



ADDIS ABABA UNIVERSITY

COLLEGE OF BUSINESS AND ECONOMICS

DEPARTMENT OF MANAGEMENT

**ASSESSEMENT OF OPPORTUNITIES AND CHALLENGES OF
ELECTRICITY EXPORT (THE CASE OF ETHIO - SUDAN)**

BY

KBREAB AFEWORK

OCTOBER, 2015

Addis Ababa

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**A Research Project Submitted to College of Business and Economics,
Department of Management of Addis Ababa University**

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DECLARATION

I, the undersigned, declare that this research project is my original work, has not been presented for a degree in any other university and that all sources of material used for the research project have been duly acknowledged.

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ENDORSEMENT

This research project has been submitted to Addis Ababa University, College of Business and Economics, Department of Management for examination with my approval as a university advisor.

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Abbreviations

CAPEX: Capital Expenditure

EAPP: Eastern African Power Pool

EEP: Ethiopian Electric Power

EEPCo: Ethiopian Electric Power Corporation

EEU: Ethiopian Electric Utility

GW: Giga Watt Hours

ICA: Infrastructure Consortium for Africa

IEA: International Energy Agency

IEO: International Energy Organization

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Abstract

This paper focuses on assessment of opportunities and challenges of electricity export - the case of Ethio-Sudan. As its focus is in electricity export to Sudan which is a newly emerging business area to Ethiopia, the study carried out different activities so as to collect primary and secondary data from different sources respectively through interviewing the designated officials of EEP and EEU and focal persons discussion along with working documents like power purchase agreement, Minutes of Understanding(MoU), Minutes of meeting in different times to negotiate and discuss on issues about the export, financial statements EEU for four years since its start is too short to take data beyond four years.

Extensive literature survey was undertaken to underpin the opportunities and challenges regarding the export so that they can be synchronized with what is actually being experienced in the case under this study.

The research has identified opportunities such as very competitive cost (tariff rate -5 against 13.18 USD cents in east African countries)by which the electricity revenue is to be aggressively increased, abundant resources and excess supply within, unsatisfied demand in neighboring country-Sudan. Moreover, the interconnection increases energy security and reliability, stability, peace and security along with the developing their national economy.

On the other hand, the paper has outlined that electricity export is being challenged by unsatisfied domestic demand, inadequate generating capacity and reserve margin due to the huge infrastructural facilities it demands, lack of managerial skill for such activities. Moreover, the intangible social resettlement cost as well as lots of acres of land used for hydropower dam construction remained to be an opportunity cost for the exporting country-Ethiopia and an opportunity to Sudan.

Finally, the research forwarded recommendations based on the findings of the study as follows; Since Ethiopia remains to be a net exporter of electricity to Sudan, it is better to insist on developing generating capacity, managerial skills to administer the contract, utilize the foreign and internal source of finances and aggressively engage in the export activity even with other neighbor countries like South Sudan, Kenya, Djibouti, Eritrea, and others so as to create a new capital in hard currency as major additions to GDP.

Key words: *Hydropower, Tariff, Electricity, Revenue, Megawatt hours, Energy, Transmission lines, Cross border, Substations, transformers, Financers, GDP.*

Chapter 1: Introduction

In this chapter, background of the study, statement of the problem, research questions, and objectives of the study, limitations of the study, significance of the study and organization of the study will be presented.

1.1. Background

Generally export by default has its own opportunities and challenges. Specifically, electric power energy export would have extreme opportunities and challenges. Energy export is widely known in the countries such as North American countries, South African countries and so on. In eastern part of Africa, in general, and, particularly, in Ethiopia where frequent power interruptions prevail, energy export is uncommon. Let alone the energy export which demands constructing an initial huge electricity infrastructure like generation dams, cross national transmission lines, substations, distribution lines, and international managerial skills, commodity exports which are initially cost free transactions are rarely carried out among African countries in general and among east African countries in specific terms. (EAPP,2008)

In the developed countries, the practice is different from that of the developing ones i.e. countries with an abundance of oil, gas, coal or other energy sources, and the ability to refine and produce, will tend to have high electricity production levels, and will often export excess supply. Countries with large populations and growing economies will tend to have growing consumption requirements, needing to import both fuel and electricity. Disruptions or threats to that supply challenges countries' 'Energy security'. When consumption exceeds production, blackouts and civil unrest are likely (Regional Power Sector Integration/ Briefing Note 004/10, 2010)

Ethiopia is a country of Abay and other rivers which have the capacity of generating up to 1.4million MW electric energy from different sources. 50000MW from hydro, 1.3million MW from wind and solar and more than 10000 MW from geothermal sources. This potential makes the country see the alternatives to export the surplus energy to those neighboring countries which are highly demanding the energy for day to day consumptions. This is not only exporting surplus energy but in doing so, the country generates revenues that stimulate the growth of the economy (Annual Report of EEPCo, 2006E.C).

1.2.Statement of the problem

Despite a fairly adequate endowment with energy resources, Africa is lagging behind other developing regions in terms of access to reliable and affordable commercial energy supplies, in particular electricity, required to put the whole continent on the path of economic growth and sustainable development. With slightly over 13% of the world's population, Africa accounts for only 3% of the world's total commercial energy consumption (United Nations Economic Commission for Africa (UNECA) report on Sustainable Development Report on Africa, 2011, pp 99)

According to the 2010 report of International Energy Agency (IEA), sub-Saharan Africa has the lowest electrification rate of any major world region with only 24% of its population electrified in 2008.

According to ICA Nov. 2011 in its report of Regional Power Status in Africa Power Pools, access to electricity in all African countries is still very low: 31% of the countries have an electrification rate below or equal to 10%. Nearly 70% have an electrification rate below or equal to 30%. As far as power trade is concerned (mainly within power pools), electricity traded is still low for CAPP (0.2% in 2009) and in EAPP (0.4% in 2008).

Having the above challenges and electrification gap, Ethiopian Electric Power Corporation, which is currently divided into two legal entities (Ethiopian Electric Utility –EEU and Ethiopian Electric Power-EEP), the designated government body to generate, transmit, distribute and sale of electric energy throughout the nation and abroad has just started exporting electricity to Djibouti, Sudan and Kenya.

The controversial issue here is that on one hand there is unsatisfied domestic demand, yet the country is exporting a portion of its produced energy to earn foreign currency on the other. Although electric energy export has power of switching the trade balance in favor of the exporting countries, Ethiopians so far are complaining of frequent black outs and power rationing as well as on the services being provided to them by EEP Co. Whatever the reasons might be, voltage drops, informed and uninformed power interruption, bill management problems are among the frequent unhealthy trends of internal electric power services Eastern Nile Power Trade Program Study /E-S-CIST-DS-08-218/ December 2008).

However, the Corporation has been monitoring the issues regarding the export data collected, bill settlement, and maintenance of the power lines crossing the border according to the contract signed between Ethiopia and the respective countries (Kenya, Djibouti, and Sudan) and it is on the way to do so with other respective countries like Somali land, Yemen.

According to the World Bank Report 2014, the Ethiopian economy has been one of the fast growing economies in the world. This behooves the country to sustain the energy supplies without which prosperity and economic growth of the country is unthinkable. In line with this, an aggressive move towards construction of hydroelectric dams is inevitably important. Accordingly, these days, the Ethiopian Government is busy in constructing various electric power infrastructures.

Considering all these facts, the country has been involved in Mega and large hydroelectric power generating projects. Hence it is timely and appropriate to study the opportunities and harvest the fruits thereof via appropriate policies and actions. It is also imperative to properly identify challenges so as to tackle them by properly trading off between internal demands which foster the domestic economy with exports that earn hard currency (Compendium of Best Practices in Utility Regulation 2012).

1.3. Research Questions

The general and specific research questions for this study are

1. What are the opportunities of exporting electricity to Sudan?
2. What are the challenges of electricity export from Ethiopia to Sudan?

1.4. Objective of the Study

1.4.1. General objective of the study

The general objective of this study is to assess the opportunities and the challenges of electric power export from Ethiopia to the republic of Sudan and suggest possible remedial actions.

1.4.2. Specific Objectives of the Study

The specific objectives of the study are to:

- a) Assess the opportunities in exporting electricity to Sudan, and
- b) Assess the challenges to export electricity from Ethiopia to Sudan,

1.5.Limitations of the Study

As the subject of the matter is relatively new to the country, data which are very important for the study is not be available in the required quantity and quality. The data involved and the information required are mainly of the nature of commercial and trade secret, hence, officials refrain from exposing such critical information.

Moreover, the two companies called Ethiopian Electric Utility (EEU) and Ethiopian Electric Power (EEP) are recently (one year ago) reformulated from Ethiopian Electric Power Corporation (EEPCo). This poses a challenge to find out fresh and deep information from the newly reformulated companies and their managers as well.

Time is also another limiting factor in this study by which the study is forced to use data on the issue of Sudan's demand of electricity from websites of National Electric Company of Sudan (NEC).

