Power Transmission Interconnector

Grand Renaissance (Ethiopia) to Khartoum (Sudan)

Project Information Memorandum

November 2017

NEPAD
TRANSFORMING AFRICA

PIDA
INTERCONNECTING
INTEGRATING & TRANSFORMING

PREPARED FOR:

EEP (ETHIOPIA) AND SETCO (SUDAN)

PREPARED BY:

NEW PARTNERSHIP FOR AFRICA'S DEVELOPMENT (NEPAD)

UNDER THE FRAMEWORK OF:

PROGRAMME FOR INFRASTRUCTURE DEVELOPMENT IN AFRICA (PIDA)

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1. PROJECT DESCRIPTION

1.1 CONTEXT AND OBJECTIVES

The Nile Basin Initiative (NBI) embarked on the creation of a regional power market amongst its Riparian States in the '90s, via NELSAP (Nile Equatorial Lakes Subsidiary Action Program), which is one of NBI's investment arms. NELSAP's near-term objective is the development of regional power infrastructure in its member states. Its long-term objective is the creation of a regional electricity market that can play a key role in ensuring that the hydropower resources of the Nile Basin are developed and managed in an integrated and sustainable manner.

Ethiopia and Sudan have some of the lowest levels of electricity generation per capita in the world. For example, in Ethiopia and Sudan only 27% and 45% of the population have access to electricity, respectively. To address this, the larger Ethio-Sudan Power Transmission Interconnection Project ("ESTIP") was identified for fast-track implementation under the Eastern Nile Subsidiary Action Program (ENSAP). In 2014, the Government of Ethiopia (GOE) and Government of Sudan (GOS) represented by Ethiopia Electric Power (EEP) and Sudanese Electricity Transmission Company Ltd. (SETCO), respectively, embarked on the development of an Extra High Voltage (EHV) Power System Interconnection between Ethiopia and Sudan ("The Project"). A topographical layout of the Project's EHV line route is displayed in Figure 1[1].

Figure 1: Project location along Zambezi River.

1 Extracted from Google Earth Pro (November, 2017).

The Project, will facilitate power transfer between the two countries as well as those in the Eastern Africa Power Pool (EAPP). The Project also enables Sudan to make use of Ethiopia's cleaner energy resources, most notably, Africa's soon to be largest hydro-electric scheme, the Grand Ethiopia Renaissance Dam project, which will have a generation capacity of 6,000MW and to which this Project will have a direct connection. This project is part of a great North-South Power Transmission Line corridor, and therefore a continental PIDA project.

1.2 PROJECT LOCATION

The Project comprises a power transmission interconnector between Ethiopia and Sudan, including 580km of new 500kV transmission lines, of which approximately 16km will be in Ethiopia, starting at the Grand Ethiopia Renaissance Dam (GERD), and approximately 564km will be in Sudan, terminating in Khartoum[2]. The Project also includes two new, 500 kV capacitated substations at Rabak and Jebel Aulia (both in Sudan), and power line bay extensions at the following existing substations: Grand Renaissance (500kV Ethiopia), Rabak (220kV, Sudan) and Jebel Aulia (220kV, Sudan). These key Project components are displayed in the electrical single line diagram (SLD) in Figure 2, and a summary on transmission line lengths is provided in Table 1[3].

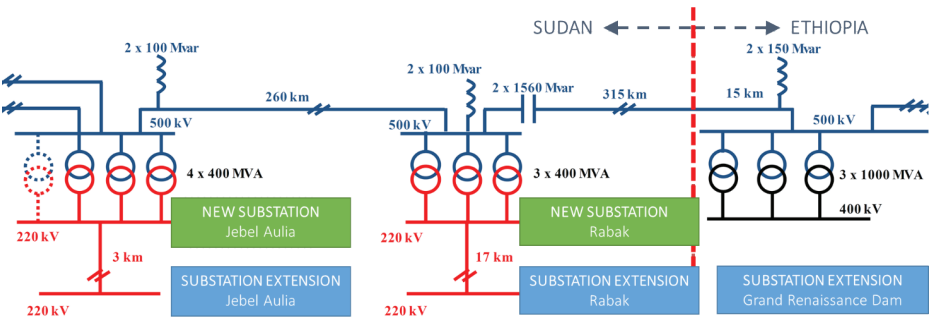

Figure 2: Single line diagram (SLD) showing key components of the power transmission interconnector.

2 The transmission line length of 580km represents the optimised length in the Feasibility Study, as a result of the field research conducted by the Consultant, EEP and SETCO (Vol. 1b). This optimised length is then used in the other Feasibility Study deliverables, such as the economic and financial analyses.

3 The SLD is not to scale and seeks only to illustrate the key Project components.

Table 1: Proposed transmission line length for optimised line route.

