SOCIO-ECONOMIC DEVELOPMENT AND BENEFIT SHARING PROJECT [SDBS]

FINAL REPORT 2008

The Impact of Regional Power Trade on Poor Communities in the Nile Basin Countries

TANZANIA

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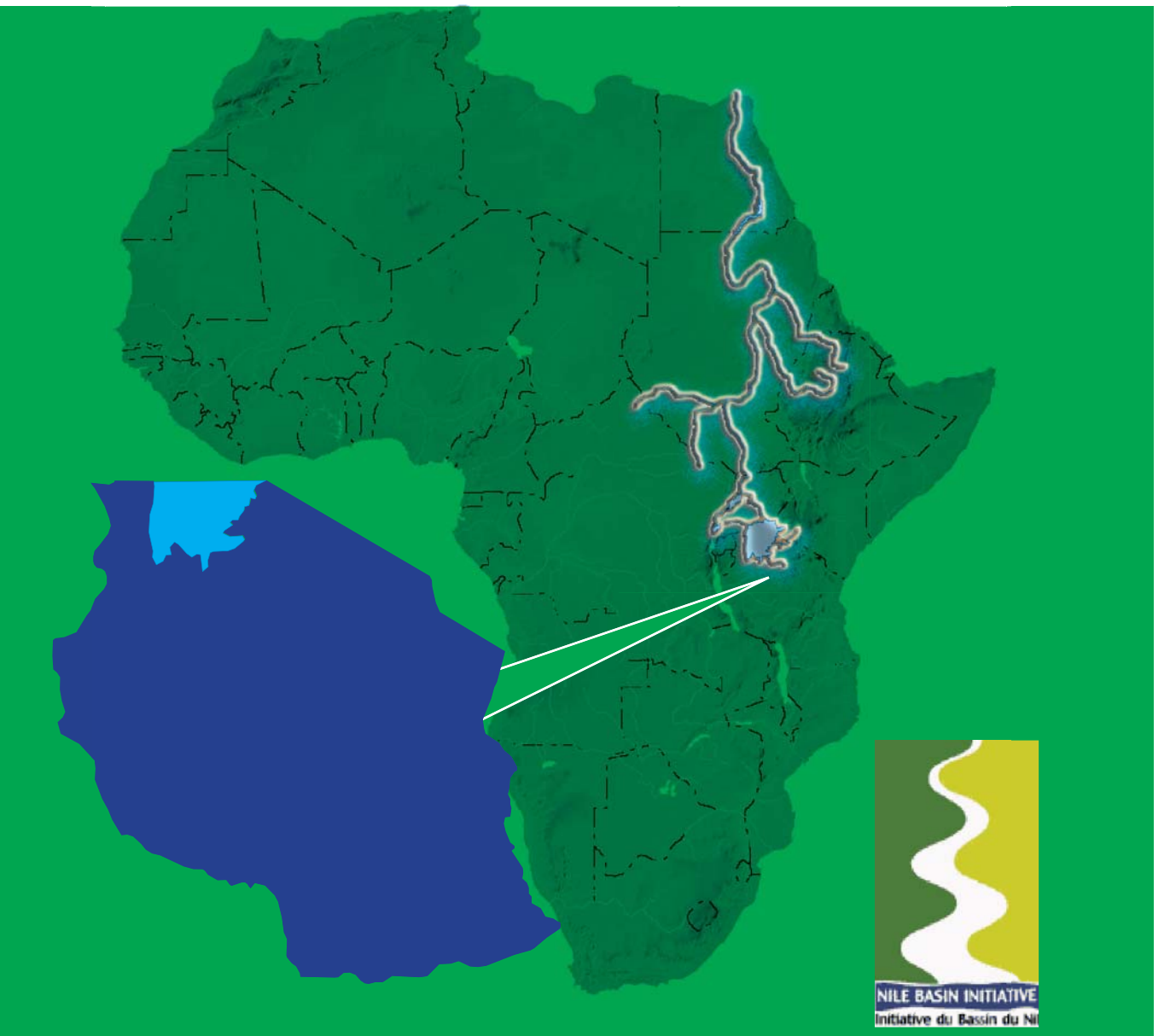

PMU, SOCIO-ECONOMIC DEVELOPMENT & BENEFIT SHARING PROJECT
NILE BASIN INITIATIVE

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Contents

List of Tables

Abbreviations and Acronyms

AfDB	African Development Bank
APL	Adaptable Programme Loan
CA	Construction Agreement
CAS/ISN	Country Assistance Strategy/Interim Strategy Note
CDM	Clean Development Mechanism
EEPC	Ethiopian Electric Power Corporation
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EEA	Ethiopian Electricity Agency
EMU	Environmental Monitoring Unit
ENSAP	Eastern Nile Subsidiary Action Programme
ENTRO	Eastern Nile Technical Regional Office
EPSEMP	Ethiopian Power System Expansion Master Plan
ESIA	Environmental and Social Impact Assessment
ETB	Ethiopian Birr
FA	Fiduciary Assessment
FIRR	Financial Internal Rate of Return
FRR	Financial Rate of Return
GoE	Government of Ethiopia
GoS	Government of Sudan
ICAS	Interim Country Assistance Strategy
ICS	National Interconnected System
ICT	Information and Communication Technology
IDA	International Development Association
IPP	Independent Power Producer
LDC	Load Dispatch Center
MDGs	Millennium Development Goals
MW	Megawatt
NBI	Nile Basin Initiative
NBTF	Nile Basin Trust Fund

NEC	National Electric Corporation
NPV	Net Present Value
O&M	Operation & Maintenance
ROW	Right of Way
SMEs	Small and Medium Enterprises

Acknowledgement

The activities and subsequent results attained in this study would not have come to fruition without the invaluable contribution of various stakeholders. Notably, these include: colleagues in other Participating Institutions, the Nile Secretariat, Shared Vision Programme (SVP) Coordination Unit, SDBS-Project Steering Committee Members, other SVP projects, Subsidiary Action Programmes (NELSAP & ENSAP); the World Bank team, the United Nations Office for Project Services team and Department For International Development team. A word of thanks also goes to all stakeholders in the Nile Basin. Lastly, special appreciations go to the team at the SDBS-Project Implementation Unit for the tireless effort and time invested in guiding this study to a successful conclusion.

Executive Summary

The Study Objectives, Coverage and Background

This Cross-border Trade Cluster Final Report covers two main study areas. The first study area is in Section A, on the Impact of Regional Power Trade, (RPT), which examines the various ways and channels through which power interconnections are likely to impact on poor communities in the Nile Basin countries. The second study area is in Section C, on the rationalization of the use of discount rates for economic analysis of water resources and related projects in NELSAP.

The first study area is a follow up of the NBI Energy Cluster Research project studies (Semboja 2007 and Ragia, 2007). The first phase energy research studies initiated under the NBI-SDBS auspices were Concept Notes and Energy Cluster Scooping Studies. The idea behind this is to capture synergies across and facilitate coordination among these projects and programs. The rationale behind this current study was the need to conduct a detailed study which will shed light on the likely impact of power trade on the poor communities along interconnections in the Nile Basin Countries, (NBI), (Wasike et al, 2007 and Semboja, 2007).

The second study area is intended to provide an input into NBI policy processes on the water resource investments, management and utilization. The SDBS Research Project is done in close collaboration with the Nile Basin Regional Power Trade, NELSAP, ENSAP and SVP Coordination Projects. The Nile Basin Initiative (NBI) is a regional partnership within which member countries have united in common pursuit of the long-term development and management of Nile waters. The initiative is developing a basin-wide framework and is guided by the countries' shared vision "to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources".

Research Team, Methodology and Approach

In order to execute the tasks as identified above, a team of senior research consultants from Economic Research Bureau, University of Dar es Salaam in Tanzania was composed to coordinate, manage and conduct these studies. This ERB Research coordinating team was assisted by national research teams in Sudan and Ethiopia.

In view of the composition of the regional and national research team(s), and so as to accomplish the objectives of the studies, four independent but complementary methodologies were used. These included [1], major desk study, [2] field research surveys in the selected Nile Basin Countries and [3] data and policy analysis and report writing and [4], National and Regional Consultative Workshops.

In order to both communicate initial findings of the current cross-border trade studies and obtain additional input from stakeholders, the national teams envisioned consultations with senior and top executives of all key ministries and national working groups, to discuss various draft reports. These consultations have, among others, been a source of input to the perfection of the final National Reports that were presented at the Regional Cross-border Trade Consultative Workshops in Cairo, Egypt and Monitoring and Evaluation Meeting in Dar es Salaam, Tanzania.

Main Issues

The economic performance of some Nile Basin Initiative, (NBI) countries during the last three to five years has been affected by variations in energy availability. Variations in the GDP growth rates in most poor NBI countries have been attributed to a severe drought that hit these countries during the 2000/1 and 2006/07 rainy seasons, to electricity shortage, increase in food prices and the increase of oil prices in the world market. Sectors that were mostly affected by the drought include agriculture, manufacturing, trade, electricity and water. The electricity sub-sector was severely affected by drought

and the escalation of petroleum prices on the world market, which led to a shut-down of hydropower generation and increased thermal power generation costs. In order to alleviate the power crisis the governments took a number of measures, including implementing emergency power generation projects and participation in regional power trade projects. The "Ethiopia-Sudan Power Interconnector" project is being developed under the umbrella of the Eastern Nile Subsidiary Action Programme of the Nile Basin Initiative. This regional power trade (RPT) Project represents one of the first tangible investments to flow from the NBI, and as such is an important step in converting the collaborative intentions of the countries into physical investments and benefits which, in turn, should reinforce increased cooperation.

The study notes both macro and micro socio-economic and environmental impacts of the Regional Power Trade. The first notable benefit by power firms in Ethiopia and Sudan is the increased sale of surplus hydropower electricity from Ethiopia to substitute for costlier thermal generation in Sudan. There are also benefits of increased reliability and energy security for the Ethiopian system (which are dependant upon the uncertainties of rainfall patterns) from integrating with the Sudanese grid but these benefits are more difficult to measure. The project has benefits and impacts to be accrued to the two countries from increased Cross-border Energy trade. The principal anticipated benefit is from the transfer of lower cost hydro power from Ethiopia to Sudan, which should reduce costs and also CO2 emissions.

At the micro level, the study notes that the demand for electricity is a complex function of socio-economic and household's characteristics such as size of households, income, education, employment, age, sex and other attributes. The immediate impacts of Regional Power Trade at the micro or household level include improved village and household accessibility to public power; increasing use of ICT appliances; low and dropping electricity bills given RPT power, cooking habits may change due to access to RPT power; increasing use of electricity for lighting purposes and the need for intensification of Specific Rural Electrification Programme. The long-term socioeconomic impacts at

micro level include significant and positive changes on households income earnings and income poverty reduction, agricultural production and markets, employment, investment, cross- border trade, livelihood and lifestyle, food security, small scale manufacturing, communication, trade and finance, labour productivity, consumption pattern, human resource development, cultural, arts and sports and public security and safety.

The first study area notes definitive and positive environmental impacts of RPT. The main environmental issues in Ethiopia are deforestation; overgrazing; soil erosion; desertification; and water shortages. Environmental problems such as deforestation are partly caused by the use of charcoal and firewood as fuel by the rural population. Specifically, the study finds that; future use of electricity will reduce the use of charcoal and fuel wood; use of RPT electricity will have potential impact on the reduction on the use of kerosene; positive impact of the future use of electricity on indoor air quality, health, and knowledge and fertility reduction.

The second study area notes that economic and investment policy analysis for NELSAP water resource projects has the objective of comparing and analyzing various energy options such as hydroelectric, thermal, geothermal, fossil fuel and generic wind options in order to decide on the best investments based on technical, economic, social and environmental criteria in order to analyze the benefits and costs of each power option.

The practice has shown that when the economic criterion is applied, water related projects in the form of hydroelectric options perform well, having the lowest per unit costs. In terms of the social criterion, hydroelectric options have variable results depending on the location of the water related project which determines the extent of rural electrification and displacement involved hence most hydroelectric options tend to perform well on the social criterion on average. When it comes to the environmental criterion the Victoria Nile – Bujagali and Karuma – as well as Ruzizi III have a good performance with regards to Environmental criteria with scores between 0.1 and 0.3. All have a high energy payback ratio and relatively low land requirements and downstream effects.

Policy Recommendations

The first study area provides two generic policies as well as specific policy objectives on Benefit Maximization in Agriculture Value Addition and Creative Industrial Development in the Rural Villages given availability of Regional Power Trade.

The first type of policy recommendations are directed to improving regional power trade in the Nile Basin Countries. These include the need for lowering electricity production costs among the regional trading partners, increasing the quality and reliability of electricity service, reduction of the level of required reserve capacity in the connected grids, and improvements in national energy security.

The second policy recommendations are directed at benefit maximization in agriculture value addition and creative industrial development in the rural villages given availability of regional power trade. These include enhancing energy efficiency in agricultural rural communities; improving farming technologies and extension services for rural communities; increasing investments in machinery and equipments for agriculture; improving information and communication technology (ICT) in rural communities and access to cross-border markets; ensuring that emerging, small scale manufacturing activities, value adding and new economic activities as a result of NBI-RPT project are provided with sufficient enabling environment to grow.

The second study area recommends the use of discount rate within the multiple criteria framework. The use of all the criteria aims at addressing the issues of having water related projects that take into account all the issues that are important in improving the livelihoods of people. The fact that the economic and investment policy analysis of NELSAP is based on using different criteria to make decisions implies that such analysis is extensive. It takes all the issues related to development into account, thereby facilitating the choice of an energy option that is balanced in terms of being able to bring about economic development without ignoring the social and environmental aspects of development thus making the benefits from water related projects sustainable.

Section A

The Impact of Regional Power Trade on Poor Communities in the Nile Basin Countries

1

Introduction

1.1. Background and Objective of the Report

This first study area is on the Impact of Regional Power Trade, (RPT), which examines various ways and channels through which power interconnections are likely to impact poor communities in the Nile Basin countries. The research study is a follow up of the NBI Energy Cluster Research studies (Semboja 2007 and Ragia, 2007).

The initial phase energy research studies initiated under the NBI-SDBS auspices were Concept Notes and Energy Cluster Scooping Studies, (Rama 2007, Ragia, 2007, Wasike et al, 2007 and Semboja, 2007). The SDBS Energy Sector Research Project is done closely with the Nile Basin Regional Power Trade, NELSAP, ENSAP and SVP Coordination Projects. The idea behind this is to capture synergies across and facilitate coordination among these projects and programs.

The rationale behind this current study was the need to conduct a detailed Cross-border Trade study which will shed light on the likely impact of power trade on the poor communities in the Nile Basin Countries. The Nile Basin Initiative, (NBI), is a regional partnership within which member countries have united in common pursuit of the long-term development and management of Nile waters. The initiative is developing a basin-wide framework and is guided by the countries' shared vision "to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources".

1.1.1. Economies of scale of the international rivers and the benefits of cooperation

Most energy research studies are founded on the need to optimize economies of scale emerging from the use of the international rivers for generating electric

power and the benefits of regional cooperation accruing to member states as a result of the trade in power. Indeed, as a World Bank Study (2006) has shown, where rivers cross or form national borders, international cooperation can generate a wide range of social, economic and environmental benefits for the riparian states. These benefits or economies of scale can be analyzed from three perspectives. These are;

First that cooperation enables better management of the natural ecosystems, thereby providing benefits to the river itself as the source of all other benefits to humanity. Secondly, the cooperative management of shared rivers can yield major benefits from the river, such as increased energy production. Thirdly, cooperation because of the river can reduce costs that inevitably arise from suspicion and mistrust in the absence of dialogue. Realization of these benefits and reduced costs can eventually lead to greater cooperation and even economic integration among riparian states, thereby generating benefits beyond the river, (Semboja, 2007).

1.1.2. Vast and untapped natural energy resources

The Nile Basin Initiative (NBI) countries depend to a large extent on biomass energy. The energy consumption from charcoal and firewood accounts for 90 percent of total energy consumption in these countries, (Rama 2007, Ragia, 2007, Wasike et al, 2007 and Semboja, 2007). Commercial energy, i.e., petroleum and electricity energy account for only 10 percent of their energy consumption. Other energy sources like coal, solar and wind accounts for less than 1.0 percent of total energy consumed. This pattern of energy consumption signifies that these countries have not yet developed other alternative sources of energy, (Semboja, 1993 and 2006). However, efforts and various strategies have been taken in developing natural gas, coal, hydropower, geothermal and the exploration of petroleum in some of the NBI countries.

1.1.3. Serious shortage of electricity generation

In recent years, most NBI countries have been experiencing a serious shortage of electricity generation. This problem is both multifaceted and complex.

Part of the constraints facing electricity generation includes the declining water levels in hydropower dams. The drop in water level in 2005/206 was due to lack of sufficient rains which subsequently caused load shedding in 2006/2007. Most NBI countries have a number of new and potential hydro power projects in order to maximize their electrical power supply. Some NBI governments are planning to intensify exploration for oil and gas with a purpose of diversifying further the energy resource base, (Ragia, 2007, Wasike et al, 2007, and Semboja, 2007). Other nations have short term projects aimed at dealing with prolonged, severe load-shedding due to an extended drought in order to address the consequent negative economic impact and disruption of social services

1.1.4. Limited Regional Electricity Power Trade

Currently, there are few regional power trade projects among NBI countries. Recently, there have been two power pools created in Eastern Africa which will not only impact on the ZTK Interconnector but will also substantially change the power market dynamics in Eastern and Southern Africa, (OPPPPZ, 2007, Semboja, 2007). The first is the East Africa power pool (comprising Kenya, Tanzania and Uganda) and the second is the Eastern African power pool (comprising, Rwanda, Uganda, Tanzania, Kenya, Ethiopia, Sudan and Somalia). The proposed Interconnector aims at linking SAPP to as far as Egypt and through Egypt to the Pan Arab Interconnector covering the Middle East. The ZTK Interconnector may therefore open up a much larger power market opportunity than originally envisaged once the two new regional power pools are fully functional, (OPPPPZ, 2007 and Semboja, 2007).

1.1.5. Inadequate policies, laws and institutional framework

Most of NBI countries have national energy policies, laws, regulations and institutions in place although they are inadequate for promoting power trade (Rama, 2007, Ragia, 2007 and Wasike et al, 2007 and Semboja, 2007). These policies and laws aim at creating conditions for the provision of safe, reliable, efficient, cost-effective and environmentally appropriate energy services to

all sectors on a sustainable basis. Most NBI countries have established an institutional framework catering for energy sector development. Further actions are still needed in the area of energy resources development to be implemented within the shared vision including hydropower development and pooling, regional energy networks, power interconnection and gas pipelines.

1.1.6. Potential and sustainable livelihood activities

The SDBS-NBI energy studies found that economic performance of some NBI countries during the last three years has been affected by variations in energy availability (Rama, 2007, Ragia, 2007 and Wasike et al, 2007 and Semboja, 2007). Variations in GDP growth rates in poor NBI countries have been attributed to a severe drought that hit these countries during the 2000/1 and 2006/07 rainy seasons, electricity shortage and increase of oil prices in the world market. Sectors that were mostly affected by the drought include agriculture, manufacturing, electricity and water. The electricity sub-sector was severely affected by drought and escalation of petroleum prices on the world market, which led to a shut-down of hydropower generation and increased thermal power generation costs. In order to alleviate the power crisis the Governments took a number of measures, including implementing emergency power generation projects and participation in regional power trade projects.

1.2. Study Objectives, Research Methodology and Approach

1.2.1. Study Objectives

The objective of this study is to make policy relevant on the impact of Regional Power Trade, (RPT), on poor communities living along the interconnections in the Nile Basin Countries in particular, Ethiopia and Sudan.

1.2.2. Research Consultant Team

In order to execute the tasks as identified above, a team of senior research consultants from Economic Research Bureau, University of Dar es Salaam in

Tanzania was composed to coordinate, manage and conduct the Study on the Impact of Power Trade on the Socioeconomic Development in the Nile Basic countries. This SDBS Energy Research coordinating, (SDBS-ERC) team was assisted by national research teams in Sudan and Ethiopia, countries selected during the Cairo Meeting. The Lead Research Study team in collaboration with these national research teams in Ethiopia and Sudan conducted the field research surveys in the villages.

1.2.3. Research Methodologies

In view of the composition of the regional research team(s), and so as to accomplish the objectives of the cross-border trade study, four independent but complementary methodologies were used. These included [1] desk review, [2] field research surveys in Ethiopia and Sudan, [3] data and policy analysis and report writing *and* [4], National and Regional Consultative Workshops.

1.2.3.1 The Field Research Surveys

The field research surveys were made in Sudan and Ethiopia focusing on the poor household communities in selected rural areas. The team consulted village leaders, informed people, and rural household members, and senior and top executive officials. With particular reference to the tasks given above, the research teams carried out the field research surveys at two levels, first focusing on macro-economic secondary data and information about current status, constraints and performance of the power energy sector.

The leading energy study teams in collaboration with selected national teams developed a quantitative survey instrument/questionnaire and administered the questionnaire. The national research teams conducted a series of in-depth interviews of purposive sample key policy/decision makers, opinion leaders and communities to probe key energy research issues and the concept of power trade development of NBI countries. The research teams circulated a survey questionnaire to other NBI countries for comments and inputs. The research teams made regular contacts with the SDBS-NBI PMU throughout the research programme, including providing updates on logistics, processes and findings.

The field research surveys were done during the first and third weeks of September 2008 in Ethiopia and Sudan covering sample population in areas where the high voltage power interconnection line was planned to pass as per the project document. In Ethiopia two regions were covered and in each region at least three sample villages were surveyed. The sample regions covered are Bahar Dar and Gondar. In Bahar Dar the team visited the following villages: Jigina Kidanemihret, Undasa Zenzelema and Addis Zemen. In Gondar the visits were made to Ikel, Ayimba and Maksegnit villages.

In Sudan the sample population and covered research area included Asar, Kajara, Gegna Kebele, Kassab and Goecha. In each country a random sample of 155 rural households was drawn. The sample rural villages covered were also drawn from both electrified villages (EV) and non-electrified villages (NEV). Similarly, both electrified and non-electrified households were also covered.

1.3. A theory of energy transition and socio-economic transformations

Over the last few decades, the energy literature has been dominated by a theory of transition. The theory of transition is based on the notion that households gradually ascend an "energy ladder", which begins with traditional biomass fuels (firewood and charcoal), moves through modern commercial fuels (kerosene and liquid petroleum gas (LPG)) and culminates with the advent of electricity. The ascent of the "energy body', though not fully understood, is thought to be associated with rising income and increasing levels of urbanization.

Empirical evidence on energy and poverty issues indicates that reality is rather more complex than the simple transitional theory would appear to suggest. To choose an appropriate set of indicators to measure the impact of electrification, this research took three basic socioeconomic perspectives on human welfare, namely, basic needs, monetary and non-monetary, into consideration.

According to the basic needs approach, welfare relates to people's ability to satisfy their basic material needs. In the monetary approach it is a generally

accepted view that the purchasing power of the household provides the best overall indicator of welfare. According to the non-monetary approach there has been a trend towards complementing economic measures of deprivation with non-monetary measures to obtain a multidimensional view of human well being, particularly by tracking economic, health and education indicators.

1.4. Data and Policy Analysis

On the basis of both the primary and secondary data obtained in the field survey, data and policy analysis was employed in examining the current and projected performance of the energy sector, policy, planning, operations, and socio-economic impact analysis. Thus, the variables that affect the functioning and determine performances, components and their effectiveness on poverty reduction impacts of RPT were explored using descriptive statistical techniques.

1.5. The Monitoring, National and Regional Consultations and Outputs

In order to both communicate initial findings of the RPT study and obtain additional inputs from stakeholders, the monitoring and national teams envision consultations with NBI-SDBS PMU and senior executives of key ministries and national working groups in Sudan and Ethiopia, to discuss various *draft reports*. These consultations were, among others, sources of inputs for the improvement of the Final Reports that were used in the SDBS and other NBI Consultative Workshops.

2

General Macro Impacts of the Regional Power Trade Project

According to the World Bank Project Document (2006) the Ethiopia-Sudan Power Interconnection involves the construction of a high voltage transmission line between the towns of Bahar Dar and Metema in Ethiopia that will link with Gedaref and Gallabat in the Sudan. This chapter examines the immediate macro-economic and financial impacts of RPT in both countries, including an analysis of higher level objectives to which the project contributes and provides short economic and financial impacts at corporate and national levels of the Regional Power Trade Project in these countries.

2.1. Ethiopia

2.1.1. General Economic Background

Ethiopia is one of the most populous countries in Sub-Saharan Africa and also one of the poorest. At US$180, Ethiopia's per capita GDP is only about a fifth of the Sub-Saharan Africa (SSA) average. Although the country has abundant resources and good potential for development, poverty is pandemic and often linked to environmental and natural resource degradation. Approximately 39 percent of people fell below the basic needs poverty line in the last comprehensive national survey (2004/05), an improvement from the 44 percent poverty headcount observed in 1999/2000, (World Bank, 2006a and 2006b). Government reported broad-based high real GDP growth of 9.6 percent in 2005/06, following 10.5 percent growth in 2004/05, and an 11.9 percent rebound in 2003/04 after a severe drought. The IMF and Government projected GDP growth of about 10 percent in 2006/07.

The official inflation rate reached 12.3 percent in 2006, and rose to 16.7 percent (year on year) in July 2007, with notable increases in food prices. Exports grew at a 21 percent rate in 2006, but imports increased 22 percent

from a larger base, leading to a widening of the balance of payments deficit and a reduction in foreign reserves. While public revenues have shown strong growth, expenditures rose faster, resulting in a small increase in the fiscal deficit (from 5 percent of GDP in 2004/2005 to 5.3 percent of GDP in 2005/2006). The share of pro-poor spending in the budget continued to rise, and in 2005/06 accounted for almost two-thirds of expenditures, while defense dropped from 3.1 percent to 2.6 percent of GDP.

2.1.2. Ethiopia Energy Background

Like many other Sub-Saharan countries, a striking feature of Ethiopia's energy sector is the high proportion of biomass (more than 90 percent) in the energy matrix. Modern forms of energy such as electricity, natural gas or LPG are responsible for less than 10 percent, (World Bank, 2006a and 2006b). This pattern of consumption has led to increasing deforestation, shortages of wood fuel, and degradation of rural ecosystems - a problem worsened by inadequate supply-side measures for improving forest stocks. The limited supply of modern forms of energy and their high costs relative to the low average income per capita has reinforced the dependence on biomass energy. LPG is not widely used in Ethiopia for heating or cooking, due to the high import costs and the barrier represented by the acquisition of millions of metal containers for household use. In the absence of this form of energy, widely used in other countries, the population uses fuel wood or electricity for basic need such as heating or cooking. From a country's perspective, the latter is also a very expensive way to meet household energy needs, except for the most affluent.