1.6.Scope of the study

Though the country has been engaged in exporting electricity to the neighboring countries like Djibouti, Kenya and Sudan which currently have signed an official overall contract with Ethiopia, this paper will focus only on the opportunities and challenges of export of electric energy to Sudan through the electric line infrastructures constructed and regulated based on the international standards.

1.7.Significance of the study

Currently Ethiopia is building large hydropower dams, wind turbines and other related infrastructures to generate and distribute electricity. Following these significant developments in the area a critical assessment and empirical study will inform and update those with interest in the subject matter. Hence this study will

- Identify and analyze the challenges and opportunities in connection with electricity export so that the country can fill the gap in managing and harnessing the fruits out of it.
- Findings of the study will be used as an input in the formulation of policies and strategies on the subject.
- Be an input for further study in hydroelectric power export.

1.8.Organization of the research

Chapter 1 of the paper introduces the back ground and discusses statement of the problem, the research questions, objectives, scope, limitations, significance of the study and organization of the paper will be laid out. In Chapter 2 literature review to establish conceptual framework for the study will be presented .In Chapter 3 research methodologies that will be employed in the study. In addition, research methods and tools of analysis will be discussed in this chapter. Chapter 4 will deal with results and discussion of data including summary of key factors. Conclusion and recommendation will be presented in chapter 5 of the study.

Chapter 2: Literature Review

2.1. Introduction

Electricity is perhaps the most versatile energy carrier in modern economies, and it is therefore fundamentally linked to human and economic development. Electricity growth has outpaced that of any other fuel, leading to ever-increasing shares in the overall mix. This trend is expected to continue throughout the following decades, as large—especially rural—segments of the world population in developing countries start climbing the “energy ladder” and become connected to power grids (Energies ISSN 1996-1073).

2.2. Review of literature

(a) Electricity systems

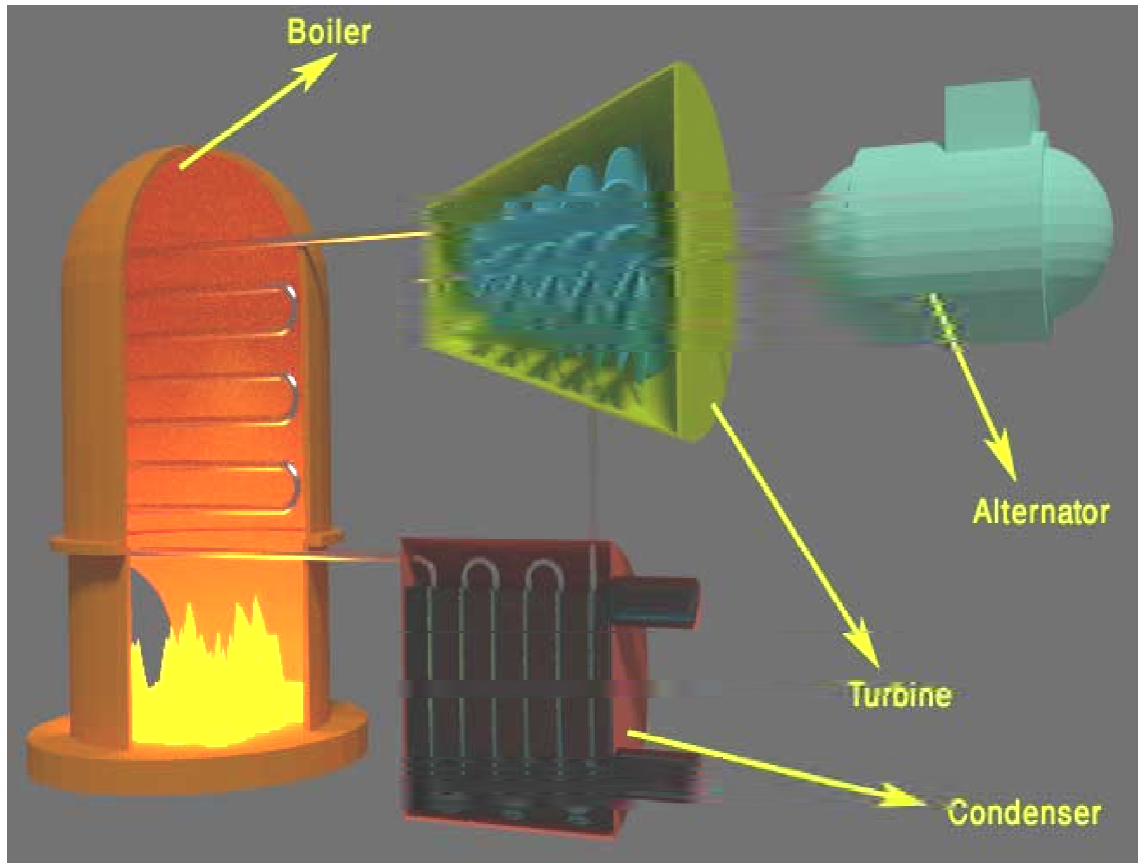
The primary aim of the electricity system is to generate and transmit electricity according to where and when it is demanded. Ensuring that supply and demand are always in balance, and therefore the integrity of the system is protected, currently relies primarily on the availability of sufficient generation that is predictable, controllable and can be operated flexibly in order to react to fluctuations in demand and supply shocks. It also requires a fit for purpose network to ensure that electricity can be moved around the system efficiently and securely (Department of Energy & Climate Change-London- 9 August 2012).

(b) Electricity Generation

There are mainly three conventional source of electric power generation, and they are thermal, hydro, and nuclear energy. As the major percentage of the electricity being generated in Ethiopia and Sudan is from hydropower, thermal and wind sources, the study will be focusing on hydropower, thermal and wind generation while dealing with the course of electricity generation. However we will briefly discuss the major categories in order to show its complexity and time consuming activities are carried on to bring power in to reality.

1. Thermal Power Generation

In a thermal power plant fuel is burnt to produce sufficient heat and this heat energy is utilized to produce high temperature and high pressure steam in a boiler. This steam is then passed through the turbine blades and the turbine shaft rotates due to this steam pressure. The rotor of an alternator is mechanically coupled with the turbine shaft and hence it also rotates. This rotation produces electric power (<http://electrical4u.com>)



Source: <http://electrical4u.com>

Fig 1: Basic Component of Thermal Power Generating Unit

Unlike Ethiopia, Sudan operates mainly thermal plants. They use paramount of coal to fuel the boiler due to which the running cost of thermal power plants is relatively higher than that of hydroelectric power generation dams. In addition, since thermal plants are not environmentally friendly in operating, Ethiopia in using hydropower sources will enjoy a greater opportunity to export electricity to Sudan at a competitively lower cost.

2. Hydropower Generation

In hydropower generation of electricity water head is used to rotate the rotor shaft of an alternator that will eventually generate the electricity. Water head can be naturally available or it can be created. In hilly regions, water head can be naturally available in the hill top natural lakes. In plain land, it can be created by constructing dams across suitable rivers.

In comparing to a thermal power plant, hydropower plants are more eco-friendly as they are free from fuel combustion. Also the running cost of hydropower plant is much cheaper than that of thermal plants as there is no need of fuel to be burnt. Although running cost of a hydro power plant is quite low, but initial constructional cost of this plant is quite high as compared to thermal power plant. As there is huge involvement of money in construction of dams and other necessary civil buildings. (<http://electrical4u.com/electric-power-generation/#Frequency,-Voltage-and-Interconnected-System>).

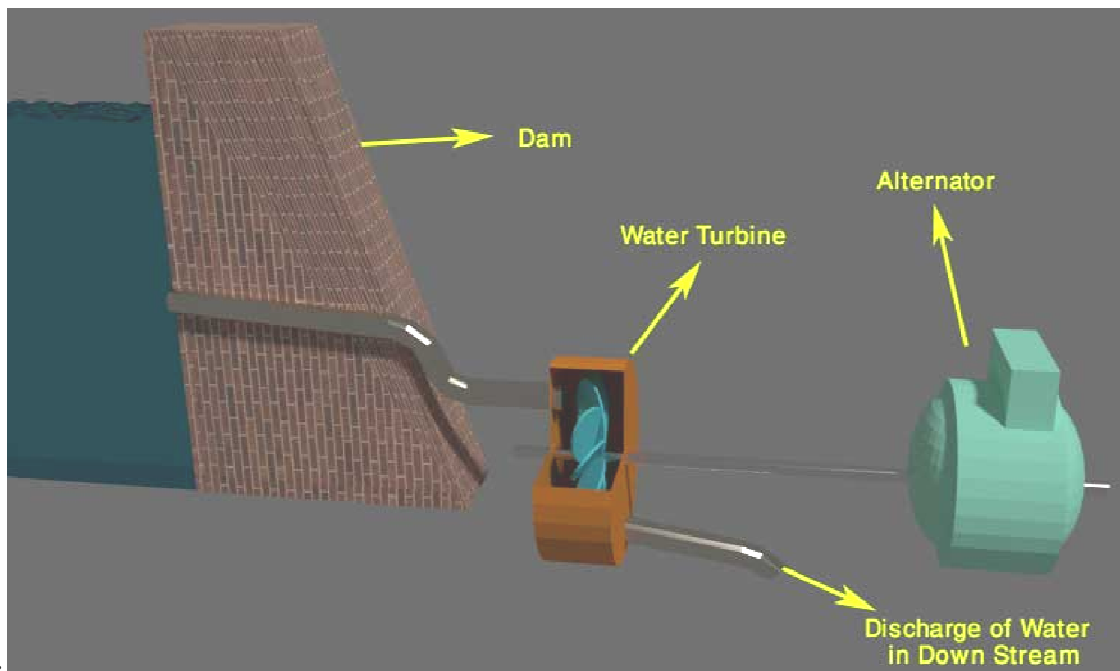


Fig 2: Basic Components of a Hydropower Generating Unit

Source: <http://electrical4u.com>

This assures that Ethiopia unlike Sudan can construct hydroelectric dams with a relatively higher initial cost and very low running costs once it is commenced its operation.