TRANSMISSION LINE LENGTHS[4]	TYPE	COUNTRY	UNITS	QTY
Renaissance Dam – BORDER	500kV DC OHL	Ethiopia	km	16
Sub-Total 500kV	-	**Ethiopia**	**km**	**16**
BORDER – Rabak	500kV DC OHL	Sudan	km	310
Rabak – Jebel Aulia	500kV DC OHL	Sudan	km	254
Sub-Total 500kV	-	**Sudan**	**km**	**564**
Grand Total 500kV	-	**Ethiopia & Sudan**	**km**	**580**
Rabak Substations: Existing – New	200kV DC OHL	Sudan	km	17
Jebel Aulia Substations: Existing – New	200kV DC OHL	Sudan	km	3
Grand Total 200kV	**200kV DC OHL**	**Sudan**	**km**	**20**

The entire Project area is mostly flat, except the first 3km where the route line crosses some hills in order to avoid a military area. The transmission line crossing from GERD to Khartoum is largely unhindered, with only two major scheduled crossings, one at the Blue Nile River and the second is the crossing of the 220kV power line of Damazin – Jebel Aulia.

1.3 PROJECT HISTORY, STAGE & CYCLE

The first transmission interconnector project between Ethiopia and Sudan was approved for implementation by the governments on 20th December 2007, and commissioned in December 2013. This earlier project, with a power capacity of 100MW, consists of a new 194 km double circuit 230/220 KV transmission line linking Shehedi (Ethiopia) to Gedaref

4 The transmission line lengths are estimates based on the route optimisation study by CESI (Feasibility Study Vol. 1b).

(Sudan)[5]. The Shehedi - Gedaref project gave rise to the following benefits which the Project will seek to emulate, namely:

- 1.4 million households gained access to affordable electricity;
- Both countries have been able to better integrate their reserve capacities, and in the process, improve reliability of supply on the interconnected system and save on capital and operating costs;
- Improvements in reliability and security of supply in both countries have yielded benefits like lighting of schools and homes, better access to social services, and greater opportunities for business development; and
- Ethiopia's increased capacity to export power and generate revenue[6].

According to PIDA's Priority Action Plan (PAP), the Project's status is **'S3 – Feasibility/Needs Assessment'**. It is the intention of the governments to achieve financial close for the Project by January 2018. To this end, market soundings have commenced to market the Project to lenders, short list potential lenders and obtain indicative term sheets for funding.

1.4 KEY PARTIES

1.4.1 PROJECT SPONSOR

The Project Sponsors are the Governments of Ethiopia (GOT) and Sudan (GOS). The two national power utilities, namely EEP and SETCO, commissioned a feasibility study in July 2015, which was managed by a Joint Technical Committee (JTC) and completed by CESI S.p.A. in January 2017 ("The Feasibility Study"). Other key governmental authorities include the Ethiopian Ministry of Water, Irrigation and Electricity, and the Sudanese Ministry of Water Resources and Electricity.

1.4.2 IMPLEMENTATION AUTHORITIES

The Project will be implemented by the two state-owned utilities; the role of each is described as follows.

5 It also included the reinforcement of Ethiopia's existing 260 km single circuit line linking Bahir Dar to Gonder and on to Shehedi, and a new 36.5 km high voltage, double circuit, 230/220 kV, three-phase alternating current transmission line linking Shehedi to Metema at the border with Sudan.

EEP, Ethiopia's state-owned power utility, will be responsible for the implementation of the 500kV double circuit transmission line in Ethiopia, running from the Grand Ethiopia Renaissance Dam to the Ethiopia-Sudan border, as well as the extension of the power line bays at the Grand Renaissance Substation to enable power transmission from the hydro-electric scheme (HES).

SETCO, Sudan's state-owned power utility, will implement the 500kV double-circuit transmission line in Sudan from the Ethiopia-Sudan border to Rabak and up north-west to Jebel Aulia, in Khartoum. SETCO will also be responsible for the two new 500kV capacitated substations at Rabak and Jebel Aulia as well as power line bay extensions to the existing substations at those locations, and the short, requisite 220kV connections between the new and existing substations.

In **Ethiopia**, the Ministry of Water, Irrigation and Energy (MOWIE) is in charge of the power sector, and EEP is the mandated power supply entity that is fully owned by the Government of Ethiopia.

In **Sudan**, the Ministry of Water Resource Irrigation & Electricity (MWRIE) is in charge of the power sector, and five companies under MWRIE are responsible for electricity supply, namely:

- Sudanese Thermal Power Generating Company Ltd. (STPG)
- Sudanese Hydro Generation Company Ltd. (SHGC)[7]
- Sudanese Electricity Transmissions Company Ltd. (SETCO)
- Sudanese Electricity Distribution Company Ltd. (SEDCO)

1.4.3 EXECUTING AGENT

The project is being implemented under the auspices of the Eastern Nile Technical Regional Office (ENTRO). The NBI, through ENTRO, was instrumental in setting up a Power Coordination Unit (PCU) at ENTRO, financed by the power utilities of Sudan and Ethiopia.