Ethiopia-Sudan, together with the Ethiopia-Djibouti transmission line, is the first interconnections in a broader regional power market envisioned by Ethiopia, (World Bank, 2006a and 2006b). The Ethiopia-Djibouti interconnection represents the first of Ethiopia's power export programs. The project, financed by the African Development Bank, will allow Ethiopia to export about 60 MW to Djibouti. The project is expected to be commissioned in 2009.

The proposed Ethiopia-Sudan transmission line would be commissioned after Ethiopia-Djibouti and represents the second stage in Ethiopia's power export programme. Ethiopia's aggressive hydro generation expansion programme has generated the capacity for exports. EEPCo is also planning to conduct some feasibility studies for potential regional interconnections, including: (i) the Ethiopia-Kenya Interconnection; (ii) Ethiopia-Southern Sudan, (iii) Ethiopia-Djibouti-Yemen; and (iv) NBI related generation opportunities.

The World Bank has been working to assist EEPCo and GoE to rationalize the electricity sector expansion plan. The dialogue has emphasized (i) strengthening least-cost integrated development planning; (ii) development of a master expansion plan that is driven more by projections on growth in demand rather than supply side generation targets; (iii) assessing domestic needs and profitable energy export possibilities; (iv) achieving a better integration between the grid and off-grid electrification; (v) examinining demand side interventions, such as energy efficiency and load management on a level playing field with supply options; (vi) mobilizing additional public and private sector financing; and (vii) developing a glide path towards cost-reflective tariffs. The issue of future tariff increases remains central to EEPCo's long-term financial standing. The Bank is working closely with GoE and EEPCo to rationalize the power sector investment programme and to assist in the funding of new projects within a sound tariff regime.

2.2. Sudan

2.2.1. General Economic Background

Sudan's economy is booming on the back of increases in oil production, high oil prices, and large inflows of foreign direct investment. At US$1,900, Sudan per capita GDP is relatively higher than that of Ethiopia. Although the country has abundant natural energy resources and good potential for development, poverty is pandemic and often linked to environmental and natural resource degradation. Approximately 40 percent of people fell below the basic needs poverty line in the last comprehensive national survey (2007), an improvement

from the 47 percent poverty headcount observed in 1999/2000, (World Bank, 2006a and 2006b).

GDP growth registered more than 10 per cent per year in 2006 and 2007. From 1997 to date, Sudan has been working with the IMF to implement macroeconomic reforms, including a managed float of the exchange rate. Sudan began exporting crude oil in the last quarter of 1999. Agricultural production remains important, because it employs 80 per cent of the work force and contributes a third of GDP. The Darfur conflict, the aftermath of two decades of civil war in the south, the lack of basic infrastructure in large areas, and reliance by much of the population on subsistence agriculture implies that much of the population may remain at or below the poverty line for years to come despite rapid rises in average per capita income. In January 2007, the government introduced a new currency, the Sudanese Pound, at an initial exchange rate of $1.00 equals 2 Sudanese Pounds. The official inflation rate reached 8 percent in 2007, and the unemployment rate has been at 18.7 per cent suggesting that both poor people in both rural and urban are facing serious socio-economic difficulties.

2.2.2. Sudan's Energy Background

As is the case in neighboring Ethiopia, the predominant source of energy in Sudan is biomass, such as firewood, charcoal, and animal residues. The Government estimates total energy consumption at about 13 million metric tons of oil-equivalence, out of which biomass accounts for about 78 percent. About 15 percent is from oil fuel, and the remaining 7 percent is electricity generated from hydro and thermal power

Petroleum has emerged as a major source of economic growth and revenue for the Government of Sudan (GoS). Sudan is currently a net exporter of oil. Oil production in 2006 reached approximately 500,000 bbls/d and is projected to increase to 1,000,000 bbls/d in the coming years, 2007/8 – 2008/9. With the production of oil, access to foreign exchange has improved through oil-related foreign investment, oil export earnings, and reduced outlays on imports of crude oil and petroleum products.

Only 22 percent of the population of Sudan has access to electricity and most of these consumers are in Khartoum where 57 percent of the available electricity is consumed. Existing generation facilities in the National Grid (NG) consist of 342 MW of hydro and 642 MW of thermal capacity (180 MW steam, 450 MW combined cycle, 25 MW gas turbines and 45 MW diesel). Due to the relatively small hydropower plant reservoir storage capacity and the preference given to irrigation, hydropower capacity has frequently been under-utilized. All thermal plants are now fueled from domestic oil production. The demand for electricity has exceeded the supply capability of NEC, and created a suppressed demand in all consumer groups, especially in industry. The existing national grid covers only nine of Sudan's 26 states.

The primary objective of GoS is to expand access to electricity. To achieve this, the Government aims to increase generation, transmission and distribution capacity and quality by (a) improving and adding new facilities, (b) minimizing losses (technical, managerial or commercial) from the existing network, (c) improving voltage levels throughout the system, (d) expanding access to electricity through national grid connections and independent grids, (e) improving the collection of revenue through the use of modern metering devices, and (f) linking Sudan's grid with those of neighboring countries.

NEC is the vertically integrated state-owned corporation responsible for expanding the power sector. It currently has approximately 920,000 customers. In addition, there are some separate stand alone systems (diesels). During the past decade, NEC has designed and implemented a number of development plans in generation, transmission and distribution for the national and isolated grids in order to eliminate load shedding and severe supply constraints. Those plans fell-short in achieving their targets, mainly due to the country's financial constraints, which reduced investments in the power sector. NEC was restructured several years ago to better equip it to meet Sudan's electricity sector challenges. A considerable downsizing in personnel has taken place in NEC in the past years, reducing the staff from 20,000 to 7,000. The utility is transforming itself into a relatively efficient and well managed entity.

2.3. Generic Impacts of the RPT Project

This section will now focus on the first and foremost desired project objectives and impacts of the Regional Power Trade Project as stipulated in the Project Document as well as other official communications.

2.3.1. General Impacts of the Regional Power Trade

RPT Project represents one of the first tangible investments within the NB region, and as such is an important step in converting the collaborative intentions of the countries into physical investments and benefits which, in turn, should reinforce increased cooperation. Although the project does not touch water issues directly, it is the fruit of the cooperation around the Nile and specifically among the Eastern Nile countries. The NBI is an historic initiative in a region characterized by poverty and conflict. The agreement of the 10 countries to cooperate in the development of the region's water resources is of major significance in signaling a shift to stability and growth and to avoiding the economic and humanitarian disasters of conflict and famine. Control of the Nile has long been a source of tension and dispute, and an issue of sovereignty, strategic necessity, and national pride. These tensions have colored geo-political relationships between riparian states and have arguably become obstacles to growth by constraining the regional political economy and diverting resources from economic development. Thus engagement in the NBI by riparian countries has signified a choice of cooperation over conflict.

Instead of the longstanding dispute over water allocations, it is increasingly recognized that managing the Nile from a system-wide perspective will increase the quality, the quantity, and the economic productivity of the river flows. The Project supports the GoE objective of monetizing Ethiopia's hydropower export potential and improving the security of its system. The Project also has important global environmental benefits as it will support the export of hydropower to displace and reduce the use and construction of diesel and other thermal units in Sudan, thereby contributing to reductions in the emission of greenhouse gases.

2.3.2. Economic and Financial Impacts of RPT

At macro levels, the major anticipated benefit and impact is the sale of electricity from hydropower in Ethiopia to substitute for costlier thermal generation in Sudan, (World Bank, 2006a and 2006b). Accordingly this is the major focus of the following economic and financial analyses. A predominantly hydro system like that of Ethiopia would also benefit through the Project from being part of a larger power system, with significant thermal generation, which serves as a hedge for periods of low rainfall. There are various assumptions which are common to both analyses, regarding, notably anticipated trade volume, (World Bank, 2006a and 2006b).

2.3.2.1 Increase reliable Firm vs. Annual Scheduled vs. Monthly Scheduled

Ethiopia and Sudan have negotiated a ten-year framework for the provision by EEPCo to NEC on an annual basis of up to 200 MW nominal as follows: (x) 100 MW firm for the term of the contract (provided at a 95 percent load factor) ("firm" energy), (y) up to an additional 75 MW (and potentially as high as 100 MW) as offered by EEPCo on an annual basis ("annually scheduled power"), and (z) monthly scheduled power for the three months of high rains (June, July and August) in the range of 25 MW ("rainy month surplus power"). This framework is consistent with the annual pattern and variability of hydro production in Ethiopia, (World Bank, 2006a)

2.3.2.2 Increasing Power Price Stability

Currently, EEPCo and NEC are finalizing negotiation of the reference price for the initial three years with discussions varying between US$5 cents and US$6 cents per kW/h for firm power (delivered with a reliability of 95%). Annually scheduled power and rainy month surplus power are set as percentages of the reference price. For purposes of evaluating the Project, a mid-range price has been selected as the Base Case, namely a reference price of US$ 5.5 cents/kWh for firm power, US$2.75 cents/kWh for annually scheduled power (i.e., 50 percent of the reference price), and US$1.65 cents/kWh for rainy month surplus power (i.e., 30 percent of the reference price).

In a high benefit (for Ethiopia) price scenario, the reference price has been set at EEPCo's proposal of US$6 cents/kWh – referred to as the "Pe Case". In a high benefit (for Sudan) price scenario, the reference price has been set at NEC's proposal of US$5 cents/kWh – referred to as the "Ps Case".

2.3.2.3 Increasing Power Volumes

Base Case: Under the terms of the PPA, EEPCo has committed to provide 100 MW of firm power to NEC, with an availability of 95 percent, which represents 832 GWh per year. In addition, it estimates that on average EEPCo would provide: (a) 75 MW of annually scheduled power at an availability factor of 60 percent, which translates on average to an additional 394 GWh per year, and (b) 25 MW of rainy month surplus power at a load factor of 60 percent, which equates to an additional 33 GWh per year. This projected average represents a total of 1,260 GWh per year and is used for purposes of the Base Case calculations. High and Low Cases: EEPCo has estimated that in a high case, the load factor for annually scheduled and rainy month surplus power would be 80 percent rather than 60 percent. Accordingly, a high case sensitivity has been set at 1,402 GWh. A low volume sensitivity assuming the availability of only firm power has been set at 832 GWh (although the likelihood of this situation persisting over a ten-year period is small).

2.3.2.4 Increasing Net Profit to EEPCo

There are calculations on the Weighted Average Revenues/kWh – Weighted Average Cost of Power Production/kWh. The net profit to EEPCo from the sale of each kWh is the difference between the weighted average revenues and the weighted average cost of production.

2.3.3. Specific benefits and impacts to Sudan.

The benefits to Sudan could potentially be measured by using the average retail tariff in Sudan (which is about US$9 cents/kWh) or by calculating the fuel savings due to the imports of hydro power. For the purposes of the economic analysis, it was assumed that the benefit of imported energy by Sudan is notionally US$6 cents/kWh (at the wholesale level), which

reflects a conservative valuation of the willingness-to-pay (after netting out transmission and distribution costs) and also approximates fuel savings. This also provides for purposes of the financial analysis a measure of the gross revenues per kWh that NEC would generate from the sale of electricity, (World Bank, 2006a and 2006b). The investment cost for the interconnector for EEPCo is $38.5M which is the sum of (i) transmission line, (iii) substation expansion, (iii) telecommunications, (iv) supervision consultant, and (v) EMP and RAP implementation. For NEC the total cost is $25.5M and it includes (i) transmission line, (iii) substation expansion, (iii) telecommunications; and (iv) implementation of environmental and social implementation plans.

2.4. Economic Analysis

The economic evaluation of the transmission line addresses the following questions: (i) does the Project generate an adequate economic internal rate of return for Ethiopia; (ii) does the proposed Project, as designed, provide an adequate return and represent the least-cost means to connect the two countries, and (iii) does the Project generate an adequate economic internal rate of return for Sudan (which is central to the sustainability of the trade).

2.4.1. ERR for Ethiopia

The economic benefits for Ethiopia are principally the revenues from the export of electricity to Sudan, net of the cost of providing and transporting the power to the Sudanese border. The NPV and EIRR for Ethiopia are very robust in the Base case (namely reference sales price of US$5.5 cents/kWh and annual sales volumes of 1,259 GWh). The figures are respectively US$123.2 million and 65 percent.

As noted in various reports, the returns to Ethiopia are robust and remain significant even under a variety of different scenarios, (World Bank, 2006a). The factors which appear to have the largest impact are significant delays in commissioning of the interconnection and the EEPCo's anticipated excess capacity not materializing (i.e., the average price for firm power is at US$4.5

cents). This latter point also reflects the fact that part of the benefits of the Project for Ethiopia quantified in this analysis derive from the ability the Project provides to monetize the incremental generation which EEPCo is expected to commission over the next several years, thereby providing greater returns on what constitute largely sunken costs from an economic perspective.

2.4.2. ERR for Sudan

The economic benefits for Sudan are primarily a function of two factors: (a) imported volumes, and (b) the difference between the economic benefits to Sudan from importing additional power and the payments made to EEPCo for power. The NPV and EIRR for Sudan are very robust in the Base case (namely annual sales volumes of 1,259 GWh and a reference sales price of US$5.5 cents/kWh, which yields a weighted average price of US$4.5 cents/kWh for those volumes). The figures are respectively US$64.9 million and 60.7 percent.

2.4.3. Combined Ethiopia-Sudan Level Analysis.

An analysis was also make combining both the benefits from Ethiopia and Sudan (which can be approximated to an analysis of the Project's benefits to the region), namely the costs are the total investment costs and the cost of producing the power; and the benefits are the economic benefit from power consumption in Sudan, (World Bank, 2006a and 2006b). As could be anticipated, the overall returns increase as the volumes traded increase. In essence, the combined returns of the interconnector will be sensitive to the volumes, but not to the sales price, which simply serves as a mechanism to allocate benefits between the two countries.

2.5. Ensured and stable power systems

There are definitive Project benefits and impacts to be accrued to the two countries from the Cross-border energy trade, (World Bank, 2006a and 2006b). The principal anticipated benefit is from the transfer of lower cost hydro-power from Ethiopia to Sudan, which should reduce costs and also

CO2 emissions. However, in the eventuality of a shortage in Ethiopia and of excess capacity in Sudan, NEC could export power to EEPCo to help EEPCo meet Ethiopia's domestic energy demand.

As the operation of the joint power systems evolve, and Ethiopia adopts a concept equivalent to the "opportunity cost of water" to make dispatch decisions, there may be situations, even before a shortage materializes, in which Ethiopia decides to import thermal generation from Sudan to keep its reservoirs at prudent levels.

In addition, there would be other supplemental benefits in operating the two systems in an integrated fashion such as reduced reserve margins, more flexible planned plant outages, more efficient response to unplanned outages, additional flexibility in new plant construction delays etc. It has to be noted that the Project also offers environmental benefits related to reduced greenhouse gas emissions through the replacement of kWh generated by thermal fuel with kWh produced from hydropower.

2.6. Financial Impacts

The economic and financial analysis for the Project can be largely equated, especially as the principal economic benefit to Ethiopia is the export revenues generated by EEPCo from the sale of power, and the principal economic cost to Sudan is the cost to NEC of importing power. Given in part this factor, and other similarities between the economic and financial costs, the analysis of the project economics and finances for Ethiopia and Sudan, on the one hand, and for EEPCo and NEC, on the other hand, are largely similar. The analysis indicates that the Project is financially viable in all cases for EEPCo. Under the Base Case, EEPCo would achieve FIRR of 64.6 percent and NPV of net benefits of US$123.2 million, (World Bank, 2006a and 2006b).

2.6.1. Financial Review of Project Implementing Agency

A financial review of the implementing agency, EEPCo, was carried out and the impact of the Project on the financial position of the utility was also assessed.

The Project is expected to make a positive impact on EEPCo's financial position, as reflected in the analysis of the Project IRR. Notwithstanding the financial strain presented by GoE/EEPCo's ambitious capital investment programme, EEPCo continues to generate sufficient revenues to meet its ongoing maintenance and other obligations, and to generate further additional cash inflows. The financial analysis developed for the Project confirms that it will add value to EEPCo, especially since it will be able to export its surplus hydro production to displace the more expensive thermal power of Sudan.

2.7. Macro Economic and Financial Impacts on the Poor Communities

The RPT project has definite positive economic and financial impacts for the governments and power utilities in both Ethiopia and Sudan. The important policy issue is to link the macro economic growth and developments and their impacts on the poor communities. The basic tenet is that growth is necessary but not sufficient for poverty reduction in both Ethiopia and Sudan. Equity issues need to be taken on board. These countries need fast but equitable growth, focusing on reducing inequalities, increasing employment and livelihood opportunities for the poor communities. Equitable growth will entail improving access to and use of productive assets by the poor in the rural areas, addressing geographic disparities and ensuring equal and universal access to electricity and other public services.

3

Socio-economic Profile and Household General Characteristics

3.1. Introduction

The geographical location, people's socio-economic and household characteristics usually impact access to and utilization of basic services, electricity included, because such characteristics embody people's socio-economic capabilities and the extent to which these are likely to translate into needs. Such characteristics also play an important part in influencing the choice of energy demanded and eventually adapted. This chapter provides an overview of key socio-economic characteristics of the study population based on data obtained through various literature reviews with the objective of showing those who live in rural Sudan and Ethiopia and the likely implications for universal access to electricity services.

3.2. Geographical location of the RPT Project Area

3.2.1. Ethiopia

The proposed RPT transmission line routes traverse the Amhara, Oromiya and Benishangul-Gumuz Regional States of western Ethiopia. The main ethnic group in the Amhara Region is Amhara, with minor representation of the Weto, Hemra and Agew. In the Oromiya Region, the major group is Oromo, with minor representation of Amhara, Gurage and other smaller groups. In the Benishangul-Gumuz Region, the Gumuz, Berta, Oromo and Amhara people can be found. The majority are Amharic and Oromiffa speakers, although other languages are spoken too. The major religious affiliations are Orthodox Christianity and Islam.

3.2.2. Sudan

In Sudan, the proposed transmission line route is in Al-Qadarif State. Al-Qadarif State is located in Eastern Sudan. It shares international borders with Eritrea in the northeast and with Ethiopia in the east and southeast. It covers an area of about 75263 km sq. Administratively, Al-Qadarif State is divided into three localities, namely Northern Gadaref, Gadaref and Gallabat. The Gallabat locality (Project affected area) consists of five administrative units.

3.3. Population Characteristics

3.3.1. Population Characteristics in Ethiopia

It is noted that the Federal Democratic Republic of Ethiopia is the second most populous country in Africa with a population of some 77 million, of which 88.8 per cent are rural. Age distribution estimates for 2004 indicate that above 50 per cent of the population of Ethiopia is less than 18 years of age. The total population of the Amhara Region was estimated at 18 million in 2004. This accounts for 25.5 per cent of the population of Ethiopia, while the Region only covers 15.4 per cent of the landmass of the country. The overwhelming majority of the population resides in rural areas (+89%) and is engaged in agriculture. Population distribution is uneven among zones and Woredas, however, and generally the highlands are more densely populated than the lowlands. The population growth rate of the Region is 2.9 per cent per annum with an average population density of 99.80 per km/sq. In the Project affected area specifically, population density is 87.88 per km/sq. The average family size in the Project affected area is 5. Around 88.84 per cent of the population in Amhara is under 15 years in age, and 5.23 per cent are over 60 years. This indicates a high dependency burden. Life expectancy rates have dropped to 43 years. Infant mortality rates are relatively high: 112/1000 live births. One out of every 10 babies dies before the age of one year.

3.3.2. Population Characteristics in Sudan

In the last census of Sudan (1993), the population of the Al-Qaradif State was estimated to be 1,022,000, with an average population density of 17 persons per km/sq. and an annual growth rate of 3.45 per cent. The high growth rate of the State is due partly to waves of immigrations from the neighboring countries and other states of Sudan. These immigrants are either refugees or workers who are attracted by the potential for employment in the agricultural sector. Some 71 per cent of the total population resides in rural areas, and most of them are concentrated in the southern and south eastern localities of Fashaga and Gallabat where the proposed transmission line route is located. The urban population represents some 29 per cent of the regional population. The remaining 2.6 per cent of the population are considered nomads. The population of the state is composed of a number of different ethnic groups. The major groups include semi-nomadic people such as the Shukriya, who occupy the western and the southwest parts of Butana; the Lehaween, who live along the River Atbara and are both livestock owners and cultivators.

3.4. Religion

Religion is an important part of life in the countries of Sudan and Ethiopia as is the case in other countries because it can serve as a powerful tool to mobilize people to adapt development oriented attitudes (Fagan, 1996). Religion can be a driving force for socioeconomic development that spurs people to adapt to changes aimed at the betterment of their lives and hence likely to go hand in hand with increased demand and use of electrical appliances which are key in the betterment of people's lives. Table 3.1 shows the religious affiliations of people in Ethiopia and Sudan at national level.

Over two thirds of Sudanese are Muslims most of whom, about 90 percent, live in the north where they constitute over three quarters of the population. Christians form 5 per cent of the population. Christianity is most prevalent among the inhabitants of the states of Equatoria: the Madi, Moru, Azande, and Bari. The major churches in the Sudan are Roman Catholic and Anglican. The

Coptic Orthodox Church's influence is also still present in Sudan. Sudanese and adherents of local religious systems lived in southern Sudan where about one-third of the Sudanese are still attached to the indigenous religions of their fore-bearers.

Table 3.1: Religious Affiliation in Ethiopia and Sudan

Religion	Sudan	Ethiopia
Traditionalists	25.0	4.6
Christians	5.0	60.8
Muslims	70.0	32.8
Others	-	1.8

Source: *CIA Fact book, 2008*

About 61 per cent of Ethiopians are Christians of which 50.6 per cent are Orthodox, 10.1 per cent Protestants and 0.9 per cent Catholic. Muslims constitute 32.8 per cent and traditionalists constitute 4.6 per cent. Most of the Christians live in the highlands, while Muslims and adherents of traditional African religions tend to inhabit lowland regions. Comparison of the two countries reveals that people in both countries practice the same religions, while Islam is predominant in Sudan and Christianity is predominant in Ethiopia.

3.5. Education

3.5.1. Education in Ethiopia

Ethiopia has one of the least educated populations by Sub-Saharan standards. While continuous improvements are being made there is still low educational coverage in the country. There is low investment in education as education expenditure in Ethiopia is 6 per cent of the annual budget. Literacy rate in Ethiopia is 42.7 per cent; however, when analyzed from a gender perspective the female literacy rate is 35.1 per cent while the male literacy rate is 50.3 per cent indicating gender inequity in access to education (CIA, 2008). Furthermore there is weak educational planning and management and low public participation in educational decision-making.

3.5.2. Education in Sudan.

Sudan has a literacy rate of 61.1 per cent whereby the male and female literacy rates are 71.8 per cent and 50.5 per cent respectively indicating that there is significant gender inequity in access to education (CIA, 2008). There is low investment in education with just a meager 6 per cent of the national budget being devoted to education expenditures (CIA, 2008) implying that there is weak educational planning and management. Education is free and compulsory in Sudan for children aged 6 to 13 years. Primary education consists of eight years, followed by three years of secondary education. However, education at the secondary and university levels has been seriously hampered due to the fact that most males perform military service before completing their education.

3.5.3. Education Status in the sample villages in Sudan and Ethiopia

Table 3.2 shows that respondents with secondary education to higher education are about 27 per cent and 50 per cent of all respondents in Sudan and Ethiopia respectively. Furthermore the number of illiterate respondents in Sudan is more than three times that of Ethiopia. The number of respondents who have not completed primary education but can read and write do not differ much in the two countries while those who have completed primary education are about a third in both the countries.

Table 3.2: Educational Level of Respondents (%) in the Sample Villages

	Sudan	Ethiopia	Average
Cannot read and write	27.5	8.7	18.1
Can read and write	10.7	9.4	10.1
Primary education	32.2	32.2	32.2
Secondary education	17.4	28.9	23.2
Higher education	12.1	20.8	16.4

The fact that the number of respondents with secondary education up to higher education in Ethiopia significantly exceeds that in Sudan implies that

households in Ethiopia may be more likely to adapt electricity as a source of energy as a result of the higher income and exposure resulting from higher levels of education (Silva et al, 2007). On average, the number of respondents with secondary up to higher education is about 40 per cent with about 28 per cent of respondents not having completed primary education. Consultations suggest that ignorance and lack of exposure may be a hindrance to the adaptation of electricity as a source of energy in the household and socio economic activities in these poor countries.

3.5.4. Gender

Gender plays an important role in shaping family attitude and behavior in many aspects of life including in forming preferences for goods and services like electricity. This is because gender can be correlated to other factors influencing preferences such as income, education and exposure to different environments. Whereas Table 3.3.a shows the population distribution by gender distribution in the two countries at national levels, Table 3.3.b shows the distribution of respondents by gender in the sample rural villages in Sudan and Ethiopia.

Table 3.3a: Population Gender Distribution

	Sudan	Ethiopia
Male	50.7	49.3
Female	49.3	50.7

CIA, Fact book, 2008

Table 3.3.b shows that about 66 per cent and 80 per cent of the respondents in Sudan and Ethiopia respectively were male with the average of the countries being 72.7 per cent male respondents. A high proportion of respondents were male because the survey targeted household heads who were mostly males in both the countries. Since most of the households in Sudan and Ethiopia are headed by males the households have a greater likelihood of them preferring electricity as an energy source. This is because males have higher incomes and are more educated than females implying that males are

more capable than females of purchasing electrical appliances as well as having the exposure which drives them to adapt to items that require them to have electricity instead of clinging to the old habitual way of doing things.

Table 3.3.b: Distribution of Households by Gender in per cent in the Sample Rural Villages

	Sudan	Ethiopia	Average
Male	65.6	79.9	72.7
Female	34.4	20.1	27.3

The fact that Ethiopia has more male headed households than Sudan implies that households in Ethiopia are more likely to adopt the use of electricity as a source of energy than those in Sudan. Gender segregation and imbalance are common in most of the rural populations. In the southern and western regions, women shoulder virtually all of the responsibility of the household, whereas in the Nile Valley men are the breadwinners. There is increasing rate of polygamy, death and divorce making women the majority of the household in rural areas. This implies that women are the main users and suppliers of energy (electricity) at the household level.

