Report No: ACS3585

Republic of South Sudan

Electricity Sector Strategy Note for South Sudan

Electricity Sector Strategy Note

April 1, 2013

AFTG1

AFRICA

CURRENCY EQUIVALENTS

Exchange Rate Effective Date: August 15, 2012

Currency Unit	=	South Sudanese Pound (SSP)
SSP 2.68	=	1 United States Dollar (US$)
US$ 1.567	=	1 Special Drawing Rights (SDR)

FISCAL YEAR

South Sudan Electric Corporation (SSEC)
April 1 – March 31

ABBREVIATIONS AND ACRONYMS

AfDB	African Development Bank
ADF	African Development Fund
AFD	Agence Francaise de Développement
APL	Adaptable Program Loan
CAS	Country Assistance Strategy
CEO	Chief Executive Officer
CFL	Compact Fluorescent Lamp
CPS	Country Partnership Strategy
EIB	European Investment Bank
EIRR	Economic Internal Rate of Return
EMP	Environmental Management Plan
EPC	Engineering, Procurement, and Construction Contract
ESIA	Environment and Social Impact Assessment
ESMF	Environment and Social Management Framework
ESMP	Environmental and Social Management Plan
FIRR	Financial Internal Rate of Return
FIT	Feed In Tariff
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GNI	Gross National Income
GRSS	Government of Republic of South Sudan
GPOBA	Global Partnership on Output-Based Aid
HVAC	High Voltage Alternate Current
HVDC	High Voltage Direct Current
ICB	International Competitive Bidding
ICS	Interconnected System

ICT	Information and Communications Technology
IDA	International Development Association
IFC	International Finance Corporation
IFRs	Interim Financial Reports
INT	Integrity Vice Presidency
IPP	Independent Power Producers
LED	Light Emitting Diode
MDG	Millennium Development Goals
M&E	Monitoring and Evaluation
MFI	Micro Finance Institution
MIGA	Multilateral Investment Guarantee Agency
MOED	Ministry of Electricity and Dams
MOFEP	Ministry of Finance and Economic Planning
MOPM	Ministry of Petroleum and Mining
NBI	Nile Basin Initiative
NPV	Net Present Value
O&M	Operations and Management
PAP	Project Affected Persons
PC	Project Coordinator
PIU	Project Implementation Unit
PPP	Public and Private Partnership
PSE	Private Sector Enterprise
PV	Photo Voltaic
RAP	Resettlement Action Plan
RPF	Resettlement Policy Framework
RSS	Republic of South Sudan
SCS	Self Contained System
SIL	Specific Investment Loan
SHS	Solar Home System
SME	Small and Medium Enterprise
SSEC	South Sudan Electricity Corporation
TOR	Terms of Reference
WB	World Bank

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EXECUTIVE SUMMARY

Country Background

1. South Sudan, a post-conflict fragile state, is embarking on a process of building its government and economy to foster growth and development. This is a daunting task for a new nation whose development related indices are amongst the lowest in Sub-Saharan Africa (SSA) and where core infrastructure is in its infancy. South Sudan's GDP is about US$ 10 billion with a population of 8.3 million. A large country of 647,095 sq km, South Sudan possesses considerable natural resources (oil and gas, hydropower, etc.). To promote growth and prosperity through efficient use of resources, the Government of Republic of South Sudan (GRSS) announced the South Sudan Development Plan (SSDP), FY2011-13, including plans for key sector investments.

Sector Analysis

2. At present, South Sudan has an installed capacity of 22 MW in three isolated distribution networks (major commercial centers) totaling 15 km in length. In FY2011, 22,000 customers (less than 1% of population) consumed about 70 GWh of energy (per capita consumption of about 10 kWh). Currently, electricity generation is thermal based (diesel, heavy fuel oil) which is very expensive (average generation cost is about US$ 0.70/kWh). Due to the low access rate, most of the population relies on burning biomass as their primary energy source for cooking, lighting, etc. Those who do have access to electricity experience unreliable quality of service (outages and disruptions) and yet, end up paying some of the highest average electricity tariff rates on the continent (average tariff is US$ 0.25/kWh) which is still below cost recovery level.

3. GRSS outlined a US$ 700 million energy sector investment plan (FY2011-13) in the SSDP. The sector plan focused on grid-based access expansion to 48,000 customers (all ten state capitals), investments in expansion of thermal generation capacity to 96 MW, as well as expansion of distribution networks. SSDP also described plans to import 140 MW power from Sudan via a 220 kV interconnector line. SSDP did not include plans for other important interventions needed urgently in the sector, such as: reforms in the institutional arrangements, legal and regulatory framework, capacity building, off-grid access expansion, etc.

4. The disparity between tariff and cost of generation, inefficiency of the system (system loss of 30%), and low bill collection rates (40-50%) have led to high financial losses for the national utility and an increasing burden on the GRSS budget. The GRSS subsidizes every kWh of electricity to the tune of US$ 0.54, burdening the fiscal resources of the country (electricity subsidy is 4% of GRSS's budget). The investment plan, without sound policy reforms, efficiency improvements and capacity building, will increase the financial viability challenges of the sector.

Recommendations

5. As a first such document, this report aims at providing a broad level discussion of key sector issues, comprehensive analysis of development challenges, and a structure for strategic interventions for sector-wide growth. Based on the analysis provided in this report, it is recommended that the GRSS take a holistic and longer term perspective for sector development in order to reform and modernize the electricity sector in a cost-effective manner.

6. Given the many sector challenges, the report is positioned as a starting document which can be used by the GRSS to attract financing from various sources including IDA, other donors, and private sector, following the outline set out in the report. It is hoped that detailed plans for implementation will be developed, as recommended in the report, following further studies and investigations, as needed. It is recommended that the implementation of sector activities be carried out in a phased approach of short-term, medium-term, and long-term programs, based on the completion targets of these activities. However, these activities should be carried out in parallel in order to achieve timely results. The World Bank intends to continue being an active partner in the development of the sector and to support GRSS in attracting traditional and non-traditional development partners.

7. **Short Term**: As a new nation, RSS needs to embark on a process of technical and institutional capacity building. GRSS should focus on ***laying the foundation of growth*** for future with the following key action items:

- Sector planning should begin with formalization of the Ministries and the utilities, enactment of the Electricity Act, as well as studies on key sector challenges.
- A sound legal and regulatory framework should be enacted to include measures to promote grid and off-grid programs, including partnership with the private sector.
- A comprehensive sector-wide capacity building program should be carried out to address the severe capacity constraints faced by the sector institutions.
- Generation program should continue on planned emergency thermal expansion and focus also on long term planning and project preparation for least-cost growth.
- Transmission and distribution program should continue on planned urban expansions and initiate the planning process of regional interconnections.
- Access enhancement program should continue on planned grid-based connectivity and also launch off-grid programs, such as, solar lighting and efficient cooking.

8. **Medium Term**: GRSS should focus on ***implementing*** identified strategic projects:

- Sector planning, legal and regulatory reforms and capacity building efforts should continue on an ongoing basis.
- Generation program should initiate implementation of a diverse mix of generation resources with special attention to large-scale hydropower development.
- Transmission and distribution program should focus on efficient management and reinforcement of an ageing network and planning for participation in power pools.
- Access enhancement program should not only increase grid-based connectivity but also broaden the off-grid renewable energy and energy efficiency programs.

9. **Long Term**: GRSS should focus on ***scaling-up*** of expansion projects:

- Sector planning, legal and regulatory reforms and capacity building efforts should continue on an ongoing basis.
- Generation program should commission plants using a diverse mix of resources, such as, large hydropower, to supply electricity for the huge suppressed demand.
- Transmission and distribution program should implement an efficient national interconnected grid network and engage in regional power trade.
- Access enhancement program should scale-up both grid-based as well as off-grid programs to enhance access to modern energy services for the population.

I. INTRODUCTION

A. Background and Country Context

1. Following years of conflict, newly independent Republic of South Sudan (RSS) is in the process of nation-building through internal and external conflict prevention. After a tumultuous past, the challenge of organizing its government and enhancing the development agenda on many fronts simultaneously is daunting indeed. This is particularly true for a country where most of the economic and Millennium Development Goals (MDG) indicators on infrastructure, health, and education are among the poorest in Sub-Saharan Africa (SSA). For instance, South Sudan has just over 180 km of paved roads and 22 MW[1] of electricity generation capacity. Most of the infrastructure is concentrated around three commercial centers (three out of ten state capitals).

2. The FY2011 gross domestic product (GDP) was estimated to be US$ 10 billion[2] with a population of 8.3 million (per capita GDP was US$ 1,204). Despite relatively high GDP figures, it is estimated that 51% of the population lives below the poverty line and the Gross National Income (GNI) is US$ 888 per capita (SSA average is US$ 1,176). Most of the growth comes from petroleum revenues which account for 80% of the GDP and 98% of exports. The economic growth rate is estimated to be 6-7% per annum, with commercial centers, such as Juba, emerging as the fastest growing cities on the continent. In the post-independence period, the consumer price index (CPI) also shot up to 51% (year to year growth rate, March 2012).

