delta.
  - 220 kV and 132 kV circuit follows the 500 kV along the Nile River, The delta zone is supplied with a meshed 220 kV network, and extends towards west to Libya with a double circuit interconnection.
  - Egypt is interconnected with Jordan through 500/400 kV TL and with Libya through 220 kV TL. It is milestone to reinforcement of the interconnection with Libya in 500/400 kV.

## Market and Power Trade Assessment

### **Ethiopia:**

- **Generation:**

Hydropower Potential: 30 000 MW.

Total installed capacity: 1487 MW (2009) including 96,3 MW of Diesel plants and a Geothermal plant and the rest are hydropower.

The forecasted peak demands for year 2030 is targeted 13,330 MW .

- **Transmission system:**

230 kV network extends from Addis Ababa about 400 km eastward to Dire Dawa, about 300 km southward to Shashemene and about 1000 km northward to Tekeze and Gonder.

400 kV network will be soon erected to evacuate the generation of Gilgel Gibe II HPP until Addis Ababa.

Ethiopia/Sudan interconnected through 230 kV double circuit line is under implementation, planed to be completed by mid 2010.

## Market and Power Trade Assessment

### **Sudan:**

- **Generation:**

Total installed capacity: 2076 MW (2009).

Committed plants: Khartoum North 200 MW, Garri (2,3,4) 1740 MW, Kilo X 80 MW, Port Sudan 405 MW, Kosti 500 MW, El Bagair 540 MW, Fula 540 MW and heightening of the Rosieres HPP 135 MW.

The main grid system is divided into Khartoum, Central, Eastern and Northern areas.

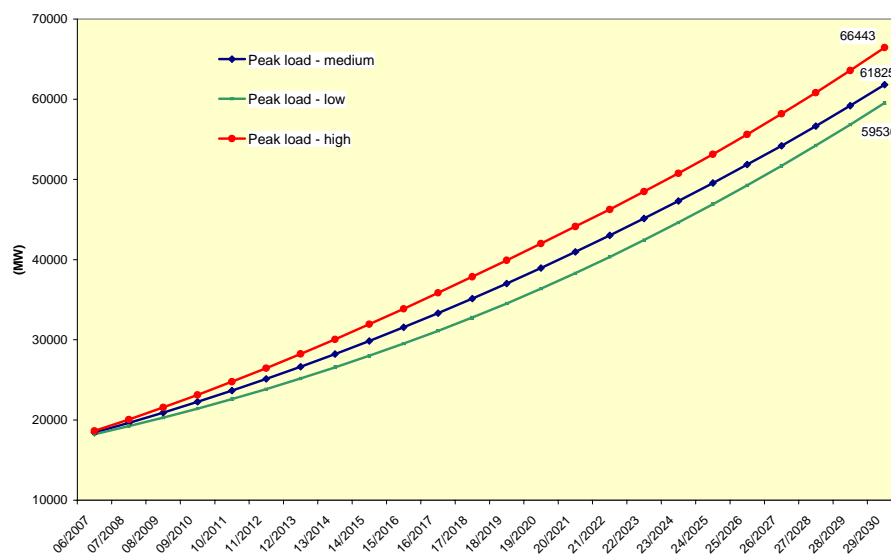
- **Transmission system:**

500 kV double circuit from Merowe HPP to Khartoum and single circuit between Merowe and Atbara.

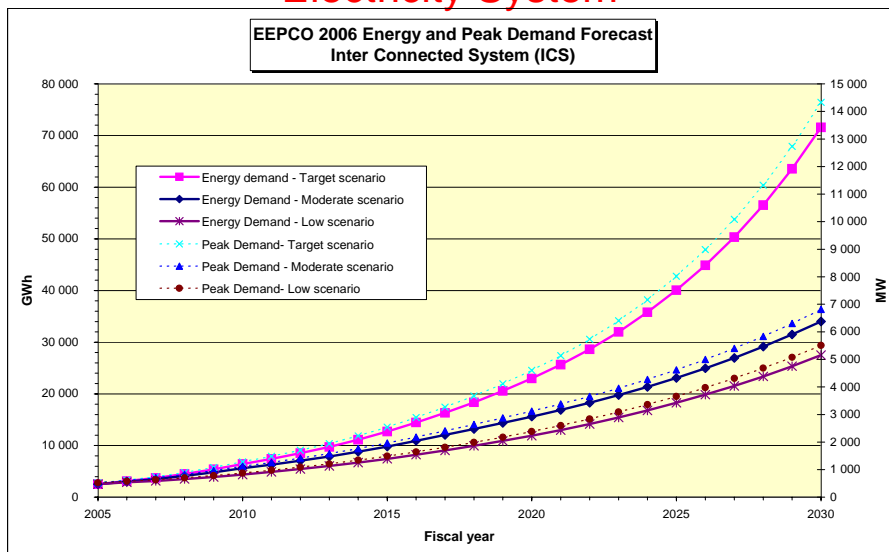
220 kV double circuit from Roseires HPP to Khartoum