3.6. Age

The younger a person is the more likely that person is to prefer is to use electricity over other energy sources. This is because younger people have a higher desire than older people to change and adapt to using modern appliances that are electrically operated. Older people have a tendency of being comfortable with their way of living which does not entail use of items requiring electricity to operate hence leading to the forming of habits which discourage the need to shift to the use of electricity. Table 3.4 shows the distribution of respondents in Sudan and Ethiopia by age.

Table 3.4: Distribution of Respondents by Age (%)

Age Group	Sudan	Ethiopia	Average
Under 18	1.3	0	0.65
18-40	33.8	73.8	53.8
41-60	44.4	22.8	33.6
60 and above	20.5	3.4	11.95

Table 3.4 reveals that just above one third and about three quarters of respondents in Sudan and Ethiopia respectively are aged between 18 and 40 which can be termed as the young population. Furthermore 44.4 per cent and 22.8 per cent of respondents are aged 41-60 in Sudan and Ethiopia respectively with just above a fifth and 3.4 per cent of respondents in Sudan and Ethiopia respectively being 60 years and above while only 1.3 per cent of respondents in Sudan being under 18 and none in Ethiopia. Table 3.4 shows that on average, the two countries have people in the young age category exceeding those in the old age category by almost 10 per cent thereby implying that on average the age structure of the two countries favours the use of electricity as a source of energy if other favourable conditions exist.

3.7. Marital Status

Marital status plays a role in the demand and use of electricity in that married and unmarried people have different demand patterns for items that have implications on the use of electricity. Table 3.5 shows the distribution of respondents by marital status.

Table 3.5: Distribution of Respondents by Marital Status (%)

Marital Status	Sudan	Ethiopia	Average
Single	10.6	32.2	21.4
Married	70.9	59.7	65.3
Widowed	10.6	2.7	6.7
Divorced	7.9	5.4	6.7

Table 3.5 reveals that about 90 per cent and about 68 per cent of respondents are either married or have been married at one time in Sudan and Ethiopia respectively. Furthermore 71 per cent and about 60 per cent of respondents were married in Sudan and Ethiopia respectively. Table 3.6 also reveals that when we compare the two countries, Ethiopia had over three times more single respondents than Sudan thereby implying that the latter was more likely to have higher demand for electricity as a source of energy than the former.

3.8. Occupation

Type and nature of occupation play a role in the demand for electricity from two angles. Table 3.6 shows the respondents' categories of occupation in Sudan and Ethiopia. Table 3.6 shows that the leading occupations in Sudan are crop production, salaried work and casual work in that order, while in Ethiopia, the leading occupations are salaried work, trading and crop production in the given order. The leading occupations in Sudan and Ethiopia of crop production and casual work do not require use of electricity on the part of the worker. Salaried work may involve the use of electricity but demand for electricity does not involve the worker and thus does not impact the respondents' demand for electricity.

Table 3.6: Categories of Occupations

Occupation	Sudan	Ethiopia	Average
Handcraft	2.8	8.2	5.5
Livestock keeper	2.1	12.7	7.4
Trading	4.2	19.4	11.8
Crop production	29.9	14.2	22.1
Vegetable production	1.4	2.2	1.8
Casual worker	22.2	4.5	13.4
Selling wood	1.4	0.0	0.7
Agriculture workers	0.7	0.0	0.4
Salaried work	25.0	22.4	23.7
Others	10.4	16.4	13.4

3.9. Household Income

Household income is a vital variable in determining whether a household can access electricity as a source of energy, as well as to the extent it can use it even if it has access to it. If a household has a good income, its style of living will most likely make it demand electrical appliances which it will be able to purchase along with being able to pay for the electricity to operate them.

Table 3.7: Household Income Levels in the Sample Rural Villages in Ethiopia and Sudan

Income	Sudan	Ethiopia	Average
Less than US$500	33.8	23.1	28.5
US$ 500-$1999	39.1	64.6	51.9
US$2000-US$2999	16.6	10.2	13.4
US$3000-US$4999	7.3	0.7	4.0
US$5000 and above	3.3	1.4	2.4

Households with larger incomes also tend to have members who are relatively more educated or who have been exposed to different environments which encourage them to adapt new and more convenient ways of living made possible by the use of modern electrical appliances. On the other hand, households with small incomes are not able to purchase electrical appliances even if they need them and hence they do not have much need for electricity. Table 3.7 shows the levels of income for respondents in Sudan and Ethiopia.

Table 3.7 shows that about 73 per cent and 87 per cent of all household have incomes of up to US$ 1,999 in Sudan and Ethiopia respectively while for the case of income ranging from US$ 2,000 to US$ 4,999, about 24 per cent and 11 per cent of all households in Sudan and Ethiopia respectively fell in this range while in the range of US$ 3,000 to US$ 4,999, 7.3 per cent of all households in Sudan and only 0.7 per cent of all households in Ethiopia had income in this range. Households in Sudan thereby seem to have greater ability than Ethiopian households to switch to electricity as a source of energy since such income enables them to be able to purchase electrical appliances which necessitate access to electricity.

3.10. Type of Dwelling

The type of dwelling people live in is closely related to income with larger income being associated with high quality dwellings and lower income being associated with poor quality dwellings.

Households residing in high quality residences are more likely to have many members who are relatively more educated or who have been exposed to different environments which encourage them to adopt new and more convenient ways of living made possible by the use of modern electrical appliances. On the other hand, households residing in poor quality dwellings are less likely to have access to electricity because the very nature of their dwellings prohibits them from being connected to electricity. Furthermore the fact that their incomes are just for subsistence does not give them the luxury of thinking about purchasing electrical appliances which they deem unnecessary since their incomes only allow them to have a hand-to-mouth existence. Table 3.8 shows the types of dwellings in Sudan and Ethiopia.

Table 3.8: Types of Dwellings

Type of Dwelling	Sudan	Ethiopia	Average
Permanent formal structure	2.0	96.0	49.2
Permanent informal structure	1.4	2.0	1.7
Traditional structure	95.9	1.3	48.5
Temporary structure	0.7	0.7	0.6

Table 3.8 reveals that traditional structures are the dominant dwellings in Sudan while permanent formal structures dominate as dwellings in Ethiopia. The quality of housing in the Project affected areas is low. The majority of rural people live in wood and mud houses with thatched roofs that give shelter to both people and their livestock. The current stock of modern villages housing - most of which are constructed from corrugated iron sheeting – is also insufficient and

of very poor quality. Permanent formal structures are conducive for electrical installation while traditional and temporary structures are not. Furthermore, the predominance of permanent formal structures in Ethiopia and traditional and temporary structures in Sudan indicate that Ethiopian households have higher incomes than Sudanese households thereby implying that they are in a better position to adopt electricity as their source of energy (Lutzenhiser, 1993).

3.11. Household Size

Household size is linked with household income in that the larger the household size the smaller the household per capita income and vice versa, the smaller the household size. This implies that a small household is more likely to be able to afford electricity than a large household, (Mekonnen and Köhlin, 2008). Furthermore, large household sizes may encourage households to prefer solid sources of energy over electricity since such households have more members who can provide labour for collecting and utilizing the fuel on a rotational basis which reduces the constraint of using such an energy source, (Macht et al, 2007).

Table 3.9 shows household size categorized by gender in the sample rural villages in Sudan and Ethiopia. Table shows about 11.5 per cent of houses in Sudan and about 20.6 per cent in Ethiopia have one person, and about 20.05 per cent in Sudan and 28.6 per cent in Ethiopia are households with two people living under one roof. The majority, i.e., about 56.85 per cent in Sudan and 46.9 per cent in Ethiopia have households of between 3 and 5 members. The table suggests that there are few households that have more than 6 persons living in one house. This suggests that household's sizes are small compared with other Sub-Saharan African countries. The gender makeup of a household also plays a part in determining whether a household prefers to use electricity or not. Women are usually the members of the household who most use the household's source of energy in carrying out their household duties.

Table 3.9 shows that the number of females and males living in a household does not differ much with slightly more females than males. As women tend to be less educated and are less exposed to different environments coupled with the

fact that such a household has more labour to facilitate use of other sources of energy, such households will be less likely to change and adapt the use of electrical appliances that would lead to an increased demand for electricity

Table 3.9: Household Size by Gender in Sudan and Ethiopia

	House Size		Sudan	Ethiopia	Average
Male	1	Single	11.70%	19.80%	15.70%
	2	Married + 0	17.10%	33.60%	25.30%
	3	3 to 5	62.30%	43.10%	52.80%
	4	Above 5	8.90%	3.50%	6.20%
Female	1	Single	11.30%	21.40%	16.20%
	2	Married + 0	23.00%	23.60%	23.30%
	3	3 to 5	51.40%	50.70%	51.10%
	4	Above 5	14.30%	4.30%	9.40%
Total	1	Single	11.50%	20.60%	15.95%
	2	Married + 0	20.05%	28.60%	24.30%
	3	3 to 5	56.85%	46.90%	51.95%
	4	Above 5	11.60%	3.90%	7.80%

Consultations suggest that the demand for electricity is a complex function of the above noted socio-economic household characteristics such as size of households, income, education, employment, age, sex and other attributes. Electricity is essential for electronic communications and together with roads connects people and their businesses to national and regional markets and beyond, and opens up new job and education opportunities. In energizing productive uses, regional energy integration fuels the economic engine for value creation, growth and connecting goods to markets. In addition, access to electricity reduces the negative impacts of inadequate modern energy access, especially for women, who bear a disproportionately high burden.

4

Immediate impact of RPT on Electricity Access, Connection and Use

The main objectives and immediate impacts of Regional Power Trade are to increase sustainable energy supply and improve energy security within the regions by institutionalizing more extensive and effective regional co-operation in the development of cost effective and cleaner electricity infrastructure and energy trading networks, and lowering energy costs by more effectively and efficiently managing the regions geographic, seasonal and daily imbalances and optimizing the utilization of energy resources across the region through increased energy trading, (Abdeen, 2006, World Bank, 2006a and 2006b). This chapter examines the first round or the immediate impact of RPT project on electricity access, connection and energy use.

4.1. Electricity Access and Connection

4.1.1. Current and Potential Access to Electricity in the rural villages

Access to energy is essential to sustain human life and to achieve the interrelated economic, social and environmental aims of human development, (Abdeen, 2003, UNDP, 2002 and World Bank 2002 and 2006a). Table 4.1.a and 4.1.b show current and potential electricity power accessibility in the rural villages in Sudan and Ethiopia. Table 4.1.a shows the percentage sample villages with electricity. About 90.6 per cent of villages in the sample area in Ethiopia and about 73.5 per cent in Sudan have access to electricity. Table 4.1.a suggests that about 82.0 per cent of the sample villages along the RPT transmission line are already connected to the public power grid. This suggests that these areas are fortunate compared with other rural villages in both Sudan and Ethiopia.

Table 4.1a: Current electricity connection to the rural villages

Response	Country		Average
	Sudan	Ethiopia	
YES	73.50%	90.60%	82.00%
NO	26.50%	9.40%	18.00%

Table 4.1.b shows potential villages to be connected and have more access to public power given availability of additional power supplies from the RPT project.

Table 4.1b: Potential connections to the main power grid/connections given access to RPT -NBI project

Response	Sudan	Ethiopia	Average
Yes	96.50%	91.30%	95.80%
No	3.50%	8.70%	4.20%

About 96.5 per cent villages in Sudan and about 91.3 per cent of rural villages in Ethiopia indicated that their villages will have access and be connected to the public power grid given available RPT power. This suggests that many villages were well informed about the RPT project benefits and were very positive about the use of electricity (World Bank 2002 and 2006a). Many of the villagers were of the opinion that additional power from the project would change their power supplies, and improve energy sustainability and reliability.

4.1.2. Current and Potential Household Electricity Connection

It was important to investigate accessibility of power by rural households / communities in both Sudan and Ethiopia. Like other developing countries the majority of households in Ethiopia and Sudan have no access to electrical energy. The current statistics show that the per capita electric energy consumption in Ethiopia is a mere 28 KW/year (Kenya 154 KW/year, Tanzania 56 KW/year Sudan 48 KW/year, Djibouti 303 KW/year). Currently, only 13.0 per cent of the total population in Ethiopia has access to electricity. Availability of electricity is almost entirely concentrated in the urban areas, as out of the

85 per cent of the population living in the rural areas, a mere 1 per cent, has access to power supply. About 5 million people (around 22 percent of the population) in Sudan have access to electricity with the residential sector as the dominant portion. Khartoum consumes about 57 percent of the available energy, (World Bank, 2006a and 2006b).

Table 4.2.a and 4.2.b shows current and potential household electricity connection in the rural villages in Sudan and Ethiopia in percentages. Table 4.2.a shows that about 72.5 per cent of households in Ethiopia and about 48.3 per cent of households in Sudan are connected to the main public electricity grid. The data suggests that despite the fact that villages are connected, not many households have access to public electricity power.

Rural households in Ethiopia are better connected than their neighbors in Sudan. Both accessibility and consumption of power in Ethiopia have been increasing over time. In the last 5 years, it has grown at a high rate of 9.6 percent. Peak demand has grown at a higher rate of 10.7 percent, suggesting a higher percentage of residential consumption and also some potential for demand management and energy efficiency.

Table 4.2a: Current household connection with public electricity

Response	Country		Average
	Sudan	Ethiopia	
Yes	48.30%	72.50%	60.30%
No	51.70%	27.50%	39.70%

Table 4.2.b shows potential electricity household connections given access to RPT power in both Ethiopia and Sudan. It is interesting to note that majority of the households were of the opinion that their houses would be connected to the public electricity given extra power supplies from the RPT project. About 100 per cent in Ethiopia and about 91.4 per cent in Sudan were very positive that their houses will be connected to the national and public power. This suggests a number of issues. The first issue is that many are aware that this will solve the problems related with the low level of access to electricity

(EEPCO, 2000, World Bank, 2006a and 2006b). Low power accessibility is a major barrier to economic development, as well as to the provision of social services in rural towns and other rural areas. The second issue is the need to minimize all potential constraints to power accessibility.

Table 4.2b: Potential Electricity Connection given access to the RPT

Response	Sudan	Ethiopia	Average
Yes	91.40%	100.00%	92.60%
No	8.60%	0.0%	7.40%

4.1.3. Current and potential constraints to electricity connection

One of the primary electricity connection constraints is insufficient generation capacity to support the expansion of the market and scale-up of energy in the rural areas, (World Bank, 2006a). Tables 4.3a and 4.3b show reasons given as main constraints or primary causes for lack of electricity in poor rural communities in both Ethiopia and Sudan. Table 4.3a shows current reasons for inability to access public electricity in Ethiopia and Sudan. Table 4.3a shows that about 69.39 per cent in Sudan and about 63.69 per cent in Ethiopia were not connected because of lack of a nearby public electricity grid in the village or and street. About 28.83 per cent in Sudan and 16.07 per cent in Ethiopia lack of power access is attributed due to low income or poverty.

Table 4.3a: Current reasons for inability to access the electricity

Reasons	Country		
	Sudan	Ethiopia	Average
	Percent	Percent	Percent
Low income levels	28.83	16.07	22.45
No grid network nearby	69.39	63.69	66.54
No information, interest	1.79	0.00	0.89
Others (Cultural, Social)	0.00	20.24	10.12

Table 4.3b shows potential reasons for continued lack of access of electricity in the rural villages in Ethiopia and Sudan. It is interesting to note that households were able to identify more constraints to access public electricity given increasing electricity supplies due to RPT power project. These include high power installation costs, high power tariffs, frequent power failures and other reasons. Table 4.3b shows that the main reason for continued lack of access of electricity in the rural villages in Sudan is high power installation costs. This accounted for about 57.61 per cent of the sample households. About 33.33 per cent in Ethiopia argued that high power installation costs may be a major reason for continued lack of access to electricity in the villages. However, about 58.02 per cent considered other various reasons. These other reasons included poor customer service for repair, no close public power offices for purchase of pre-paid electricity and low family incomes.

Table 4.3b: Reasons for continued lack of access of the electricity in the village/town

Reasons	Sudan	Ethiopia	Total
	Percent	Percent	Percent
High power installation costs	57.61	33.33	45.47
High monthly tariffs	14.13	8.64	11.39
Frequent power interruption/ power ration/ power cut	14.13	0.00	7.07
Frequent power fluctuation	14.13	0.00	7.07
Others, (poor customers service for repair e.g. delay response, no nearby office for purchase of pre-paid electricity, low family income, no credit facilities, un reliable/ varying power consumption bills)	0.00	58.02	29.01

4.2. Use of electricity appliances in the household

Table 4.4a and 4.4b show current and potential types of electricity appliances using public power in the rural residences in Sudan and Ethiopia. In addition to lighting, the largest use of electricity in both Sudan and Ethiopia households was

for communications appliances (including radio and TV). About 78.86 per cent in Ethiopia and 61.49 per cent in Sudan indicated that use of communication and broadcasting refrigerators consume a large percentage in the residential sector.

Table 4.4a: Current types of electricity appliances using power in the residence

Type of the electricity appliances	Sudan	Ethiopia	Average
	Percent	Percent	Percent
Washer/dryer	0.76	0.00	0.38
Hot water heater	3.56	1.75	2.66
Microwave	1.40	0.00	0.70
Oven/stove	4.96	4.12	4.54
Refrigerator	27.83	15.26	21.55
Radio/TV	61.49	78.86	70.17

The second most important are refrigerators. About 27.83 per cent in Sudan and about 15.26 per cent in Ethiopia indicated that refrigerators are the second most important household electricity appliances in the rural communities. There were no cases of households using air-conditioning. There are few other electrical appliances. These included some appliances, such as oven stoves and hot water heaters. These are typically found in well-to-do rural household families. Table 4.4.b suggests that the largest use of conventional electricity in both Sudan and Ethiopia households will still be for communications appliances (including radio and TV). However, the pattern will change. Only about 44.86 per cent in Sudan and 27.63 per cent in Ethiopia indicated that they will continue to use communication and broadcasting as their first electricity appliances. The second most important desirable electricity appliances, given extra power supplies in Ethiopia, are oven / stoves. These are expected to increase. About 30.57 per cent households in Ethiopia will switch to using oven/stoves given access to RPT power supplies. Sudan indicated that refrigerators are second most important household electricity appliances in the rural communities. About 27.76 per cent will continue using refrigerators as the second most important electricity appliances.

Table 4.4b: The electricity appliances planned to be used given access to RPT power

Electricity appliances	Sudan	Ethiopia	Average
	Percent	Percent	Percent
Washer/Dryer	4.82	7.25	6.04
Hot water heater	9.99	6.91	8.45
Microwave	4.82	4.26	4.54
Oven/stove	7.74	30.57	19.16
Refrigerator	27.76	23.37	25.57
Radio/TV	44.86	27.63	36.25

4.3. Current and projected total costs of electricity installation/connection

Table 4.5a and 4.5b shows current estimated and projected second costs of installation or connection as suggested by rural households in Sudan and Ethiopia in US Dollars September 2008. Table 4.5a shows that about 93.0 per cent in Ethiopia indicated that on average cost of installations/connections are less that US$ 100. Few, about 6 per cent in rural villages in Ethiopia indicated, that installation/connection costs range between US$ 100 and US $ 200. This is in contrary to Sudan. Table 4.5.a suggests that installation/connection costs in Sudan are high and vary with village and street locations. About 15.1 per cent have costs which are below US$ 100. About 24.6 per cent have costs ranging between US$ 100 and US $ 200. About 42.5 per cent of population sample suggested that costs are relatively high, above US$ 250

Table 4.5a: The total cost of installation in US$

Cost of installation in USD	Sudan	Ethiopia	Average
	Percent	Percent	Percent
1 to 50	5.5	45	25.25
50 to 100	9.6	49	29.3
100 to 150	12.3	3	7.65
150 to 200	12.3	3	7.65
200 to 250	17.8	0	8.9
Above 250	42.5	0	21.25

Table 4.5b shows the projected total costs of installation/connections given availability of RPT power. Table 4.5b shows that about 92.0 per cent in Ethiopia indicated that on average projected costs of installations/connections will be less that US$ 100. Few, about 4 per cent, in rural villages in Ethiopia indicate that installation/connection costs range between US$ 100 and US $ 150 and about 4 per cent indicated that costs will increase to over US$ 150. It is interesting to note that Table 4.5b suggests that installation/connection costs in Sudan will be low and vary according to village, street and household locations. About 63.0 per cent are expecting to have low electricity connection costs which will be below US$ 100. About 28.7 per cent will have costs ranging between US$ 100 and US $ 250. About 7.2 per cent of population sample suggested that costs are relatively high above US$ 300. Tables 4.5a. and 4.5b suggest that costs connected with installations/connections will decrease given an increase of power due to RPT power project.

Table 4.5b: The projected total cost of installation given availability of RPT power.

Cost of installation in USD	Sudan	Ethiopia	Average
1 to 50	26.10%	44.00%	29.40%
51 to 100	36.90%	48.00%	39.00%
101 to 150	6.30%	4.00%	5.90%
151 to 200	10.80%	0.0%	8.80%
201 to 250	2.70%	0.0%	2.20%
251 to 300	9.90%	0.0%	8.10%
301 and above	7.20%	4.00%	6.60%

4.4. Ratings of levels of costs of current electricity installation in the villages

Tables 4.6a shows perceived views and household ratings on current and potential costs connected with installations and connections in Ethiopia and Sudan. Table 4.6a shows the ratings done by households on the relative costs connected with installation and connections in the rural villages in Sudan and Ethiopia. About 62.2% of households in Sudan and about 42.9 per cent in Ethiopia consider that costs of installations are relatively high. On average about 53.6 per cent of the sample population, (both Sudan and Ethiopia), consider that installation/connection costs are high. About 33.7 per cent of the population sample thinks that these installation costs are moderate and very few about 13.7 per cent consider these as reasonably low.

Table 4.6a Rating of the total costs of current electricity installation the villages

Rating of total cost	Country		Average
	Sudan	Ethiopia	
Very low	0.70%	2.70%	1.70%
Low (reasonable)	7.90%	16.10%	12.00%
Moderate	29.10%	38.30%	33.70%
High (expensive)	53.60%	36.90%	45.30%
Very High	8.60%	6.00%	7.30%

Table 4.6b shows the ratings done by the households in Sudan and Ethiopia on the potential cost of new electricity installations given RPT power supplies. About 15.6 per cent of households in Sudan and about 71.9 per cent in Ethiopia consider that the future or potential costs of installations will be relatively high given access to RPT power supplies. It is interesting to note that whereas poor households in Sudan hope that installation and connection costs will drop, their counterparts in Ethiopia are more pessimistic and project an increase in installation and connection costs. This may be attributed to increasing fuel oil prices, costs of electricity equipments, and variations in interest rates, inflation and forex in the international markets.

Table 4.6b Rating of the potential cost of new electricity installation given RPT

Rating of potential cost	Sudan	Ethiopia	Average
Very low	30.50%	3.10%	25.40%
Low (reasonable)	25.50%	9.40%	22.50%
Moderate	28.40%	15.60%	26.00%
High (expensive)	14.90%	53.10%	22.00%
Very high	0.70%	18.80%	4.00%

On average about 26.0 per cent of the sample population expects that installation/connection costs will be relatively high given more supplies from the RPT power project. About 26.00 per cent of the population sample thinks that these installation costs will be moderate, and very many, about 46.9 per cent, envisage reasonable low connection costs and affordable by the majority of poor households in the rural communities. Where grid connection is an option, be it to the regional or national grid or a micro-grid, then one method of making it an affordable option is to keep the connection costs and subsequent bills to a minimum. Often, rural domestic consumers will require only a small quantity of power to light their houses and run a radio or television.

4.5. Current and Potential Estimated Electricity Costs/ Power Tariffs

The cost of electricity consumption depends on where people live, how much they use, and possibly when they use it. There are also fixed charges that they pay every month no matter how much electricity they use. The electricity companies measure how much electricity households use in kilowatt-hours, abbreviated kWh. Their bills might have multiple charges per kWh (e.g., one for the "base rate", another for "fuel") and they have to add them all up to get the total cost per kWh. It is argued that most utility companies in developing countries charge a higher rate when people use more than a certain amount of energy, and they also charge more during certain periods when electric use is higher.

Tables 4.7a and 4.7b show the current and projected average cost of residential electricity use per month as recorded in September 2008 in both Sudan and Ethiopia in US $. Table 4.7a shows that on average about 89.4 per cent of households in Ethiopia and about 52.7 per cent in Sudan have their electricity bills below US$ 10 per month. On average about 71.0 per cent of the sample households indicated that electricity costs were below US$ 10 per month.

Table 4.7a: Current estimated electricity cost per month in US$

Cost Range in US$ per month	Sudan	Ethiopia	Average
	Percent	Percent	Percent
0.5 TO 5	13.2	79.8	46.5
5 TO 10	39.5	9.6	24.55
10 TO 15	18.4	3.8	11.1
15 TO 20	15.8	3.8	9.8
Above 25	13.2	2.9	8.05

Table 4.7b shows the projected electricity consumption cost per month given access to RPT Power in Sudan and Ethiopia in US$. Table 4.7b shows that on average about 73.9 per cent of households in Ethiopia and about 87.4 per cent in Sudan project that their future electricity bills will be below US$ 10.5 per

month. On average about 85.4 per cent of the sample households indicated that electricity costs will be below US$ 10 per month given increasing access to power from RPT project. These tables suggest that electricity bills per month will drop due to increasing cheap, reliable and accessible public power.

Table 4.7b The projected electricity cost per month given access to RPT Power.

Cost per month in USD	Sudan	Ethiopia	Average
0.5 to 2.5	12.60%	39.10%	16.50%
2.6 to 4.5	14.10%	8.70%	13.30%
4.6 to 6.5	25.90%	17.40%	24.70%
6.6 to 8.5	14.10%	0.0%	12.00%
8.6 to 10.5	20.70%	8.70%	19.00%
10.5 and above	12.60%	26.10%	14.60%

4.6. Current and projected rating of the power tariff

Tables 4.8a and 4.8b show perceived views and ratings on current and projected power tariffs per month in Ethiopia and Sudan in September 2008. Table 4.8a shows the perceptions and ratings done by households on the average power tariffs in the rural villages in Sudan and Ethiopia. About 49.7 per cent of households in Sudan and about 40.3 per cent in Ethiopia have the view that power tariffs are relatively high. On average about 43.7 per cent of the sample population consider that electricity power tariffs are high. However, about 40.3 per cent of the population sample views that these electricity power tariffs are moderate and very few about 14.7 per cent consider these are reasonably low.