(c) SWOT Analysis

In this section, strengths and weaknesses which are internal factors to be considered as an input for electricity export will be shown simultaneously with the external factors which are opportunities and threats of the country in general and for EEP and EEU in particular.

<i>Strengths</i>	<i>Weaknesses</i>
• Due attention given by the government for electricity export • EEPCo is divided in to two independent companies for easy manageability • Encouraging policies for private investors to involve in power generation activity. • The economic development which enables the country to exploit its natural resources	• Lack of managerial skill in the area of energy export and contract administration of same. • Frequent domestic power interruption due to old and un standardized distribution systems throughout the country • Lower electric access in the nation
<i>Opportunities</i>	<i>Threats</i>
• Lower running cost of Hydropower dams once they are in operation. This gives Ethiopia the leverage to export electricity to Sudan at an affordable and stable cost. • Since Ethiopia's topography is convenient for hydropower sources, it is viable and environmentally friendly over other sources. This gives an advantage over Sudan which utilizes coal and fuel to generate much of its electricity consumption. • Unsatisfied demand in Sudan. • Competitive electricity tariff in the region • Economic value in generating hard currency despite its lower tariff rate • Electricity export can help create regional integration leading to peace and energy security, trust among nations	• Seasonal drought and reduced water levels of the reservoirs leading to insufficient power generation • Huge initial investment cost of hydroelectric dams and other infrastructures along with the associated difficulty to source the financing cost. • Constructing hydroelectric dams require lots of acres of land that could have been used for agricultural sector. • Social costs such as resettlement of the people residing in and around the area of the dam. • Sudan's capacity to generate power for its own electric consumption.

Table 1: SWOT analysis

(d) Opportunities of power trade

i. Competitive tariff rate in the region

The report of the International Energy organization in 2010 stated that the concerns about environmental consequences of green house gas emissions has led to renewed interest in renewable energies like hydropower and nuclear energies. Based on the rapid increase in world energy price during 2003 to 2008, the report estimates that the long term prospects continue to improve for generation from both nuclear and renewable energy sources—

supported by government incentives and by higher fossil fuel prices.

A recent study by the Regional Electricity Regulators Association show average tariffs ranging from less than 4 USc/kWh (South Africa and Malawi), to between 4 and 7 USc/kWh (Botswana, Mozambique, Namibia, Swaziland and Zambia), and above 8 USc/kWh (Angola and Tanzania)

If we see the tariff out of Africa, the electricity prices in the private wholesale market in Turkey are among the highest in Europe. The average private wholesale price was 12 USc/kWh in 2008 though falling in the latter half of the year to 9,2 USc/kWh in December 2009.

Comparing to Ethio Sudan Tariff, it is very lowest of all the countries. It is 5USD cents per KWh. (PPA between Ethiopia and Sudan, 2012)

ii. Abundant resources and excess supply

According to The Green Energy Task Force's report, released by the US government in April 2010, it was generally very optimistic about the benefits of pursuing electricity exports, especially given the increasing demand for low-carbon energy. The province's most important asset, according to the task force, is its hydroelectric storage capacity that allows it to help its own and other jurisdictions cope with the fluctuations in power supply created by increasing reliance on intermittent sources of renewable power.

Mr. P. Niyimbona,(2005) in his presentation on the issue of "the challenges of operationalizing power pools in Africa" has stated that out of Africa, hydropower energy is accumulated in Central and Eastern Africa with highest potential in DRC, Ethiopia and Cameroon respectively. And geothermal energy in East Africa region (Kenya, Ethiopia and Djibouti) respectively.

The abundant hydroelectric power generation resources enable Ethiopia to be a net exporter of electricity to neighbor countries particularly, to Republic of Sudan, if it optimally utilizes its hydroelectric surplus. Because, Ethiopia is a country of Abay and other rivers which have the capacity of generating up to 1.4million MW electric energy from different sources. 50000MW from hydro, 1.3million MW from wind and solar and more than 10000 MW from geothermal sources.

This potential makes the country see the alternatives to export the surplus energy to those neighboring countries which are highly demanding the energy for day to day consumptions.

This is not only exporting surplus energy but in doing so, the country generates revenues that stimulate the growth of the economy. Annual report of EEP Co for 2006 EFY.

Though Ethiopia has abundant resources its name is listed at a very lower rank in the index of exporting countries at 126th among 192 countries. Even out of African countries, only South Africa is listed at 13th and Egypt at 47th in the top 50 exporters list. This is an indication of unutilized demand in Africa in general and east African in a specific term. (Refer Annex VI and VII)

➤ **Electricity Generation in Ethiopia**

In Ethiopia, source of electricity ranges from the traditional combustible materials to the modern and technology intensive hydro power, Wind and Geothermal energy. (Mersea Kidan 2010)

For this study, hydropower generations are widely reviewed since their contribution to the total energy generated throughout the country is inevitably and unquestionably substantial. In the following sections lists of in service and under progress hydroelectric dams are cascaded for reflecting its abundance and the efforts made by Ethiopian government for its development.

Table2: List of in service hydropower projects

No.	Hydroelectric station	Type	Capacity(MW)	Year completed	Name of reservoir	River
1	Tis Abay I Power Station	Reservoir	12	1953	Lake Tana	Abay River
2	Koka Power Station	Reservoir	43	1960	Lake Gelila	Awash River
3	Awash II Power Station	Reservoir	32	1966	Lake Koka	Awash River
4	Awash III Power Station	Reservoir	32	1971	Lake Koka	Awash River
5	Fincha Power Station	Reservoir	134	1973		
6	Melka Wakena Power Station	Reservoir	150	1989		
7	Sor Power Station	Reservoir	5	1990		

No.	Hydroelectric station	Type	Capacity(MW)	Year completed	Name of reservoir	River
8	Tis Abay II Power Station	Reservoir	73	2001	Lake Tana ^[2]	Abay River
9	Gilgel Gibe I Power Station	Reservoir	184	2004	Gilgel Gibe Reservoir	Omo River
10	Tekeze Power Station	Reservoir	300	2009	Tekeze Reservoir	Tekeze River
11	Gilgel Gibe II Power Station	Run of river	420	2009	Gilgel Gibe Reservoir	Omo River ^[3]
12	Beles Power Station	Reservoir	460	2010		Lake Tana/Beles
14	Fincha Amerti Neshe	Reservoir	100	2013		
	Total		1,945			

Table3: List of under construction or proposed hydropower projects

Hydroelectric station	Type	Capacity (MW)	Estimated Year to complete	Name of reservoir	River
Gilgel Gibe V	Reservoir	660			Omo River
Grand Ethiopian Renaissance	Reservoir	6000	2018		Blue Nile River
Halele Worabesa	Reservoir	440	2015		Omo River
Chemoga Yeda	Reservoir	278	2015		
Gilgel Gibe III	Reservoir	1870	2013		Omo River
Gilgel Gibe IV	Reservoir	1472	2014		Omo River
Total		10,060			

Source /WWW.eepco.gov.et

Comparing to Sudan's potential, the hydropower generation capacity of Ethiopia including

the projects under process which are to be operational by 2018 exceeds that of Sudan. This, in return, can be exported to Sudan at a regulated slack hour of the local demand.

iii. Energy security, reliability, Stability, peace and security

Lots of studies have assured that countries which are connected to others through electrical transmission line have been earned lots of financial benefits in addition to the energy security, stability, and trust among each other, reliability and socio political integrity as well. (EAPP-2011), (UNCA,2010) , and (African Power Pool, 2010)

“In line with the increasing world demand of electricity, it is increasing for African in general and east African countries in a specific term. By 2012 shows that above 75% of the population in East African countries are not able to access electricity like those who have been enjoying the pros and cons of electricity. ” International Energy Outlook, July 2010.