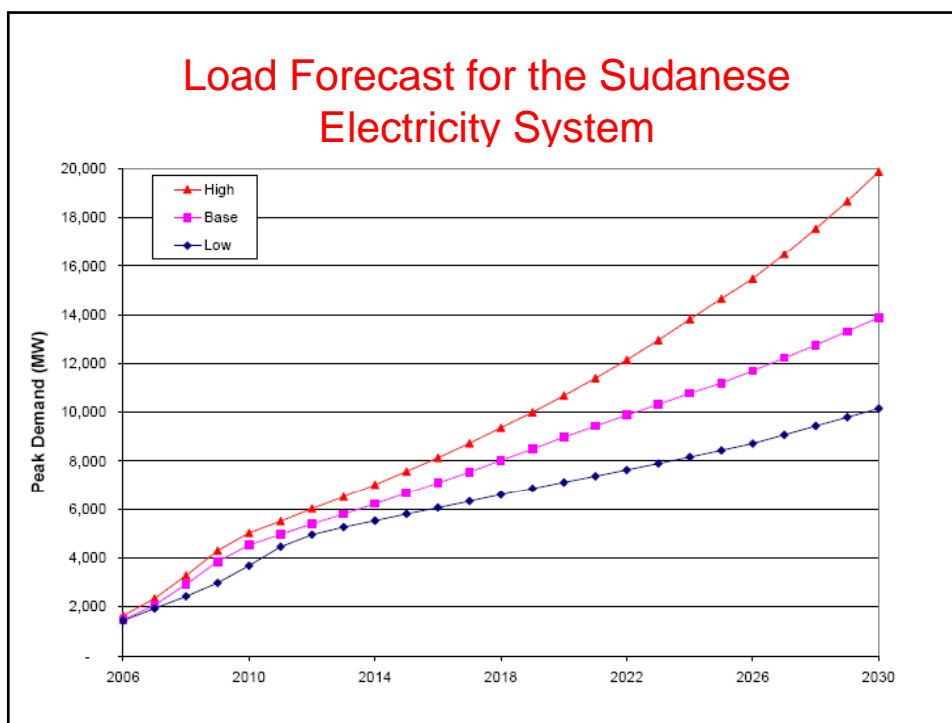
110 kV double circuit ring supplies Khartoum.

## Load Forecast for the Egyptian Electricity System



## Load Forecast for the Ethiopia Electricity System





### Electricity Demand Projection till year 2030

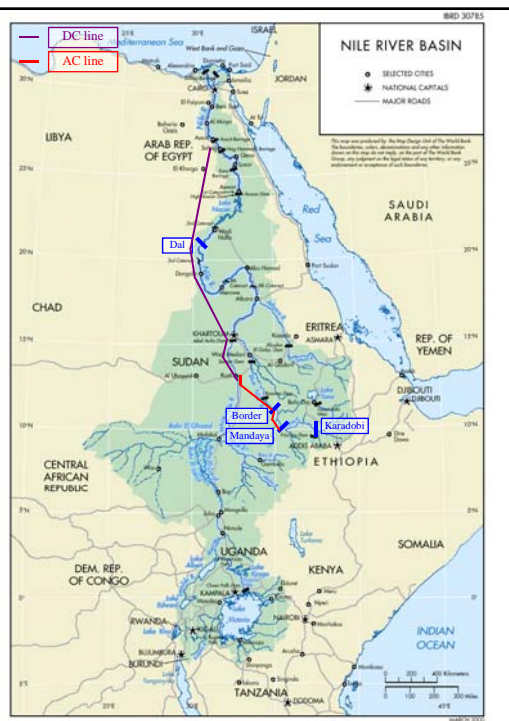
Scenario (MW)	High	Normal	Low
<b>Egypt:</b>	<b>66.4</b>	<b>61.8</b>	<b>59.5</b>
<b>Ethiopia:</b>	<b>13.3</b>	<b>6.8</b>	<b>5.5</b>
<b>Sudan:</b>	<b>19.2</b>	<b>13.9</b>	<b>9.8</b>

## Power Trade

Export capacity from Ethiopia of 1200 MW to Sudan and 2000 MW to Egypt, is profitable for the region

Benefit to cost ratio varies between 2.7 and 4.0 and the payback period is less than 10 years.

## Electrical Interconnection



## Electrical Transmission Interconnection

- AC/DC Mix with tapping station in Sudan
  - Ethiopia exports 3200 MW to Sudan, including 2000 MW for Egypt.
  - 500/400 kV substation located at Mandaya HHP equipped with four 500/400 kV transformers 510 MVar each.
  - Four 500 kV AC circuits between Mandaya HPP and Kosti 500 kV substations (570 km)
  - AC/DC 2 x 1075 MW converter station located at Kosti substation in Sudan, and a SVC.
  - 600 kV DC bipolar line between Rabak and Nag Hammadi. (1650 Km)

### Development of a Strategy for Power Trade

Task 1: Commercial Aspects of the  
Electricity Market

Task 2: Legislative and Regulatory Aspects

Task 3: Institutional Structure for the  
Regional Electricity Market

Task 4: Implementation of the Market:

## **Feasibility Study for the Interconnection**

- Detailed Power System Study
- Topography and Survey of the Transmission Line Routing
- Environmental and Social Impact Assessment
- Preparation of Technical Specification:
- Operation and Maintenance Requirements:
- Implementation Arrangements
- Institutional Analysis
- Financial Analysis

## **Moving Forward**

### Activities required:

- Liberalization of EN Electricity sectors to move into competitive market.
- Establish of Regional Market Coordinator (RMC)
- Define new market rules
- Agreements and protocols.
- Harmonization between technical, financial and legal aspects.
- Establish of Regional Electricity Market
- Operate of Regional Electricity Market



## Challenges

- To initiate any power interconnection proposal there are several issues that must be settled; among them the way of partnership in ownership of assets, investments and Profitability of the project.
- Project's risks have to be assessed and consider plans for mitigation. The first step is to recognize that risk exists as a consequence of uncertainty. Risk mitigation involves the formulation of management responses to the main risks.

## Recommendation

Establishment of a multinational project entity composed of three countries officials and other regional concerned agencies to Build, Own and operate the interconnection and Setup a Regulator dedicated to this interconnection.

Thank you