Table 4.8a: Rating of the power tariff from the main grid electricity

Rating of the power tariff	Country		Average
	Sudan	Ethiopia	
Very low	4.00%	2.00%	3.00%
Low (reasonable)	7.90%	15.40%	11.70%
Moderate	38.40%	42.30%	40.30%
High (expensive)	44.40%	38.30%	41.30%
Very high	5.30%	2.00%	3.70%

Table 4.8b shows the ratings done by the households in Sudan and Ethiopia on the average electricity power tariffs. Few, about 9.8 per cent of households in Sudan, and a significant number of households, about 45.4 per cent in Ethiopia, consider that the future or potential average electricity power tariffs will be relatively high given access to RPT power supplies. It is interesting to note that whereas poor households in Sudan hope that average electricity power tariffs will drop, their counterparts in Ethiopia are more pessimistic and project an increase in installation and connection costs.

This pessimistic perception has also been noted in other reports. The Austrian Development Cooperation, (2007), noted that the current price of electricity averages about 0.056 USD/KW, during 2006/07 which is relatively low by world standards and covers only 62 per cent of the long-run marginal cost of supply. On average about 16.3 per cent of the sample population expects that average electricity power tariffs per month will be relatively high given more supplies from the RPT power project. About 28.40 per cent of the population sample thinks that these average electricity power tariffs will be moderate and many, about 55.1 per cent, envisage reasonable low electricity costs per unit and affordable by majority poor households in the rural communities.

Table 4.8b: Rating of the potential cost of RPT electricity use/power tariffs

Rating of the potential cost	Sudan	Ethiopia	Average
Very low	29.40%	3.00%	24.40%
Low (reasonable)	33.60%	18.20%	30.70%
Moderate	27.30%	33.30%	28.40%
High (expensive)	9.10%	42.40%	15.30%
Very High	0.70%	3.00%	1.10%

4.7. Energy Use in Cooking

Cooking is the most overlooked study area when renewable energy is one of the primary concerns in home design. It is the largest known energy use, after heat, hot water and electricity. In some homes, energy used for cooking may even exceed the home's electrical energy consumption. The question of energy sources and equipment for cooking is one of the more difficult and complex decisions communities have to make. Table 4.9a and 4.9b shows current and projected energy use in cooking in rural communities in Sudan and Ethiopia. Table 4.9a shows that the main energy forms are Fuel Wood, LPG, Kerosene, Electricity and Coal or Coke. It shows that about 83.3 per cent in Ethiopia and about 55 per cent in Sudan households are using Fuel Wood for cooking. The majority of households i.e., about 69 per cent in the sample areas use biomass as their main source of fuel for cooking. The table suggests that the second main form of energy used in cooking in Sudan is LPG. About 33.8 per cent of households are using this form of energy.

Kerosene and electricity use accounts for only 1.7 per cent and 1.0 per cent respectively. Our consultations with some villages suggest that the use of other fuels such as crop residues and cow dung has been decreasing and is now very minimal. In most households where firewood is the main cooking fuel, traditional tripod styled stove or the 3-stone stove are used. This stove is inefficient, emits smoke into the cooking environment and also blackens

the cooking pot. Besides the heat radiation from the stove is dangerous for children and pregnant women in particular

Table 4.9a: Energy use for cooking in your home

Type of Energy	Country		Average
	Sudan	Ethiopia	
Bottled gas (LPG Propane)	33.80%	2.00%	18.00%
Kerosene	1.30%	2.00%	1.70%
Electricity	2.00%	0.0%	1.00%
Coal or Coke	7.90%	12.80%	10.30%
Fuel wood (charcoal and fire wood)	55.00%	83.20%	69.00%

Table 4.9b presents energy to be used for cooking given the availability of RPT power. Table 4.9b shows that about 53.3 per cent of Sudanese and about 64.2 per cent of Ethiopian households are expecting to switch or shift and use electricity for cooking. Many of households i.e., about 58.6 per cent in the sample areas are expecting to shift to use electricity as their main source of fuel for cooking. The table suggests that the second main form of energy used in cooking in Sudan will still be LPG. About 33.8 per cent of households in villages in Sudan will continue using electricity as the main form of energy for cooking. About 31.8 per cent of rural households in Ethiopia will continue to use fuel wood as main energy for cooking. This suggests that fuel wood will continue to be the least expensive cooking energy source in Ethiopia and LPG will be the least expensive in Sudan.

Tables 4.9a and 4.9b present an interesting investigation on energy use. First is the impact of RPT on energy consumption pattern or structures. Tables suggest that energy switching and stacking are possible given increasing availability of clean and relatively affordable commercial energy forms. Alemu Mekonnen and Gunnar Köhlin (2008) noted that one set of factors necessary for switching to other fuels particularly in poorer developing countries (like Ethiopia) is better availability of alternative fuels other than traditional biomass fuels.

Table 4.9b Energy to be used for cooking given availability of RPT power

Type of Energy	Sudan	Ethiopia	Average
Bottled Gas(LPG or Propane)	38.90%	0.0%	19.50%
Kerosene	2.00%	0.0%	1.00%
Electricity	53.00%	64.20%	58.60%
Coal or coke	0.70%	4.10%	2.40%
Fuel Wood (Charcoal and firewood)	4.70%	31.80%	18.20%
Solar collectors	0.70%	0.0%	0.30%

Household fuel choice depends on complex social, economical and cultural factors, and these are important in determining the future use of energy. Tables 4.9a and 4.9b suggest that household energy demand and choice for cooking, for rural households in Ethiopia with low levels of income will continue to rely on biomass fuels, such as fuel wood and charcoal, while those with households in Sudan with relatively higher incomes will continue to consume energy that is cleaner and more expensive, such as LPG. However, our consultations with rural households in Sudan suggest that some households will switch — from traditional to cleaner (and more efficient) energy sources— and consume what are called transition fuels, such as kerosene and charcoal. Consultations in Sudan suggest that more electricity supplies from the RPT project will replace traditional fuels as households will switch to the electricity. Tables 4.9.a and 4.9b, suggest that households in Ethiopia are expected not to switch to greater use of electricity, but instead will continue to consume a combination of fuels, i.e combining solid fuels with non-solid fuels as sources of energy. Thus, households in Ethiopia are facing hard choices. They may choose a combination of high-cost and low-cost fuels, depending on their budgets, preferences, and needs. This has led to the concept of fuel stacking (multiple fuel use), as opposed to fuel switching or an energy ladder, (Alemu Mekonnen and Gunnar Köhlin (2008)).

4.8. Energy in House Lighting

The sun and moon are dominant sources of energy for lighting in most villages in Sub-Saharan Africa during day and night time respectively. Adequate lighting during evening and night helps increase the productivity of people and enterprises. Adequate lighting should therefore be of paramount importance to every government.

Table 4.10a and 4.10b present current and potential energy use for lighting in the rural households in Ethiopia and Sudan as of September, 2008. Table 4.10a shows that about 87.2 per cent in Ethiopia use electricity for lighting and only about 45.5 per cent in Sudan use electricity for lighting in the rural areas. About 49.0 per cent in Sudan use kerosene and about 12.10 per cent in Ethiopia use kerosene. This pattern may be attributed to the fact that Sudan is an oil-producing country and Ethiopia is rich in hydropower.

Consultations suggest that the use of liquid fuel-based lighting is more common in Sudan than in Ethiopia. The quality of light obtained from flame-type devices (hurricane lanterns, candles etc.) is very poor (< 100 lm). Besides it is based upon incomplete combustion principles. Hence the yellow flame produces soot, CO and CO_2. In the confined space of rural households the use of such lanterns can be injurious to health. However, the light from pressurized mantle lamps (Petromax type) is comparable to that from light bulbs or fluorescent lamps and hence these offer the best place for improvement. The good lanterns in this genre have efficient and complete combustion of fuel. Recently there has been an upsurge of LPG-powered mantle lamps in some sample villages in Sudan.

Table 4.10a: Energy used for lighting in the homes

Type of Energy	Country		Average
	Sudan	Ethiopia	
Kerosene	49.00%	12.10%	30.55%
Electricity	45.70%	87.20%	66.45%
Coal or Coke	0.0%	0.70%	0.30%
Wood	2.60%	0.0%	1.30%
Other Fuels	2.60%	0.0%	1.30%

Table 4.10b presents energy to be used for lighting given availability of RPT power. The Table shows that about 96.60 per cent in Ethiopia are expecting to use electricity for lighting and about 94.6 per cent in Sudan will shift to the use of electricity for lighting in the rural areas. About 95.6 per cent of the rural households in the sample villages will use electricity power for lighting given an increase of power due to the RPT project. The results in Table 4.10. b. suggest that one of the greatest impacts of RPT will be a clear shift and an increase in the use of electricity for lighting in many villages.

Table 4.10b Energy to be used for lighting given availability of RPT power

Type of Energy	Sudan	Ethiopia	Average
Kerosene	2.00%	2.00%	2.00%
Electricity	94.60%	96.60%	95.60%
Coal or coke	1.30%	1.40%	1.30%
Solar collectors	2.00%	0.0%	1.00%

4.9. Energy used for Household Electronic Equipments

The energy use of electronic equipment often goes unnoticed. But as it turns out, the increasing number of well-to-do households using electricity can be attributed to the emergence of electronic devices. The vast majority is consumed by home entertainment systems and home office equipment. But

small energy users, including portable devices with battery chargers, make up a significant share—not because they use a lot of energy individually, but because of their sheer numbers.

Tables 4.11a and 4.11b show current and potential energy use for electronic equipment in the rural communities in Sudan and Ethiopia. Table 4.11a indicates that about 87.2 per cent in Ethiopia and 50.0 per cent in Sudan of the electricity is used for electronic equipment.

Dry cells are the second most important energy used by this electronic equipment in both Ethiopia and Sudan. About 49.3 per cent of households in Sudan and 12.8 per cent of households in Ethiopia use dry cells to operate electronic devices.

Table 4.11a: Energy used for electronic equipments (Radio, TV etc) in your home.

Type of Energy	Country		Average
	Sudan	Ethiopia	
Dry cells	49.30%	12.80%	30.70%
Electricity	50.00%	87.20%	69.00%
Other Fuels (SPECIFY)	0.70%	0.0%	0.40%

Table 4.11b shows the potential energy to be used for electronic equipment (radio, TV etc) given increasing availability of the RPT power. Table 4.11b indicates that about 97.9 per cent households in Ethiopia and 91.9.0 per cent households in Sudan are expected to use electricity for electronic equipment. The table suggests that one of the effects of the RPT is to reduce the use of dry cells. The use of dry cells will be very minimal in both Ethiopia and Sudan. About 3.4 per cent of households in Sudan and 2.1 per cent of households in Ethiopia continue using dry cells to operate electronic devices despite improvements in power supplies due to RPT project.

Table 4.11b: The energy to be used for electronic equipment (Radio, TV etc) given availability of RPT power.

Type of Energy	Country		
	Sudan	Ethiopia	Average
Dry cells	3.40%	2.10%	2.70%
Electricity	91.90%	97.90%	94.90%
Solar collectors	4.70%	0.0%	2.40%

Tables 4.11a and 4.11b suggest that the increasing availability of electricity will induce increased use of electronic equipment and their use of electricity. This entails the improved use of ICT facilities and services. In turn, an increase of both the amount of electronic equipment and its services will increase the household electricity consumption. This demands correct and timely energy policies to be put in place.

4.10. Household energy costs as percentage of total income

Household energy cost is an important household expenditure component determining relative levels of inflation and cost of living. Household energy costs are a complex function of energy prices and amount of energy used in the households. It has been noted that commercial energy prices have been rising over time in both rural households in Sudan and Ethiopia, leading to increasing energy cost shares as a percentage of total expenditure/income.

Tables 4.12a and 4.12b present current and potential energy expenditure as percent of total income in Sudan and Ethiopia. Table 4.12a shows that about 73.8 per cent of households in Sudan and about 51.4 per cent households in Ethiopia put their energy expenditure as percent of total income at less than 10 per cent. Table 4.12a suggests that energy expenditure as percentage of total income for about 26.75 per cent of the sample population is less that 5 per cent and about 35.6 per cent range between 5 per cent and 10 per cent.

Consultations during our research field survey in Sudan and Ethiopia noted that increasing environmental fuel wood constraints and current global energy price movements have had a positive impact on the domestic energy prices and costs. Household energy cost shares have been rising at a higher rate than non-energy expenditures over the long term. In the final analysis this has resulted in increasing energy expenditure as percentage of total income in many rural areas.

Table 4.12a: Energy expenditure as percent of total income

Range	Sudan	Ethiopia	Average
	Percent	Percent	Percent
0.5 to 5	43.8	9.7	26.75
5 to 10	30.1	41.7	35.9
10 to 15	6.2	13.9	10.05
15 to 20	9.6	17.4	13.5
20 to 25	2.7	4.9	3.8
above 25	7.5	12.5	10

Table 4.12b shows that about 91.0 per cent of households in Sudan and about 31.4 per cent households in Ethiopia expect that their energy expenditure as percent of total income will be less than 10 per cent given access to RPT power. However, about 54.5 per cent in Ethiopia suggest that energy expenditure as percentage of total income will be between 11 per cent and 20 per cent.

Table 4.12b: Energy expenditure as percent of total income

Percent	Sudan	Ethiopia	Average
1 to 10	91.00%	31.80%	68.50%
11 to 20	3.50%	54.50%	22.80%
21 to 30	3.50%	11.40%	6.50%
41 to 50	0.70%	2.30%	1.30%
51 and above	1.40%	0.0%	0.90%

4.11. Main electricity consumption problems

The electricity sub-sector faces a number of problems or constraints. In the electricity sub-sector, specifically, the main issues in Ethiopia are the: (i) low rate of the population's access to power supply (less than 6 percent based on the number of people actually connected to the electricity supply or about 15 percent when all persons living in electrified areas are counted); (ii) insufficient generation capacity to support the expansion of the market and scale-up of energy in the rural areas; and (iii) the financial deterioration of EEPCo, a historically strong utility, under the weight of ambitious distribution and generation expansion plans, compounded by low tariff levels. Also, the main issues in the Sudanese electricity sub-sector are: (i) low electrification rate (about 22 percent), (ii) insufficient generation capacity to support the expansion of the market and scale-up of energy in the rural areas; and (iii) insufficient reserve capacity to meet fluctuations in hydro-generation (in case of severe drought conditions) resulting in an unreliable power supply and need for industry to maintain costly back-up.

Table 4.13: The main three electricity consumption problems

Electricity consumption problems	Sudan	Ethiopia	Average
	Percent	Percent	Percent
High power installations costs(a)	34.55	14.08	24.31
High monthly tariffs(a)	13.60	9.37	11.48
Frequent power interruption/ power ration/ power cut(a)	23.56	31.65	27.60
Frequent power fluctuation(a)	12.57	19.55	16.06
Others, (poor customers service for repair e.g. delay response, no nearby office for purchase of pre-paid electricity, low family income, no credit facilities(a)	15.73	25.36	20.55

Table 4.13 shows main electricity consumption problems in Sudan and Ethiopia as perceived by the rural household communities. The most important problems include high power installations costs, high monthly tariffs, frequent

power interruption/ power ration/power cut, frequent power fluctuation, and others. Other problems included poor customers service for repair e.g. delay response, no nearby office for purchase of pre-paid electricity, low family income and lack of credit facilities in the rural communities. About 34.55 per cent of households in Sudan argued that high power installation costs are the most important constraints followed by frequent power interruption/ power ration/power cut by 23.57 per cent. About 31.65 households in Ethiopia argued that frequency power interruption/ power ration/power cut as the most important electricity consumption problem in the villages.

4.12. Rural Electrification Programme

Several actors are involved in the energy sector reforms in these countries. Ethiopia has established an Ethiopian Rural Energy Development and Promotion Centre with the objective of creating an enabling environment for the development and promotion of rural energy resources and technologies, (Aklilu, 2003). The Rural Electrification Fund (REF) was established in 2003 with the objective of providing loans and technical services for rural electrification projects on renewable energy sources carried out by private operators, cooperatives and local communities as well as to encourage the utilization of electricity for production and social welfare purposes in the rural areas. Tables 4.14a and 4.14b show support and forms of support of rural electricity programs in Sudan and Ethiopia as perceived by rural communities. The above analysis suggests the need for government support in order to maximize the socio-economic benefits of RPT projects in the rural areas. Table 4.14a shows that about 92 per cent of households in Ethiopia and 72.4 per cent in Sudan are expecting to receive one form or another of the rural electrification programs given availability of RPT.

Table 4.14a: Support of Rural Electrification Programme from the government in per cent

Response	Sudan	Ethiopia	Average
Yes	72.40	92.00	82.2
No	26.00	0	13.0
Not aware	1.60	8.00	4.8

Table 4.14b shows forms of government supports of rural electrification programmes expected by rural household communities. These include subsidies in power installation costs, reduction of monthly power tariffs, provision of credit facility to cover installation costs and others. Other forms include stern measures to overcome power interruption, and ensure technical supports are available in rural areas. About 61.08 per cent of households in Sudan and 44.85 per cent in Ethiopia are expecting to receive subsidies to electricity installation costs

Table 4.14b Forms of government support to rural electrification programmes

Forms of government support	SUDAN	ETHIOPIA	AVERAGE
	Percent	Percent	Percent
Subsidies to installation costs	61.08	44.85	52.96
Reduce monthly power tariffs	13.53	6.32	9.93
Provide credit facility to cover installation costs	2.40	14.99	8.69
Others (stern measure to overcome power interruption, ensure technical support are available)	22.99	33.84	28.42

Financing -- rural electrification is not the sort of investment that is going to attract private investors looking for somewhere to maximize their return. True, there are examples where state-provided schemes have been taken over by private investors and run profitably by cutting costs (particularly of staffing) and adjusting tariffs. However, most of these schemes have been

purchased on very favorable terms from the utility. Private developers have mostly been motivated by providing power for their own productive uses (e.g. agro-processing of various types, workshops, shop lighting) or as a public service, to provide domestic electricity to the community at low marginal cost. Private finance is more commonly a loan component complementing a mix of government grant/subsidy and local equity capital. Where such private sources of credit are not available there can be a role for the development finance institutions to provide bank guarantees or credit packages specifically for community micro-hydro.

5

Socio-economic Impact of Regional Power Trade (RPT)

Chapter Five provides data analysis on the immediate and long-term socio-economic impacts given access to power due to RPT- NBI project. The data analysis focuses on the RPT impacts on a household's income earnings, income poverty reduction, agriculture production and markets, employment, investment, cross- border trade, livelihood and lifestyle, food security, small scale manufacturing, communication, trade and finance, labour productivity, consumption patterns, human resource development, culture, art and sports and other soci-economic activities.

5.1. Electricity use, household incomes earnings and the potential for income

Improving access to and broadening the choice of energy sources for households in the villages and communities may affect socio-economic welfare among poor households in several ways. Table 5.1a shows the perceived potential impact of electricity use to the rural poor community of Ethiopia and Sudan on income and poverty reduction. According to this table, about 98 percent of respondents in Ethiopia and about 96 per cent in Sudan find that availability and use of electricity has the potential to raise their incomes and reduce poverty.

Table 5.1a: Potential impact of electricity on household income and poverty reduction

	Sudan	Ethiopia	Sudan and Ethiopia
Response	Percent	Percent	Percent
Yes	96	98	97
No	4	2	3

Table 5.1b shows the various means and ways in which potential use of electricity can impact on the household level of income, earnings and income poverty reduction. From this table we realize that, in both countries most people, over 35.29 percent, link potential use of electricity to such activities as provision of secretarial services, running internet café, opening small garage for tire repair and welding activities, floor mills industries and the like. About 20.07 percent of respondents in Ethiopia said that availability and use of electricity can lead to the establishment of more hotels and guest houses. The case is different in Sudan where only 9.6 percent link the two; this could be the influence of religious affiliation which shapes culture and belief.

Table 5.1b: Various ways in which electricity impacts on household income and earnings

Items	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Agriculture: Increase agriculture production	17.16	8.35	12.75
Trade: more opening hours	19.68	27.62	23.65
Manufacturing: small scale manufacturing, wood works and metal works, agriculture value addition	17.70	9.23	13.46
Service: more hotels, guest houses, saloons	9.61	20.07	14.84
Others: (floor mills, credit facilities, garage, stationeries, internet café, secretarial services.	35.85	34.73	35.29

5.2. Potential impact of electricity use on agriculture activities

Since the economies of Ethiopia and Sudan depend heavily on agriculture, it was important to investigate and determine the impact of electricity in general and provide particular attention on agricultural activities. Table 5.2a provides the feedback of the survey regarding the impact of electricity on agriculture in Sudan and Ethiopia.

It shows that 86.8 percent of people in Sudan and about 76.5 percent in Ethiopia have the opinion that availability and use of electricity has a positive impact on agriculture activities. These findings suggest that electricity will induce efficiency, commercialization and transformation of the agricultural sector.

Table 5.2a: Impact of electricity use on agriculture activities

Response	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Yes	86.8	76.5	81.65
No	13.2	23.5	18.35

One important area in which production efficiency could be enhanced in agriculture, is that of post-harvest losses. Introduction of improved threshing and storage methods could substantially improve the welfare of subsistence farmers. Invariably, availability and use of electricity in farming activities has a potential to increase farming technologies, opportunities and/or increase the number of productive people involved in the sector.

Table 5.2b below presents various ways by which electricity use can improve households' agriculture activities. According to this table, about 40.25 percent of respondents in Ethiopia argue that accesses to electricity will not only increase the number of people and farming opportunities, but it will also bring about new economic activities; this argument is supported by 31.97 percent of Sudanese. Thus, it is important that rural expansions of energy supply be timed to coincide with implementation of integrated rural development projects covering water supply, irrigation, farm-to-market roads, sanitation and sewerage, agricultural processing facilities, and public health and education facilities, so that the synergy among these activities stimulates economic growth and reduces poverty.

Table 5.2b: Ways linking household agriculture activities and availability and use of electricity

Items	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Increase number of people	6.29	7.68	6.98
Cash crop farming	25.68	28.42	27.05
Increase number of people and Cash crop farming	36.06	23.65	29.86
Others	31.97	40.25	36.11

Equally significant, an average of 29.86 percent of respondents in Ethiopia and Sudan argue that availability and use of affordable and efficient energy source such as electricity from the RPT project should provide an opportunity for anincreased number of people in the sector particularly in cash crop farming.

5.3. Potential impact of electricity on agriculture investment

There is no direct linkage or automatic transformation in farming techniques and practice as a result of the availability of electricity in a farming community. Notably; need for training, and empowerment and investment in modern farming equipment and techniques are inevitable.

Table 5.3a below indicates the potential impact of electricity on the need to invest in modern farm tools and equipments. There is need for additional investment in electricity to bring about the anticipated change in the agriculture sector. About 68.2 percent of respondents in the sample area in Ethiopia and Sudan realize that electricity will have an impact on agriculture investment in machinery and equipment with the aim of transforming the agricultural system and increasing use of modern technologies. This can also explain the current rudimentary farming practice taking place in both countries. Typically, subsistence mixed farming system prevails in most of the Ethiopian highlands as is the case with Sudan. Traditional agricultural tools and paired oxen for

fewer families are used for production, and access to modern inputs such as chemical fertilizers or improved seeds is also limited (EEA 2005/2006).

Table 5.3a: Potential impact of electricity on agriculture investment

Response	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Yes	85.4	51	68.20
No	14.6	49	31.80

To be more precise, it was also important to specifically determine the type of additional or new investment needed to exploit the benefit of availability of RPT and bring about the desired development. Table 5.3b below presents various types of machines, appliances and equipment needed by country. From this table we find that virtually all forms of equipment investments are equally needed; the variation in response on what investment is needed most is less than 20 percent for all equipment in both countries.

Table 5.3b: Type of Machinery, appliances and equipment requirements

Type	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Water pump	31.13	37.91	34.52
Spray machines	28.41	19.37	23.89
Oil processing machines crusher and squeezers	14.20	20.94	17.57
Others (modern farming technology)	26.26	21.78	24.02

For example, in Ethiopia 37.91 percent suggest that for electricity from RPT to bring about improvement in the agriculture sector additional investment in water pump for irrigation is essential. On average, another 24.02 percent in Ethiopia and Sudan combined find that, apart from water pumps, spraying machines, crushers and squeezers, new investment in other modern farm tools such as hay lifters, combine harvesters and tractors are essential to support large and medium scale farming and irrigation. These findings are in line with

the various government and international reports of the two countries which provide that the role and share of the medium and large scale commercial farms in the national economy and food security is still low (CSA, 2006 and FAO 2000).

5.4. Potential impact of electricity use on agricultural production and products markets

Table 5.4a shows the survey responses on the potential impact of electricity on agriculture production and product markets in Ethiopia and Sudan. According to this table, an average of about 85.5 percent in Ethiopia and Sudan suggest that availability and use of electricity will have positive impact on agriculture production and product markets. The impact is expected to manifest itself through increasing knowledge and information, through the use of internet and mobile phone for market information search. Other ways include use of refrigerators to store vegetables and fruits for up markets and improve production methods using modern production facilities. However, studies indicate that Ethiopia and Sudan rural areas have limited power supplies which will facilitate optimal use of ICT facilities. Thus, effective communication in rural communities cannot be accomplished in the absence of electricity.

Table 5.4a: Electricity impact on agriculture production and product markets

Response	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Yes	94	77	85.5
No	6	23	14.5

There are various ways in which electricity can have an impact on agricultural production and product markets. By employing new production technologies, using an efficient power source, output can increase. Invariably, employing new technologies may also entail the refinement or upgrading of existing products and production methods to improve performance, functionality or appeal and cost of production for competitive advantage. Table 5.4b below

shows various ways which electricity can impact agriculture production and product markets. According to this table 41.40 percent of people in Sudan suggest that electricity can increase farming activities by improving quality and quantity of output. This stance is higher by 6.3 percent when compared to Ethiopia. Another 30.08 percent and 24.65 percent in Sudan and Ethiopia respectively suggest that improved agro business and trade activities as a result of availability and use of electricity by rural poor communities will stimulate greater production of agriculture output.