Figure 1: Map of South Sudan with Major Cities (State Capitals) and Electrified Areas

Source: World Bank

South Sudan Development Plan (SSDP) 2011-13

3. Currently, subsistence agriculture provides a living for the vast majority of the population. In FY 2011, GRSS introduced the SSDP with the objective of recovering from conflict and with the goal of moving onto a fast-track development path through use of its vast natural resources (mainly petroleum, oil, and gas). Under the SSDP, large-scale infrastructure development, particularly focusing on rapid expansion of the road network and provision of energy, were planned.

[1] World Bank 2012 estimates

[2] Data from National Bureau of Statistics (NBS) and South Sudan Center for Census, Statistics and Evaluation (SSCCSE), 2011 and 2012 estimates

4. Energy sector related targets were outlined in the Economic Development Pillar - which was one of four key pillars of the SSDP. It called for an ambitious investment program of US$ 700 million for the energy sector aimed at more than doubling the number of customers and tripling the total installed generation capacity of the country by FY2013. The SSDP also called for electrification of all ten state capitals, expansion of the local distribution networks, and installation of the regional interconnections (to Sudan). A summary of energy sector targets in the Government's SSDP is provided in the Figure below.

Figure 2: SSDP Energy Sector Related Targets

Target	*2011*	*2012*	*2013*
Number of Customers Connected (Thousands)	31	41	48
Installed Capacity in (MW)	36	76	96
Imports from Sudan Interconnection (MW)	40	80	140

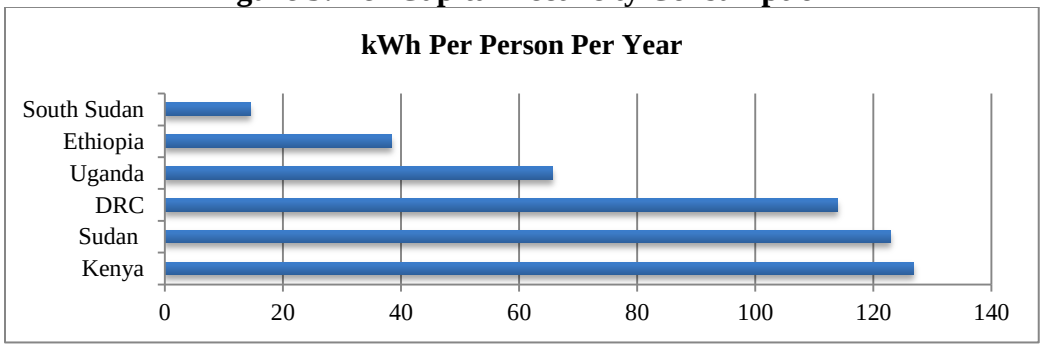
Source: SSDP, 2011

B. Sectoral Context

5. As is the case in much of rural SSA, most of the energy consumed at the household level in South Sudan is used for cooking, lighting, etc. According to the National Baseline Household Survey[3], 96% of the population used firewood or charcoal as the primary fuel for cooking (which typically constitutes 90% of the energy used in a rural household). In terms of lighting, over 50% of the population used firewood as the primary source, 20% depended on kerosene, paraffin, etc., and 2% used captive power (generators)[4]. Of the remaining population, 27% had no access to lighting sources, and only about 1% of the population had access to grid electricity, most of these consumers are in Juba city area with the remaining in Malakal, Wau, and Renk.

6. At present, the grid-based electricity situation in South Sudan is characterized by routine power outages and lack of efficiency in the distribution system. Despite the SSDP targets, energy sector situation has not changed much from the pre-independence period. Per capita electricity consumption of South Sudan is about 10 kWh[5] - the lowest compared its neighboring countries (average per capita electricity consumption for the SSA is about 80 kWh).

Figure 3: Per Capita Electricity Consumption



Source: World Bank estimates

[3] Data from National Bureau of Statistics (NBS), 2009
[4] Source: Statistical Yearbook for Southern Sudan, 2010
[5] While avg. consumption of electricity per connection is over 3,000 kWh

7. South Sudan's electricity sector can be summarized as follows:

- **Grid Network**: there is no transmission back-bone or any interconnected grid network. The supply system consists of 3 isolated distribution networks in the commercial centers of Juba, Wau and Malakal totaling about 15 km of 11 kV lines plus some other minor electrified areas (mini-grids implemented by donors) and an interconnection with Sudan to Renk Town.

- **Electricity Generation**: grid-connected generation sources consist exclusively of thermal generators (diesel and heavy fuel oil, HFO). Total installed capacity for the country is 30 MW, of which, only 22 MW is currently operational (12 MW in Juba, 2 MW in Wau, 5 MW in Malakal, and three mini-grids). The electricity supply generally services rich residential customers and some commercial centers in the cities, whereas most of the industries and businesses rely on captive power for electricity needs. Apart from the 3 government-run distribution networks mentioned above, donor funded projects (NRECA/USAID) also run mini-grids in the town of Yei (1.2 MW), Kapoeta (0.8 MW) and Maridi (0.8 MW).

- **Electricity Access**: the total number of customers connected to the electricity network is 22,000 (includes 1,500 customers of NRECA/USAID). Remainder of the population does not have access to any modern sources of energy and, as mentioned above, rely on firewood as their primary source of energy.

- **Off-Grid and Other Renewable Energy**: Currently, there are no Government programs for rural energy access or off-grid distributed energy generation. However, in the past, some programs have provided solar street lighting in Juba, solar home systems, as well as solar lanterns to a few rural communities.

8. South Sudan not only has low access and low consumption rates, but those who are connected to the grid have to pay a high cost for the service (household connection costs US$ 500-600 and average tariff is US$ 0.25/kWh). Due to the extensive outages and often lack of generation capacity (due to problems in the generation plant) the quality of service is very poor. Most large scale private companies resort to expensive self-generation or have stand by plants. The resulting high costs and productivity losses is a major hindrance to the growth of industrialization which is urgently needed to boost the fledgling economy.

II. GOVERNMENT'S VISION FOR THE SECTOR

A. Public Policy Goals

9. The SSDP describes four pillars of the Government's growth agenda: (i) governance; (ii) economic development; (iii) social and human development; and (iv) conflict prevention. Energy sector related targets are outlined in the economic development pillar. The objective of this pillar is to achieve diversified private sector led economic growth. The target calls for an extremely ambitious investment program of US$ 700 million[6] for the electricity sector as a key driver of

[6] Details in Annex 1

growth in South Sudan. The development of energy, mineral and mining sectors (including oil and electricity) are identified as the key priorities for the Government; however, some of the key elements of a comprehensive energy sector policy are missing from the SSDP.

10. GRSS's public policy goals related to the electricity sector can be categorized as follows:

- **Grid-Based Access Enhancement**: GRSS's target is to increase the number of customers connected to the grid from 22,000 in 2010 to 48,000 by 2013. For achievement of this target the Ministry of Electricity and Dams (MOED) and the South Sudan Electric Corporation (SSEC) plan to expand the distribution network (conductors, insulators, electric poles, and transformers) and connect many households (mainly urban and peri-urban) using prepaid meters (single phase, three phase, and high currents). SSEC is also focused on sound operations and maintenance of its distribution system to increase efficiency and to offer a higher quality of service to its customers.

- **Increasing Generation Capacity**: The MOED and the SSEC plan on increasing South Sudan's installed capacity to 96 MW by 2013. In the short term, the added capacity is planned to be derived from commissioning of new thermal power stations (can be considered as emergency measure) in each of the seven un-electrified state capitals (Bor, Yambio, Rumbek, Torit, Kwajok, Aweil, and Bentiu). Also, an additional 40 MW is planned for Juba. GRSS plans on initiating the process of exploiting its vast hydropower potential (such as the Fula Rapids hydropower project – more details in sections below).

- **Establish Regional Interconnections**: The MOED and SSEC plan to participate in a bilateral interconnection with Sudan (220 kV transmission line from Renk Town to Malakal). The GRSS plans to import up to 140 MW of firm electricity from Sudan by 2013. In the long term, the GRSS is also considering participating in regional interconnections: the East Africa Power Pool (EAPP) via Ethiopia.

11. The above mentioned plan was already quite ambitions for a post-conflict state still recovering from turmoil. On top of that, budgetary constraints have limited the availability of funds for long-term infrastructure projects at the MOED and SSEC. As a result, to date, there has been limited or no progress on implementation of any of the sector projects listed in the SSDP.