According to EAPP-Final master plan, SNC Lavallin and Parsons Brinkerhoff, May 2011, in 2008, power generation in EAPP member countries grids is estimated at 148,700Gwh out of which Egypt alone represents 86.6% of total generation, followed respectively by Kenya4.3%, Sudan 3.7%, Tanzania 2.8% and Ethiopia 2.6%.

However, with respect to Ethiopia and Sudan, since they were not connected to any countries until 2011, they have lost the benefits mentioned above despite their start in 2012 to connect to each other

Accordingly, Ethio-Sudan interconnection is a promising deal so that they can wisely and optimally utilize their natural resources along with the additional energy security, reliability, trust and security in between. . ICA,Regional Power Pools Report,(November 2011)

(e) Challenges of power trade

i. Cost of constructing a hydroelectric Dam

The table below is a rough ballpark estimate of typical project costs for systems requiring an ‘average’ amount of civil engineering works and grid connection upgrades and assuming access to the site was reasonable. In all cases it is assumed that good quality hardware is used throughout, which we would recommend anyway if you want a reliable hydro system in the long-term. (<http://www.renewablesfirst.co.uk>)

Maximum Power Output	Estimated Project Cost	£ / kW installed
5 kW	£100k	£20k
25 kW	£190k	£7.5k
50 kW	£330k	£6.5k
100 kW	£560k	£5.6k
250 kW	£1.13M	£4.5k
500 kW	£1.86M	£3.7k

Table4: Cost of constructing a hydroelectric Dam

Source: <http://www.renewablesfirst.co.uk/hydro-learning-centre/how-much-do-hydropower-systems-cost-to-build/>

From the above table, in average 1MW (1000KW) power output will cost \$3,950.881 i.e. £3.7k divide by 0.9365 using the exchange rate of 21st November 2015 which is \$20.9658 is equivalent to £22.3873 (or £1=\$0.9365) – source of the exchange rate, Zemen Bank Sc. Mobile banking.

However, in order to highlight the cost of construction of hydroelectric dam in the Ethiopian current context, one can refer to the fact that the Great Ethiopian Renaissance Dam(GERD) being built on the river Abay is estimated to cost 4.8billion USD (close to Birr 100billion) This cost by far exceeds the average cost mentioned above. Financing for such big investment cost by itself pose a great challenge for Ethiopia.

ii. Electricity transmission infrastructure

Once the electricity is produced, it must be delivered to where it is needed homes, schools, offices, factories, etc. The electric sources are often in remote locations and the power must be transmitted over some distance to its users. Vast networks of transmission lines and facilities are used to bring electricity to us in a usable form. All the electricity made at a power plant comes first through transformers which raise the voltage so it can travel long distances through power lines. Voltage is the pressure that forces an electric current through a wire. At local substations, transformers reduce the voltage so electricity can be divided up

and directed throughout an area. RECI, (2000)

Transformers on poles or buried underground, further reduce the electric power to the right voltage for appliances and machineries. This process makes the electricity infrastructure extremely complicated and time consuming in addition to its cost.

iii. Cost of cross border transmission Lines

Investment in transmission lines is a capital-intensive business, usually costing from millions to billions in US dollars. Table 1 shows the capital expenditure (CAPEX) of some typical projects undertaken in the ASEAN countries, using data from ADB. The average cost of a transmission line in megawatt per kilometer (MW/km) terms decreases as the length and capacity of the line increases.

Case	Voltage	LineLength (km)	Capacity	CAPEX (US\$)	\$/MWh*
1	500 kV	200	500	167,200,000	9.1
2	500 kV	400	500	297,900,000	16.1
3	500 kV	200	1000	242,000,000	6.6
4	500 kV	200	1000	152,400,000	4.1
5	500 kV	400	1000	449,500,000	12.2
6	500 kV	200	2000	312,100,000	4.2
7	500 kV	200	2000	292,200,000	4.0
8	500 kV	400	2000	732,500,000	9.9
9	500 kV	400	2000	630,800,000	8.5

Table 5: CAPEX of Power Transmission Lines in the ASEAN Context Case

Source: Infrastructure Investments for Power Trade and Transmission in ASEAN+2: Costs, Benefits, Long-Term Contracts, and Prioritized Development

Taking the above benchmark cost of cross border transmission lines, for instance case 2, to transmit 50MW energy over a length of 400km would require a potential capital investment of 29,790,000 USD. This huge sum of money poses a great challenge for Ethiopia as an exporter unless international financiers intervene to finance such projects.

iv. Unsatisfied domestic and neighbor countries' demand

When we see the demand of electricity in east Africa - a region which includes Ethiopia, one can conclude that it still remains unmet. Let us see the figure below:

According to EAPP-Final master plan, SNC Lavallin and Parsons Brinkerhoff, May 2011, in 2008, power generation in EAPP member countries grids is estimated at 148,700Gwh out of which Egypt alone represents 86.6% of total generation, followed respectively by Kenya 4.3%, Sudan 3.7%, Tanzania 2.8% and Ethiopia 2.6%. As a result of this master plan Ethio-Sudan interconnection is a promising deal so that they can wisely and optimally utilize their natural resources.

“In line with the increasing world demand of electricity, it is increasing for African in general and east African countries in a specific term. 75% of the population in East African countries are not able to access electricity like those who have been enjoyed the pros and cons of electricity..” International Energy Outlook, July 2010.

Therefore, Ethiopia will enjoy the unmet demand of its neighboring countries in east Africa specifically Republic of Sudan by exporting surplus energy to it. But 70million Ethiopian population is living without access to electricity despite its plan to be a net exporter of power in the region. So, this is a challenge for the country during the activity of exporting electric energy to neighboring countries like Republic of Sudan.

On the other hand, the unsatisfied demand in the neighboring countries is an opportunity for Ethiopia so that it can have an unexploited energy market as it exports electricity to.

v. Lack of managerial skills in the field

Though it is known that interconnection projects in developing countries assume symbolic meaning managerial skills in the field are inevitably required.

The Eastern Nile Power Trade Program, December 2008 has critically reviewed and identified the managerial skills and the gap there on in such a way that the 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. But lack of adequate managerial skills challenge such a step forward collaboration to come up against issues of sovereignty, resistance to power sector reforms and privatization as well as serious capacity constraints. All these items have hampered the development and expansion of trans-

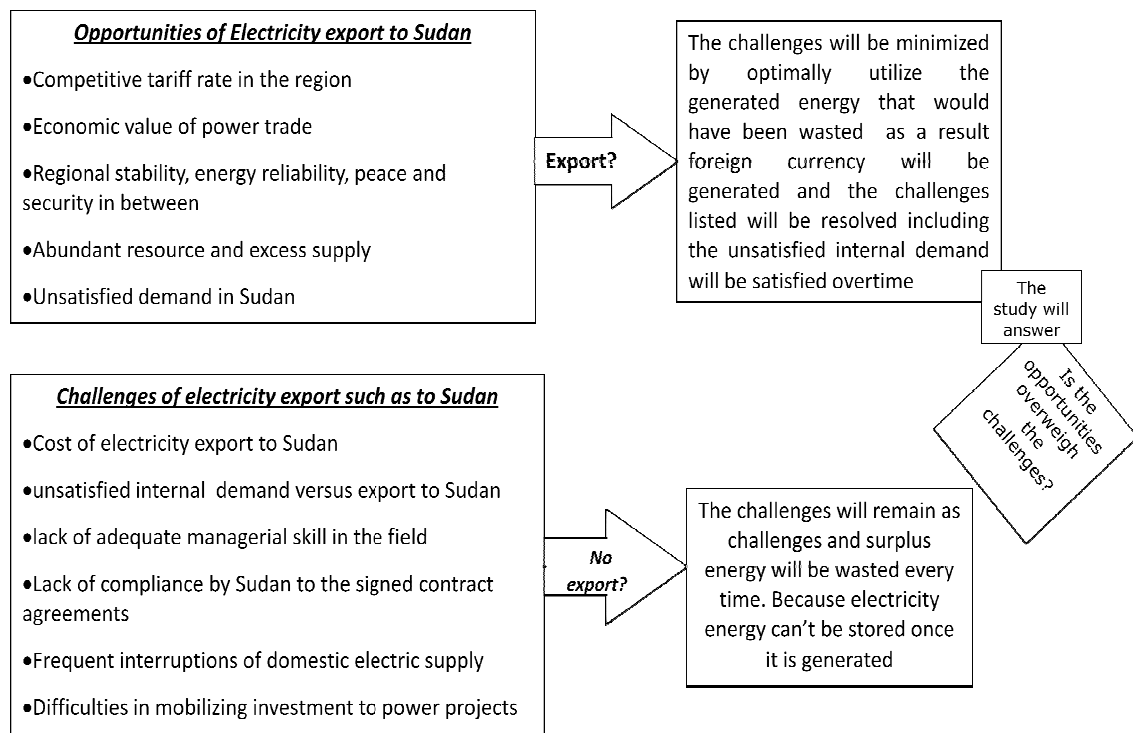
border grids and Power Pools in the region.