Table 5.4b: Ways which electricity impact agriculture production and product markets

Items	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Increase quality and quantity of production	41.40	35.10	38.25
Increase type of crops	7.37	7.56	7.46
Improve trade activities	30.08	24.65	27.36
Increase investment in agriculture	11.32	13.77	12.55
Others (more market information, milk and vegetable production)	9.83	18.93	14.38

Another area of interest from this table is the potential increase in agricultural investment following availability and use of electricity. This argument is propounded by over 12.55 percent of the respondents in Ethiopia and Sudan and it supports the fact that adequate, affordable, and reliable energy supplies are an essential requirement for speeding up investment and achieving self-sustaining economic growth and development, (UNCTAD 2000).

5.5. Potential impact of electricity use on cross-boarder trade

Cross boarder trade, particularly intraregional food markets is another potential source of demand for agricultural products. Table 5.5a below shows

the impact of future electricity use on cross-border agriculture trade. More than 80 percent of respondents in Ethiopia and Sudan indicated that access to efficient energy source from RPT project will certainly have a positive impact on cross- border agricultural trade, and less than 20 percent felt that availability and use of electricity cannot have any impact on trade of agricultural commodities across the border. While on one hand those who believe that electricity will bring an impact on cross-border trade justify their view on the basis of increased production and labour productivity, the others believe that even with increase in production. Other cross-border trade related barriers overwhelm the potential for improved cross-border trade.

Table 5.5a: Impact of electricity on cross boarder trade

Response	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Yes	89.4	72.5	80.95
No	10.6	27.5	19.05

In theory export performance is considered to be a function of supply capacity and foreign market access. Overall, access to foreign market, particularly intra-region markets by many developing economies has been rationalized in many ways through various inter and intra region groupings. Chronic poor export performance is largely explained by limited supply capacity, constrained by various interlocking physical and software infrastructure. Table 5.5b below shows the main constraints faced by people in Ethiopia and Sudan that limit production for export to other NBI countries. According to this table the main constraint in both countries is high transportation costs, on average over 32 percent of Ethiopian and Sudanese consider transportation cost a major bottleneck. If we consider each country separately, the problem is more alarming in Sudan (42.8%) than Ethiopia (21.2%), an indication that a large part of Sudan's rural area is not connected. Other highly pronounced constraints are related to costs of complying with gsovernment rules and procedures such as the acquisition of export licenses. This has been the case mainly in Ethiopia where 38 percent of respondents identified it as a problem; this is higher by over

23 percent when compared to Sudan where only 14.41 percent of Sudanese cited export procedure as a problem. Thus, while it is important to improve power infrastructure and other flanking measures to promote export by rural poor, export policy has to deliberately address the current constraints.

Table 5.5b: Constraints on Cross-boarder Trades

Constraints	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
High transportation costs	42.83	21.21	32.02
High custom duty and tax	32.48	19.50	25.99
High input Costs	5.14	7.11	6.13
Risk and security problems	5.14	14.10	9.62
Others (difficulty to get export license, difficulty export procedures, low production)	14.41	38.08	26.24

5.6. Potential impact of electricity use on lifestyle

Electricity is the most convenient form of energy for applications other than transport, and even small quantities dramatically improve the quality of life. The uses of electricity are very well known in modern communities. Without electricity, life can be very difficult and awkward for many people. Availability of electricity can influence and change life-styles in many ways; it can change shopping habits from early morning and afternoon to late evening, it makes possible and safe for people to to go out at night clubs; it can change eating habits, from heavy traditional food to light and much tastier take-away foodstuffs improve information sources from print only to audio, audiovisual and internet and it can also increase leisure and entertainment time.

Table 5.6a: Potential impact of Electricity use to change lifestyle

Response	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Yes	100	96.6	98.30
No	0	3.4	1.70

Table 5.6a above shows the influence of future electricity use to the rural poor community of Ethiopia and Sudan and its potential to change their life-style. An average of 98.3 percent argue that future electricity use has a great potential to change livelihood and lifestyle of the rural community, and less than two percent finds that the influence of electricity on lifestyle is limited. The majority claim that the influence of electricity on lifestyle can be manifested through better access to information and availability of modern and efficient cooking, storage, security, communication and entertainment facilities. Regarding ways in which electricity can have an impact on livelihood and lifestyle according to survey response, Table 5.6b summarizes the various ways in which people of rural Ethiopia and Sudan perceive the impact of electricity on rural community contemplates how electricity can impact their life style. An average 26.68 percent of respondents feel that electricity has a potential to improve access to information and knowledge source; this affects various aspect of social life, including the use of latrines.

Table 5.6b: Various ways electricity impacts on lifestyle

Items	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Better access to information and knowledge	28.98	24.38	26.68
increase consumption of non traditional goods and services	26.49	22.75	24.62
Change culture	12.53	13.79	13.16
Improve means of production	10.49	10.95	10.72
Others (better education, more working hrs, more entertainments, less time for cooking, health information)	21.51	28.13	24.82

Another 26.49 percent and 22.75 of Sudanese and Ethiopians respectively argue that consumption of non-traditional food and alcohol may also increase following availability and use of electricity. People can learn and start blending and storing juice in refrigerators for their meals. About 25 percent said that cooking habits in terms of type of food and time spent in cooking can change, people can attend evening classes and children can watch TV during evening and have more time for reading at home, although during field visits we could not see books in many of the households for children to read during the evening.

5.7. Potential impact of electricity use on food security

FAO defines food security as a "situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002a). This definition comprises four key dimensions of food supplies: *availability*, *stability, access and utilization*. On the other hand the recent growing dependence of agriculture on energy markets has also created a growing concern that high and rising energy prices will create new or augment existing food security problems as a growing number of poor consumers are priced out of the food markets by rising energy demand or are exposed to more pronounced swings in food supplies and prices. Table 5.7a shows the potential impact of electricity use on food security, and Table 5.7b extends the analysis by providing a description of various ways which use of electricity by rural communities can change food production, availability and security for households. According to Table 5.7a, over 93 percent of rural poor in Sudan and 75 percent in Ethiopia believe that access to efficient energy source has the potential to improve food production and food security. These findings confirm that rising energy prices create food security problems, not only because of the substitutability and competing use of land for food production and bio energy, but also as a consequence of production efficiency which could be improved by access to efficient energy sources.

Table 5.7a: Potential impact of electricity use on food security

Response	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Yes	93.4	75.8	84.60
No	6.6	24.2	15.40

Similarly, ways in which electricity has potential to impact food security according to this survey is provided in the table 5.7b below. This table shows that an average of 47.5 percent of the respondents in Ethiopia and Sudan say that, with efficient and affordable energy source, there is great potential for increased food production and 33.53 percent said that with electricity use the food security problem risks being low. Another 4.05 percent and 1.79 percent in both countries argue that electricity increases food choices and improves food quality respectively. This suggests that with use of efficient energy source coupled with better farming practices acquired through improved access to information and modern farming tools there is a great potential to minimize food security problems.

Table 5.7b. Various ways electricity impacts on food security

Items	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Increase food production	43.21	51.80	47.50
Ensure food security	36.90	30.16	33.53
Increase food choices	3.89	4.22	4.05
Improve food quality	2.42	1.17	1.79
Others	13.57	12.66	13.11

The major problem of food security in Ethiopia, particularly amongst poor farmers and farmers in marginal areas, is the lack of agricultural development and extreme vulnerability to drought. Overpopulation and the lack of irrigation and food storage infrastructure increase the risk of famine.

5.8. Potential impact of electricity on small scale manufacturing activities

Manufacturing at the small-scale level is especially well matched to the circumstances of the rural poor. It is a fact that millions of poor people worldwide already derive their livelihood directly and indirectly from small-scale manufacturing activities. Until the early 1960s, many economists and business managers attributed the limited number of small-scale manufacturing in less developed countries to the scarcity of capital and administrative experience; to date one of the major bottlenecks to the establishment, growth and competitiveness of SMEs in Africa is non availability of reliable and competitive energy sources. Invariably, the recent energy crisis had a significant impact on the international competitiveness of the manufacturing sector and Africa's credibility as a place to invest (World Investment Report, 2005).

Table 5.8.a shows that about 94 percent in Sudan and 92.6 suggest that there is potential positive impact of electricity on small scale manufacturing activities in the rural areas. In general, households in Ethiopia and Sudan demonstrate that access to electricity has a potential impact to induce and improve the quality and quantity of small-scale manufacturing products and activities.

Table 5.8a: Potential impact of electricity use on small scale manufacturing

Response	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Yes	94	92.6	93.30
No	6	7.4	6.70

Despite the numerous angles whereby electricity can have impact on small-scale manufacturing, the survey responses reveal that, of all the possible areas of influence the rural population of Ethiopia and Sudan repeatedly point out oil processing, floor mills machines, bread baking, ice cream making, metal works and wood works as key areas where availability of electricity stands a great potential to improve.

Table 5.8b: Various ways electricity use impact on small scale manufacturing

Items	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Oil processing	35.81	20.58	28.20
Floor mills	30.86	24.10	27.48
Bread baking	4.50	9.58	7.04
Ice cream making	6.98	4.04	5.51
Others (garage, barber shops, banking service)	21.85	41.69	31.77

Table 5.8b shows that about 35.81 percent of people in Sudan find that access to electricity use has a potential to improve oil processing industries in rural areas; the corresponding figure in Ethiopia is less by 15 per cent. The story is reversed when other services such as garages, barbershops and banking services are considered. In this case Ethiopia (41.69%) surpasses Sudan (21.85%) by at least 20 percent. This deviation reflects that while people of Sudan would invest more in agriculture sector activities given access to reliable power source, the Ethiopians are likely to switch into other business.

5.9. Potential impact of electricity use on household communication

Small farmers and artisans living in rural areas typically lack access to information about prices, data on crops, weather conditions, credit facilities, and market opportunities. Availability of electricity has a potential to upgrade household access to ICT; this can remedy such information asymmetries and stimulate poor people's entrepreneurship by better connecting them to markets. However, realization of balanced access to information by the rural community is not guaranteed; high access costs and illiteracy can bestow this opportunity to the detriment of the poor.

Table 5.9a below shows the survey response on the potential impact of future electricity use to change and or improve communication in rural households. The Majority, 97 percent of the response in Sudan and Ethiopia, indicate that

access to electricity has the potential to improve communication and only three percent suggest that even with access to electricity, house-hold means and channels of communication are less likely to change.

Table 5.9a: Potential impact of electricity on households communication change

Response	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Yes	96.7	97.3	97.00
No	3.3	2.7	3.00

Table 5.9b extends the analysis on the impact of electricity use to improve households' communication. This table shows the various ways the potential use of electricity can change and/ or improve households' mode of communication. From this table we deduce that 39.24 percent in Sudan feel that with access to electricity they would be able to own television and or radios, and this will enhance their access to not only information but quality, reliable and up-to-date information. The corresponding figure in Ethiopia is 25.84 percent, about 15 percent less than Sudan, an indication that Ethiopians place relatively less importance on the use of television and radio as a means of information source or they would climb a higher ladder towards telephone and internet use as provided by 35.88 percent and 27.82 percent respectively.

Table 5.9b Impact of electricity availability on the choice of mode of communication

Items	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
TV/Radio	39.24	25.84	32.54
Telephones	20.70	35.88	28.29
ICT- internet	26.56	27.82	27.19
Others	13.50	10.46	11.98

For example, Jigina Kidanemihret village in Ethiopia which is one of the RPT beneficiaries, some farmers own mobile phones to communicate market

information for their products with business people in other parts of the country. "Villagers appreciate that efficient use of land; hard work and availability of mobile phones have had a great impact on their income" said the village chairman. Electricity helps improve communications, and media coverage that bring communities close (Toman, M. et al 2002)

5.10. Potential Impact of electricity use on trade, tourism and finance

Like any other business undertaking, modern and competitive investment in trade, tourism and finance can hardly be achieved without efficient and reliable energy. With the growing development and competition in the service sector, customer needs are becoming more sophisticated; invariably there is a systematic shift of competition from the low order price based competition to a higher ladder technological and innovation based business competition. E-Business (e-commerce, e-banking and e-tourism etc) are among the modern ways to transform business surpassing all geographical boundaries and trade barriers. Technically it is difficult to imagine how one can become an integral part of these developments without efficient and reliable energy.

Table 5.10a shows the potential impact of electricity use to change and/or improve businesses, trade, tourism and finance to rural households. On average 85.35 percent in both countries felt that access to electricity has the potential to improve trade, tourism and finance. On trade the argument is that use of electricity makes possible for rural business people to use refrigerators to store perishable products for up-markets, and it serves as an opportunity for extended business hours. In turn use and ownership of such facilities as refrigerators, television and mobile phones increases the creditworthiness of the rural people and hence greater access to micro finance.

Table 5.10a: Impact of electricity use on trade, tourism and finance

Response	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Yes	86.8	83.9	85.35
No	13.2	16.1	14.65

Table 5.10b below provides the various areas which have a potential to change and/or improve businesses given availability and use of electricity. In Ethiopia 64.56 percent of respondents said that, financial services can improve in terms of access to finance and easy access to banking (deposit and withdraw) and improve the banking hour's restrictions in so far as ATM is installed. The corresponding figure in Sudan (19.87 per cent) is less by over 45 percent. It should be noted that, although this argument is largely propagated by Ethiopian rural people who are skilled and have a wide national and even international exposure, it is somewhat difficult to explain the significant range in perception and feelings on the same in the two bordering countries.

Table 5.10b: Potential areas of impact due to electricity use

Areas of Impact	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Economic services-trade	46.28	17.72	32.00
Financial service	19.87	64.56	42.22
Others – tourism	33.85	17.72	25.78

In general, both people of Sudan and Ethiopia agree that with efficient energy, there is a great potential to undertake sophisticated business such as tourism and banking. to increase visibility; a vital effect for any business, opens customer base beyond border and slash costs, enhances productivity and streamlines the entire business process.

5.11. Potential impact of electricity use on social consumption pattern

In theory, availability and use of electricity has a potential to improve not only time spent for preparing food but also the type of food prepared and consequently

the consumption pattern of the households. Table 5.11a below shows the potential impact of electricity use to change a household's consumption pattern. According to this table 84.7 percent and 90.6 percent of the people in Sudan and Ethiopia respectively accept that use of efficient energy source has the potential to change household consumption behaviour. A study in Bangladesh designed to examine the economic and social impact of the rural electrification programme also found that the food and non food expenditure patterns in electrified rural areas were almost similar to that in urban areas (HDRC 2002). Thus, electrification has acted as a factor in urbanizing the consumption pattern of the rural people having electricity in their households.

Table 5.11a: Potential impact of electricity use on household consumption

Response	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Yes	84.7	90.6	87.65
No	15.3	9.4	12.35

Regarding the quality and quantity of food intake, studies indicate that electrified households are much better off than non-electrified households. Table 5.11b below shows the various ways in which electricity use can have potential impact on household's consumption pattern. This table reveals that the magnitude of impact is more or less the same in both countries and the context of impact is manifested on increased drinking (35.8%), more eating (32.9%), reduced sleeping time (19.9%) and others (11.4%). Increase in consumption of foods implies, among other things improved variety of foods, taste, quality and availability.

Table 5.11b: Impact of using electricity on consumption pattern

Impacts	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
More drinking	35.87	35.77	35.8
More eating	34.19	31.67	32.9
Less sleeping time	20.97	18.81	19.9
Others	8.97	13.75	11.4

5.12. Potential impact of electricity use on emerging economic activities

There are various emerging economic and creative activities that could be linked to availability and use of electricity in rural areas. Villagers can learn, adopt and use modern sewing machines, ICT-related business activities and other services such as welding, salon and barbershops. Table 5.12.a shows the potential impact of future electricity use due to RPT- NBI project to bring about new economic activities. According to this table an average of 71.1 percent of the respondents in both countries foresee new economic activities resulting from connection to electricity from the NBI- RPT project. The ability to foresee new economic activities, which is a *reflection of entrepreneurial tendency,* is higher in Ethiopia, (81.9%) by at least 20 percent than Sudan, (60.3%).

Table 5.12a: Emerging economic activities following availability of RPT electricity

Response	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
Yes	60.3	81.9	71.1
No	39.7	18.1	28.9

Table 5.12b shows various emerging economic activities which can be linked to the availability of electricity from RPT the project. According to this table 30.94 percent of respondents in Sudan find more new economic activities of trade in goods; the corresponding figure in Ethiopia is 28.13 percent. Trade in services opportunities are almost 10% higher in Ethiopia (34.38%) than in Sudan. Where we acknowledge significant growth potential in service sector, ICT related economic activities present greater opportunities. This is not the case in Sudan (7.91%) and Ethiopia's (5.39%) rural community. Inability of the rural community in the two countries to foresee the ICT potentials to provide more employment opportunities is not a true reflection that there are limited opportunities in the sector, but rather an indication of limited exposure, skill and knowledge of the rural community.

Table 5.12b: Emerging economic activities following availability of RPT electricity

Emerging economic activities	Sudan	Ethiopia	Sudan and Ethiopia
	Percent	Percent	Percent
ICT services	7.91	5.39	6.6
Trade in goods	30.94	28.13	29.5
Trade in services	24.58	34.38	29.5
Manufacturing	19.90	20.55	20.2
Others	16.67	11.57	14.1

5.13. Engagement in Emerging Economic Activities

Use of electricity as a source of energy is important in the sense that it can help achieve pro poor growth by stimulating households to engage in activities that are made easier by increased access to electricity. Table 5.13.a shows the perceptions of respondents towards engaging in emerging economic activities as a result of the availability of electricity.

Table 5.13a: Potential Impact of electricity use on emerging economic activities

Response	Sudan	Ethiopia	Average
Yes	83.3	66.4	74.9
No	16.7	33.6	25.2
Total	100	100	100

Table 5.13a shows that about 83.3 per cent of rural households in Sudan and 66.4 per cent in Ethiopia have the opinion that more electricity will stimulate households to engage in emerging socio-economic activities. However, about 33.6 per cent of households in Ethiopia view that this may not necessarily happen for a number of reasons or constraints. Table 5.13b shows the reasons or obstacles for the effective participation of household members in engaging in new and emerging economic activities.

Table 5.13b: Obstacles to Engagement in Emerging Economic Activities (%)

Obstacles to Engagement	Sudan	Ethiopia	Average
Limited skill	10.4	2.8	6.6
Low education level	10.4	10.9	10.7
No experience	0.0	5.2	2.6
Other reasons	79.1	81.0	80.1

Table 5.13b shows that of the identified factors, limited skills and low education level are the major ones. These factors boil down to the fact that low levels of education will not encourage people to demand electrical appliances due to the low incomes associated with lower education levels along with the lack of exposure associated with low levels of education.

5.14. Impact of RPT on socio-economic development projects

One of the benefits of RPT is to promote socio-economic development activities. One instance in which RPT electricity can play an important role in promoting development in an area is through providing electricity in areas which have development projects and which can benefit from the use of electricity. Table 5.14a shows the views of respondents to whether RPT electricity can benefit projects existing in the areas while Table 5.14b shows specifically which projects RPT electricity can potentially benefit.

Table 5.14a: Impact of RPT's on socio-economic development projects

Response	Sudan	Ethiopia	Average
Yes	91.4	57	74.2
No	8.6	43	25.8

Table 5.14a shows that RPT electricity has more potential benefits in Sudan than Ethiopia on the socio-economic development projects. This may be because Ethiopia has fewer projects than Sudan, which makes people in Ethiopia less able to determine the potential benefits of RPT electricity. Table

5.14b shows that people perceive that RPT will benefit projects related to social services, especially education and health. Since social services such as education and health services have significant pro poor effects from the fact that they are related to enhancing human capital which results in higher productivity that consequently will lead to higher household earnings.

Table 5.14b: Type of Public Projects Benefiting from RPT Electricity

Type of Public Projects	Sudan	Ethiopia	Average
Education / Schools	31.9	38.4	35.1
Hospital and Health centre	33.60	35.9	34.7
Mosque and Churches	4.01	0.9	2.4
Others (Community Development)	30.53	24.8	27.7

5.15. Impact of Electricity on Cultural, Arts, Sports and Social Activities

Electricity can have an impact on creative cultural activities in that it can change the way people take part in both traditional and modern cultural activities. Electricity enables people to access social activities and sports events through electrical appliances and by doing so exposes household members to information that may influence households to change cultural preferences or consumption preferences. Table 5.15a shows peoples' opinions as to whether future use of electricity will impact or have an affect on cultural activities while Table 5.15.b shows the ways in which electricity impacts on cultural activities in the two countries.

Table 5.15a: Impact of Electricity on Cultural Activities

Response	Sudan	Ethiopia	Average
Yes	88.7	83.9	86.3
No	11.3	16.1	13.7

Table 5.15b: Impact of Electricity on Cultural Activities

Cultural Activities	Sudan	Ethiopia	Average
Culture	27.5	23.0	25.2
Sports	31.4	31.9	31.6
Arts	20.0	12.7	16.3
Social clubs	14.1	18.3	16.2
Others	7.0	14.1	10.6

Tables 5.15a and 5.15b reveal that a majority of people perceive that electricity will have an impact on cultural activities with the impact cutting across almost all spheres of culture. People perceive that electricity will have such a significant impact on cultural activities because the availability of electricity works to improve cultural activities since such activities tend to depend a lot on electricity.

5.16. Impact of Electricity on Human Capital and Social Capital Activities

Electricity can help improve the delivery of education and health services which play a vital role in building up human capital and social capital. Electricity achieves this by enabling educational actors, namely teachers and students, to undertake their activities more smoothly and in a more efficient manner. Furthermore, electricity also enables the smooth and efficient delivery of health services in a manner that improves the well being of the population. Table 5.16a shows peoples' opinions as to whether future use of electricity will impact human capital and social capital activities, while Table 5.16b shows the manner in which electricity impacts human capital and social capital activities. Table 5.16a shows that about 94.35 per cent, i.e., the majority of respondents in sample villages, are of the opinion that RPT electricity will have an impact on human capital and social capital activities.

Table 5.16b reveals that the predominant specific effect of electricity on human capital and social capital activities in Sudan is on tertiary education while in Ethiopia it is on secondary education. This may be due to the fact that people in Sudan are of the perception that tertiary education has the most

value added towards human capital and social capital activities while in the case of Ethiopia the perception is that electricity will increase human capital and social capital activities in secondary education because such services are not in good shape.

Table 5.16a: Impact of Electricity on Human Capital and Social Capital Activitiess

Response	Sudan	Ethiopia	Average
Yes	97.4	91.3	94.35
No	2.6	8.7	5.65

Table 5.16b: Specific Impacts of Electricity on Human Capital and Social Capital Activities

Level of education	Sudan	Ethiopia	Average
Primary education	17.2	26.6	21.9
Secondary education	8.0	46.9	27.4
Tertiary education	41.4	9.3	25.4
Vocational training education	3.5	7.9	5.7
Others	29.9	9.3	19.6

5.17. Other General Impacts of Regional Power Trade

Regional power trade has the objective of expanding the populations' access to electricity. Apart from the benefit of expanded access to electricity and above specific socio-economic effects, there are other general effects. Table 5.17 shows other effects of regional power trade at the village level.

Table 5.17: Other Impacts of Regional Power Trade

Items	Sudan	Ethiopia	Average
Reduce rural urban migration	7.6	6.9	7.3
More/ better access to development by the poor	18.9	20.9	19.9
More rural development	38.0	51.2	44.6
Others (reduce deforestation)	35.4	20.9	28.1

Table 5.17 shows that people in Sudan and Ethiopia consider that rural development will have the most strategic impact given access to additional stable regional power. People perceived the next important impact of regional power trade as better access to development by the poor which fits into the overall picture of rural development.

The data analysis suggests that there are several socio-economic activities, and possible channels through which increased energy availability in rural communities of Ethiopia and Sudan could disproportionately affect economic development and income poverty reduction. These may entail, reallocation of household time (especially by female gender) from energy provision to improved education and income generation and greater specialization of economic functions; greater flexibility in time allocation through the day and evening; greater market size and access; more access to information and health related benefits; all combined yield direct benefits and higher productivity in agriculture, trade, manufacturing and hence greater welfare to the rural poor communities in both Sudan and Ethiopia.

6

Environmental Impact of RPT

6.1. Nature of the RPT Project

It is natural to investigate all forms of environmental impacts given the size and nature of the Project. The RPT Project involves, construction of a high voltage transmission line from Ethiopia to Sudan to utilize surplus hydropower from Ethiopia to replace oil-based thermal generation in Sudan. The interconnection would also provide benefits of common reserves in emergency cases (electricity could be transferred from Sudan to Ethiopia under severe hydrological conditions in Ethiopia) and achieve considerable savings in timing of power plants in the long run.

6.2. Environmental and Social Impact Assessment

The Environmental and Social Impact Assessment, (ESIA), (World Bank, 2006b), indicated that traditional environment impacts associated with the Project are of a temporary nsature resulting during construction, and can be minimized by good engineering practice and implementation of recommendations outlined in the EMP. Much of the natural vegetation along the route has been disturbed already by traditional mixed subsistence farming in Ethiopia and mechanized rain-fed agriculture in Sudan so that there is unlikely to be any new loss in biodiversity of plants or vegetation. In addition, emissions of greenhouse gases and other air pollutants will be reduced due to the substitution of thermal generation in Sudan by hydropower generation from Ethiopia. To mitigate and minimize the environmental impacts, an EMP has been prepared to address these issues from the planning phase through to the implementation and operation phase.

Because of the linear nature of a transmission line development, the ESIA study concluded that the Ethiopian-Sudan Power System Interconnection Project will have minimal impact on communities or persons, and on private

or common property assets. However, compensation will be due where towers or Project right-of-way (ROW) affect residential dwellings or social services (which will pose health and safety problems); will fragment cultivated fields and compromise productivity and income; will involve the removal of fruit-bearing trees and other economically valuable natural resources, or may partially or totally disturb cultural properties such as churches, mosques, or archaeological sites. Although the Project will have minimal impact upon Project Affected Persons (PAPs), site-specific relocation may have to occur where access routes, line corridors or transmission towers are to be located.