B. Emerging Sector Institutions and Capacity Constraints

12. The pre-independence interim Government (of autonomous South Sudan) established the Ministry of Energy and Mining (MOEM) in 2009. The MOEM had the responsibility of policy development and sector planning for the petroleum, energy and minerals sector. However, in the post-independence era, the MOEM was divided into the Ministry of Electricity and Dams (MOED) and the Ministry of Petroleum and Mining (MOPM). An Electricity Act has been drafted; however, it is yet to be updated and ratified in light of the new ministries and other institutional changes. The government is in the process of finalizing the details of the new arrangements. Currently, the key institutions in the electricity sector are as follows:

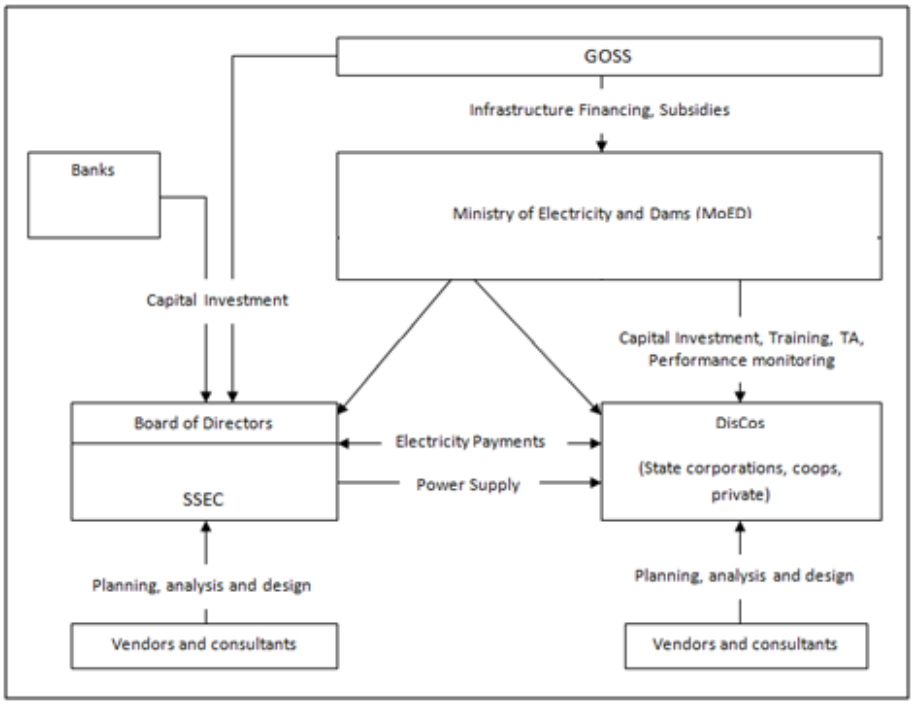
- **MOED** will be responsible for overall sector policy and strategy and will also be involved at a hands-on level for major projects in transmission (anything above 33 kV) and other large hydropower and regional integration projects. The Ministry has recruited some senior technical personnel from the former Sudanese electricity corporation into managerial positions; however, MOED's capacity at other staff levels remains very limited.

- **SSEC** is deemed to be an autonomous national utility acting as a public sector undertaking (PSU). However, at the moment, it functions as a unit of the MOED with all its expenditures and revenues being rolled up into the Ministerial budget with capital investments from commercial banks. The utility will be involved in electricity generation, transmission and distribution, and access related projects in South Sudan along with its current role of operations and maintenance. The capacity of the SSEC is very limited in terms of technical and managerial skills, and resource availability; yet, there are nearly 800 staff members on the payroll.

- **State Electric Distribution Companies (SEDC):** GRSS also plans to include the SEDCs to manage local electric power distribution services (such as: rural electric cooperatives) that can obtain supply from SSEC. Independent Power Producers (IPPs) and other non-government entities would obtain licenses to develop, finance, and operate distributed electric generation systems (mini-grids).

13. Overall, the capacity of all of the sector institutions is severely lacking. The clarity of roles and responsibilities of the institutions has not been achieved. It is hoped that the updated Electricity Act and other regulations will help in proper organization of the sector institutions.

Figure 4: Electricity Sector Institutional Framework



Source: MOED

III. DEMAND AND SUPPLY

A. Evolution and Forecast of Demand

14. In 2011, total energy sales in South Sudan (by SSEC) were estimated to be 70 GWh with the peak load of 22 MW. Based on the economic growth rates in the post-independence period, the demand for electricity is expected to increase at around 7-8% per annum in the medium to long term. However, based on the GRSS's upcoming access expansion plans, the electricity demand growth rate is expected to be much higher in the near term, given the fact that the sector is starting from a very low base (expected to be over 30% in FY2012 tapering to 15% by FY2015). All forecasts in this report are based on GRSS's plans.

15. It is important to highlight that the demand for electricity has been steadily increasing with new economic opportunities in the post-independence era and that the growth of the electricity sector in South Sudan is not restrained by demand but by the lack of supply. In the major cities there is a substantial amount of *suppressed demand* and captive generation used by the private sector will increase the load as a step function if supply sources are made available. There is also significant demand for electricity in the rural areas with only about 1% of population connected to the grid. According to recent projections[7], in the long term, the demand for electricity in South Sudan could grow to 1,400 MW by 2030 if the supply sources and networks are made available.

16. Based on current plans (and assuming that the plans will be implemented), this report estimates that South Sudan will have a total peak load demand of nearly 100 MW by FY2015 with energy sales of nearly 200 GWh by FY2015. Also, the number of customers connected to the grid would increase to over 55,000 from the current 22,000 (details in the Figure below).

Figure 5: South Sudan Electricity Demand and Supply 2011-15

Targets	*2011*	*2012*	*2013*	*2014*	*2015*
Number of Customers (Thousands)	22	31	41	48	55
Growth Rate (%)		30%	23%	15%	15%
Peak Load (MW)	22	27	36	76	96
Load Factor (%)	52%	60%	60%	33%	30%
Energy Generated (GWh)	99	142	189	220	252
System Loss (%)	30%	29%	28%	27%	26%
Energy Sales (GWh)	70	101	136	160	186
Average Energy Consumed per Connection (kWh)	3,160	3,250	3,323	3,341	3,375

Source: Data from SSEC and SSDP with World Bank estimates

17. As the GRSS plans to electrify all ten state capitals and is also considering moving the national capital city from Juba to Ramciel, this could create electricity demand hotspots. It is interesting to point out that in a country where per capita electricity consumption is about 10 kWh; the electricity consumed by those connected to the grid is well over 3,000 kWh. This is a clear indication of the inequitable skew of energy access in South Sudan today.

B. Electricity Supply Challenges

[7] Source: PB power, a consulting firm, 2010

18. During the pre-independence period only a few thermal power generation units were installed in Juba, Wau, and Malakal with total available capacity of 22 MW. Some other localized mini-grids were set up in Kapoeta in Eastern Equatorial state, Yei in Central Equatorial state, and Maridi in Western equatorial state with diesel power plants. These were established by USAID and accomplished through National Rural Electricity Cooperatives of America (NRECA). At present, South Sudan's generation capacity relies completely on thermal generators. However, the long term goal of the government is to heavily invest in hydropower generation. Since the development of large hydropower plants will take many years to complete, the supply scenario in the coming five years (short term targets) will continue to be limited to thermal sources (Figure below). By FY2015, the total installed capacity in South Sudan is expected to be about 100 MW with energy generation capacity of about 250 GWh.

Figure 6: South Sudan Electricity Supply 2011-15

Generation Source	*2011*	*2012*	*2013*	*2014*	*2015*
Thermal Power (MW)					
Existing Capacity					
Juba	12	12	12	12	12
Wau	2	2	2	2	2
Malakal	5	5	5	5	5
Yei (USAID)	1	1	1	1	1
Kapoeta (USAID)	1	1	1	1	1
Maridi (USAID)	1	1	1	1	1
Total Existing	22	22	22	22	22
New Generation (Planned)					
Juba	0	5	5	25	45
Bor	0	0	3	3	3
Yambio	0	0	3	3	3
Rumbek	0	0	3	3	3
Torit	0	0	0	5	5
Kwajok	0	0	0	5	5
Aweil	0	0	0	5	5
Bentiu	0	0	0	5	5
Total New	0	5	14	54	74
Total Installed Capacity (MW)	**22**	**27**	**36**	**76**	**96**
Total Energy Generation Capacity (GWh)	**99**	**142**	**189**	**220**	**252**

Note: There is an existing 40MW interconnection with Sudan to Renk Town, but the consumption from the line is limited to local demand (only an estimated 1.5% of supply is used)
Source: Data from SSEC and SSDP with World Bank estimates[8]

C. Generation Mix

19. The current generation mix in South Sudan is completely reliant on hydrocarbons (diesel and HFO). This makes the electricity supply expensive and somewhat unreliable (due to the greater difficulties faced by developing countries in maintaining thermal plants). In recent months, there have been supply outages due to rapid variations in fuel prices, the GRSS's ability

[8] Analysis is based on best estimates on data from SSEC, SSDP, and GRSS. There are also plans for hydropower generation such as Fula Rapids and Yei River Projects but they are not expected to be commissioned before 2015. Also, it is possible that some of these projects may be funded by donors (USA, Norway, Japan, Egypt, etc.). Plans are also being development to interconnect South Sudan with Sudan and Ethiopia which can be realized after 2015.

to purchase and import the expensive fuel oil, and due to logistical and transportation challenges associated with the supply chain.