7 Merger with Merowe Generation Company.

The PCU was responsible for updating the feasibility study and mobilising funds. ENTRO is the executive and technical arm of the Eastern Nile Subsidiary Action Program (ENSAP), an institution jointly owned by Egypt, Ethiopia, South Sudan, and Sudan. ENTRO is based in Addis Ababa, Ethiopia and is responsible for driving the Water Resource Development function in ENSAP.

1.4.4 OTHER KEY PARTIES

The Project is in the REC (Regional Economic Community) of IGAD (Intergovernmental Authority on Development), and receives administrative support from the IGAD Secretariat.

The Project is also being supported by NELSAP in collaboration with NEPAD.

1.5 DELIVERY & BUSINESS MODELS

Both EEP and SETCO decided to structure the transmission line interconnector as an extension of their existing national electrical grids, to ensure full ownership and control during operations. The total capital costs of the interconnector, including the 200kV and 500kV transmission lines and new and extended substations, will be borne by each utility according to its geographic location. Furthermore, financing will be provided directly to each utility, guaranteed by their respective government. The utilities chose not to explore a PPP model or other private sector participation models, as they believed it would limit their control over the assets during the private concession period.

The implementation model assumes that EEP and SETCO will each procure Engineering Procurement Construction (EPC) Contractors for the sections within their geographical boundaries on a competitive basis. EPC contracts are the most common form of contract used to construct transmission lines.

The State utilities will be compensated for operating the proposed transmission line via tariffs and power export revenues; therefore, it is critical that the Project performs as required in terms of availability, efficiency and reliability. The EPC contracts[8] will therefore be structured

7 The EPC Contractors will also assume the construction, installation, integration and performance risks, as they are responsible for both the design and construction/installation of the Project.

to contain performance guarantees backed by performance liquidated damages (PLDs) payable by the EPC contractor if it fails to meet the specifications.

1.5.1 PRIVATE SECTOR OPPORTUNITIES

Under the Project's proposed Public Financing model, the primary opportunity to the private sector relates to the physical implementation of the Project via EPC Contracts. The utilities may elect to procure a single EPC Contractor to minimize implementation delays and synchronise integration of the interconnector[9].

1.6 REVENUE MODEL

In terms of power availability and energy exchange between the two countries, the Feasibility Study concluded that a Bilateral Power Trade Agreement (BPTA) will offer the most appropriate legal framework for the Project. The BPTA will facilitate power trading in a reciprocal manner between Ethiopia and Sudan, irrespective of the power plant that has actually generated the power. Moreover, both parties will at time act as buyers and purchasers, according to price-differentials as well as to market needs. A BPTA typically has fewer requirements than a PPA as it does not explicitly include clauses or conditions on specific power plants and does not seek to ensure bankability of specific assets.

The diagram below (Figure 3) illustrates the counterparties to the BPTA, and introduces the indirect opportunity to strengthen power trade agreements with the Eastern Africa Power Pool (EAPP).

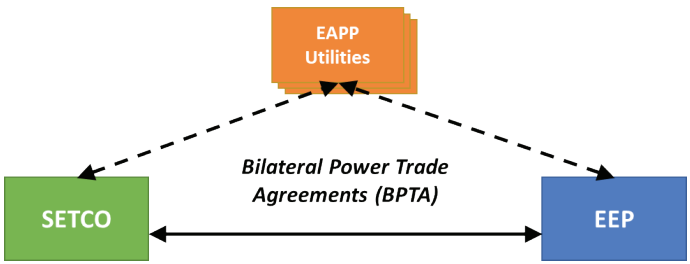

Figure 3: Power trade agreements still to be concluded between countries and EAPP.

9 Neither utility has indicated whether they will procure a single EPC contractor jointly, or procure multiple contractors.

1.7 POLITICAL SUPPORT

As noted above, the Project is part of a greater transmission interconnector programme between Ethiopia and Sudan, and the construction of the other parts of the programme were completed in 2009, in Sudan, and by 2010, in Ethiopia, with final commissioning in December 2013. In general, both governments have supported and continue to support this Project, and are aware of the important benefits that can be derived at a national level, including: (1) Ethiopia will generate revenue by exporting power to Sudan, (2) Sudan will benefit by replacing its current thermal power generation with surplus hydropower from Ethiopia thereby reducing Sudan's greenhouse gas emissions, and (3) the Project improves the availability and reliability of power supply to both countries since it provides its helps in meeting the variability in peak demand[10].

10 Where Sudan can be provided with power during the day time when demand is higher, and Ethiopia can use the power during the night time when demand is high.

2. TECHNICAL FEATURES

2.1 POWER CAPACITY

For **Ethiopia**, power generation has increased at an average annual rate of 13.7%[11], whilst power consumption grew by 12.1% per annum over the same period[12]. The difference between Ethiopia's power generation and its total energy sales gives rise to energy losses which represented 10% of power generated in 2008 and 36% in 2012. This supports the rationale of the Project, which is to export this surplus power to neighbouring countries such as Sudan.