Short-term socio-economic impacts are anticipated to occur predominantly during the construction phase with the importation of skilled workers into the area, and the construction of work camps and temporary access roads and the establishment of the transmission line ROW. While major attention will be focused on loss of income due to temporary disturbance to crops or grazing areas, and on health conditions related to the influx of workers from outside the region (HIV/AIDS being the major concern), positive opportunities to PAPs may be presented in the form of temporary employment, as well as through income generated by the sale of food to immigrant workers. The resettlement plan or a resettlement policy framework is done for the involuntary loss of land or other assets including the loss of income sources or means of livelihood. This chapter presents environmental impact of RPT after the completion and operation of the project. The content of environmental effects caused by RPT-NBI project appears to be sensitive in the contemporary project area. The chapter will present the two project areas both in Sudan and Ethiopia. It will be based on objectives of the project including environmental current issues in Sudan and Ethiopia, the availability of switching to other sources of energy, environmental degradation like deforestation as a result of charcoal /fire wood, impacts on natural resources and environmental problems.

6.3. Potential impact on the use of Fuel Wood and Charcoal

The environmental impacts caused by the use of fuel like charcoal and firewood change the whole environmental structure of the affected areas. People in African countries like Sudan and Ethiopia experience environmental problems especially in villages where people do not have other sources of power like electricity. In rural areas households rely more on fuel wood and charcoal than those in urban areas; well over half of all urban households in sub-Saharan Africa rely on fuel wood, charcoal, or wood waste to meet their cooking needs (IEA, 2006). Table 6.1 suggests that the majority, about 99.30 per cent in Sudan and about 87.20 per cent in Ethiopia, indicated that the future use of electricity due to increased access to RPT will have potential impact on the use of fuel wood and charcoal.

Table 6.1: Potential impact on the use of fuel wood and charcoal

Response	Country		Average
	Sudan	Ethiopia	
Yes	99.30%	87.20%	93.30%
No	0.70%	12.80%	6.70%

6.4. Activities impacting the use of fuel wood and charcoal

Chapter Five suggests that the use of fuel wood and charcoal are among the daily activities performed in rural areas because people lack other modern sources of energy like electricity which would be used as a substitute. There is total dependency in the use of fuel wood and charcoal in rural areas especially in places which do not have access to electricity. This contributes to environmental degradation by cutting trees for fire wood and burning charcoal for cooking. Table 6.2 shows the respondents appraisal on the activities which can be done in order to reduce the usage of fuel wood and charcoal in villages in Ethiopia and Sudan. About 91.66 per cent in Sudan and about 79.39 per

cent in Ethiopia argued that decrease in the use of fuel wood and charcoal and utilization of other sources of energy like electricity, then electricity will prove to have potential effects on people through the RPT power project.

Table 6.2: Activities impacting the use of fuel wood and charcoal

Items	Sudan	Ethiopia	Average
	percent	Percent	Percent
Decrease in use of fuel wood and charcoal	91.66	79.39	85.52
More use of other energy sources	8.34	20.61	14.48

6.5. The future use of electricity and its potential impact on the use of kerosene

Chapter Five noted that kerosene is among the fuels used in villages. It is a product which seems to be important to those who have access to it. The future use of electricity will have a potential use among the people and kerosene will be as a transitional energy substitute for people who can afford.

Table 6.3: The future use of electricity and its potential impact on the use of kerosene

Response	Country		Average
	Sudan	Ethiopia	
Yes	98.00%	80.30%	89.20%
No	2.00%	19.70%	10.80%

The field data shows that most of the respondents, about 89.30 per cent of the sample households in Sudan and Ethiopia, have the view that the future use of electricity will have potential impact on the use of kerosene. This suggests that people with certain income levels, given access to electricity, will be able to switch from kerosene to electricity.

Table 6.4: Direction of Impact

Type	Sudan	Ethiopia	Average
	Percent	Percent	Percent
Negative impact	22.32	10.57	16.45
Positive impact	77.68	89.43	83.55

Table 6.4 shows that on average about 83.55 per cent of the households in sample rural villages are ready to use electricity as a change from kerosene given increased availability and accessibility of cheap, clean and modern energy source from the RPT project. Kerosene is regarded among the fossil fuels which has effects on people's health because of the emission of toxic gases like carbon dioxide. This happens during lighting, using kerosene, or cooking. Household fuel choice also depends on other factors, which makes knowledge of the determinants of urban households' choice of fuel important. In the literature on household energy demand and choice, it has been argued that households with low levels of income rely on biomass fuels, such as wood and charcoal, while those with higher incomes consume energy that is cleaner and more expensive, such as electricity. This depends on the availability of fuels and the level of the household's income. (ESIA, 2006).

6.6. Switching to other sources of energy

A related concept is fuel switching, where it is argued that introduction of superior fuels will phase out traditional fuels as households will switch to the former. ESMAP (2000) presents a theory with a ladder of energy demand, rather than of fuel preferences, where more diversified demand for energy sources is explained in terms of the nature of appliances used and the purpose, as incomes rise.

Table 6.5. Switching to other sources of energy

Response	Country		Average
	Sudan	Ethiopia	
Yes	19.20%	67.10%	43.00%
No	80.80%	32.90%	57.00%

Table 6.5 shows that a about 67.10 per cent of rural households in Ethiopia will switch to other sources of energy and about 80.80 per cent in Sudan indicated a negative response towards switching to other sources of energy. On average, the table shows that about 57 per cent of sample households are not ready or willing to switch to other sources. Ethiopians may be ready to change to other sources of energy because of the life style, sources of alternative energy, general input and output price structures and trend and levels of socio-economic developments in respective villages. The Sudanese are already using modern energy such as LGP people may be reluctant and seem to get used to their current energy use in cooking and lighting. More recently, it has been argued that households in developing countries do not switch direct to modern energy sources but instead tend to consume a combination of fuels, which may include combining solid fuels with non-solid fuels as sources of energy. Thus, instead of moving up the ladder step by step as income rises, households choose different fuels as from a menu. They may choose a combination of high-cost and low-cost fuels, depending on their budgets, preferences, and needs, (World Bank, 2003). This led to the concept of fuel stacking (multiple fuel use), as opposed to fuel switching or energy ladder, (Alemu and Gunnar, 2008).

6.7. Types of other energy sources

Table 6.6 shows that there are other types of energy sources which can be used as a substitute in giving people alternative ways of getting energy according to the levels of incomes. Different sources of energy improve the efficiency of the performed activities in the household. Furthermore, the availability of different sources of energy simplifies the activities and reduces the time of performance.

6.7.1. Gas

Table 6.6 shows that about 60.57 per cent of households in Ethiopia and 17.93 per cent in Sudan are willing to switch to gas as another source of energy. Switching to gas as a reliable source of energy will give people

reliability and a cheap way of cooking and other activities. The reason for switching to gas as a source of energy is largely due to increasing availability, price levels, increased information and knowledge and change of way of life and economic activities.

6.7.2. Solar

Solar is another source of energy which was indicated by respondents in Sudan. About 36.55 per cent of households in rural areas in Sudan are ready to use solar as alternative source of energy. Switching to solar energy has potential effects on people's life as it is easy to obtain and has lower costs. This will make people more comfortable in their daily life. Uses of solar electric systems decrease the amount of local air pollution. With a decrease in the amount of kerosene used for lighting, there is a corresponding reduction in the amount of local pollution produced. Solar rural electrification also decreases the amount of electricity needed from small diesel generators.

6.7.3. Electricity

Electricity seems to be a potential especially to people in Ethiopia who comprised 38.64 per cent supporting the use of electricity in their household while there was no kind of response given from Sudan. People of Ethiopia have recognized the use of electricity in their daily life while in Sudan electricity does not have potential use according to the results given from the field. It is indicated that electricity is a more efficient source of energy. Electricity can be used in doing different activities in the household like cooking. It is suggested that the food prepared using electricity has good test different from wood fuel which sometimes can contaminate the food with smoke.

It is good to use electricity for people's health because of preparing food in clean environment not like charcoal. The time consumed while using electricity whether for ironing or cooking is less than using charcoal or fuel wood. According to the data given people who use electricity become less tiredbecause of the use of machines instead of their hands.

Table 6.6: Type of energy sources

Type of energy sources	Sudan	Ethiopia	Average
Electricity- People use more efficient energy source, good for health, less time, less tiring, good food test.	0%	38.64%	19.32%
Solar- why less cost and easy obtainable	36.55%	0.79%	18.67%
Gas- People may use more efficient energy source, good for health, less time, less tiring.	17.93%	60.57%	39.25%
Others- People may use more efficient energy source, good for health, less time, less tiring.	45.52%	**0%**	**22.76%**

6.8. Deforestation in the village/town as a result of charcoal/firewood

Due to deforestation people miss sources of fuel like charcoal and destroy the whole nature of the environment. Natural vegetation is very important in the life of human beings because it provides the environment with rain and sunshine which help the plants to grow. The concept of deforestation is man's activity of cutting and burning natural vegetation because of personal needs like charcoal and wood fuel.

Table 6.7 shows that about 99.3 per cent rural households in Sudan and about 95.3 per cent in Ethiopia suggest that there is deforestation in the village /town as a result of the use of charcoal/firewood. The presence of different activities like getting fuel wood and charcoal threaten the whole structure of the project area due to the increased rate of deforestation, (Masera et al, 2000).

Table 6.7: Deforestation in the villages /towns as a result of charcoal/firewood extraction

Response	Country		Average
	Sudan	Ethiopia	
Yes	99.30%	95.30%	97.30%
No	0.70%	4.70%	2.70%

The future impacts of deforestation like drought and land degradation might threaten the life of living organisms. The present deforestation rate, as indicated by the respondents, brings into awareness that there is a lack of responsibilities among the people in villages and there is no follow up from the Government. These are contemporary issues which affect the future generation of living organisms and put life at a great risk.

6.9. The use of electricity as a substitute of charcoal / firewood and reduce deforestation

Substituting new and renewable energy like electricity helps to reduce deforestation which is caused by cutting trees and vegetation for fuel wood and charcoal in house holds, (Allemu and Gunnar, 2008). Table 6.8 shows the use of electricity and substitution to the use of charcoal/firewood and reduce deforestation in the villages in Sudan and Ethiopia

Table 6.8 indicates that the use of electricity replaced the use of charcoal/fire wood and reduced deforestation. About 99.3 per cent of households in Sudan agreed that use of electricity has over time replaced the use of charcoal/fire wood and thus reduced deforestation. However, the case is different for Ethiopia. About 54.40 per cent of households in Ethiopia have the view that the use of electricity has not replaced and will not necessarily replace the use of charcoal/fire wood and thus reduce deforestation in the rural areas. Again this suggests that there are other complex factors determining substitutability of energy sources among households. Some of the people in Sudan are using fuel wood and solar because of the availability of these energy sources while Ethiopians are in great need of using electricity as a replacement for charcoal/ fire wood.

Table 6.8: The substitution of charcoal/firewood for electricity

Response	Country		Average
	Sudan	Ethiopia	
Yes	99.30%	45.60%	72.70%
No	0.70%	54.40%	27.30%

6.10. Ratings on reduced deforestation

The reduced rate of deforestation brings back the concept of sustainable socio-economic development in the project areas. The deforestation rate can be controlled and managed if there is a clear policy and maximum institutional follow-up. This will maximize the environmental capacity building and create sustainable environmental systems in Sudan and Ethiopia. Table 6.9 shows household perceptions and ratings on the reduced deforestation in both Sudan and Ethiopia. About 68.8 per cent of households in Sudan and 17 per cent in Ethiopia have the view that there is a high deforestation in their respective villages. About 49.2 per cent in Ethiopia argue that deforestation is moderate. These are the key concepts in dealing with environmental degradation, which is caused by lack of knowledge and resources like having alternative sources of energy, and get rid of the use of charcoal and fuel wood.

Table 6.9: Ratings/perceptions on reduced deforestation

Ratings/perceptions	Country		Average
	Sudan	Ethiopia	
Very high reduction	50.40%	6.80%	37.50%
High	18.40%	10.20%	16.00%
Moderate	25.50%	49.20%	32.50%
Low reduction	5.00%	27.10%	11.50%
Very low reduction	0.70%	6.80%	2.50%

6.11. Potential impact on indoor air quality, health, knowledge and fertility reduction

The concepts of air quality, health, knowledge and fertility reduction are the important aspects in the life of the people in improving their living standards. People in village areas lack some of these aspects especially those who do not have access to electricity or other sources of energy like solar. All these

aspects affect the social setting of the people in positive or negative way. People will improve their life standards by having electricity, which will give them opportunity to acquire such potential aspects. Table 6.10 indicates people's perception of the potential impact of RPT on indoor air quality, health, knowledge and fertility reduction. About 64.70 per cent of households in Sudan and 91.9% in Ethiopia have the view that the future use of electricity will have an impact on indoor air quality, health, and knowledge and fertility reduction.

Table 6.10. The potential impact of the future use of electricity on indoor air quality, health, knowledge and fertility reduction

Response	Country		Average
	Sudan	Ethiopia	
Yes	64.70%	91.90%	78.30%
No	35.30%	8.10%	21.70%

Table 6.11 shows that about 91.21 per cent in Sudan and 95.19 in Ethiopia suggest that the potential future use of electricity which will have a positive impact on indoor air quality, health improvements, and knowledge and fertility reduction. The future use of electricity will improve the indoor air quality within households, like having air conditioning and fans in the hot areas. Health facilities will be improved by making use of machines which use electricity like microscopes, ultra-sound machines in hospitals for the areas which can afford them. People in Sudan and Ethiopia will be getting the chance to improve their knowledge by accessing computers, having more reading allowance in schools and colleges. The fertility reduction will reduce because people will have light at night and reduce their sleeping time. They will be able to divide their available time among different activities like reading, entertainment by watching TV and listening to radios.

Table 6.11: Direction of Impact

Type	Sudan Percent	Ethiopia Percent	Average Percent
Positive	91.21	95.19	93.20
Negative	8.79	4.81	6.80

6.12. Potential impact of electricity on quality and quantity of natural resources

The extent to which the potential effects of electricity can also be directly reflected on the quality and quantity of natural resources like vegetation, air quality, surface/ground water and animal/aquatic life is a matter of debate. If a generating facility is being developed to capture the potential benefit of the underlying new and renewable energy resource, electricity use should be considered as potential reflecting that benefit.

Significant environmental benefits on quality and quantity of natural resources could emerge in Sudan and Ethiopia if regional power trade were developed on a least-cost basis. Such benefits could result from water conservation and land protection effects. Certain potential power considerations in relation to these environmental benefits are discussed in the following subsections.

Table 6.12: The future use of electricity and its potential impact on quality and quantity of natural resource

Response	Country		Average
	Sudan	Ethiopia	
Yes	73.80%	91.70%	82.80%
No	26.20%	8.30%	17.20%

Overall, Table 6.12 indicates that more than two third of the respondents in Sudan and Ethiopia, of about 82.80 per cent in the sample, were convinced that the use of future electricity will have a great potential impact on quality

and quantity of natural resource in the interconnected regions. Both male and female respondents shared the same view though in varying proportion in terms of percentage. The results found give an interpretation that electricity use will change their life style and give them access to better life by having quality air in their houses.

6.13. Impact predicted on air quality and quantity

Table 6.13 shows ratings on the intensity of the effects of electricity on air quality and quantity. The data indicate that about 74 per cent of households in Sudan have the view that there will be a low level of impact of electricity on air quality and quantity. However, the story is different for Ethiopia. Table 6.13 shows that about 69.6 per cent of households in Ethiopia have the view that there will be a high level of impact of electricity on air quality and quantity in these rural communities.

Table 6.13. Impact predicted on air quality and quantity

Impact	Country		Average
	Sudan	Ethiopia	
Very low	49.6%	5.1%	25.7%
Low	24.4%	1.4%	12.1%
Moderate	19.3%	23.9%	21.8%
High	6.7%	10.9%	8.9%
Very high	0	58.7%	31.5%

6.14. Vegetation quality and quantity

Land use and vegetation quality and quantity have been strongly influenced by the climate, topography and population. The potential impact of the future use of electricity concerning the quality and quantity of natural vegetation will support the conservation of vegetation by using electricity in homes instead of fuel wood. Few if any undisturbed natural forests remain, most have been heavily disturbed and degraded. Forest types range from natural forest, plantation forest (mainly

introduced eucalyptus trees); farm forest (eucalyptus) and acacia woodland/ savannah. Vegetation associations have been disturbed by human activities and changes in hydrology (water regimes). Many road verges have also been planted with introduced eucalyptus trees and these trees are gradually spreading into remnant native vegetation. The table below indicates the predicted impacts on vegetation quality and quantity in Sudan and Ethiopia;

Table 6.14: Impact predicted on vegetation quality and quantity

Impact	Country		Average
	Sudan	Ethiopia	
Very Low	34.5%	4.3%	18.3%
Low	38.7%	2.2%	19.1%
Moderate	23.5%	29.0%	26.5%
High	1.7%	21.7%	12.5%
Very High	1.7%	42.8%	23.7%

Table 6.14 shows that about 73.2 per cent of households in Sudan have the opinion that increasing use of electricity will have low impact on the vegetation quantity and quality. However, about 64.5 per cent of the respondents in Ethiopia have the view that there will be high level of impact of electricity on air quality and quantity given more power access.

6.15. Animal and aquatic life

Land clearing, land degradation and large stock numbers have also taken their toll on the study area's biodiversity and although vegetation types are diverse, they are severely degraded. Similarly, the area's wildlife diversity has been significantly reduced, especially with respect to the larger mammals. The diversity of bird species has also been reduced though many endemic species (occurring nowhere else) still occur in Ethiopia, (ESIA, 2006). The future use of electricity will facilitate more alternative ways of reducing the death of wildlife animals by putting camps for auxiliary police to stay and keep the environment safe.

Table 6.15: Impact predicted on animal and aquatic life

Impact	Country		Average
	Sudan	Ethiopia	
Very low	59.7%	3.6%	29.6%
Low	26.1%	3.6%	14.0%
Moderate	10.9%	32.6%	22.6%
High	3.4%	24.6%	14.8%
Very high	2.7%	35.5%	19.1%

Table 6.15 shows perceived views and ratings on the effects of the potential future use of electricity on animal and aquatic life in Sudan and Ethiopia. It shows that about 85.8 per cent of households in Sudan have the view that there is a low impact of the potential future use of electricity on animal and aquatic life in the rural villages. However, the table shows that about 60.1 per cent of households in Ethiopia have the view that there is a high impact on increasing use of electricity on animal and aquatic life in the rural villages.

In Ethiopia, several species of large wild animals have been reported from the area. However, an encounter with large mammals is very rare. This is not surprising since there has always been an ongoing conflict between wildlife conservation and the increasing demand on land for agricultural and livestock development, (ESIA, 2006). Wildlife cannot survive if it constantly has to compete with human interest in the form of cultivation and livestock raising that invariably cause destruction of wildlife. The study area is no exception to this process.

6.16. Surface / Ground Water

Many of the watercourses flow only during the rainy season from April/May to September/October. Outside these times many watercourses are reduced to intermittent pools. Access to potable (drinking) water supplies is often a problem during the dry season especially on the lowlands in Sudan and in Ethiopia near the border with Sudan. Villagers rely on groundwater wells and

small shallow dams (wadis/ hafirs in Sudan) for water supply during these times. In the Blue Nile State, there are four sources of surface water: The Blue Nile River, Khors and seasonal streams, rain water collecting in natural depressions and Hafirs; (ESIA, 2006). There is impact predicted on the quality and quantity of natural resources from the proposed new development as indicated in Table 6.16.

Table 6.16: Impact predicted on Surface/Ground water

Impact	Country		Average
	Sudan	Ethiopia	
Very low	64.7%	4.3%	32.3%
Low	18.5%	5.1%	11.3%
Moderate	10.1%	35.5%	23.7%
High	2.5%	7.2%	5.1%
Very high	4.2%	47.8%	27.6%

Table 6.16 shows that about 83.2 per cent of households in Sudan were of the opinion that the power interconnections will have a low impact on the quality and quantity of surface/ground water. Again, the picture is different for Ethiopia. Table 6.16 shows that about 50 per cent of households in Ethiopia were of the view that the interconnections will have a high impact on the quality and quantity of surface/ground water.

6.17. Other specific environmental problems

Tables 6.17 and 6.18 show that there are several environmental problems that may have a relationship or linkage with improved access of electricity due to RPT project. Table 6.17 shows that whereas about 80.9 per cent in Sudan argue that there are few or no impact of RPT on these environmental systems, about 76.9 per cent of the respondents in Ethiopia are very positive and argue that electricity will have an impact on these environmental systems.

Table 6.17: Potential Impact on Specific Environmental problems

Response	Country		Average
	Sudan	Ethiopia	
Yes	10.1%	76.9%	43.4%
No	89.9%	23.1%	56.6%

Table 6.18: Specific Environmental problems

Environmental problems	Sudan	Ethiopia	Average
	Percent	Percent	percent
1. Air pollution	17.81	12.07	14.94
2. Water pollution	27.40	16.99	22.19
3. Noise pollution	9.59	1.94	5.76
4. land degradation	17.81	69.00	43.40
5. others	27.40	0.00	13.70

Most of the respondents indicated different environmental problems like air pollution which comprised an average total percent of 14.94 per cent.The highest average total was water pollution which was 22.19 per cent, while noise pollution was only 5.76.The data shows that the enviromental problems are present though not a large percentage.

6.17.1. Land degradation and other environmental problems.

Land degradation is a general problem in many of the African countries where different activities like cutting of trees and natural disasters which occur, increase and cause the degradation of the land. About 43.4 per cent of the respondents in the sample villages in Sudan and Ethiopia indicated a great risk to the environmental structure of the areas and living organisms. These are very crucial issues in the contemporary world where there is a total disappearance of natural vegetation. Furthermore, there are other environmental problems, as mentioned in the total average of 13.70 per cent. These environmental problems like deforestation, because of the use of fuel wood and charcoal,

endanger people's lives and especially the future generation. There is an aspect of sustainable development missing among the people where they should use the resources sparingly and think of other generations.

6.18. Other remarks on the potential impact of RPT

Power interconnections and regional trading have the potential to offer significant benefits to the African countries particularly Nile Basin Countries like Sudan and Ethiopia in the future. Power interconnections and regional trading can be motivated by three factors: security of supply, economic efficiency and environmental benefit. System security will be attractive to smaller sized power systems whose ability to provide adequate reserves is limited. Energy exchange will be attractive to larger systems that wish to diversify their energy resource bases and improve economic efficiencies. All parties will find benefit in the economic development of cleaner sources of energy. For any power interconnection proposal to materialize major technical and non-technical issues and concerns must be addressed by the government policy makers involved and affected stakeholders.

7

Conclusion: Main Findings and Policy Recommendations

7.1 Objective and research team, approach and methodology

The study objective was to make policy relevant to the impact of Regional Power Trade, (RPT), on poor communities living along the interconnections in the Nile Basin countries. In order to execute the tasks as identified above, a team of senior research consultants from Economic Research Bureau, University of Dar es Salaam of Tanzania was composed to coordinate, manage and conduct the Study on the Impact of Power Trade on the Social Socioeconomic Development.

This SDBS Energy Research (SDBS-ERC) coordinating team was assisted by national research teams from Sudan and Ethiopia. In view of the composition of the regional and national research teams, and so as to accomplish the objectives of the Cross-border Trade study, four independent but complementary methodologies were used. These included [1], major desk study, [2] field research surveys in the selected Nile Basin countries [3] data and policy analysis and report writing and [4] internal M & E, National and Regional Consultative Workshops.

7.2. Main findings

The report has five substantive chapters. Chapter Two provided background, objectives, purpose and issues related with the Nile Basin Initiative and emerging Regional Power Trade in Eastern Africa. The "Ethiopia/Nile Basin Initiative Power Export Project is one of the Regional Power Trade projects under the NBI. Ethiopia-Sudan Interconnector is being developed under the umbrella of the Eastern Nile Subsidiary Action Programme (ENSAP) of the Nile Basin

Initiative. This RPT Project represents one of the first tangible investments to flow from the NBI, and is therefore, an important step in converting the collaborative intentions of the countries into physical investments and benefits which, in turn, should reinforce increased cooperation.

7.2.1. The increased sale of surplus hydropower electricity from Ethiopia to substitute for costlier thermal generation in Sudan.

At macro levels, the major anticipated benefit and impact was from the sale of surplus hydropower electricity from Ethiopia to substitute for costlier thermal generation in Sudan. A predominantly hydro system like that in Ethiopia would also benefit by being part of a larger regional power system, with significant thermal generation, which serves as a hedge for periods of low rainfall. The main measurable benefit for Ethiopia (economic) and EEPCo (financial) will be the revenues from the sale of hydropower to Sudan; this is a function of volumes exported and future sales prices, (power tariffs).

7.2.2. Ensured and stable power systems

There are also benefits of increased reliability and energy security for the Ethiopian system (which are dependent upon the uncertainties of rainfall patterns) from integrating with the Sudanese grid but these benefits are more difficult to measure. The principal anticipated benefit is from the transfer of lower cost hydro power from Ethiopia to Sudan, which should reduce costs and also CO2 emissions. However, in the eventuality of a shortage in Ethiopia and of excess capacity in Sudan, NEC could export power to EEPCo to help EEPCo to meet Ethiopia's domestic energy demand.

7.2.3. Socio-economic and household characteristics in electricity use

Chapter Three presented the geographical location, people's socio-economic and household characteristics usually impact access to and utilization of basic services, electricity included because such characteristics embody people's socio-economic capabilities and the extent to which these are likely to translate them into met needs. Such characteristics also play an important

part in influencing the choice of energy demanded and eventually adapted. The demand for electricity is a complex function of the above-noted socio-economic and household's characteristics such as size of households, income, education, employment, age, sex and other attributes. Electricity is essential for electronic communications and, together with roads, connects people and their businesses to national and regional markets and beyond, and opens up new job and education opportunities. In energizing productive uses, regional energy integration fuels the economic engine for value creation, growth and connecting goods to cross-border markets. In addition, access to electricity reduces the negative impacts resulting from inadequate access to modern energy.