20. Furthermore, the current system, albeit small, is extremely carbon intensive with high per capita emissions. In order to design the electric power generation system of the future, it is important to plan for a generation mix that not only considers the cost and availability of generation resources in South Sudan, but also considers the appropriate plant availability (sufficient reserve margin), reliability (low supply interruption frequency), diversity of the generation mix (risk mitigation), and respect for the environment (renewable energy). Some of the core principles upon which the generation mix should be based upon are:

- **Least-Cost Approach**: The basic idea is that electricity is classified as 'intermediary goods' and is not the final product. It is important to consider what services it provides, such as, energy for cooking, lighting, other productive uses, etc. If these services can be met through alternate means, then the costs involved in such replacements should be compared with the costs involved in expanding supply. If the demand reduction measures are cheaper, then they should be preferred to investing in expanding electricity generation.

- **Abundance of Resource**: Generation planning should take a holistic approach in ascertaining the availability of generation resources. In the case of South Sudan this could include, inter alia, fossil fuels, hydropower, solar power, wind power, geothermal, other renewable resources, as well as imports of electricity through a bilateral interconnection or a regional power pool.

- **Reliability of Service**: Reliability of generation is very important for the power system. Generating units will have scheduled outages, forced outages, as well as variation in energy generation (load factor). Following deterministic approach of addressing reliability, reserve margin of 15% over the peak demand may be considered to estimate the generation capacity requirements.

- **Diversity of Resources**: Fuel diversity is important for affordable and reliable electricity. A diverse fuel mix protects utilities as well as consumers from any contingencies, such as: fuel unavailability, price fluctuations, and changes in regulatory practices. A diverse generation mix can also ensure energy security.

- **Environmental and Social Considerations**: The generation mix should consider environmental and social issues. Renewable energy is inexhaustible and abundant and has many inherent advantages, such as: mitigation of climate change, generation of employment and reduction of poverty, as well as increased energy security and supply. Further, the exploitation of natural resources, such as renewable energy should not unduly burden the citizens of the country (equity of use, relocation, etc.).

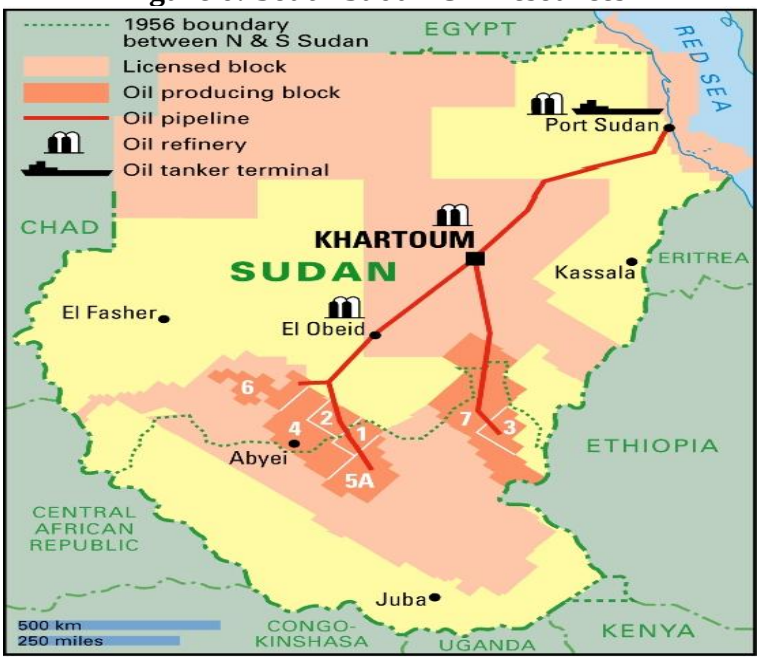
21. It is recommended that a comprehensive study must be carried out in order to draft a *master plan* and a *least-cost generation plan* for South Sudan incorporating the principles outlined above. This study should also include a complete *resource mapping* of available

generation resources as well as a prioritized roadmap of generation. This should be followed by a detailed technical and economical feasibility study for each project and other project design essentials. An overview of potential generation resources available in South Sudan is below.

Thermal Generation

22. It is estimated that South Sudan has 5 billion barrels of oil reserves (the third largest in SSA) and 3 trillion cubic feet of natural gas reserves (Figure below). In the post-independence period, the GRSS is keen on attracting oil majors to develop production in blocks that are not yet producing. Overall, given the local availability of fuel, there is a huge potential of establishing more hydrocarbon based thermal power plants in the country and the GRSS is already exploring plans to install a 150-200 MW thermal power plant in Unity State. As the need for electricity is high, in the short term, majority of the upcoming power plants will be thermal power based. However, there are several impacts of relying on petroleum and natural gas based power generation. Not only is the cost of generating power from such sources high, it also has a potentially harsh environmental impact. In the long term, the government should explore cheaper and cleaner sources of generating power.

Figure 6: South Sudan Oil Resources



Source: Inside Kenya Today

Hydropower Generation

23. South Sudan has vast untapped hydropower potential. The exact scale (in terms of total MW exploitable) of the resource has not yet been completely studied. However, it is anticipated that the greatest potential is concentrated on the stretch of Nile between Nimule and Juba. Along with this, mini-hydropower projects may also be feasible in many other parts of the country. Based on the information provided by the GRSS, at the moment, there are about 2,105 MW of potential hydropower project sites under various stages of pre-feasibility and feasibility studies.

Some of these prospective sites are: Fula 890 MW, Bedden 570 MW, Shukoli 230 MW, Lakki 410 MW, etc. Result of feasibility studies of these projects are summarized below.

24. **Fula Hydropower Project:** Fula hydropower project has a potential installed capacity of 890 MW. It is located 33 km downstream of Uganda border at the downstream end of the Fula Rapids. Under the best economic option, the Fula dam will have a length of 760 M, a maximum height of 60 M, spillway of 135 M with 11 gates and Vertical Francis Turbines. There has also been a study by Norfund on the feasibility of a smaller project designed as a run-of-the-river project - **Fula Rapids.**

25. The estimated installed capacity of Fula Rapids project is up to 30 MW, to be developed in two stages of 15 MW. The potential annual production was estimated to be 232 GWh. The GRSS is keen on development of the Fula Rapids site. Recently, the GRSS also announced plans to co-finance the development of the Fula Rapids project by approximately US$ 30 million.

26. **Bedden Hydropower Project:** Bedden is a high priority project for the GRSS and has a potential installed capacity of 570 MW. It is located 136 km downstream of Uganda border. Under the best economic option, the Bedden dam is expected to have a length of 2775 M, a maximum height of 42 M, spillway with 12 gates and Vertical Kaplan Turbines.

27. **Shukoli Hydropower Project:** Shukoli has a potential installed capacity of 230 MW. It is located 46 km downstream of Uganda border at the upstream end of the Yeroba Rapids. Under the best economic option, the Shukoli dam is estimated to have a length of 500 M, a maximum height of 75 M, spillway with 12 gates and Vertical Francis Turbines.

28. **Lakki Hydropower Project:** Lakki has a potential installed capacity of 410 MW. It is located 77 km downstream of Uganda border. Under the best economic option, the Lakki dam is expected to have a length of 385 M, a maximum height of 45 M, spillway with 12 gates and Vertical Kaplan Turbines.