“Without appropriate management strategies, sub-Saharan Africa will be unable to learn and benefit from the energy efficiency practices that were innovated by, and are now integrated into, the leading economies of Western Europe and East Asia.” (L. Mohapelao, pp.9-41) and Ethiopia (M. Teferra, pp.42-84)

The problem of inadequate electricity supply is multifaceted: it includes a lack of generating capacity, rundown existing stock and limited transmission and distribution infrastructure. These problems are known to be resulted out of the poor managerial and leadership skills prevailed in the countries of sub-Saharan Africa *Compendium of Best Practices in Utility Regulation, February, 2012*

2.2. Conceptual...framework...of...the...study

Having the variety of literatures reviewed in the way mentioned above, the researcher has designed the conceptual framework of the study as follows. This can clearly show the starting of the assessment regarding opportunities and challenges of electricity export to Sudan up to the end of the findings that will be found out from the study.



Chapter 3: Research Design and Methodology

3.1. Introduction

In this chapter, research design and method, types and source of data, instruments of data collection and methods of data analysis will be presented.

3.2. Research Method and Research Strategy

This study applied descriptive research method. As the study focuses on electricity export from Ethiopia to Sudan, it employs a case study as a research strategy. The study applied descriptive method as it describes and interprets findings from secondary data. The study employed mixed methods i.e. both quantitative and qualitative.

3.3. Types and Source of Data and Instruments of Data Collection

3.3.1. Types and source of data

By and large, secondary data were used from published annual reports of EEPCo, EEU and EEP, literature review and other sources related to the study. Due to recent start of electricity export in Ethiopia, the study managed to get secondary data which covered four years (2005-2007 E.C.) after export to Sudan and one year (2004 E.C.) before export. In addition, primary data were collected through the interview administered questions.

3.3.2. Instruments of data collection

In addition to document review, interview-administered questions with five senior executives of planning and strategic department and four senior executives from energy management and international bill management department was conducted. The planning and strategic department is very relevant to this study as it is the basic unit which formulates export related strategies and the energy management and international bill management also engaged in handling all export contract administration including bill settlement issues.

As additional information, the study used the data taken from (<http://www.mbendi.com/indy/powr/af/su/p0005.htm>) for demand side or Sudanese power generation capacity and demand because of time and budget constraint. Since the sampling technique of the study being employed is convenience or purposive sampling, the researcher has taken the major contributors in the course of electricity export to Sudan as it is mentioned above.

3.1. Methods of Data Analysis

The study applied descriptive data analysis in a way that shows the average, percentage and graphs for the findings obtained from secondary sources.

3.2. Consistency

Triangulation of quantitative and qualitative analysis was made to ensure the consistency of findings.

3.3. Ethical issues

While undertaking interviews and discussions on the issue, the consent of respondents was obtained and the objectives, methods used and the demands of the study were informed. Respondents provided their response voluntarily and reassured that the privacy of their response was maintained. In addition, the integrity of data collection, analysis and reporting of results were maintained.

Chapter 4: Results and Discussion

In this section, the results and discussions of the study will be presented corresponding to each research questions being organized through the interview administered questions. During the interview and focus group discussion, since the respondents and participants of the focus group discussion have a direct know how of the issue under study, the opportunities and challenges of electricity export to Sudan are identified and discussed in the following sections. However, the demand side or Sudanese power generation capacity and demand is taken from (<http://www.mbendi.com/indy/powr/af/su/p0005.htm>), because of the time and budget constraint.

4.1. Opportunities in exporting electricity to Sudan

a) Competitive tariff rate

The table below shows a comparison of export tariff with the tariffs of domestic, African countries, and Europeans. In this study, the term “tariff” represents the unit price of electricity per kilowatt hour.

Eastern Africa - Comparative Tariff (cents USD/kwh)

Category of customers	Power provided	East African countries						
		Burundi	Rwanda	Sudan	Kenya	Ethiopia	Uganda	Mauritius
Social Tariff(E=100kwh/month)	1kw	3.7	13.99	3.4	9.7	4.25	23.74	8.42
Single phase domestic usage(E=200kwh/month)	2kw	3.82	13.99	9.88	13.5	5.09	24.79	10.04
	4kw	3.82	13.99	9.88	13.5	5.09	24.79	10.04
Tri-phase domestic usage (E=600kwh/month)	6kw	5.84	13.99	9.88	15.4	6.26	25.49	14.04
	10kw	5.84	13.99	9.88	15.4	6.26	25.49	14.04
Commercial +usage (E=1800kwh/month)	12kw	11.79	13.99	12.29	15.9	7.69	24.25	12.45
	15kw	11.79	13.99	12.29	15.9	7.69	24.25	12.94
Semi-Industrial & Motive power (E=2500kwh/month)	20kw	11.79	13.99	12.25	8.45	6.42	25.5	8.03
	25kw	11.79	13.99	12.25	8.45	6.42	26.26	8.53
Medium Voltage (E=35000kwh)	25kw	17.4	13.99	4.97	7.25	4.54	12.83	7.05
Average Tariff for all category of users		8.758	13.99	9.697	12.345	5.971	23.739	10.558

Table 6: Data taken from UPDEA General Secretariat, Comparative study of electricity

tariffs used in Africa, December 2009

Based on the above table, comparative tariff of East African countries, it is a very good opportunity for Ethiopia to attract neighboring countries so as to demand and import electricity with a discounted tariff. Out of the tariffs listed above Ethiopia's tariff is the lowest of all or around 50% decrease per kilo watt hour. Here, the domestic tariff i.e. the tariff which is levied on the consumers internally is being depicted.

Once again, let's compare the Ethiopian tariff levied to its internal users (in an average 5.971USD cents) with the export tariff levied on Sudanese, the internal tariff – 5.971 USD cents is still greater than that of the export which is 5 USD cents by about 0.971 USD cents. This shows that Sudan could benefit from cost of electricity imported from Ethiopia regardless of other intangible benefits. Hence, Sudan is strongly attached to Ethiopia to purchase a firm energy of 100MW or more in order to simply bring about an access of electrification to its population and for industrialization of the country itself.

As it is explained in [www.afdb.org/The High Cost of Electricity Generation in Africa](http://www.afdb.org/The%20High%20Cost%20of%20Electricity%20Generation%20in%20Africa) 18 Feb 2013, in 2010, the average effective electricity tariff in Africa was US \$0.14 per kilowatt-hour (kWh) against an average of US \$0.18 per kWh in production costs. Consumption is effectively subsidized, but with significant disparities among African countries. For example, while electricity tariffs in South Africa and Zambia are among the lowest in the world, prices in Djibouti and Gabon are among the highest globally. However, when we see the tariff out of Africa Continent, in 2010, the average effective tariff in South Asia was US \$0.04/kWh, while that for East Asia was US \$0.07/kWh.

Based on the above data, Ethiopia's electricity tariff internally and for export remains among the lowest in the world including Asian countries so that it can sustainably export its surplus power to Sudan and can create an additional demanding eyes on other countries surrounding it. It is why the neighboring countries other than Sudan like Kenya, Somalia; Yemen and Egypt has shown their interest to be engaged in power purchase from Ethiopia in the near future.

b) Economic value of power trade

In line with the tariff seen above, the economic value of power trade or electricity export to Sudan is valuable for generating foreign currency accumulation in the nation. International financiers and investors have started to grant it due attention and are encouraged to finance the mega hydropower projects in the country. Because they know the financial capabilities created from it enables the country to pay back its financing loans on demand of the stakeholders.

The following three in one table compare and contrast the revenue generated by export to Sudan with the total export and total revenue of the exporting company – EEU

Year	<i>Sudan</i>	<i>Djibouti</i>	<i>Kenya</i>	<i>Total export Revenue</i>	<i>Total revenue(with export)</i>
2004	-	111,017,093.99	-	111,017,093.99	3,993,564,567.41
2005	289,298,005.45	333,051,281.98	7,744,385.01	630,093,672.44	4,290,535,644.41
2006	399,604,572.84	460,040,555.98	10,697,245.07	870,342,373.89	4,959,706,887.19
2007	331,560,615.26	476,322,490.63	51,391,753.00	859,274,858.89	5,108,498,093.81
Total	1,020,463,193.55	1,269,414,328.59	69,833,383.08	2,359,710,905.22	14,358,740,625.41
Contribution Percentage in Export					
2004	-	100.00	-	N/A	N/A
2005	45.91	52.86	1.23	N/A	N/A
2006	45.91	52.86	1.23	N/A	N/A
2007	38.59	55.43	5.98	N/A	N/A
Total	43.25	53.80	2.96	N/A	N/A
Contribution Percentage in total revenue					
2004	-	2.78	-	2.78	N/A
2005	6.74	7.76	0.18	14.69	N/A
2006	8.06	9.28	0.22	17.55	N/A
2007	6.49	9.32	1.01	16.82	N/A
Total	7.11	8.84	0.49	16.43	N/A

Table 7. Percentage contribution in Export and total revenue of EEPCo for 2005-2007 E.C

Source: Data taken from EEU and Compiled by the researcher

As shown in the above table, the export of power to Sudan generates Birr 1,020,463,193.55 during three consecutive fiscal years (2005-2007E.C.) Note that the power trade media of exchange is USD. However, since the data is compiled from the financial statement of EEU, the above figure is the result of exchange rate of USD at each and every bill period.