For **Sudan**, the Feasibility Study analyses the evolution of the country's peak load over the period 2001-2014 along with the total generation. The results show that the load factor is decreasing over the period, from 0.65 in year 2001 to 0.51 in year 2014 (confirmed by SETCO), meaning the maximum power demand is becoming increasingly greater than the mean power demand, introducing undesirably high variability into the electricity market. It is envisaged that the Project will improve the stability of power demand in Sudan.

2.2 DESIGN STATUS

A full Preliminary Design was completed as part of the Feasibility Study, which included an options analysis to select the preferred transmission line route as well as a detailed route optimisation exercise by means of a topographic and environmental survey. Transmission lines angle points[13] have also been laid out in close consultation with EEP and SETCO.

In addition, full technical specifications have been developed for both the Ethiopian and Sudanese sides of the Project. The technical specifications address the design, engineering, manufacture, inspection, testing, packing for export, supply to site, erection and commissioning, setting to work, and a warranty period of 24 months (from the system of starting-up), related to the overhead transmission lines.

11 The growth in power generation capacity has occurred over two distinct periods: (1) from 2002 to 2010, with an average rate of growth of 10.4%, and (2) from 2010 to 2015 with an average annual rate of 19.2%, almost double of the average rate of growth in the first period.

12 This power generation has two distinct periods: (1) from 2002 to 2010, with an average rate of growth of 10.4%, and (2) from 2010 to 2015 with an average annual rate of 19.2%, almost double of the average rate of growth in the first period.

13 Angle points are specific points in the transmission line that have a change direction.

3. SECTOR

2.1 POWER CAPACITY

The countries of the region are grouped into a super power pool (the EAPP) that covers geographically over a third of Africa. However, only a small subset of the countries of this power pool is presently interconnected or in the process of being interconnected. An assessment of the generation development plans of Ethiopia and Sudan was performed, as part of the Feasibility Study, to identify potential issues. This exercise considered whether the national grids would be able to meet the projected peak loads with a sufficient operational margin and whether the two countries would be able to do energy transfers to other countries with an appropriate energy reserve.

3.2 MARKET SIZE, DEMAND & PROJECTIONS

The power system demand forecasts for each transmission system was analysed in the Feasibility Study, in addition to a review of the countries' respective transmission system master plans[14], and the salient features are noted for each country as follows:

Ethiopia's Transmission Master Plan is suitable to deal with the expected evolution of the demand and generation up to the year 2037, both with regards to the loading of the components and the voltage profiles. In particular, the planned development of the 500kV, 400kV and 230kV transmission lines in the proposed Project, are adequate considering the expected growth rate of the demand.

14 With electrical engineering experts in EEP and SETCO.

Sudan's Transmission Master Plan, which is applicable up to 2031, is in need of modification in respect of the planned electrical grid expansions such as the proposed 500kV and 200kV transmission lines in the proposed Project. The main changes of Sudanese transmission system, together with the structure and demand on the 500kV system at different target years, are outlined in the Feasibility Study.

The Feasibility Study demonstrates that the new power transmission interconnection facilitates the exporting of hydro-electrical resources from Ethiopia to Sudan, allowing Sudan to diversify its energy sources away from thermal generated energy. Hydro-electrical energy is a cleaner power generation source than thermal energy, which enables sustainability-oriented opportunities, such as climate financing.

4. PROJECT COSTS, ECONOMIC & FINANCIAL ANALYSES

4.1 PROJECT COSTS

"Alternative 2, Option 2" was identified as the preferred option during the options analysis phase of the Feasibility Study and a detailed breakdown of costs were provided for the preferred option as illustrated in Table 2.

Table 2: Capital costs for the preferred transmission line route option (ex. VAT)[15].

DESCRIPTION	QTY	UNIT	UNIT COST US$ ('000)	ETHIO-PIA US$ ('000)	SUDAN US$ ('000)	TOTAL US$ ('000)
TRANSMISSION LINES						
500 kV Double Circuit OHL Renaissance Dam – Rabak	330	km	600	9,000	189,000	198,000
500 kV Double Circuit OHL Rabak – Jebel Aulia	260	km	600	-	156,000	156,000
SUB-TOTAL: LINES	590	km	-	9,000	345,000	354,000
SUBSTATIONS						
Series Capacitors	2	set	31,000	-	62,000	62,000
SUB-TOTAL: SUBSTATIONS	2	set	-	-	62,000	62,000
SUBSTATION EXTENSIONS						
500 kV Line Bay at Renaissance Substation	2	set	2,500	5,000	-	5,000
500 kV Line Bay at Jebel Aulia Substation	2	set	2,500	-	5,000	5,000
500 kV Line Bay at Rabak Substation	4	set	2,500	-	10,000	10,000
SUB-TOTAL: EXTENSIONS	-	-	-	5,000	15,000	20,000
GRAND TOTAL: CAPEX	-	-	-	14,000	422,000	436,000

15 This breakdown of capital cost items is not for the optimised route, which is 10km shorter at 580km.

However, when the preferred option was subsequently optimised[16], using route optimisation by means of a detailed topographic and environmental survey and by testing[17] this with power availability and demand scenarios, the Project's overall capital cost increased by US$78.0m or 17.8% as illustrated in Table 3. A breakdown of this optimised cost is given per country, as shown in the table below, and used in the financial analysis presented in the following subsections.