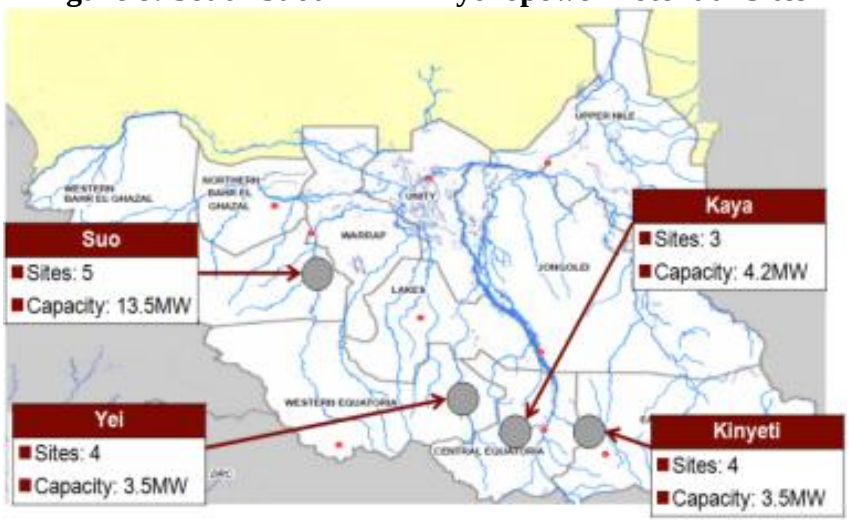
Figure 7: South Sudan Large-Scale Hydropower Potential Projects

Dam	***Fula***	***Shukoli***	***Lakki***	***Bedden***
Installed Capacity (MW)	890	230	410	570
Dam Height (M)	60	75	45	42
Dam Length (M)	760	500	385	2775
Lead Time (Years)	5	5	5	5

Source: Data from SSEC, SMEC and World Bank estimates

29. It is to be expected that the large-scale hydropower projects (those listed above as well as other potential future projects such as Bahr-El-Ghazal, Western/Eastern/Central Equitoria, Juba Barrage, etc.) would take considerable amount of time to commission. In order to meet the generation requirements in the near term, mini-hydropower sites should be implemented. Pre-feasibility and design works have reportedly been completed for up to 8 mini-hydropower plants (see Figure below) ranging from 3 to 11 MW of capacity, such as: **Suo and Yei River** projects.

Figure 8: South Sudan Mini-Hydropower Potential Sites



Source: 'Power in South Sudan 2006-2028'

Solar Generation

30. Amongst the renewable energy generation resources, solar energy has excellent prospects in South Sudan. There are plenty of sunshine hours in South Sudan and the country has potential for stand-alone solar photovoltaic units and possibly for large-scale solar thermal generation as well. The country also enjoys a high value of solar hour all year around (Figure below). Especially, the Northern-Eastern parts of the country experiences approximately 12 hours of sunshine per day all year round. Solar radiation ranges from 5.5 - 6.0 kWh/m^2/day.

Figure 9: South Sudan Average Monthly Sunshine Hours

Source: Weather and Climate Online

31. Given the many benefits of solar energy (such as noise reduction, ease and speed of installation, etc.) detailed technical and economic feasibility studies should be carried out to ascertain the full potential of solar power in South Sudan. Some small donor projects based on solar technologies have already been implemented in South Sudan, such as: Juba city street lighting system based on solar power, solar home systems in the rural areas of the country, etc.

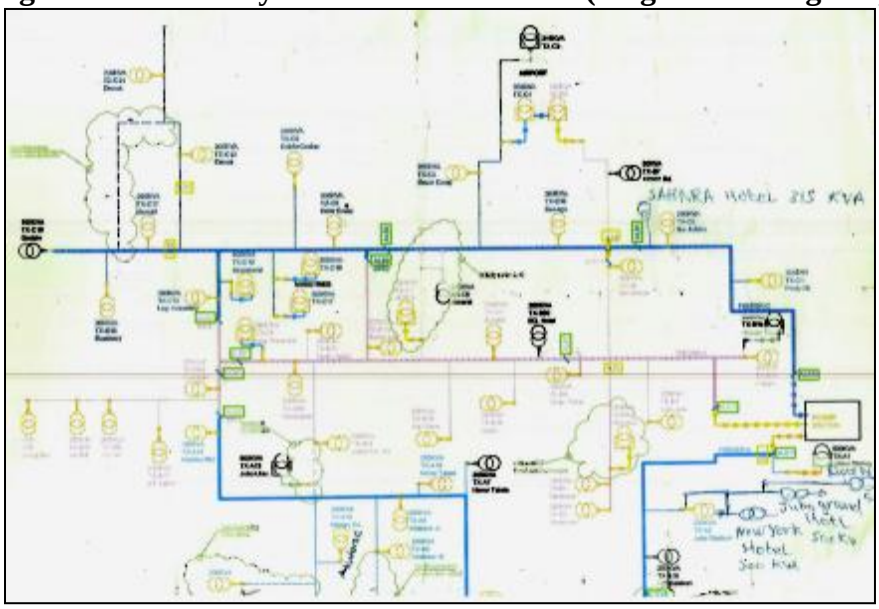
Other Generation Options

32. In addition to thermal, hydro, and solar, there is also a potential to develop biomass-based power generation in rural parts of the country. There are possibilities of exploring wind power and geothermal power in the eastern part of the country that needs to be studied further for feasibility. As mentioned before, a detailed resource mapping and least cost generation study must be carried out in order to establish the resource potential and a feasible generation mix.

D. Transmission and Distribution Networks

33. As is the case of much of South Sudan's infrastructure, the electricity transmission and distribution networks are in their embryonic state. Presently, there are no high voltage transmission lines or any interconnected grid networks in South Sudan. The current distribution network consists of 3 isolated networks in the commercial centers of Juba, Wau and Malakal totaling about 15 km of 11 kV lines (an example in the Figure below) and smaller networks in a few other cities.

Figure 10: Juba City Distribution Network (Single Line Diagram)



Source: SSEC

34. Most of the consumers are fed via medium voltage (11 kV) feeders that distribute electricity via a network of old and relatively large (50 to 500 kVA) distribution transformers. SSEC has also been piloting the use of pre-paid meters in Juba. But, the pre-paid meters use conventional A-base mounts, meaning that they are quite vulnerable to theft. The rest of the consumers either have no meters at all, or have meters that have not been calibrated, cleaned, nor received any form of maintenance in at least ten years. According to SSEC, their outdated equipment causes large system losses (technical). Also, much of the customer base of SSEC is large and typically rich urban residential clients (high per connection consumption of over 3,000 kWh). Per the SSEC, these clients tend to be politically connected who do not always pay their bills on time. So, financial loss (non-technical) due to reduced collection (40-50%) is also high.

35. Overall, it is estimated that the system losses for SSEC are in the range of 30%, causing significant loss of revenue for SSEC in an already expensive generation system. This inefficiency in the distribution network (combined with loss of revenue due to low collection rate) should be addressed prior to the scale-up of the networks. The GRSS has plans on expanding 11 kV lines (in the seven new state capitals being electrified) and installing new 33 kV distribution lines (in the Juba city area) as well as associated step-up step-down sub-stations. If left unchecked, the inefficiency will continue to propagate in the grid network. As the Government plans to lay the foundation of future growth, sound principles of operations and maintenance of the grid networks must be incorporated[9]. These measures should also include consumer awareness and theft prevention.

E. Regional Interconnections

36. The GRSS is keen on participating in regional interconnections as a way to increase power trade with its neighbors and for its overall energy security. In the short term, SSEC plans on construction of the Sudan-South Sudan interconnection to 220 kV transmission lines and sub-stations between Renk and Malakal as well as reinforcement of the local distribution network around Malakal and Renk. This interconnection was expected to bring in at least 140 MW by 2013 to South Sudan. There were discussions in the past regarding power purchase agreements (PPA), construction contracts, etc.; however, given the political turmoil in the region, scarcity of power in Sudan itself, progress on the interconnection remains unclear. Malakal is situated in the Upper Nile region (over 500 km from Juba and 400 km from Ramciel) and it will not be possible to utilize the 140 MW of power until extensive transmission lines are built to other parts of the country. This connection may be used primarily to feed the close by towns of Bantu (capital of the Unity Region), Fanjak, Al Nasir and Jokau in addition to the major load at Malakal.

East Africa Power Pool

37. The East Africa Power Pool (EAPP), which was established with a vision to develop a regional power pool in order to facilitate regional integration, presents a great opportunity for the GRSS to participate in regional electricity market. The primary objective of EAPP is to make affordable, sustainable, and reliable electricity available for the Eastern Africa region. Currently, the member states of EAPP include Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Libya, Rwanda, Sudan and Tanzania. The potential new members are Uganda, Somalia, Eritrea, Djibouti and South Sudan. South Sudan, in the medium to long term, plans on participating in the regional electricity trade via an interconnection with Ethiopia.

38. Ethiopia and South Sudan can gain from closer cooperation and have already signed a *Memorandum of Understanding* to this effect. Ethiopia has a regional comparative advantage in hydropower which can be generated at much cheaper cost than any other countries in the region. It has a potential of 45,000 MW of generation capacity which is enough to meet much of the region's current demand. The proposed interconnection plan calls for a 335km 230 kV transmission line from Gambela to Malakal and a 700 km 500 kV transmission line from the Dedesa to Juba (via Tepi). The implementation of this project would require in-depth feasibility studies and surveys – a commercial contract has been signed with a Chinese contractor.