Compared to the total export revenue, Sudan's export covers about 43.25 % next to Djibouti which is about 53.80 % and the remaining 2.96 % is an income from energy export to Kenya through high tension distribution lines unlike the cross country transmission lines and substations in the case of Ethio- Sudan and Ethio-Kenya power export.

In other words, out of the hard currency transaction revenue of electricity export, Sudan so far is the major contributor since its start despite the lowest tariff in the region of East Africa. This is obtained by selling a 100MW or less power to Sudan according to the power purchase agreement signed by both.

Compared to total revenue of EEPCo, revenue from power export to Sudan embraces about 7.11% next to Djibouti's 8.84 %. As it is revealed from the discussion with EEP and EEU officials, this would substantiate the hard currency appetite of the country which is promising once interconnection infrastructure has been put in place.

c) Regional trade integration, energy security and reliability, peace and security

Regional integration creates economies of scale, permitting for lower costs across all aspects of infrastructure including for power. Estimate show that cross-regional collaboration could reduce electricity costs in Africa by US \$2 billion per year. (ICA Nov.2011)

In addition to financial impact, intangible advantages are there in power trade. For instance, if Sudan has started to construct a grand dam for hydropower projects in Sudan it would have lost acres of lands which could be used for industrialization and agricultural activities. And the intangible costs such as social cost for resettlement of the people at the would be dam location would be minimized. In effect of the trust and reduction of capital and operating costs through improved coordination among power utilities, optimization of generation resources with large units, improved power system reliability with reserve sharing, enhanced

security of supply through mutual assistance, improved investment climate through pooling risks, coordination of generation and transmission expansion, increase in inter-country electricity exchanges, and development of a regional market for electricity.

The advantage of exporting electricity is socio political rather than economic only. Social integration, peace with in the transacting countries and peace within the region of the transacting would have a substantial element for doing the business smoothly so that the region as a whole and the transacting countries of Ethio-Sudan in particular would sustain their integration forever.

On top of this, the societies in the transacting countries of Ethio-Sudan can simply protect the electricity infrastructure from any threat like terrorism, anti-governmental movement and attack on the lines as well as the substations as there is a profound stakes within them. Unquestionably, the electrical interconnection between Ethiopia and Sudan have the lion share in developing energy security, sustainability, trust ,peace and security in the society of both countries.

d) Abundant resources and excess supply

The main reasons for increasing Ethiopian electricity export are mainly the cost- and climate-efficient existing supply capacity and the comparative advantages for new renewable electricity generation in Ethiopia like hydro, wind and geothermal electric power generation.

“Ethiopia is a land of diversified and immense natural resources including green renewable energy. The country has a total potential capacity of 1.4 million MW electric energy from different resources out of which 50,000 MW from hydro, 1.3million MW from wind and solar and more than 10000 MW from geothermal sources” (Ethiopian Electric power-2013/14 annual performance bulletin pp.23).

According to the EEU’s annual performance report of 2013/14 and the senior executives, currently, the total electric power generating capacity of the country is 2,268 MW. The total numbers of electrified towns are 5000 against the 320 in 1991. At present electric access has increased to 54% against 12% in 1991.

e) Unsatisfied demand in neighboring country-Sudan

The demand for electricity in Sudan is increasing and unsatisfied so far. According to IEA, (2010), about 25 million people in Sudan do not have access to electricity. Rather, they depend on the combustible and charcoal found around their environment.

Sudan's electrical power sector has been subject to poor infrastructure and experiences frequent power outages (<http://www.mbendi.com/indy/powr/af/su/p0005.htm>). At present, according to EEPCo officials, Sudan's electricity generating capacity consists of about 760 megawatts of thermal power, about 320 megawatts of hydropower capacity, and total electricity generation is 3.2 billion kilowatt hours.

Hence, Ethiopia has an opportunity to supply the unsatisfied demand in Sudan using the abundant sources of hydropower, wind, solar and geo-thermal.

4.2. Challenges of electricity export to Sudan

The study found out the following challenges of electricity export to Sudan.

a) Cost of electricity export to Sudan

In order for electricity to avail to the end users from the Generation area, it demands huge infrastructural facilities like constructing of grand dams for generating the energy, electro mechanical instruments which can change the pressurized water fall from the dam into mechanical then to electrical by which it creates electricity. After electricity generation, it should be taken to the end users via step up transformers, transmission lines on the toll towers, substations, and step down transformers etc.

Moreover, for the purpose of dam construction, on which EEU's and EEP's officials are emphasizing, Ethiopia suffers various opportunity costs more than the electricity importing countries- in our case Sudan. The dam utilizes fertile acres of land for the water reservoirs. These acres of land would have produced agricultural products for sustainability of the nation as a whole and for the people around the construction area in particular.

On top of the constructing cost and the long time consumed for feasibility study, the intangible costs like social impacts during resettlement programme, acres of land utilized for the dam water reservoirs instead of using them for agricultural productivity, and the risks in

connection to the remote and difficult topography of the project makes it much complex and deters the project not to be commenced at the prescheduled project period. Most of the above mentioned challenges will remain as opportunity costs of Ethiopia and opportunity for importing countries –in our case Sudan.

Besides, it is time consuming and it is deployed through the inconvenient topography around the country. As a result, let alone constructing and put that electricity in place, it is very difficult to carry out feasibility study of one of the activities among the process without the help of financiers. With Ethio-Sudanese interconnection, it is a success story. Because the World Bank has provided a 41-million-dollar soft loan to the Ethio-Sudan Transmission Line project which is about 230 KV transmission line to be stretched 296 kilometers-long.

According to ICA regional power pool report May 2011, inclusively, the Ethio-Sudan interconnection is estimated to consume USD 511million for its realization against USD 292 up to 312million from the average cost mentioned in the literature section of the study. This remains a challenge as far as the country or the transacting countries get together and finance it for their mutual benefits extracted from doing so.

Moreover, according to the literatures reviewed, the average cost of 1MW (1000KW) power output in average will cost \$3,950.881 But the cost estimated for Grand Ethiopian Renaissance Dam which is around \$4.8 billion/6000MW is much more costly than the given average for hydropower generation dam of 1MW. (<http://www.renewablesfirst.co.uk/hydro-learning-centre/how-much-do-hydropower-systems-cost-to-build/>)

b) Unsatisfied domestic demand versus export to neighboring countries

The country exports electricity energy while there is unsatisfied domestic demand. According to Mersea Kidan 2010, in his study of Powering Ethiopia Out of Poverty: A Case for Diversified Electrical Energy Generation using data from the 2008 energy balance table of Ethiopia at www.iea.com, of the 32million tones oil equivalent of energy consumed by Ethiopia in that year, 29million is generated from combustible and waste material which is about 90.6%. Most of the combustible renewable material that was used is wood in a form of charcoal or dry wood. Most Ethiopian households utilize wood as a source of energy which they acquire in a traditional method.

In line with this, the people in the accessed electricity area also could not get the request power in time. Even in one region of EEU, there are many customers are waiting for new power connection after they have finalized the required payments.(Illustrated in Annex V)

The study assesses either the export is one of the reasons listed above for unsatisfied demand domestically or these reasons affect the export by one or the other. But the focus group did not agree on it, rather it can be a major source of revenue via hard currency for reinvestment on quality distribution lines and capacity building on quality customer service because once generated, electricity would not be stored to use later. Nonetheless, the lack of sufficient installed capacity so far would affect exporting electricity to Sudan even to the extent of the agreed firm power.

c) Lack of adequate managerial skills in the field

So far, Ethiopia or the designated corporation-Ethiopian Electric Power or Ethiopian Electric Utility has never ever practiced such a power trade with neighboring countries. One can expect it lacks managerial skills which are backed by international latest best practices regarding the power purchase and sales system, financial accounting related with power export, operational and maintenance of the transmission lines and substations which exist on both sides of the transacting countries (Ethiopia and Sudan), metering and billing management for the amount of energy sold every month and the dispute resolution if any.

Such problems are mainly explained through the inefficient feasibility study project management and through lack of controlling domestic power interruption which in turn affects the customer in general and the industrial and commercial customers in particular.