Table 3: Total capital cost per country for the optimized transmission line route (ex. VAT).

DESCRIPTION	OPTIMISED COST US$ ('000)	ORIGINAL COST US$ ('000)	DIFFERENCE US$ ('000)
TOTAL CAPEX ETHIOPIA	29,030	14,000	+ 15,030
TOTAL CAPEX SUDAN	484,940	422,000	+ 62,940
GRAND TOTAL: CAPEX	513,970	436,000	+77,970

Operational costs (Opex) were forecast at 1.00% of CAPEX, indexed to inflation. The operational period presented in the financial analysis of the Feasibility Study is 35 years, with an inflation rate assumption of 8% for both Ethiopia and Sudan[18].

4.2 ECONOMIC ANALYSIS

An economic analysis is presented in the Feasibility Study, beginning in 2020 and covering a period of 35 years. The aim of the economic analysis was to determine whether the proposed Project will bring about a net economic benefit for both Ethiopia and Sudan. The method used was a comparison of the 'reference' scenario (current undeveloped scenario) to four other scenarios ('coordinated', 'integrated', 'market' and 'regional') which offer different mechanisms for electricity exchange. Other key economic analysis assumptions were:

- An annual discount rate of 10%;
- A lost load (VOLL) value equal to 2 US$/kWh;
- Long-term inflation rate of 7%;

16 in Vol. 1b.

17 in Volumes 2 and 3.

18 For Ethiopia, the annual inflation rate in the long term is expected to amount to 8.00%, as forecasted by the National Bank of Ethiopia; for Sudan, the latest statistics by the African Development Bank report high inflation in Sudan (16.9% from 2007 to 2016), but the Feasibility Study estimated the annual inflation rate in the long term at the level of 8.00%, which they state is in line with Africa's average.

- Price of CO_2 emissions grows from 12 US$/tonne in 2020 to 26.9 US$/tonne in 2055[19].

Electrical interconnector projects can potentially realise a large and diverse range of benefits, for developers, power generators, consumers and governments. Table 4 summarises the benefit/cost ratios calculated for each of the four scenarios and concludes that all four scenarios will give rise to significant net benefits.

Table 4: Net economic benefit using a 10% discount.

INDICATOR	COORDINATED	INTEGRATED	MARKET	REGIONAL
NPV (US$ 000)	10,209,305	41,080,515	39,665,209	38,999,634
IRR	169%	186%	168%	171%
BENEFIT/COST RATIO	**20.56**	**79.70**	**13.27**	**12.30**

In comparison to the 'reference' scenario, the 'integrated' scenario is the most beneficial as it is designed in such a way that Ethiopian and Sudanese electricity markets become one, assuming distribution and regulatory integration. On the other hand, the 'market' scenario, which requires a single bilateral trade agreement (BLTA) and the 'regional' scenario which requires two BLTAs (one with Sudan and the other one with Egypt), are still highly beneficial. All four scenarios' economic internal rates of returns (IRRs) are very high, and according to the Feasibility Study, very robust to all sensitivities analysed.

4.3 FINANCIAL ANALYSIS

The Feasibility Study made use of a corporate financing approach as opposed to a project financing approach and assumes that the two utilities will finance the Project with a combination of equity and debt whilst recovering costs and returns through tariffs.

Revenue Assumptions

A 'cost-plus approach' makes use of a rate of return assumption to solve for the revenue that the Project will need to generate via tariffs to cover the Project's costs and to allow for each

19 Price of CO_2 emissions is defined as the social cost of carbon under the US Environmental Protection Agency estimation.

utility's cost of capital. 'Rate-of-return' (RoR) calculations are predominantly used by state utilities to calculate electricity tariffs that are fully cost reflective at a national level rather than a project level. Revenues calculated for the Project, using the RoR method are the sum of the Project's operational costs, charges[20], asset amortization and capital remuneration. The capital remuneration portion, which seeks to compensate the utility for it its cost of capital, is obtained by multiplying amortized asset values, adjusted for inflation, by a weighted cost of capital (WACC).

Financial Analysis Characteristics

The Ethiopian portion of the Project is modelled over a 36-year period (2019-2054), with an estimated construction start date of January 2019, while the Sudanese portion is modelled over a 37-year period (2018-2054), with an estimated construction start date of January 2018. The Feasibility Study assumed an annual inflation rate of 8.00%[21] for both Ethiopia and Sudan[22] over the respective periods modelled which appears to be based on an African average in the case of Sudan rather than country actuals which are significantly higher. Other key financial assumptions used in developing the two financial models are set out in Table 5.