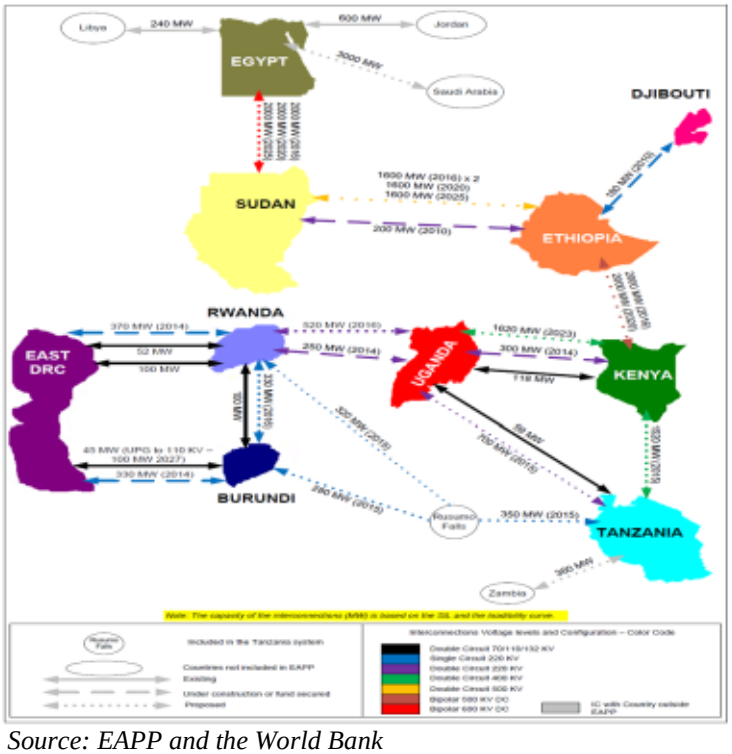
[9] An IFC funded study - Juba Power System Diagnostic is underway (carried out by NRECA International).

Figure 11: Proposed Ethiopia-South Sudan Interconnection

Source: EEPCO, Ethiopia

39. Another option to be considered is the interconnection with Uganda. Currently, Uganda is expanding its transmission network at 220 kV towards its northern border up to Gulu which is only about 75 km from the border town of Nimule and within 200 km from Juba. Although Uganda is presently facing power shortfalls, the Bujagali power plant (250 MW) is expected to be commissioned shortly. In addition other hydro plants are being planned (Karuma 200 MW and Isimba 120 MW) for construction shortly. Planned interconnections between Uganda and Kenya as well as between Kenya and Ethiopia can enable the wheeling of power from Ethiopia if a Uganda-South Sudan interconnection is available. Furthermore, the major hydropower sites in South Sudan are concentrated close to Nimule at the Ugandan boarder. An interconnection between Juba and Gulu with intermediate stations for the new hydro power plants can allow for limited power flows to South Sudan in the initial years and power export to Uganda in the longer term. Currently, discussions are ongoing on such an interconnection under the Nile Equatorial Lakes Subsidiary Action Program (NELSAP) which is part of the Nile Basin Initiative (NBI).

Figure 12: East Africa Power Pool – Future Interconnections



Source: EAPP and the World Bank

F. Off-Grid, Renewable Energy, and Energy Efficiency

40. Currently, there are no formal GRSS programs for promoting off-grid renewable energy (RE) and energy efficiency (EE) technologies in South Sudan. While grid extension to all parts of the country and universal electrification remains as a long term vision, incorporation of off-grid renewable energy options for rural electrification is a very viable and cost-effective way of providing modern energy services to remote parts of South Sudan. These products and services are not only useful in off-grid areas but are also useful to those within the gird-connected areas unable to afford a connection. In this section, some of the possible programs and opportunities regarding off-grid RE and EE technologies in South Sudan have been discussed.

Efficient Cooking

41. Energy for cooking constitutes nearly 90% of the energy consumed by a rural household. An average household in South Sudan burns about 3 tonnes[10] of woody biomass per year for cooking emitting nearly 2 tonnes of carbon equivalents per year as the cooking is done mainly using three-stone open fires. Women and children, who are primarily responsible for providing firewood for cooking, spend many hours searching for it. Moreover, particulate emissions due to inefficient combustion from such cooking practices are also considered a major cause of indoor air pollution in the rural households.

42. Improved cookstoves, which cost about US$ 20 each, should be introduced in South Sudan providing modern energy efficiency tools for the rural population. The economic benefit of the cookstoves is far more than just the reduction in cooking costs. Reported benefits of the cookstoves include: increased efficiency (reduced firewood consumption), reduced pressure for women and children to waste many hours gathering firewood, cost savings for purchased firewood, as well as reduced indoor air pollution. World Bank's Africa Clean Cooking Initiative (concept stage approved, expected to be effective soon) is designed to provide clean cooking solutions across SSA and could be used as a framework for GRSS's cookstoves strategy.

Solar Lighting

43. Nearly 27% of the rural population in South Sudan has no access to lighting services and in most other cases access to lighting is limited to burning hydrocarbons, such as: kerosene or candles or using low quality dry-cell based light emitting diode (LED) lanterns. Villagers not only pay a high premium for these lighting sources due to frequent, small volume purchases and poor distribution networks that add a huge overhead to the price, they also rely on inefficient tools for combustion that do not produce the best lighting possible. In some SSA surveys the cost of lighting has been estimated to be between about US$ 50 and US$ 80 per household per year[11]. Solar lighting technologies (solar lanterns, solar home and institutional systems) have been successfully implemented in many rural areas in Africa and must be introduced in South Sudan as a fast, economical and scalable way to provide efficient lighting to many rural households. These products (lanterns), typically in the US$ 40 - US$ 60 range, often pay for themselves in less than a year (cost substitution) and provide other benefits such as cell phone charging, operating radio, etc.

[10] Millennium Villages Project, 2010
[11] Earth Institute at Columbia University, 2010

44. Lighting Africa[12], a joint program of the World Bank and the International Finance Corporation (IFC), has accelerated the development of commercial off-grid lighting markets and should also be part of the South Sudan off-grid strategy. The program aims to mobilize the private sector to build sustainable markets to provide people with safe, affordable, and modern off-grid lighting through a variety of tailored products, many of them are solar lanterns.

Box 1: Examples of Renewable Energy (Solar) Programs in Africa

The three UNDP/Global Environment Facility (GEF) projects listed below illustrate the two primary approaches to solar home systems - a fee-for-service model and a dealer-sales model.

Ghana: The goal of the Ghana project is to establish a sustainable capacity in Ghana to provide decentralized renewable energy-based electricity services to rural communities through the fee-for-service model. The project is under implementation through a special office - Renewable Energy Services Project (RESPRO) – established in the Ministry of Mines and Energy (MOME). RESPRO is intended to act as a for-profit enterprise to be "spun-off" as a private sector company towards the end of GEF project design. This is a departure from the original project design, where the project had been implemented by the Volta River Authority/Northern Electric Department (VRA/NED) the electricity utility in Ghana, which is expected to be privatized in the future. The current implementation structure does raise questions about the potential for privatization of RESPRO, as it is currently housed within a Ministry. The project targets some of the poorest households in northern Ghana, and expects to sell electricity through installation of 50 Wp (for US$7 equivalent per month) or 100 Wp (through US$12 per month) in households.

Uganda: The project is based on the sales model. Consumer credit is provided through two local credit institutions: a private rural development bank and a credit-union type women's trust. In addition to the GEF grant, UNDP has provided co-financing to guarantee credit lines of these institutions. The project is at very early stages of implementation, and hence it is not possible to assess the likelihood of overall project success. But there is a clear contrast in this approach to the Ghana project, in that in Uganda the project is clearly targeted towards those who are credit-worthy and can afford the cost of credit (perhaps only the top 10% wealthiest households). Households that cannot afford commercial credit still constitute the vast majority of the rural population.

Zimbabwe: This project was also based on the sales model. From 1995 to 1998, over 10,000 solar home systems were sold, primarily through private dealers. A utility-sales model was also piloted, through the national electric utility, which sold about 200 systems under the project but appeared to lack sufficient interest to continue after the project completed. Expected experience with sales by NGOs was limited. Consumer credit was provided by the Agricultural Finance Corporation (AFC), a development institution, through a revolving fund mechanism. The AFC provided credit to 4,200 households but has been unable to replenish the fund, which will deplete without replenishment. The Zimbabwe project was designed to enhance and upgrade indigenous solar manufacturing and delivery infrastructure, to develop an expanded commercial market in rural areas for affordable domestic solar electric lighting by providing low- interest financing through existing institutions, and to establish new credit mechanisms at the grassroots level to benefit lower income groups in rural areas (both households and community-based institutions).

In comparing these projects, the fee-for-service delivery model seems to be more oriented towards the poorest of the rural population compared to the sales model. Also, the fee-for-service model looks affordable to larger sections of the rural population, and hence might have better potential for developing large markets for rural solar PV applications. Regardless of the model used, however, continued finance after the project, either from private or public sources, will be essential for the sustainability of the energy-service businesses or the delivery of consumer credit through development-finance or credit-union institutions.