Discussions held with EEP Co officials affirm the fact that there are problems related to managerial and contract administration specially in implementing the conditions put in the following major agreements: (i) Interconnection Agreements, (ii) Operation and maintenance Agreement, and (iii) Power Purchase Agreement.(Annex II)

Moreover, EEP Co officials showed that, the salary and related benefits of all employees of EEP Co have been increasing annually by 30% on average for the last three years. But the selling price – USD cents 5/KWH remains as it is for the last three years. (Illustrated In Annex II, Page 7) This is the indication of poor management of costs and earnings and lack of

experiences in the area. Had the agreement- price been amended at least by 20% to 30% in order to offset the increment in cost of production a year ago the last year foreign currency generated from Ethio-Sudan power trade would have increased in the same direction and so would have been for foreign currency accumulation of the country for reinvestment.

d) Lack of compliance by Sudan to the signed contract agreements

Ethiopia and Sudan have designed contract agreements for interconnection, power purchase, and operation and maintenance by which they reveal the experiences of the power pools of Africa in general and east African power pool in particular. However, the practicability of those well formulated contract agreements needs experience and political decisions to smoothen the relationship of the countries in different dimensions. In addition, there are problems in dealing with settlement of electric bills. Discussions held with officials of EEPCo indicated that there are repeated payment reminders given to the counterpart electric agency in Sudan. The official of EEPCo further explained that there were times that EEPCo was urged to disconnect the power supply to Sudan for three months though its reconnection through political intervention. (Illustrated in Annex III & IV – EEU-Briefing note on Power Purchase Agreement of EEPCO With NEC of Sudan along with the Minutes of meeting held between EEU and Sudanese Electricity Transmission Company Ltd in Addis Ababa on 06/02/14)

e) Frequent interruptions of domestic electric supply

Domestic electric power supply has been suffering from frequent interruptions. Sometimes, unregulated power surges have caused damages on electric run machines, equipment and electronics.

Some of the reasons identified during the study are;

- The insufficient magnitude of energy generated from different sources within.
- The poor and incremental way of expanding distribution systems throughout the country.
- The scattered and inconvenient residing system of the people in rural areas.
- The poor existing distribution lines which are old and vulnerable to wind and rain falls.

- Lack of capable contractors in distribution lines since it was being monopolized by EEPCo long time ago.

No matter what the reasons are as mentioned above, Ethiopia has started exporting electricity export to Sudan since November, 2012 as per the power purchase agreement signed by both parties on 20th August 2009 for the sale of firm capacity of 100MW and energy of 876GWH per year by EEPCo and the purchase of the same by NEC for five (5) United States (US) Cents/kWh. (This is illustrated in annex II, Power purchase agreement, Article 4, Sub Article 4.1.a. page 7)

f) Difficulties of mobilizing investment for power projects

Two decades ago, Ethiopia as a country have not been participating in mega power projects to the extent of the latest technology transfer would enable the citizens to construct major infrastructures including hydropower projects, transmission lines as well as distribution lines.

In order to mobilize resources for power projects, a huge capital investment and international recognized human resources are required initially. The hydro power projects by their nature are not able to pay back the debts or investments vested on them in a short period of time (10-20years) according to the officials of EEP and EEU during the focus group discussion session. This extended payback period discourages most investors to engage in; despite the amendment of the earlier proclamation to let investors involve in energy generation projects.

However, in an incremental approach, Ethiopia is now at the right track to harness its hydro power potentials including the Nile River to generate power and fulfill the domestic demand as well as exporting slack energy to neighbor countries like Sudan in our case even though its cost remains a challenge without international financiers. As a result, Ethiopia should collaborate with its development partners in order to build a reliable power sector within and for export if at the time of power surplus.

4.3.Measures to address these challenges

Despite almost all the measures are incorporated in the recommendation section of the study, based on the interviewees' point of view some of the measures to be taken to address the challenges are:

- Capacity building in resource, either for material resource including finance or human resources must be aligned with the ever growing of project construction to the extent of international standards.
- Lessons must be taken from Ethio–Sudan Power Purchase Agreement and its implementation for the potential neighbor countries.
- Rehabilitate the existing distribution lines through which the inconvenience of domestic customers will be resolved once and for ever.

4.4. Summary of Key factors of the study

As it is shown in the table what follows the opportunities of electricity export to Sudan is challenged by the factors such as cost of constructing and difficulties in mobilizing investments to hydro electric dams, unsatisfied internal demand and lack of managerial skill in the area. in order to highlight the degree of the factors affecting, the key factors are shown below.

<i>Factors</i>	<i>Impacts on</i>		<i>Ascertained by the interviewee' remark</i>
	<i>Ethiopia-Exporter</i>	<i>Sudan- Importer</i>	
- Tariff rate of Ethio-Sudan and - economic value	Lower and very competitive in the region (USD cents 5/Kwh). This can attract demanding eyes from neighbor countries-in our case Sudan by which it can fuel the economy	Enables Sudan to sustain on importing electricity and satisfying its demand in a cost efficient way.	The Tariff would have been escalated should other costs like resettlement and opportunity costs of the dam be included to it
- Abundant resources and excess supply of electricity - Unsatisfied demand in Sudan	Depends largely on hydropower with less running costs despite its huge initial cost. Ethiopia existing capacity is 2268MW from hydro	Depends largely on geothermal with higher running costs. Sudan has 760 MW of thermal power and 320 MW of hydro	The respondents are declined in the quantity of MW generated. Because all hydro electricity generation dams are not fully utilized their installed capacity due to one or other reason
- Cost of electricity infrastructure and - difficulty in mobilizing investments to hydropower dams	Huge initial investment along with the intangible costs such as resettlement cost of the people around the dam	Since it is an importer of transmitted electricity. No resettlement cost and huge investment to construct dams	Confirmed from Grand Ethiopian Renaissance Dam which costs close to 4.8 billion USD/ 6000MW
Adequate managerial skills in the field and	Lacks adequate managerial skill since it is too early to accumulate such experience in the field	Lacks adequate managerial skill since it is too early to accumulate such experience in the field	Agreed
Complying with the signed contract agreements of PPA	Un settled bills by Sudan are still being dealt as redundant issue among the companies of both countries.	Trust will be questionable unless it is settled timely.	Agreed while redundant deals

Chapter 5: Conclusions and recommendations

5.1. Conclusions

On the basis of the studies described in the preceding sections, the following conclusions have been drawn;

- Regarding electricity tariff, the Ethio-Sudan tariff (5 USD cents per kwh) is the lowest of all east African countries or an average of 50% decrease per kilo watt hour. Here, the domestic tariff of Ethiopia (5.971/Kwh) is also higher than the tariff agreed with Sudan. This can be a driving force to Sudan so as to purchase power with a competitive tariff from Ethiopia in one side and a very good opportunity to attract neighboring countries for electricity supply and a major source of foreign currency for Ethiopia on the other side.
- The export of power to Sudan generates Birr 1,020,463,193.55 during three consecutive fiscal years (2005-2007E.C.). Compared to the total export revenue, Sudan's export covers about 43.25 % next to Djibouti which is about 53.80 % and the remaining 2.96 % is an income from energy export to Kenya through high tension distribution lines unlike the cross country transmission lines and substations in the case of Ethio- Sudan and Ethio-Kenya power export.
- The advantage of exporting electricity is socio political rather than economic only. Social integration, peace within the transacting countries and peace within the region of the transacting would have a substantial element for doing the business smoothly so that the region as a whole and the transacting countries in particular would sustain their integration forever.
- Ethiopia is a land of diversified and immense natural resources including green renewable energy.

Though the above opportunities outweighed them, the following challenges are also identified and brought about the conclusion.

- Availing electricity is costly and time consuming and it is deployed through the inconvenient topography around the country. As a result, let alone constructing and

put that electricity in place, it is very difficult to carry out feasibility study of one of the activities among the process without the help of financiers.

- Lack of managerial skills and contract administration is purely identified as a challenge since in the course of PPA implementation, redundant discussions and written communications were carried out. Still no final solution or agreement is reached at the issue of 9.1million USD unpaid bills of in the early time of interconnections despite the articles which state to penalize the delay by applying 2.5 % on the due amount per annum.
- The unsatisfied domestic demand also another challenge. Given the hydropower generation potential, Ethiopia could not satisfy the electricity demand internally due to the imbalanced demand and supply, lack of quality distribution lines, scattered and inconvenient residing system of the people in rural areas, lack of capable contractors in distribution lines since it was being monopolized by EEPCo long time ago.

5.2. Recommendations

- The Ethiopian government should strive to meet the domestic demand for power. Meeting domestic demand for power has got multi-faceted benefits to the local economy. Specially, at times in which the country plans to develop further its industrial sector which demands increased energy intensity.
- It is not enough to increase generation capacity. Complementary investment in substations, power transmission and distribution is also required to carry power to users. Doing so will improve power interruptions and delivery of sustained energy to household and industrial users.
- Ethiopia should continue tapping energy from various environmentally friendly sources. Efforts should be made to improve poor and incremental way of expanding distribution systems throughout the country. Clustering of scattered and inconvenient residing system of the people in rural areas could improve delivery of reliable energy supply.
- Poor existing distribution lines which are old and vulnerable to wind and rain falls should be replaced with new ones.
- EEP or EEU should open up its doors and involve the participation of competent local contractors who are capable of maintaining and constructing new distribution lines.
- Ethiopia has got abundant resources and excess supply of power options. Hence, efforts should be made to improve the quality and competitiveness of energy sector. To this effect, improving the quantity and quality of energy to be supplied to domestic users will help increase the production capacity of productive sectors to reach their potential production capacity of the economy. In addition, EEU should strive to unleash the comparative advantage of exporting power to neighboring countries without compromising the domestic demand.
- Since the cost and climate efficiency of the Ethiopian electricity supply is a comparative advantage for the country, such a development would be beneficial for the entire East African Region in our case Sudan given the competitive tariff. Thus, Ethiopia should continue to engage in developing and maintaining of the infrastructures like hydropower dams, cross border transmission lines, substations and etc. in a full-fledged way.
- Given the broad opportunity towards exporting its electricity to Sudan and other countries, Ethiopia should build its human resources in the power management as well as contract administration.