7.2.4. Visible and significant first round or immediate energy access and use impacts

Chapter Four presented first round or immediate impacts of Regional Power Trade. These included an increase of sustainable energy supply and improved energy security within the regions by institutionalizing more extensive and effective regional co-operation in the development of cost effective and cleaner electricity infrastructure and energy trading networks, and lowering energy costs by more effectively and efficiently managing the region's geographic, seasonal and daily imbalances and optimizing the utilization of energy resources across the region through increased energy trading. The following were specific viable and significant impacts perceived by the rural communities in both Sudan and Ethiopia;

- Improved village and household accessibility to public power
- Increasing use of ICT appliances
- Care taken to installation/connection costs which are still a major electricity issue
- Low and dropping electricity bills given RPT power
- Cooking habits may change due access to RPT power
- Use of more electricity for lighting purposes
- Electronic equipments in the rural household will be using power

- Increase household energy cost shares
- Complex electricity sub-sector problems need special attention
- Need for intensification of Specific Rural Electrification Programme

7.2.5. Positive immediate and long term impacts on socio-economic activities given access to power due to RPT

Chapter Five discussed the potential immediate and long-term socio-economic impacts given access to power due to RPT- NBI project. These were definitive, significant and positive impacts on household income earnings and income poverty reduction, on agriculture production and markets, employment, investment, cross- border trade, livelihood and lifestyle, food security, small-scale manufacturing, communication, trade and finance, labour productivity, consumption pattern, human resource development, cultural, arts and sports and public security and safety. Specifically, the following were some of positive immediate and long term impacts of RPT Project;

- Use of electricity has the potential to raise their income and reduce poverty
- Use of electricity has a potential positive impact on agriculture activities
- Has an impact on agriculture investment in machinery and equipment
- Has a positive impact on agriculture production and products markets
- Change life style
- Provides potential to improve food production and food security
- Increasing potential to change socio-economic and income generating activities
- Increasing small scale manufacturing activities and products
- Increasing use of ICT in the villages
- Impact on new economic activities

7.2.6. Impacts on environment are known

Chapter Six presented the environmental impact of RPT. In Sudan there are some serious environmental issues like "inadequate supplies of potable water; wildlife populations threatened by excessive hunting; soil erosion; desertification; periodic drought The most serious concerns are land

degradation, desertification and the spread of deserts southwards by an average of 100km over the past four decades. The known environmental issues in Ethiopia are deforestation; overgrazing; soil erosion; desertification; water shortages in some areas, from water-intensive farming and poor management. These environmental issues, like deforestation which are caused by the use of fuel charcoal and firewood, can be reduced in the villages. Specifically, specific, the study found that;

- Future use of electricity will reduce the use of charcoal and fuel wood
- Use of RPT electricity will have potential impact on the reduction of the use of kerosene.
- There will be positive impact of the future use of electricity on indoor air quality, health, and knowledge and fertility reduction

7.2.7. Main generic environment impact issues

The potential benefits of power trade between the Nile Basin countries of Sudan and Ethiopia are based on implementation of the project and the significant output regarding the poor communities, by sharing the benefits equally. Significant environmental benefits could emerge in this region if regional power trade were developed on a least-cost basis. Such benefits could result from water conservation and land protection effects and from a reduction in greenhouse gas and other pollutant emissions caused by a shift from thermal to hydropower-based generation. The substitution of wood fuel dependency and its potential watershed degradation effects with hydropower-based rural electrification that incorporates watershed management has several environmental effects. Among other things, it reduces local pollution and health problems, limits greenhouse gas emissions, abates land degradation, mitigates flash flooding, and affects downstream sedimentation. Benefits can be substantial in downstream reaches and should be credited to upstream projects if sediment loads are diminished and low-flow augmentation combined with flood peak reduction result. The listed environmental premises for power trade in the Nile Basin suggest that efforts should be spent on screening potential benefits.

In recent years the environmental aspects in the production and consumption of energy have received increased attention. Changes in the types of fuel used in electricity production affect overall air pollution and emissions in a significant manner. The development of environmentally responsible energy resources for the benefit of an entire region can be facilitated through the interconnection of RPT of the countries involved.

7.3. Policy recommendations

7.3.1. General recommendation

Ethiopia and Sudan have made concerted efforts to establish regional electric power grids and pool their energy resources as part of the regional cross-border trading of electricity. The cross-national border interconnections are going to be a reality for various reasons, and designed to provide benefits such as the lowering of electricity production costs in Sudan and Ethiopia as the regional trading partners, increasing the quality and reliability of electricity service, reduction of the level of required reserve capacity in the connected grids, and improvements in national energy security. There are, however, general policies as well as specific policy objectives of regional power trade which need to be emphasised.

The main objectives of regional power trade were to lower electricity production costs among the regional trading partners, increasing the quality and reliability of electricity service the reduction of the level of required reserve capacity in the connected grids, and improvements in national energy security (Rama, 2007, Ragia, 2007, Wasike et al, 2007 and Semboja, 2007).

The specific policy objectives of the power trade include:

- Promoting long term regional power trade through coordinated planning and development of power projects and transmission interconnection in the context of multi-purpose water resources development.
- Initiating the development of a regional power trade generation and investment programme.

- Collaborating with energy policy researchers, power system experts, and engineers from the power trading countries so that potential benefits, constraints, and barriers can be identified during implementing electric power grid interconnections.
- Increasing sustainable energy supply and improve energy security within the regions by institutionalizing more extensive and effective regional co-operation in the development of cost effective and cleaner electricity infrastructure and energy trading networks
- Lowering energy costs by more effectively and efficiently managing the regions geographic, seasonal and daily imbalances and optimizing the utilization of energy resources across the region through increased energy trading;
- Reducing the overall amount of capital needed for the expansion of energy systems in the region by creating an investment environment that will facilitate the implementation of environmentally sustainable and bankable projects on a least-cost basis;
- Establishing an ongoing forum that can effectively share information, build trust and consensus, and work out and agree upon regional energy issues within an agreed-upon policy framework and set of operating principles,
- Creating transparent and reliable mechanisms for the prompt settlement of commercial energy transactions and resolution of disputes.

7.3.2 Specific socio-economic policy objectives

For both Ethiopia and Sudan, it is evident that access to an efficient energy source has the potential to raise household income and reduce income poverty. The government of Ethiopia and the government of Sudan should ensure that acscess to electricity by the majority rural poor is made available. RPT is one window to make reliable and efficient power available to the rural poor. Other rural electrification programmes should serve as a complement to the NBI-RPT project.

Specifically the following issues should be taken into account:-

- Enhance energy efficiency in agricultural rural communities
- Improve farming technology and extension services for rural communities
- Ensure that access to RPT electricity by rural poor is coupled with additional investment in machinery and equipment for agriculture
- Ensure that access to RPT electricity improves information and communication technology (ICT) in rural communities and access to up markets.
- Ensure that electrical appliances such as TV, electrical stoves and refrigerators are available and affordable for the rural poor to the RPT electricity can have an impact on culture and lifestyle
- Ensure that food production is not a very tiring job by improving efficiency by using electricity from RPT project. This has the potential to improve food security.
- Ensure that supporting infrastructure such as roads, water, economic policy, investment policy, trade policy, are well enchored to exploit and support RPT project to boost cross-border trade.
- Ensure that emerging and new economic activities as a result of NBI-RPT project are provided with an enabling environment to grow
- Ensure that the large potential of small-scale manufacturing activities, following availability of electricity, are provided with an optimal support to establish and grow.

7.3.3 Specific financial policy objectives

There is need to increase the sale of surplus hydropower electricity from Ethiopia to substitute for costlier thermal generation in Sudan. The two countries should make power trading a national priority by making international electricity trading an integral component of their policies

Specific

The two countries should examine the compatibility of existing legislation, regulations and contracts in order to assess and ensure that that they are conducive for increased trading of power between the two countries.

7.3.4 Ensured and stable power systems

The task of coordinating the planning, development, operation and regulation of power trade should be organised.

Specific

- There should be consistency regarding issues to do with policy on taxation and royalties on exports of electricity, accompanied by clear communication to all interested parties.
- Strengthening of regulators in both countries in order to reduce financial uncertainties.

7.3.5. Socio-economic and household characteristics matters in electricity use

Both governments should increase expenditure towards pro poor activities that work to improve the socio-economic and household characteristics that have an impact on electricity used, such as education and job creation initiatives.

7.3.6 Visible and Significant First Round or Immediate Energy Access and Use Impacts

There is need for sensitization of people on the existence of RPT and its economic impact on electricity use.

Specific

- Coordination between government and NGOs to educate the public on benefits of RPT and using electricity.
- Establishment of a master plan providing information on least cost plant locations and transmission development.
- Government commitment on both sides to construct low risk, least-cost transmission lines.

7.3.7 Main generic environment impact issues

Setting aside resources from government and soliciting help from development partners to facilitate the sensitization of the public various methods on the

impact of the use of non-electricity energy sources on the environment as well as the benefits of electricity use over other sources of energy.

7.3.8 Poverty alleviation

Increase budgetary allocation to pro poor programmes in order to enhance people's ability to use things that are operated by electricity as well as to enhance their ability to afford to pay for the use of electricity. There is a need to design specific investment programs aiming at improving access to and ability to use electricity intensive productive assets for the poor communities, e.g. those in small-scale agriculture and rural non-farm activities; private, SME's and groups such as women and youths.

It is important to address geographic disparities by identifying the economic potential of the villages in the Nile Basin countries and supporting the exploitation of this potential and raising returns and productivity in those villages where RPT Transmission lines pass. It may be possible to design spatial development and development corridor planning approaches and investment programs in the NBI countries as part of Cross-border Trade initiatives. The investment programs must ensure equal and universal access to public electricity services – physical infrastructure and social services in the rural areas – through the budgetary financing of social programmes and support to community-based initiatives considering the special needs of the poor communities.

Section B

A Policy Brief

Benefit Maximization in Agriculture Production Value Addition and Creative Industries in the villages in the Nile Basin Countries

8

Executive Summary

The economic performance of some Nile Basin Initiative, (NBI) countries during the last three to five years has been affected by variations in energy availability. Variations in the GDP growth rates in most poor NBI countries have been attributed to a severe drought that hit these countries during the 2000/1 and 2006/07 rainy seasons, electricity shortage, increase in food prices and increase of oil prices in the world market. Sectors that were mostly affected by the drought include agriculture, manufacturing, trade, electricity and water. The electricity sub-sector was severely affected by drought and, escalation of petroleum prices on the world market, which led to a shut-down of hydropower generation and increased thermal power generation costs. In order to alleviate the power crisis, the Governments in Nile Basin countries took a number of measures, including implementing emergency power generation projects and participation in regional power trade projects.

Ethiopia-Sudan Power Interconnection is being developed under the umbrella of the Eastern Nile Subsidiary Action Programme (ENSAP) of the Nile Basin Initiative. This RPT Project represents one of the first tangible investments to flow from the NBI, and as such is an important step in converting the collaborative intentions of the countries into physical investments and benefits which, in turn, should reinforce increased cooperation. The objective of this study is to make policy relevant to the Impact of Regional Power Trade (RPT), and to poor communities living along the interconnections.

The study provides two generic policies as well as specific policy objectives on Benefit Maximization in Agriculture Value Addition and Creative Industrial Development in the Villages given availability of Regional Power Trade.

The first type of policy recommendations are directed at improving regional power trade in the Nile Basin countries. These include the need for lowering electricity production costs among the regional trading partners; increasing the quality and

reliability of electricity service; the reduction of the level of required reserve capacity in the connected grids, and improvements in national energy security.

The second policy recommendations are directed at Benefit Maximization in Agriculture Value Addition and Creative Industrial Development in the Rural Villages given the availability of Regional Power Trade. These include enhancing energy efficiency in agriculture; improving farming technology and extension services for rural communities; increasing investments in machinery and equipment for agriculture; improving information and communication technology (ICT) and access to cross-border markets; ensuring that emerging small-scale manufacturing activities benefit from the NBI-RPT project.

9

Background

This first study area sheds light on the likely impact of power trade on the poor communities in the Nile Basin countries. The Nile Basin Initiative (NBI) is a regional partnership within which member countries have united in common pursuit of the long-term development and management of Nile waters. The NBI shared vision is "to achieve sustainable socio-economic development through the equitable utilization of, and benefit from, the common Nile Basin water resources".

The SDBS-NBI energy studies found that economic performance of some NBI countries during the last three to five years has been affected by variations in energy availability. Variations in GDP growth rates in poor NBI countries have been attributed to a severe drought that hit these countries during the 2000/1 and 2006/07 rain seasons, electricity shortage and increase of oil prices in the world market. Sectors that were mostly affected by the drought include agriculture, manufacturing, electricity and water. The electricity sub-sector was severely affected by drought and the escalation of petroleum prices on the world market, which led to a shut-down of hydropower generation and increased thermal power generation costs.

In order to alleviate the power crisis the Governments in Nile Basin countries took a number of measures, including implementing emergency power generation projects and participation in regional power trade projects.

10

Research objectives, Team, Methodology and Approach

10.1. Study objective

This RPT Project represents one of the first tangible investments to flow from the NBI, and as such is an important step in converting the collaborative intentions of the countries into physical investments and benefits which, in turn, should reinforce increased cooperation. The objective of this study is to make policy relevant on the impact of Regional Power Trade, (RPT) on poor communities living along the interconnections in the Nile Basin countries.

10.2. Research team

A team of senior research consultants from Economic Research Bureau, University of Dar es Salaam of Tanzania coordinated, managed and conducted the Study on the Impact of Regional Power Trade on the Poor Communities that live along the interconnections in the Nile Basin Countries. The Lead Research Study team in collaboration with national research teams in Ethiopia and Sudan conducted the field research surveys in the selected villages.

10.3. Research methodologies

In view of the composition of the regional research team(s), and so as to accomplish the objectives of the study, four independent but complementary methodologies were used. These included [1], major desk study, [2] field research surveys, [3] data and policy analysis and report writing and [4], National and Regional Consultative Workshops.

10.4. A theory of transition

Over the last few decades, the energy literature has been dominated by a theory of transition. The theory of transition is based on the notion that households gradually ascend an "energy ladder", which begins with traditional biomass fuels (firewood and charcoal), moves through modern commercial fuels (kerosene and liquid petroleum gas (LPG)) and culminates with the advent of electricity. The ascent of the "energy body', though not fully understood, is thought to be associated with rising income, increasing availability of cheap, clean and modern energy source and increasing levels of urbanization.

10.5. Data and policy analysis

On the basis of both the primary and secondary data obtained in the field survey, data and policy analysis was employed in examining the current and projected performance of the energy sector, policy, planning, operations, and socio-economic impact analysis. Thus, the variables that affect the functioning and determine performances, components and its effectiveness in the poverty reduction efforts were explored using descriptive statistical techniques.

11

Main Findings

The following were some of the key findings

11.1. Increased electricity from Ethiopia to replace thermal generation in Sudan

The first and foremost immediate impact would be increased sale of surplus hydropower electricity from Ethiopia to substitute for costlier thermal generation in Sudan. The principal anticipated benefit is lower cost hydro-power from Ethiopia to Sudan, which should reduce costs and also CO2 emissions.

In addition, it was found that socio-economic and household characteristics determine the use of electricity by households. The demand for electricity is a complex function of socio-economic and household characteristics such as size of households, income, education, employment, age, sex and other attributes.

11.2. Increase accessibility and use of electricity in the households

There are several visible and significant immediate effects associated with increasing energy access at household levels. These include: improved village and household accessibility to public power; increasing use of ICT appliances; ever lower electricity bills, given RPT power; change in cooking habits towards a healthier diet due to access to power; increasing use of more electricity for lighting purposes; introduction of modern electronic equipment in rural households; and decreasing household energy cost shares. The minimization of complex electricity sub-sector problems needed special attention.

The study found positive potential immediate and long-term socio-economic impacts given access to power due to the RPT- NBI project. These were

definitive, significant and positive impacts on: household income earnings and income poverty reduction impact on agriculture production and markets; employment; investment; cross- border trade; livelihood and lifestyle; food security; small scale manufacturing; communication; trade and finance; labour productivity; consumption pattern; human resource development; culture, art and sports; and public security and safety.

11.3. Use of electricity has a potential to raise their income and reduce poverty

The study found that about 98 percent of respondents in Ethiopia and about 96 percent in Sudan argued that availability and use of electricity has a potential to raise their income and thus reduce poverty. The study suggests that there are various ways in which potential use of electricity can affect households' level of income, earnings and income poverty reduction. The data analysis links potential use of electricity to such activities as provision of secretarial services, running internet cafés, opening small garages for tire repair and welding activities, floor mill industries and the like in small towns or modern villages.

11.4. Use of electricity has a potential positive impact on agriculture activities

The study found that about 86.8 percent of people in Sudan and 76.5 in Ethiopia have the opinion that availability and use of electricity have a potential positive impact on agricultural activities. One important area, in which production efficiency could be enhanced in agriculture is that of post-harvest losses. The introduction of improved threshing and storage methods could substantially improve the welfare of subsistence farmers. Invariably, availability and use of electricity in farming activities has the potential to increase farming technologies, opportunities and/ or increase the number of productive people involved in the sector. Other related effects on the agricultural sector include an impact on agricultural investment in machinery and equipment; and positive impact on agriculture production and product markets, and the increasing potential to improve food production and food security.

11.5. Impacts on environment are positive

The study noted that there are some serious environmental problems like inadequate supplies of potable water; wildlife populations threatened by excessive hunting; soil erosion; desertification; periodic drought. The most serious concerns are land degradation, desertification and the spread of deserts southwards by an average of 100km over the past four decades. The known environmental issues in Ethiopia are deforestation; overgrazing; soil erosion; desertification; and water shortages in some areas. The environmental issues like deforestation which are caused by the use of charcoal and firewood as fuel can be reduced in the villages. The study found that the future use of electricity will definitively reduce the use of charcoal and fuel wood and the use of kerosene. Also, there are positive effects of the future use of electricity on indoor air quality, health, and knowledge and fertility reduction

11.6. Poverty Alleviation

Ethiopia and Sudan have amongst the lowest levels of electricity generation per capita in the world. Electricity is essential to the development of agro-processing industries, commercial enterprises and irrigation facilities in rural areas. Electricity supplied to rural towns would replace/reduce the consumption of wood biomass and petroleum products used for cooking, lighting, and motive power. It would support development in the agricultural sector (irrigation pumps, poultry, animal husbandry, preservation of products); in the commercial sector; small and medium industries (flour mills, rural water supply installations, tanneries, and coffee processing plants), in the residential sector (lighting, heating, and cooking), in education (kindergarten, elementary schools, junior secondary schools, secondary schools and technical colleges), and in the health sector (pharmacies, clinics, health centers and hospitals). In brief, the regional power trade would assist in the facilitation of economic growth in the affected areas and create long-term employment opportunities for the poor, including women, thereby increasing income levels and reducing poverty.

12

Policy Recommendations

12.1. General and specific policy recommendations

Ethiopia and Sudan are making concerted efforts in establishing regional electric power grids and pooling their energy resources as part of the regional cross-border trading of electricity. The cross-national border interconnections are going to be a reality for various social, economic and political reasons, and designed to provide benefits such as lowering of electricity production costs in Sudan and Ethiopia as the regional trading partners, increasing the quality and reliability of electricity services, reducing the level of required reserve capacity in the connected grids, and making improvements in national energy security.

The study proposes two general policies as well as specific policy objectives on Benefit Maximization in Agriculture Value Addition and Creative Industrial Development in the Villages given availability of Regional Power

The first type of policy recommendations are directed to improving regional power trade in the Nile Basin countries. These include the need for lowering electricity production costs among the regional trading partners, increasing the quality and reliability of electricity services, reducing the level of required reserve capacity in the connected grids, and improving national energy security (Rama, 2007, Ragia, 2007, Wasike et al, 2007 and Semboja, 2007). The specific policy objectives the regional power trade project should aim at are:

- Promoting long-term regional power trade through coordinated planning and development of power projects and transmission interconnection in the context of multi-purpose water resources development.
- Initiating the development of a regional power trade generation and investment programme.
- Collaborating with energy policy researchers, power system experts, and engineers from the power trading countries so that potential benefits,

constraints, and barriers can be identified while implementing electric power grid interconnections.

- Increasing sustainable energy supply and improve energy security within the regions by institutionalizing more extensive and effective regional co-operation in the development of cost effective and cleaner electricity infrastructure and energy trading networks.
- Lowering energy costs by more effectively and efficiently managing the region's geographic, seasonal and daily imbalances and optimizing the utilization of energy resources across the region through increased energy trading;
- Reducing the overall amount of capital needed for the expansion of energy systems in the region by creating an investment environment that will facilitate the implementation of environmentally sustainable and bankable projects on a least-cost basis;
- Establishing an ongoing forum that can effectively share information, build trust and consensus, and work out and agree upon regional energy issues within an agreed upon policy framework and set of operating principles,
- Creating transparent and reliable mechanisms for the prompt settlement of commercial energy transactions and resolution of disputes.

12.2. Implementation arrangements and line of activities

The second policy recommendations are directed towards generic implementation arrangements and lines of activities for Benefit Maximization in Agriculture Value Addition and Creative Industrial Development in the villages given availability of Regional Power Trade. For both Ethiopia and Sudan, it is evident that access to efficient energy source has the potential to transform rural households activities, income and reduce poverty. The governments of Ethiopia and Sudan should ensure that access to electricity by the majority of rural poor through rural electrification programs are enhanced, implemented, monitored and evaluated by the government ministries in collaboration with national utility institutions.

Specifically the following lines of activity should be taken into account:-

- Enhance energy efficiency in agricultural rural communities;
- Improve farming technology and extension services for rural communities
- Ensure that access to RPT electricity by the rural poor is coupled with additional investment in machinery and equipment for agriculture
- Ensure thats access to RPT electricity improves information and communication technology (ICT) in rural communities and access to markets.
- Ensure that electrical appliances such as TV, electric stoves and refrigerators are available and affordable for the rural poor for the RPT electricity to have impact on creative industry, culture and lifestyle.
- Ensure that food production and preparation is less tiring by improving access to electricity from RPT project. This has the potential to improve food security.
- Ensure that supporting infrastructure such as roads, water, economic policy, investment policy, trade policy, are in place to support RPT project to boost cross-border trade.
- Ensure that emerging and new value adding economic activities as a result of NBI-RPT project are provided with sufficient enabling environment to grow.
- Ensure that the large potential of small-scale manufacturing activities in the rural villages following availability of electricity is provided with an optimal support to establish and grow.
- There should be consistency as regarding issues to do with policy on taxation and royalties on exports of electricity, accompanied by clear communication to all interested parties.
- Strengthening of regulators in both countries in order to reduce financial uncertainties.
- Coordination between government and NGOs to educate the public on benefits of RPT and using electricity.
- Establishment of master plan providing information on least cost plant

locations and transmission development.

- Government commitment on both sides to construct low risk, least cost transmission lines.
- Setting aside resources from government and soliciting help from development partners to facilitate the sensitization of the public through various methods on the impact of the use of non-electricity energy sources on the environment as well as the benefits of electricity use over other sources of energy.
- Increase budgetary allocation to pro poor socio-economic programmes in order to enhance people's ability to use things that are operated by electricity as well as to enhance their ability to afford to pay for the use of electricity.

Section C

Rationalization of the Use of Discount Rates for Economic Analysis of Water Resources and Related Projects in the Nile Equatorial Lakes Subsidiary Action Programme (NELSAP)

13

Introduction

13.1 Objective of the study

This second SDBS study area is "on the rationalization of the use of discount rates for economic analysis of water resources and related projects in the Nile Equatorial Lakes Subsidiary Action Programme (NELSAP). NELSAP is one of the two investment programs of the Nile Basin Initiative (NBI) and includes the member countries of Burundi, D.R. Congo, Egypt, Kenya, Rwanda, Sudan, Tanzania, and Uganda. NELSAP was launched in 1999 with the goal of identifying, preparing and funding cooperative investment projects at the sub-basin level within NBI framework. The programme is structured in two pillars for investments: (i) power development and trade and (ii) natural resources management and development.

NELSAP has identified and is implementing a number of water-resource projects. There is a continued effort of scaling-up current project activities and identifying new cooperative and consultative investments in new geographical areas and sectors. These include fisheries development and management, power generation, transmission interconnection, power trade, river basin management and development, and regional agriculture development. Table 1 shows types of water resources and related projects and benefits.

There have been significant achievements through cooperation that have led to the creation of a strong foundation for larger-scale Nile investment projects and networks. This has brought about the need for the other NBI institutions to support each other, network and provide an input into economic and investment policy analysis on the on-going and planned NELSAP investment projects.

13.2 Water resources

The water resources of the Nile Equatorial Lakes Region (NEL) are composed of one of the world's greatest complexes of lakes, wetlands, and

rivers. The NEL sub-basin includes the headwaters of the White Nile, which are located in the upland plateau and from which water flows northwards via lakes and rivers to landforms at lower altitude. There are strong hydrological and environmental interactions between the individual hydrological units comprising the NEL Region. The water resources of the NEL sub-basin are central to the survival and livelihood of local populations and the sustenance of the region's unique natural ecosystems. There is great potential for these resources to underpin strong economic growth in the region.

14

Types and Behaviour of Discount Rates Used in Water-Related Projects in the NELSAP

Whenever we deal with investment projects that exist for long, it is necessary to have a mechanism which can link the future impacts of a project to the period in which analysis is being undertaken to decide whether such a project is worthwhile to pursue or not in that the money to be invested in the project has a time value. This can be done by comparing investments over time by using a discount rate which reduces the flows of benefits and costs to its present value. There are two major ways of thinking about discount rates and how they can be determined. A key feature of both approaches is that they have an element of opportunity cost underlying them. The *first approach* thinks of a discount rate as the rate of return an investor would expect from different opportunities that have equal risk while the *second approach* is to think of a discount rate as the change in the value of consumption in different periods.

Table 14.1: Types of water resource and related projects and benefits s

Class of benefits	Input parameters	Units	Description (location)
Hydropower	Power production Value of hydropower Change in value	GW-hr/yr US cents/kW-hr per cent/yr	Hydropower can be generated by running carefully-released water through turbines just below a large dam (Benefits _spec).
D/s[1] hydropower	D/s[1] hydropower Value of d/s hydropower	GW-hr/yr US cents/kW-hr	Altering the flow regime in a water course d/s of a large reservoir can affect d/s hydropower generation (Benefits_ spec).
Agriculture	Irrigated area Rents from irrigation Change in value	hA $/hA-yr %/yr	Irrigation is often made possible on a dam site if there is good agriculture land nearby because dry season water supply can be assured (Benefits_spec2).
D/s agriculture	Add. downstream water Value of d/s[1] water Change in value Cost of d/s[1] development D/s[1] land are developed	Mcm/yr US$/cm %/yr US$/hA hA	As with d/s hydropower, d/s agriculture is affected by the changes to a water course. In particular, if low season flow is amplified, additional irrigation may be possible d/s. Alternatively, large consumptive uses could reduce d/s water supply (Benefits_spec2).
Other water supply	Domestic withdrawals Industrial withdrawals Value of withdrawals Change in value	Mcm/yr Mcm/yr US cents/cm %/yr	Sometimes, a reservoir is built in part to satisfy industrial and residential water demands. (Benefits_spec3).
Fisheries	Cost of fishing effort Market value of fish	MUS$/yr MUS$/yr	New fisheries can be created in reservoirs, or established fisheries in river reaches can be adversely affected by dam construction (Benefits_spec4).
Recreation	Baseline value of rec. Value of rec. with dam	MUS$/yr MUS$/yr	Reservoir lakes often create new opportunities for recreation, but they may reduce opportunities if the environment becomes less attractive (Benefits_spec4).
Flood Control	Method (see annex) Change in probability	- %	Reservoirs can be useful for storing water from large flood events, reducing peak flows (Benefits_spec5).