Source: UNDP / GEF

[12] More details at: www.lightingafrica.org

Other Options

45. Other options that should be pursued in South Sudan include technologies, such as:

- **Biogas**: There is a huge potential for biogas in South Sudan given the large herds of cattle that are maintained by most rural communities. Individual biogas plants have proven very successful in developing countries around the world. These units can provide methane-based clean cooking, lighting as well as energy for other productive uses. Moreover, the waste from the plants can be used as an environmentally friendly fertilizer by the farmers.

- **Small Wind Projects**: Wind based generation projects can be used to install stand-alone systems in remote villages that can be used not only for lighting but also for agricultural energy and other productive uses.

- **Mini-Grids**: Mini-Grids are low-voltage (LV) networks within a village or neighborhood supplied at a single point by a diesel generator or other generation sources, such as, mini-hydropower plants, etc. The mini-grids include service connections, wiring for households, and typically, a pre-paid meter. In many cases, such generation sources are designed for uses such as grain-mills, agricultural productivity, or telecom stations and can provide surplus power to the households during off-peak hours.

Renewable Energy Institutional Framework

46. For the success of above-mentioned options, GRSS should focus:

- **Adopting Comprehensive RE and EE Legislation**: The legislation should start with an EE and RE framework law. This law would provide the overarching legal structure for all existing and future secondary legislation (laws and decrees) on EE and RE. These laws will also need to be complemented by regulations on load management, building codes, equipment and fuel efficiency standards, energy audits for large energy consumers, legislation on import of appliances, and regulation for renewable energy development, including feed-in-tariffs (FITs);

- **Establishing an RE and EE Agency**: The agency would be supervised by the Ministry of Electricity and Dams but with operational independence. It would help formulate policy and legislation in these areas and ensure implementation;

- **Preparing RE and EE Strategies and Action Plans**: The EE and RE Agency should take the lead in developing these strategies and action plans and carrying out energy audits;

- **Development of Financing Mechanism for RE and EE**: Most countries who promote EE and RE have put in place special financial incentives. A list of actions has been tested in various countries. Measures which have proven to be effective are:

- Favorable tax regimes for the import of RE and EE equipment;
- Direct targeted subsidies for selected RE and EE programs, provided stable financing of these subsidies can be secured through surcharges on electricity or gasoline;
- Creation of a compensation mechanism to finance the cost difference between renewable energy and least-cost conventional energy, under a tariff system or a competitive tendering system;
- Investment credits and tax credits to induce consumers to buy energy efficient equipment and to encourage development of renewable energy;
- Dedicated credit lines with selected commercial banks that are interested in investing in these areas (with micro-finance institutions, MFIs).

G. Access Enhancement

47. As is the case of most other developing countries, South Sudan's major goal in the energy sector is to expand access to modern energy services to the masses with appropriate *speed* and *cost-effectiveness*. In this regard, grid-based electrification of the country is a worthy vision to have. However, universal grid expansion to remote rural parts of the country is a very long term proposition. Based on the experience of cases from around the world, such efforts have taken many decades to complete. Moreover, there are open questions of cost-effectiveness and affordability for grid-based access expansion strategy and its relevance in the context of each developing country. In the current SSDP, the GRSS plans to invest nearly US$ 700 million for generation capacity increase, distribution network expansion, and related activities. However, despite the high cost of the plan, by 2015, the SSEC will only be able to connect an additional of 33,000 customers to the grid (total of 55,000). Thus, the grid-based expansion plan would still be able to only increase access to modern energy services to about 3%[13] of the population at a per capita investment of US$ 3,500[14]. This represents a large portion of GRSS's constrained budget. In terms of affordability of the households, each connection from the SSEC costs the households approximately US$ 500-600 in fee, meter/wiring, and other charges. Furthermore, the electricity tariff rate in South Sudan is one of the highest in the region with average tariff being US$ 0.25/kWh (see Figure below), but much below full cost recovery. Thus, even if the grid expansion is universal, the high cost of connection and the high monthly utility charges would be prohibitive for most rural households and the access intensification efforts could be stalled due to this.

Figure 13: SSEC Cost of Connection for Households

Fee Type	*Rate (SSP)*	*Rate (US$)*
Connection Fee	1,100	423
Meter/Wiring/Etc.	300	115
Ownership and Others	54	21
Total Cost (for a typical HH)	1,454	559

Source: SSEC

[13] 55,000 customers represents about 330,000 people, in a population of 10 million (2015 projections)
[14] An investment of US$ 700 million for 33,000 new customers or 198,000 people (avg. of 6 people / household)

Figure 14: SSEC Tariff Structure

Customer Type	*Rate (SSP/kWh)*	*Rate (US$/kWh)*
Domestic	0.50	0.19
Commercial/Industrial	0.70	0.27
Government	0.80	0.31
Average Tariff	0.66	0.25
Average Cost of Generation	1.84	0.70

Source: SSEC

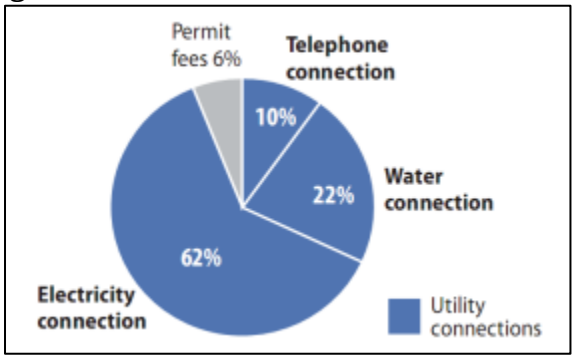
Figure 15: Tariff in Regional Countries

Country	*Residential Tariff US$/kWh*	*Industrial Tariff US$/kWh*	*Commercial Tariff US$/kWh*
Ethiopia	0.03	0.03	0.04
Botswana	0.06	0.07	0.03
Cameroon	0.8~0.12	0.09~0.11	0.08~0.09
Kenya	0.04~0.44	0.21	0.14~0.16
Senegal	0.23~0.26	0.14~0.20	0.13~0.18
Tanzania	0.13~0.41	0.5	0.4
Uganda	0.23~0.34	0.21	0.16
Zambia	0.03~0.16	0.03	0.01~0.02

Source: The World Bank

48. Affordability is also a concern for the private sector: 87% of the firms identify the lack of electricity as a major impediment for their business and 93% of power consumption came from generators[15]. An entrepreneur in Juba could spend up to US$ 45,000 to obtain electricity (high connection charges plus usually a transformer and new wiring is required) which typically, accounts for 60% of the utility installation costs.

Figure 16: Cost of Utilities for Private Sector



Source: Doing Business in Juba, 2011

49. Compared to the grid-based strategy, the off-grid RE/EE based access expansion would be faster and much more cost-effective. Programs such as Lighting Africa and Africa Clean Cooking Initiative can promote private sector led interventions that can expand access to modern energy services for many rural people in South Sudan. For example, if the GRSS were to invest one-tenth (US$ 70 million) of the SSDP planned energy sector investments in just two programs for off-grid RE products (US$ 35 million for lighting and US$ 35 million for cooking), it would be able to provide *access to modern lighting to 40%*[16] *of the population and access to efficient*

[15] Doing Business in Juba, 2011 and World Bank's Investment Climate Assessment
[16] An investment of US$ 35 million for 700,000 households or 4.2 million people (avg. of US$ 50 per unit)

cooking to nearly 100%[17] *of its population* at a per capita investment of less than US$ 50. It is recommended that GRSS take a longer term perspective on grid-based access expansion and continue on those plans while also incorporating a rapid off-grid rural electrification programs in the short term. Furthermore, a formal study could also be carried out (as part of the tariff structure study) that would ascertain the appropriate level of affordability of electricity by households in South Sudan.

H. Demand Side Management

50. GRSS should also consider incorporation of demand side management (DSM) programs to promote efficient electricity usage by modification of consumer demand using incentives and awareness campaigns. Such initiatives could include: distribution of energy efficient compact florescent light-bulbs (CFLs), turning off lights and appliances when not in use, as well as other potential household and industrial efficiency programs (insulation, retrofitting, etc.). In a country curtailed by availability of electricity, efficient use of scarce resources can be beneficial.

IV. SECTOR FINANCIAL ANALYSIS

A. Operational Financial Performance

51. This section provides an analysis of the operational financial performance (revenue and expenses) as well as a discussion on the investment program. It includes a model of future financial projections along with highlights of some of the major challenges affecting financial performance of the sector and their potential fiscal impact. In FY2011, SSEC's operational revenue (based on 70 GWh of electricity sold and about 99 GWh of electricity generated) were about US$ 17 million, and its operating expenses were US$ 71 million.