Table 5: Key financial modelling characteristics.

DESCRIPTION	UNITS	ETHIOPIA	SUDAN
Start Date	Date	01/01/19	01/01/18
Construction	Yrs	1	2
Operation	Yrs	35	35
Period Modeled	Yrs	36	37
Annual Inflation Rate (10-Yrs Mean)	%	8.00%	8.00%
Tax Rate	%	30.00%	15.00%
Vat Rate	%	15.00%	17.00%
Debt: Equity	%	80:20	80:20
Interest Rate – Long Term Debt	%	6.00%	6.50%
Debt Tenor	YRS	20	12 - 20

20 Assumed to mean charges other than interest

21 Based on a National Bank of Ethiopia forecast.

22 Latest statistics by the African Development Bank report high inflation in Sudan (16.9% from 2007-2016)

Financing Structures

For **Ethiopia**, the Feasibility Study assumed that a senior debt facility will be used which will fund 80% of Ethiopia's capital expenditure or US$23.2mil, and which will have an interest rate of 6.0%[23]. A working capital VAT facility[24] was also modelled, which will be fully repaid by 2022. The Feasibility Study states that the interest rate modelled is lower than the average lending rate in Ethiopia (calculated at 8% in the Feasibility Study), as it is assumed that the Ethiopian section of the Project will benefit from a government guarantee. Senior debt is assumed to be repaid over 20 years, once commissioned, using a mortgage style repayment profile. The model assumes that US$5.8mil of equity will be provided by EEP to fund the remaining 20% of capital expenditure.

For **Sudan**, the Feasibility Study assumes that two debt facilities will be used to fund 80% of Sudan's capital expenditure or US$97.0mil. A senior debt facility and a zero-coupon bond were modelled which attract an interest rate/yield of 6% and 8%, respectively[25]. Since no data on Sudanese average lending rates was available, the Feasibility Study used the same interest rate applied for Ethiopia of 8.00% which is low compared to a 2012 US$ denominated Sukuk which attracted a yield of 16-20%. A working capital VAT facility[26] was also modelled, which will be fully repaid by 2022. The Feasibility Study also makes reference to a government guarantee that will be issued in respect of the Ethiopian section's debt. The model assumes that the senior debt will be repaid over a 20-year period, once commissioned, using a mortgage style repayment profile and that the zero-coupon bond will be repaid after 12 years.

To calculate the cost of equity, the Feasibility Study used the capital asset pricing model (CAPM) to arrive at a 12.58% cost of equity for Ethiopia and 17.17% for Sudan. The respective equity requirements were used to calculate a weighted average cost of capital (WACC) that underpins the revenue calculation as illustrated in Table 6.

23 Rate used in model is 2% lower than rate calculated in table 2.1 in the Feasibility Study for Ethiopia (i.e. 8%).

24 Working capital facility used during construction period

25 Once the VAT facility is repaid, the senior debt accounts for 75% of debt and the zero-coupon bond for 25%, senior debt attracts an interest rate of 6% and the bond a yield of 8% (resulting in a blended interest rate of 6.5%).

26 Working capital facility used during construction period

Table 6: WACC Calculations.

DESCRIPTION	ETHIOPIA	SUDAN
Cost of Debt	6.00%	6.50%
Cost of Equity (Capm)	10.58%	15.17%
Illiquidity Premium	2.00%	2.00%
Cost of Equity	12.58%	17.17%
WACC	**6.77%**	**9.04%**

Financial Viability

The modelling exercises undertaken as part of the Feasibility Study forecasts that both sections of the project will result in positive net present values however, the Ethiopian section will have a significantly longer payback period. The returns forecast presuppose that each utility will be able to recover the revenues calculated for the two sections of the Project via its tariff mechanism.

Table 6: WACC Calculations.

DESCRIPTION	ETHIOPIA	SUDAN
Discount Rate (Wacc Assumed)	6.77%	9.04%
Project IRR (Pre-Tax)	10.2%	13.8%
Project IRR (After-Tax)	9.9%	13.0%
Equity IRR (After-Tax)	17.2%	20.7%
Payback Period (Years)	24	18
NPV (Pre-Tax)	**US$ 12,823,590**	**US$ 258,478,330**

A sensitivity analysis was undertaken as part of the Feasibility Study which quantified the impact on the Ethiopian section of an increase in interest rates and quantified the impact of construction delays, cost overruns and mezzanine debt on the Sudanese section. The sensitivity analysis concluded that a 4% increase in interest rates on the senior debt would result in the Ethiopian equity payback period increasing from 17 years to 29 years. In Sudan, three specific sensitivities were checked collectively, namely: a delay in infrastructure completion, construction cost overruns of 50%, and replacing the zero-coupon debt with mezzanine debt financing. A delay in completion by two years and a 50% overrun in construction cost resulted in the Project's payback period increasing from 18 to 20 years.