- The unpaid bill amount should be resolved with a combination of politically and administrative means so that the transaction will be promising through creating trust and mutual benefits between them.

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Addis Ababa University
College of Business and Economics
Executive MBA Program

My name is Kbreab Afework. I am a postgraduate student of Executive MBA program at the Department of Management, College of Business and Economics at the Addis Ababa University. I am conducting a research project with theme of “Assessment of Opportunities and Challenges of Electricity Export: the case of Ethio-Sudan”. This research is required to fulfill the partial requirements for the Executive MBA degree. This questionnaire is designed to validate findings from document review and analysis. I would like to assure you that this research is only for academic purpose. No other person will have access to the data collected. In any sort of report I might publish, I will not include any information that will make it possible to identify or intrude the privacy of any respondent.

Interview-administered questions:

1. My findings from document review suggested that numerous opportunities associated with the export of electricity to Sudan. What would you think of this finding and your comment please?
 - 1.1. Do you think that the tariff rate of Ethio-Sudan is the lowest among the East African countries? Is it an opportunity to Ethiopia for attracting demanding eyes from the neighboring countries?
 - 1.2. If your answer for 1.1 above is yes, how large is the economic value of electricity export to Sudan in relation to other sales, either export or domestic sales? Or how far has electricity export to Sudan succeeded in terms of foreign currency earnings?
 - 1.3. What is the attribution of electricity export to Sudan regarding regional trade integration, energy security and reliability, peace and security?
 - 1.4. Do you think that Ethiopia has an abundant resources and excess supply of electricity by which it can fully satisfy domestic and neighboring countries demand?
 - 1.5. Is there ever increasing demand of electricity import in neighboring country-Sudan?
2. What are the key internal and external challenges that affect electricity export to Sudan?
 - 2.1. Is the cost of electricity infrastructure a challenge for an electricity export to Sudan

- 2.2. How do you see the unsatisfied domestic demand versus export to neighboring countries- Sudan?
- 2.3. So far, Ethiopia has never been experiencing electricity export management. What is the capability and readiness of the existing management of adequate managerial skills in the field
- 2.4. Is Sudan complying with the signed contract agreements of PPA especially in monthly bill settlement?
- 2.5. What is the impact of frequent interruptions of domestic electric supply on the electricity export?
- 2.6. Does Ethiopia deemed to face sort of difficulties of mobilizing investment for power projects?
3. In your assessment, what measures should be taken to address these challenges?

Rank of World countries' electricity export in 2014

Country Name	Electricity - exports (million kWh)	Year of Estimate
France	73,400	2014
Germany	66,810	2014
Canada	57,970	2014
Paraguay	46,120	2014
Switzerland	34,570	2014
Sweden	31,280	2014
Czech Republic	27,450	2014
Norway	22,170	2014
Austria	20,460	2014
Spain	19,590	2014
Russia	19,140	2014
China	18,670	2014
South Africa	15,040	2014
Netherlands	15,020	2014
Slovakia	13,080	2014
Poland	12,640	2014
Bulgaria	12,110	2014
Uzbekistan	12,090	2014
United States	12,000	2014
Denmark	10,710	2014

Mozambique	9,462	2014
Hungary	9,000	2014
Slovenia	8,363	2014
Belgium	6,911	2014
Iran	6,707	2014
Serbia	5,707	2014
Bhutan	5,400	2014
Belarus	5,067	2014
Estonia	4,950	2014
Israel	4,224	2014
Greece	4,122	2014
Ukraine	3,852	2014
Croatia	3,294	2014
United Kingdom	3,103	2014
Turkmenistan	2,885	2014
Portugal	2,873	2014
Latvia	2,764	2014
Luxembourg	2,623	2014
Kyrgyzstan	2,620	2014
Brazil	2,544	2014
Laos	2,537	2014
Italy	2,304	2014
Kazakhstan	1,800	2014
Argentina	1,701	2014

Hong Kong	1,650	2014
Finland	1,645	2014
Egypt	1,595	2014
Bosnia and Herzegovina	1,569	2014
Thailand	1,535	2014
Georgia	1,492	2014
Turkey	1,490	2014
Albania	1,424	2014
Armenia	1,360	2014
Colombia	1,294	2014
Mexico	1,286	2014
Romania	1,150	2014
Syria	1,043	2014
Ghana	1,036	2014
Tajikistan	1,000	2014
Vietnam	964	2014
Congo, Democratic Republic of the	916	2014
Algeria	803	2014
Montenegro	730	2014
Venezuela	626	2014
Zambia	578	2014
Cote d'Ivoire	471	2014
Azerbaijan	462	2014
Ireland	370	2014

Guatemala	193	2014
Lithuania	186	2014
Malaysia	151	2014
Costa Rica	135	2014
Libya	129	2014
Peru	112	2014
El Salvador	102	2014
Namibia	89	2014
Jordan	86	2014
Uganda	75	2014
Macedonia	62	2014
India	62	2014
Zimbabwe	56	2014
Nicaragua	43	2014
Panama	39	2014
Kenya	31	2014
Nepal	30	2014
Mongolia	22	2014
Honduras	22	2014
Uruguay	19	2014
Ecuador	14	2014
Rwanda	3	2014
Saudi Arabia	0	2014
Saint Kitts and Nevis	0	2014

Seychelles	0	2014
Sierra Leone	0	2014
Singapore	0	2014
Somalia	0	2014
United Arab Emirates	0	2014
Trinidad and Tobago	0	2014
Senegal	0	2014
Saint Lucia	0	2014
Sudan	0	2014
Saint Vincent and the Grenadines	0	2014
Burkina Faso	0	2014
Tonga	0	2014
Togo	0	2014
Sao Tome and Principe	0	2014
Tunisia	0	2014
East Timor	0	2014
Taiwan	0	2014
Tanzania	0	2014
Western Sahara	0	2014
Samoa	0	2014
Swaziland	0	2014
Yemen	0	2014
Equatorial Guinea	0	2014
Djibouti	0	2014

Dominica	0	2014
Dominican Republic	0	2014
Central African Republic	0	2014
Cuba	0	2014
Cape Verde	0	2014
Chile	0	2014
Cayman Islands	0	2014
Cameroon	0	2014
Comoros	0	2014
Ethiopia	0	2014
Eritrea	0	2014
Fiji	0	2014
Falkland Islands (Islas Malvinas)	0	2014
Guinea	0	2014
Guyana	0	2014
Haiti	0	2014
Grenada	0	2014
Greenland	0	2014
Antigua and Barbuda	0	2014
Afghanistan	0	2014
Andorra	0	2014
Angola	0	2014
Bahamas, The	0	2014
Bangladesh	0	2014

Belize	0	2014
Bahrain	0	2014
Barbados	0	2014
Botswana	0	2014
Bolivia	0	2014
Burma	0	2014
Benin	0	2014
Australia	0	2014
Solomon Islands	0	2014
Brunei	0	2014
Burundi	0	2014
Cambodia	0	2014
Chad	0	2014
Sri Lanka	0	2014
Congo, Republic of the	0	2014
Gambia, The	0	2014
Gabon	0	2014
Iceland	0	2014
Indonesia	0	2014
Iraq	0	2014
Japan	0	2014
Jamaica	0	2014
Korea, North	0	2014
Kiribati	0	2014

Korea, South	0	2014
Kuwait	0	2014
Lebanon	0	2014
Liberia	0	2014
Lesotho	0	2014
Mali	0	2014
Morocco	0	2014
Mauritius	0	2014
Mauritania	0	2014
Malta	0	2014
Oman	0	2014
Malawi	0	2014
Madagascar	0	2014
Macau	0	2014
Moldova	0	2014
Nauru	0	2014
Suriname	0	2014
New Caledonia	0	2014
Niger	0	2014
Vanuatu	0	2014
Nigeria	0	2014
Pakistan	0	2014
New Zealand	0	2014
Philippines	0	2014

Puerto Rico	0	2014
Papua New Guinea	0	2014
Guinea-Bissau	0	2014
Qatar	0	2014

Source: [CIA World Factbook](#) - Unless otherwise noted, information in this page is accurate as of January 1, 2014

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