Drought mitigation	Method (see annex) Risk of d/s deficits Average deficit in drought Cost of average deficit Damage-risk curve params	- % Bcm US$/cm Various	Dams can also be used to augment low season flow in a water course, reducing the probability of droughts affecting d/s irrigation schemes (Benefits_spec6).
Carbon offsets	Target market Project emissions Price	- Tons CO_2/yr US$	Hydropower is often considered a "clean" form of energy, because it does not require the burning of fossil fuels. However, organic decay in reservoirs can also generate greenhouse gases (Benefits_spec7).
Sediment control	Sediment reduction Value of d/s infrastructures Rate of capital depreciation Time remaining d/s infra. Cost of Gezira O&M % Gezira O&M for desilting	% MUS$ % Yrs MUS$/yr %	A large new reservoir can reduce the d/s flow of sediment, providing significant benefits: 1) A longer lifespan for d/s infrastructures, 2) lower desilting costs in d/s irrigation schemes (Benefits_spec8).
Navigation	Value without dam Value with dam	MUS$/yr MUS$/yr	Benefits occur if dry season flow is augmented enough to enable new navigation opportunities (Benefits_spec9).

[1]D/s = downstream

Source: *Marc Jeuland (2007), User Manual for the Economic Appraisal of Reservoirs Model – Beta Version 1.0 (EARM)., Software designed for NBI Projects*

The first approach can be thought of as the opportunity cost of capital which is the rate of return the capital must fetch for investors in order to enable them to invest (social opportunity cost) while the second approach can be considered to be the rate at which people are prepared to trade consumption in the present for consumption in the future (social rate of time preference).

The social opportunity cost basically reflects the cost of undertaking a project in financial market terms in that it takes into account what returns since projects would provide if they were undertaken by the private sector.

The social opportunity cost therefore focuses mostly on financial sector considerations as the benchmark for making a decision on whether to pursue a project or not. The social rate of time preference on the other hand is equal to the marginal rate of substitution between consumption in the present period and consumption in the future period. The social rate of time preference differs from the social opportunity cost in the sense that it reflects social preferences and not just financial sector considerations. Although there are two common approaches for selecting discount rates, namely the social opportunity cost of capital and the social rate of time preference is suitable under differing situations. The social rate of time preference is appropriate when policy makers are considering whether to pursue new projects or to terminate existing projects. The social opportunity cost is suitable when the objective is to determine the manner in which to undertake project activities once there is a decision to pursue a project.

14.1 Selection of discount rate

Selection of the appropriate or rationale discount rate has emerged as a critical issue in natural resource planning. Analysts have argued at length over which of several potential discount rates should be used as social discount rate (Marglin 1963; Baumol 1968; Lind 1982). In economics, the choice of the discount rate is controversially discussed especially when investments in the public sector are at stake (Lind 1990; Livingstone and Tribe 1995 and Azar and Sterner 1996). The choice of discount rate is inherently complex in situations where there is distortion to the economy such as corporate and personal taxes or environmental externalities. The debate about how to choose an appropriate discount rate has been long and wide-ranging between industrial and developing countries and is a crucial issue for evaluating projects with long-term environmental impacts. Choosing an appropriate discount rate is important because otherwise one cannot obtain efficient results and the least cost solution for any given objective may change depending upon the choice of the discount rate. A low discount rate will favor high capital investment projects with low running costs. When evaluating the benefits of a project,

the lower the discount rate, the higher the present value. A low discount rate is preferred by anyone wanting to show a long-term investment in its most favorable light. When looking at costs, the higher the discount rate the lower the present value. This could be the preferred approach for anyone wanting to show that costs in the long run are small.

The use of discount rates can lessen the impact on future generations of today's investment plans. It is evident, therefore, that the use of various discount rates can be manipulated to serve a predetermined result. Because of this, environmental concerns are not best addressed by lowering the discount rate- an action that might have both benefits and costs for the environment (Markandya and Pearce, 1991). One needs to consider factors that determine discount rates, i.e., the private and social rates of time preference, the opportunity cost of capital, risk and uncertainty and the interest of future generations. In deciding the proper discount rate, considering the rate of foreign exchange, inflation and the expectations for inflation, and the risk involved in the project are necessary. Other important factors are the extent to which public investment displaces or generates consumption or private investments throughout the lifetime of the project, the extent to which project risk is captured by discount rate and Weyant 1999 in Ben Groom 2005. The guiding concept of the choices of the appropriate discount rates being the social time preference, the cost of funds, and the opportunity cost of capital.

14.2 Rationale discount rates

When using the social discount rate the best approximation is the interest rate of long-term government bonds sold directly to savers. Table 14.2 provides a sample of discount rates in use for water resource projects in selected countries and in the NELSAP/ENSAP projects. On the average discount rate has been around 10 percent as standard rates for many water resource projects. In practice, for example, all government projects in Britain are required to use a discount rate of 10 per cent in conducting their analysis. In

the US, various discount rates are used. Every year, the US Water Resources Council establishes the federal government average long term borrowing costs to determine the discount rate to be used by the federal agencies during the coming fiscal year for analyzing water related projects. The US office of management and Budget (1972) circular required a 10 per cent discount rate on all federal projects, but its use varies according to the agency.

In the case of Bujagali Fall project, it was proposed that a discount rate of 10 per cent be used, but this has been criticized by the African Development Bank (ADB). The issue put forward by the ADB is that; such a rate is extremely high and does not consider the climate change impact. In Sterner Review on the Economics of Climate change, a discount rate of about 0.1 per cent was used when assessing the impact of global warming. Others disagreed with this rate; instead, he utilized a discount rate of 3 per cent that slowly decreases to 1 per cent over a 300 years period, (World Bank 2006a). The paper suggests that it is rational to used standard discount rate applicable in many water resource projects.

Table 14.2: Sample Discount Rates for Water Resource Projects (2008)

	Country	Discount Rate	General Remarks
1	Britain	10	UK Government
2	USA	10	USA Government
3	Uganda	10	Bujagali Project
4	Angola	10	Divundu Hydro Power Project
5	India	10	Government
6	NELSAP	10*	World Bank, 2006b

14.3 Classical rationalization of discount rate

The earlier debate on rationale discount or which rate to use to be focused on the sources of the fund applied to the project and eventual use of benefits of the project (Pearce and Nash 1981; Lin 1982 and Markandya and Pearce 1991). Recently, the issue has gained new importance in the context of climate change policies, (see e.g. Arrow et al. 1996). As Toth (1995a) notes, the effective

discount rate is one of the most sensitive parameters in integrated climate-economy assessments as we deal with long-term impacts.

The use of the classical net present value (NPV) rule to assess the economic efficiency of policies with costs and benefits that accrue in the long term is felt by many non-economists to be particularly problematic (Ben Groom 2005). Much of the environmental literature argues against discounting in general and high discount rate in particular saying, there is no unique relationship between high discount rate and environmental degradation.

There is a wide agreement that discounting at constant positive rates in environment-related issues is problematic, irrespective of the particular discount rate employed. It is argued that a wide constant rate, costs and benefits accruing to generations in the distant future appear relatively unimportant in the present value terms. Hence a decision made today on the basis of BCA appear to oppress future generations. Another criticism against discounting is that discounting appears to be contrary to the widely supported goal of sustainability. Discounting attaches little weight to future welfare, hence no intergeneration equity. Many economists have argued that when evaluating the intergenerational consequences of climate, a high discount rate unfairly places a smaller weight or value on the well being of the future generation relative to the well being of the current generations.

Water resources projects need to be evaluated over a time span of several hundred years to take into account climate change, biodiversity loss etc, hence the use of a constant discount rate is not welcomed. According to Zhu and Weikard (2003), using a social discount rate in the analysis without considering the environmental aspects may delay our actions for the environmental projects if environmental quality is decreasing. This has an obvious implication for climate change policy. On the other hand, if we expect environmental quality to increase, we should choose a lower discount rate and achieve a shorter-run solution for the environmental problems. Otherwise the environmental quality is difficult to maintain. Lind (1982, 1995) analyses the welfare foundations of cost-benefit analysis and its role in climate change

policy-making. He also discusses the discount rate in an optimization model and obtains the relationship between the pure rates of time preference, the elasticity of the marginal utility of consumption, the consumption growth rate and consumption discount rate. This relationship is also shown in Manne (1995) who uses an aggregated growth model. Weitzman (2001) and Horowitz (2002) focus on the effects of uncertainty on the discount rate.

15

Benefits and Costs for Water Related Projects in the NELSAP

The discussion on the rationale discount rate is based on the need for optimal utilization of water resources within the benefit and costs models. The Nile Equatorial Lakes (NEL) Region of Africa faces an acute lack of electric power which hampers development in the region and thereby makes life more difficult than needbe. In the context of the Nile Basin Initiative (NBI) and the Nile Equatorial Lakes Subsidiary Action Programme (NELSAP), participating countries have agreed that development of low-cost power generation and regional electricity trade are means to address the problem in a manner that is less costly than a go-alone approach by individual countries which would lead to greater impact on the environment with less electrical power security.

The issue of addressing the problem of acute power shortage in the Nile Equatorial Lakes (NEL) Region of Africa focuses on developing more power generation activities. There are several options which can be adopted to address the problem, namely hydroelectric, thermal, geothermal, fossil fuel and generic wind options. Naturally the aim is to adopt the best option based on technical, economic, social and environmental criteria in order to analyze the benefits and costs of each power option. The various criteria are all used to determine the benefits and costs of each power option in order to decide on the best option for addressing the problem of acute power shortage in the Nile Equatorial Lakes (NEL) Region of Africa. The technical criterion focuses on the relevance of technology used to region, size of plant and time required to implement the option. The economic criterion focuses on minimizing unit cost while the social criterion focuses on maximizing contribution to rural electrification while at the same time minimizing land and resettlement requirements. The environmental criterion focuses mainly on energy payback ratio, greenhouse gas and air pollutant emissions, and land requirements.

16

Multiple-objective Analysis: Theoretical Framework

The above presentation suggests the need for conceptualization of rationale discount rate within the framework of multiple-objective models. The main argument is that the discount rate is rational if and only if the other multi-criterion conditions are satisfied. This section shows the use of a multi-criterion analysis in NELSAP water resource projects and perform utilize this analysis to perform economic and policy analysis of NELSAP projects. The framework for multi-objective analysis may take the form of a social welfare function. This can be represented in the following simple equation

$$4.1.1 \qquad I = \alpha_1 G_1 + \alpha_2 G_2 + ... + \alpha_n G_n = \sum_{i=1}^{n} \alpha_i$$

Where I is an indicator function of goal achievement, α_i weighting factors (the sum of α_i must be 1.0) and G_i individual goal achievements (such as net benefits) for specific projects.

In the light of international experience some developed nations, e.g., U.S. had developed principles and standards for Planning Water and Related Land Resources, under the authority of the Water Resources Planning Act of 1965. Later, however, they were repealed in 1982. The objectives set forth in the principles and standards were based on an overall goal of water planning which is to "promote the quality of life" through two objectives:

- To enhance national economic development (NED) by increasing the value of the nation's output of goods and services and improving national economic efficiency;
- To enhance the quality of environment by the management, conservation, preservation, restoration, or improvement of the quality of certain natural, cultural and ecological systems.

Under this complex setting, government decision making is based on a simple concept of multi-objective analysis, i.e. the display of goal-achievement indicators in a matrix form. More analytical techniques are used in multi-objective problems which include linear and dynamic programming, and decision models like Analytic Hierarchy Process (AHP). Detailed description of these models will be beyond the scope of this report.

16.1 Use of a Multi-criterion Analysis in NELSAP

The options retained from the screening and described are analyzed with a description of the environmental and social issues associated with each one. These need to be compared with each other. This is carried out using a multi-criterion analysis (MCA). The characteristic feature of MCA methods is the establishment of formal and, to some extent, quantified procedures for the following three phases of options assessment[1]:

- Identification of criteria, i.e., points of view or axes of preference according to which possible courses of action can be distinguished;
- Ranking, or more extensive evaluation, of alternative courses of action according to each identified criterion;
- Aggregation across criteria to establish an overall preference ranking for the alternatives.

There is a variety of MCA methods that define the procedures to be followed in each phase and several ways of classifying them. These include 1) value measurement, 2) goal programming and aspiration levels, 3) outranking methods and 4) ordinal methods. After examining various methods the SSE study decided to rank options on the basis of a multi-attribute method. This method is part of the value measurement category of MCA School of methods referred to by the World Commission on Dams. With this method, each option is scored against each criterion and not simply ranked from the most preferred to the least preferred. Percentage points are associated with

1 Nichols, David and David Von Hippel (Tellus Institute, USA), Theo Stewart (University of Cape Town, South Africa). November 2000. Thematic Review. VI Planning Approaches. Chapter 4: Multi-Criteria Analysis Methods. Report Prepared for the World Commission on Dams.

each criterion as an indication of their relative importance (the sum of the weights must add to 100). The final value score of each option is obtained as a weighted average of the scores for the individual criteria.

16.2 Steps involved in the Multi-Criteria Analysis Method

The five steps followed in the MCA method are described below.

16.2.1 Step 1: Identification of evaluation criteria and indicators

Each power development option is evaluated against a set of criteria, i.e. points of view to be taken into consideration when comparing power options. One indicator will be associated with each criterion so as to guide the rating and the scoring of options. The list of criteria and indicators retained for the comparison of power options on the basis of the MCA method was based on three categories (cost, socio-economic and environmental) and 11 criteria, as presented in Figure 4.1. The list of criteria, indicators and project risks was validated with participants in one of the NELSAP Stakeholders Consultation Workshops.

16.2.2 Step 2: Determination of the relative importance of criteria

Within the socio-economic and environmental categories, weights are assigned to each criterion to reflect their relative importance using percentage points. Table 16.1 shows the weights assigned to the selected evaluation criteria. In order to evaluate to what extent the results of the comparison of options on the basis of the MCA method are dependent on ascribed weights, sensitivity analyses were carried out on alternative sets of weights.

Table 16.1. Criteria and indicators used for the comparison of power options on the basis of the MCA method

Criteria	Indicators
Category: Cost	
Economic Viability	Unit cost of firm energy per kWh over the projected life of the facility (US¢/kWh), taking into account: - Direct investment – plant - Engineering and owner's costs - Interest during construction - Operating and maintenance costs - Environmental and social mitigation costs (included in the civil works contingency amount) - Multi-purpose benefits (irrigation, fisheries) – treated by cost sharing for the dam (unless a specific allowance has been included in the estimates, in which case that estimate is used) - Contingency allowance for uncertainties (e.g. technical, financial and geological risks)
Category: Socio-economic	
Impacts due to population Displacement	Number of persons affected by project infrastructure and ancillary facilities (People/GWh)
Promotion of rural electrification	Number of rural persons living in a 10 km radius of the power station and in a 10 km wide corridor along the transmission line between the option and the main transmission grid (People/GWh)
Socio-economic impacts on the downstream reaches	Number of persons living in a 1 km corridor along the river stretch with altered flow downstream of the dam (People/GWh)
Land Issues	Area required for project infrastructure, including reservoir and transmission facilities (ha/GWh)
Category: Environment	
Impact on resource depletion	Energy payback ratio: ratio of energy produced during the normal life span of the option divided by the energy required to build, maintain and fuel the generation equipment. This indicator is a measure of the global pressure of an option on the environment
Impacts of greenhouse gas emissions	Net CO_2 equivalent emissions over the life cycle of the project (t/GWh)

Criteria	Indicators
Impacts of air pollutant Emissions on biophysical environment	SO_2 equivalent emissions over the life cycle of the project (t/GWh)
Land requirements	Area required for project infrastructure, including reservoir and transmission facilities (ha/GWh)
Waste disposal	Land area required for ash disposal (ha/TWh)
Environmental impacts on the downstream reaches	Length of river with altered flow downstream of the dam (km/TWh)

Table 16.2. Weights assigned to criteria selected for the comparison of options on the basis of the MCA method

Criteria	Class of Importance	Weight (%)
Category: Cost		
Economic Viability		100
Category: Socio-economic		
Effects due to population displacement	Important	15
Promotion of rural electrification	Very important	35
Socio-economic impacts on the downstream reaches	Important	15
Land issues	Very important	35
Category: Environmental		
Impact on resource depletion	Important	25
Impacts of greenhouse gas emissions	Less important	10
Impacts of air pollutant emissions on biophysical environment	Less important	10
Land requirements	Important	25
Waste disposal	Less important	5
Environmental impacts on the downstream reaches	Important	25

16.2.3 Step 3: Ranking of options for each criterion

During this stage of the comparative analysis, the performance of each option against each criterion is assessed according to quantitative indicators defined

on the basis of ratio scales so as to measure the magnitude of impacts related to each criterion per unit of energy generated.

Under the cost category, there is only one criterion: "Economic viability" with only one quantitative indicator: "Average cost per kWh over the projected life of the facility". This indicator can thus be used directly for rating and ranking options in this category. This indicator includes a number of elements that must be factored into the cost assessment.

In the Socio-economic and environmental categories, there are several criteria and indicators. In order to arrive at a ranking within each category, the indicators are represented in terms of numerical scores on an absolute scale from 0 (best) to 10 (worst). For each criterion, the best value (conceivable from a practical point of view regardless of whether or not such a value applies to any of the options in the list) for the selected indicator will be defined as 0 and the worst value (again from a practical point of view) will be defined as 10. All power options are then scored on a pro-rata basis using the numerical values of their indicators, as calculated for them. When an extreme value cannot be defined on the basis of existing literature on environmental and social impacts of electricity production options, the extreme value calculated for an option in the SSEA region is taken as a reference. In most cases, the evaluation of the performance of power options against criteria has been made on the basis of the following:

- Environmental impacts known to occur in similar projects;
- Internationally recognized mitigation measures;
- Information from government sources on environmental and socio-economic characteristics at country, province or district levels;
- Visits made by the consultant to the Rusumo Falls, Murchison Falls, Karuma and Ruzizi III Project sites;
- Information on technical characteristics of project components available in technical reports.

When information required for the evaluation of the indicators is not available, assumptions made are indicated at the bottom of tables. The Masigira, Mpanga and Upper Kihansi options could not be scored because the

required information on technical characteristics of project components was not available in technical reports. For the latter project, some information on environmental and socio-economic impacts could be derived from the Lower Kihansi EIA report. For air pollutant emissions, mitigation measures are explicitly taken into account when determining the value of the indicator for each option. For other indicators, it is assumed that internationally recognized mitigation measures are applied to all options, such as the implementation of a resettlement and rehabilitation plan or the release of a minimum water flow in a bypassed river section.

16.2.4 Step 4: Ranking of options within each category of criteria

Following the scoring of power options for each criterion, the options are subsequently ranked within the socio-economic and environmental categories on the basis of the weighted average of the scores for each individual criterion.

16.2.5 Step 5: Selection of options to be included

Comparisons across sets of evaluation criteria involve normative judgments (e.g. the importance of the cost category of criteria relative to the environmental category of criteria or socio-economic category of criteria) and are beyond the scope of this study. The cost ranking is used as a reference base for the discussion on the selection of options to be included in power development portfolios since dilemmas are generally raised as trade-offs to be made between least cost and other factors. When conclusions reached for the socio-economic and environmental categories of criteria differ from the cost ranking of power options, dilemmas raised are spelled out and analyzed. In addition, inputs from the assessment of project risks must also considered.

Consequently, options to be considered in power development portfolios will be identified on the basis of the following categories of considerations: 1) cost criterion; 2) socio-economic criteria; 3) environmental criteria; 4) project risks. On this basis, two groups of options to be considered in power development portfolios will be identified: 1) best evaluated options and 2) other options.

17

Results of Economic and Policy Analysis for NELSAP Water Based Projects

Economic and policy analysis for NELSAP water resource projects has the objective of comparing and analyzing various energy options such as hydroelectric, thermal, geothermal, fossil fuel and generic wind options in order to decide on the best option based on technical, economic, social and environmental criteria in order to analyze the benefits and costs of each power option.

When the economic criterion is applied, water related projects in the form of hydroelectric options perform well in the sense of having the lowest per unit costs. In terms of the social criterion, hydroelectric options have variable results depending on the location of the water related project which determines the extent of rural electrification and displacement involved, hence most hydroelectric options tend to perform well on the social criterion on the average. Regarding environmental critera the Victoria Nile – Bujagali and Karuma – as well as Ruzizi III have a good performance with scores between 0.1 and 0.3. All have a high energy payback ratio and relatively low land requirements and downstream effects.

Use of technical, economic, social, and environmental criteria to evaluate different energy options and specifically options which are related to water related projects are geared towards eliminating water related projects that may have significant economic benefits at the expense of high social and environmental costs which has led to some people being adversely affected by the construction and operation of the water related projects. The use of all the criteria aims to address the issue of having water related projects that take into account all the issues that are important in improving the livelihoods of people. The fact that economic and policy analysis of NELSAP is based on using different criteria to make decisions implies that such analysis is extensive in that it takes all the issues related to development into account thereby

facilitating the choice of an energy option that is balanced in terms of being able to bring about economic development without ignoring the social and environmental aspects of development so as to make the benefits from water related projects sustainable.

The economic and policy analysis conducted for the NELSAP projects that water related projects in terms of hydroelectric options perform exceptionally well in the economic criterion since they have the lowest per unit cost. When it comes to the social criterion, water related projects also score highly since they have a strong potential for rural electrification as a result of producing power that can reach many people at a low cost. Furthermore, although water related projects may have the problem of high land and resettlement requirements, the NELSP water related projects had low-to-moderate land and resettlement problems thereby giving a higher social score to such water-related projects. The performance of NELSAP water related projects within the environmental criterion is mixed with some projects having high energy payback ratios accompanied by relatively low land requirements, and downstream and other projects having low energy payback ratio accompanied by high land requirements or more significant downstream impacts.

In conclusion, the current practice on water resource planning in NBI countries is, in principle, in favour of use of the rationale discount rates in a pluralist and multiple criteria framework and development. Overall, it can be said that analysis of NELSAP water-related projects shows that they are well balanced in terms of taking into account not only economic issues but also social and environmental issues and thereby implying that such projects will be able to reduce the problem of acute shortage of electricity in the Nile Equatorial Lakes Region in a sustainable manner that does not have social and environmental repercussions.

NELSAP is recommended not to reject large scale water resource and related projects, provided that they are thoroughly and carefully planned, taking all relevant problems and issues into account, that they have no adverse effect on the communities concerned or on the local environment, and that their benefits

are shared by the surrounding NBI communities. However, consultations suggest that small-scale and user-based schemes have greater advantages, are less costly, more practical and more sustainable. Such water investment schemes should therefore be given greater emphasis by policy makers, planners and other stakeholders. Moreover, the current fashion makes a strong case for community participation, ownership and management of water projects. Finally, the purpose of water resource and related projects in the NELSAP should be to increase social benefits and to meet critical needs, such as food security, cross-border regional power trade and poverty alleviation.

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Annex

Brief Report on the Energy Cluster Workshop

July 7th, 2008

Landmark Hotel, Dar es Salaam

Objectives

The workshop had two objectives. The first objective was to present the preliminary findings and the methodology to be used in carrying out research work on the impact of regional power trade on poor communities living along the connections in the Nile Basin countries and rationalization of the use of discount rates for economic analysis of water resources and related projects in NELSAP. The second objective was to inform the general public on what was going on as far as the role of ERB as a PI in the SDBS project within the Nile Basin Initiative was concerned.

Opening and coverage

The workshop was opened by Dr. Semboja Haji who explained to the participants the objectives of the workshop. He then introduced the Director of ERB Dr. Joseph Shitundu and other international NBI members. The workshop followed with two presentations, one by Dr Semboja on current research work on the impact of regional power trade on poor communities living along the connections in the Nile Basin countries. The second presentation was by Dr. Helen Natu – Project Manger SDBS.

In his presentation, Dr Semboja emphasized the preliminary findings from the literature survey and then elaborated in detail the steps and issues to be considered in the remaining work for this study. More importantly, the discussion was on types of data to be collected, the research instrument (questionnaire) and study area i.e. Ethiopia and Sudan.

Dr. Natu began by explaining the overall objective of the project and provided a brief anatomy of the establishment of the project. She then named the

participating institutions and what they were involved in. Dr. Natu then explained the schedule and deadlines for completing activities.

Dr. Natu noted that it was essential for the study to use the already identified communities by other PIs so that there was no further need for identification. Dr. Natu pointed out that the current research works have to come up with only one relevant policy recommendation with the corresponding implementation strategy. The study should also make extensive use of secondary data on existing policies and selct a few relevant policies to be studied in detail.

The general discussions revealed that there were available resources such as "Stakeholder Mapping" and ENSAP feasibility studies which could be shared as inputs into this study.

List of participants

	Name	Organization
1	Mengesha Shiferwa	RPTP
2	Dr. Hellen Natu	SDBS Regional Project Manager
3	John Bosco Bampabwire	SDBS Research Analyst
4	Peter Nabende	SDBS Programme Administrator
5	Dr. Semboja Haji	SDBS Team Leader
6	Dr. Joseph Shitundu	Director, ERB
7	Daniel Mbilinyi	ERB/ SDBS team member
8	Otieno Osoro	ERB/SDBS team member
9	Mcharo Mrutu	Journalist – Channel Ten
10	Stella Mgala	Ministry of Water and Irrigation
11	Joseph Perfect	ERB/SDBS team member
12	Aloyce Hepelwa	ERB/SDBS team member
13	Abdulwakil Saiboko	Journalist – Daily News
14	Pendo Masasa	Journalist – AN-NUUR
15	Willy Kitima	Chair NMN – Tanzania
16	Aisha Mora	Journalist – Channel Ten
17	Gandye George	ERB/SDBS team member
18	Stephen Mmassy	ERB/SDBS team member