4.4 DOMESTIC RESOURCE MOBILIZATION OPPORTUNITY

A corporate financing approach was adopted in the Feasibility Study, as requested by both utilities, which assumes that the Project's capital expenditure will be funded using 80% debt and 20% equity and that each utility will fund assets on a geographic basis. Table 8 quantifies the debt that will need to be raised for both sections of the Project as well as the equity that each utility will need to inject to fund the Project's capital expenditure.

Table 8: Debt and Equity Requirements.

DESCRIPTION	ETHIOPIA (US$000)	ETHIOPIA (%)	SUDAN (US$000)	SUDAN (%)	TOTAL PROJECT
Equity	5,806	20%	96,988	20%	-
Senior Debt	23,224	80%	290,964	60%	-
Zero-Coupon Bond	-	-	96,988	20%	-
Total Capex (Excl. Vat)	**29,030**	**100%**	**484,940**	**100%**	**513,970**
Vat Facility	4,355	15%	82,440	17%	86,794
Total Capex (Incl. Vat)	**33,385**	-	**567,380**	-	**600,764**

An opportunity may exist for private sector lenders to provide loans to the two utilities that could be used to finance the senior debt portions of the Project, however, it is unlikely that private sector lenders would be able to lend at the rates modelled (i.e. 6% over a 20-year period). It is more likely that concessionary loans will need to be raised from development finance institutions (DFI) such as the African Development Bank (AfDB), World Bank and the Green Climate Fund (GCF) that would attract concessionary interest rates that are closer to those assumed by the Feasibility Study.

Since the Project will allow Sudan to replace thermal generated electricity with hydro-electrical generated electricity, the Sudanese section of the Project may be able to raise a combination of concessionary loans and grants from the GCF, given the CO_2 benefits that are likely to arise. The GCF could also potentially act as a guarantor to reduce the funding costs offered by other DFIs or commercial lenders to the two utilities. To obtain green climate funding, the Project will need to quantify the carbon emission reductions that will be generated by the Project as part of a funding application.

The zero-coupon bond that has been modelled for the Sudanese section of the Project offers an opportunity for local and regional institutional investors, with an appetite for Sukuk financing, to provide around US$97 million of funding. The yield assumptions used in the Feasibility Study will however need to be tested with institutional investors as it is significantly lower than yields achieved on a 2012 Sudanese Sukuk issue.

Market soundings should be undertaken with DFIs, the GCF and institutional investors to test the funding terms used in the Feasibility and the financial models should subsequently be updated with market tested funding terms. The updated model should allow the two utilities to conclude on the affordability of the Project and the impact on each country's tariff price path.

5. ENVIRONMENTAL, SOCIO-ECONOMIC IMPACT AND RESETTLEMENT

Environmental & Social Impacts

To minimise the negative impacts of the Project while enhancing the positive impacts, an **Environmental and Social Management Plan (ESMP)** framework has been adopted. This plan is based on a **preliminary Environmental and Social Impact Assessment (pre-ESIA)**, which identified potential impacts related to the implementation of the Project – both during the construction and operational phases. These impacts were classified into the following groups, namely: social impacts, air and dust emissions, biodiversity and ecosystems, avifauna, water use and discharge, hazardous material use as it impacts on soil and groundwater recharge, noise and other nuisances, solid waste and wastewater, visual and aesthetic impacts, tourism and cultural heritage, and electro-magnetic fields.

The ESMP recommends mitigation measures to manage and reduce these potential impacts to minimal or insignificant levels. For each construction or operational risk identified, a series of specific mitigation actions is presented. The Plan also recommends creating a management structure to address the concerns of stakeholders, and to establish an M&E programme for environmental management practices[27] during all phases of development. In addition, the ESPM aims at identifying measures that could optimize the beneficial impacts of the Project.

Resettlement Considerations

Among the risks identified, the Project considered the social risk of resettlement as being particularly serious. According to the pre-ESIA, neither dwellings nor people will need to be resettled within the right-of-way (ROW) of the proposed alignment, whose width is approx. 56m. However, one cannot exclude this condition, as it may it may still be valid by the time construction works commence. Therefore, a **Resettlement Action Plan (RAP)**[28] has been developed[29]. The Plan meets the requirements defined by the Governments of Ethiopia

27 Such practices must be compliant with the ESMP, and aligned with the principles of Integrated Environmental Management.

28 The RAP is an information-gathering and analytical process that helps ensure that the Project will have minimal impact on communities.

29 The RAP has been developed through a series of activities: a desk review, environmental and social field surveys, a broad consultation with relevant Project stakeholders, and a land compensation calculation on a sample household. Synergies between this Project RAP and the Renaissance dam RAP (a RAP developed for people that will be resettled after the inundation of the Renaissance dam basin) will be explored. Successful initiatives of the Renaissance dam RAP (around rural electricity developments for example) might also be replicated in the Project area.

and Sudan, in relation to physical resettlement requirements and the requisite financial compensation.

After evaluating risks that may be experienced by Project-affected communities, the RAP suggests actions to minimize damage and/or loss of life and property. These risks include adverse physical and/or economic impacts, temporary or permanent displacement, as well as temporary or permanent loss of assets, facilities or access to resource such as crops, woodlots, grazing lands, wells, businesses and services, etc. The RAP aims at ensuring that the losses incurred by affected people are readdressed; importantly, it aims at ensuring that these people are assisted in the development of their social and economic potential, in order to restore (or even improve) their income and living standards to pre-Project levels.

6. GOVERNANCE & RISKS

6.1 GOVERNANCE STRUCTURE

According to the Feasibility Study, there are four core components to the governance of the Project, namely: (1) the legal right given to the utilities to construct and operate, (2) the EPC contract(s) for implementation of the Project, (3) an operation and maintenance (O&M) agreement(s) over the design life of 35 years, and (4) the financing and security agreements to fund the development of the Project. Each is briefly noted as follows:

- **A legal right**, giving the State utilities the right to construct and operate, as foreseen in the National laws establishing the respective State-owned companies.
- **A construction contract**, governing the construction of the transmission line via an EPC contract which will allow for a maximum transfer of risk to the private sector and which will ensure a single point of responsibility.
- **An operation and maintenance (O&M) agreement**[30], covering a significant portion of the power transmission line's life.
- **Financing and security agreements**, between EEP, SETCO and their respective lenders, to finance the development of the Project.

6.2 PROJECT RISKS

The Feasibility Study highlights two sets of project-related risks in the ESMP, namely construction risk and operation risk. These risks have been unpacked and assessed in the study, and ten salient risks for each set is recorded in Table 9.

30 To draft Operation & Maintenance Agreement the consultant's recommendation is to follow the "ENTSO-E14 Operational handbook".

Table 9: Salient project-related risks.

CONSTRUCTION	OPERATIONS
Air emissions from construction equipment.	Air emissions from maintenance equipment.
Dust emitted during site preparation.	Permanent interferences between the project and local habitats.
Greenhouse gases emission from vehicles, trucks and transformers.	Tree cutting along the ROW.
Potential degradation and damage of the existing structures (including any archaeological materials) and terrains due to excavation, trampling linked to vehicle traffic, installations of pylons.	Collision of birds with conductors.
Vegetation clearance along the row.	Minimal water demand during the operational phase due to maintenance activities.
Temporary interferences between the project and local habitats, especially migratory bird species (e.g. Noise, dust emissions, habitat clearance, etc.).	Contamination from use of PCBs.
Construction activities may interfere with natural drainage systems and modify flow of surface water.	Use of pesticides to control vegetation growth during ROW maintenance.
Impact on water bodies from effluent discharge.	Audible noise resulting from corona effect and conductor Aeolian vibrations.
Use of water for concrete preparation, watering roads and paths before compaction and to support construction activities.	Visual intrusion of a 500kV power line on existing views of sensitive visual receptors (inhabited areas).
Hazardous industrial waste: oil and other lubricants resulting from routine maintenance of generators.	Possible adverse community health and safety effects from electromagnetic fields.

7. KEY PROJECT MILESTONES

Figure 4 illustrates the project preparation milestones and target dates under a public finance model to before achieving financial close.

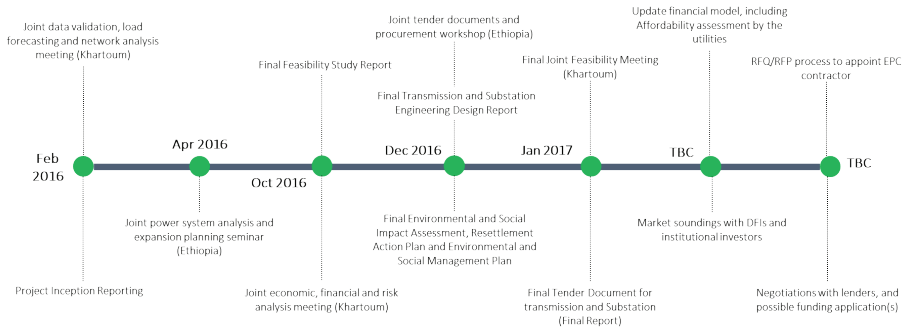

Figure 4: Project preparation milestones and target dates to achieve financial close.

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Eng. Mustafa M Ahmed, Infrastructure Technical Expert at Intergovernmental Authority on Development (IGAD). Correspondence on project-related questions between 31st October – 9th November 2017.

VERSION CONTROL

VERSION NUMBER	DATE	PREPARED BY	REVIEWED BY
VERSION 1	10 November 2017	Pegasys	IGAD, NEPAD Awaiting feedback from SETCO and EEP.

DISCLAIMER

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