52. Thus, the operational loss for SSEC in FY2011 was US$ 54 million. The average cost of generation was US$ 0.70/kWh and the average tariff from sales was US$ 0.25/kWh. On top of that, the system losses are in the range of 30%. In net, it can be concluded that SSEC is in deep financial trouble. Without GRSS subsidy, SSEC would not remain operational.

53. This subsidy amounts to about US$ 0.54 for every kWh of energy generated in South Sudan (99 GWh generated in FY2011). Furthermore, there are no signs that this scenario will improve in the coming 3-5 years. As SSEC plans on incorporating more and more thermal based generation capacity, the amount of subsidy required to the sector will continue to increase proportionally. In FY2011, GRSS's subsidy to the electricity sector was estimated to be US$ 54 million. In FY 2015 which will increase to US$ 133 million (see Figure below).

[17] An investment of US$ 35 million for 1.75 million households or 10 million people (avg. of US $ 20 per unit)

Figure 17: SSEC Financial Projections

Financial Line Items	*2011*	*2012*	*2013*	*2014*	*2015*
Income					
Revenue (US$ million)	17	25	34	40	47
Cost of Sales (US$ million)	70	99	132	154	176
Other Operating Expenses (US$ million)	1	2	3	3	4
Operating Income/Loss (US$ million)	(54)	(76)	(101)	(117)	(133)
Cost of Service					
Energy Sales (GWh)	70	101	136	160	186
Energy Generation Required (GWh)	99	142	189	220	252
System Loss (%)	30%	29%	28%	27%	26%
Avg. Per Unit Cost of Generation (US$/kWh)	0.70	0.70	0.70	0.70	0.70
Avg. Tariff (US$ /kWh)	0.25	0.25	0.25	0.25	0.25
Implicit GRSS Subsidy - at Generation (US$ /kWh)	0.45	0.45	0.45	0.45	0.45
Actual GRSS Subsidy - Including System Losses (US$ /kWh generated)	0.54	0.54	0.53	0.53	0.53

Source: SSEC Data and World Bank estimates

B. Investment Program Financing

54. GRSS's SSDP related sector investments call for US$ 700 million worth of new projects (details in Annex 1). Financing for these public sector projects has not yet been secured. It is anticipated that a portion of this investment will come from bilateral and multilateral donors (as grants). However, the GRSS will also need to raise its own funds in order to fully finance the plan. The sources for raising financing could be: Multilateral Development Banks (MDBs) such as the World Bank, commercial investment banks, and the private sector (direct investments).

55. Given the context of South Sudan, much of this financing is expected to be raised via donors or concessional financing. Typical terms for concessional loans are 0.75% charge on a 40 year loan with 10 year grace period (World Bank International Development Association, IDA terms). Commercial loans can be as high as 6% interest with a 10 year repayment schedule.

56. As described in the previous section, SSEC is currently (and in the foreseen future) incurring operating losses. The GRSS is providing subsidy to maintain basic operations in the sector. On top of that, if the GRSS were to finance the capital investments, it would further worsen the financial viability of the sector. It is important to highlight that in the short term, the financial situation of the sector would primarily be based on SSEC's operational performance. Even if the entire investment plan financing is secured and invested, the effect of it would only be felt a few years from now (when the debt service obligations are due). However, it is critical that GRSS and SSEC plan for a buffer for future debt service when planning for the long term financial health of the sector. Furthermore, GRSS should look for private sector investments opportunities (concessionaires, independent power producers - IPPs, licensed suppliers, etc.) and be selective with scarce public sector funds when it comes to capital investments.

C. Fiscal Impact of Subsidy

57. SSEC is part of MOED and as such its revenue and expenses are part of the Government budget. Since there are significant tariff subsidies provided to SSEC, there is a direct fiscal

impact to the GRSS. Based on the financial analysis, it can be concluded that for every kWh of electricity produced in South Sudan, the GRSS incurs a US$ 0.54 charge (as subsidy).

58. At the current level of production, the subsidy is equivalent to 4% of GRSS's annual budgetary expenditure (see Figure below); however, at the current rate of growth, by FY2015, the subsidy to the electricity sector would increase to 8% of GRSS's budget. Clearly, this level of financial burden from one sector is not sustainable and there is an urgent need for broad level reform in the sector in order to attain financial viability in a fiscally constraint environment.

Figure 18: Fiscal Impact of Electricity Subsidy

Fiscal Items	*2011*	*2012*	*2013*	*2014*	*2015*
Revenue (US$ million)	17	25	34	40	47
Operating Cost (US$ million)	71	101	135	157	180
Shortfall or Subsidy (US$ million)	(54)	(76)	(101)	(117)	(133)
Government Budget (US$ million)	1,200	1,320	1,452	1,597	1,757
Subsidy as % of Government Budget	4%	6%	7%	7%	8%

Source: SSEC Data and World Bank estimates

59. As discussed above, it is imperative that GRSS carry out changes in order to maintain *financial viability* of SSEC and that of the sector. In the longer term, GRSS should focus on more cost-effective means of providing modern energy services to the population. This can not only be achieved through a decrease in cost of generation (renewable energy generation such as hydropower) but also by increase in overall efficiency of the system (including cost-recovery tariff structure), and introduction of cost-effective off-grid RE and EE solutions. A summary of some such measures is provided below:

- **Improve Distribution Network Efficiency**: upgrade ageing network to steadily reduce the system losses from the current 30% to a near term target of 25% to be followed by a reduction to 15% in the medium term.

- **Improving Revenue Collection**: enforcement of a strict bill collection policy (including possible penalties for default) to reduce payment arrears to 10-15%.

- **Tariff Structure Revision**: for many affluent South Sudanese, the willingness to pay for electricity in South Sudan is estimated to be over US$ 1/kWh. A tiered tariff has been proposed that does not burden the poor (through a lifeline connection charge) but represents the economic cost of production. The GRSS should consider stricter implementation of the tariff structure and also to move towards a cost-recovery tariff in order to reduce the fiscal burden.

- **Reducing the Cost of Generation**: diversification of generation mix from current reliance on expensive thermal based generation is necessary, however, this is a longer term action item.

- **Introduction of Off-Grid RE and EE Technologies**: as described in this report, a balanced sector strategy combining grid-based and off-grid solutions can ensure that access to modern energy services is provided to the masses in a cost-effective manner.

- **Reducing the Cost of the Investment Program**: GRSS should also consider moderating the investment program and exploring prudent ways of financing it (concessional terms, donors, etc.) so that the fiscal impact is not increased further.

V. SECTOR REFORMS

A. Laying the Foundation for Growth

60. South Sudan is a newly independent country and has very little electricity generation capacity and limited transmission and distribution infrastructure. South Sudan is also in the process of developing a policy and institutional framework for its electricity sector. Being a late starter in electrification, RSS has the advantage of benefitting from the lessons learned from international experience of electrification regarding best practices of the sector.

61. Developing countries that have been able to provide reliable electricity include Brazil, Kuwait, South Africa, Turkey and Argentina. Review of electricity sectors of such countries that have succeeded in providing reliable and universal or near universal access to electricity for its citizens provides the following insights. Many successful countries have:

- Moved away from vertically integrated electricity sectors to unbundling of the sector by dividing it along three functional lines: generation, transmission and distribution. These newly created entities have been provided with significant autonomy in carrying out their business.

- Priced both energy resources (e.g. gas, coal, liquid fuel) and energy commodities such as electricity (tariff) in line with their economic cost of production i.e. reflecting their long-run marginal costs.

- Have not depended on a single source of primary energy for power generation and have utilized a diversified pool of energy sources to meet their power generation needs.

- Followed the principle of least cost expansion for the expansion of their electricity sectors. Factors that need to be taken into consideration for least cost power generation include proximity of generation sites to load centers and their forecast load demand, transmission from generation sites to the load centers, availability of adequate space and fuel deliverability at the generation site, the suitability of the ground and geotechnical conditions for construction of the plant, the possibility of flooding and seismic events, sources of fill and construction materials and finally, access to the generation site for transportation of heavy equipment and construction materials. Factors that require consideration in order to ensure least cost transmission and distribution, system configuration, pattern of loading of transmission and distribution lines, magnitude and types of loads, characteristics of equipment, etc.

- Gradually shifted from conventional sources to renewable sources of energy for power generation thus, insulating their supply of electricity from rising prices of conventional energy sources.

- Increased their electricity sector's efficiency through the minimization of both technical and non-technical losses.

- Not only adopted energy efficient technologies and appliances but have promoted energy efficient practices across residential, commercial and industrial sectors.

- Have been able to attract private investment in generation and distribution.

- Followed transparent and non-discriminatory procurement process.

- Have not relied only on domestic power generation and have engaged in electricity trade with neighboring countries to meet their demand and supply gaps.

62. For the socio-economic development of the country, South Sudan requires accelerated electricity development. Accomplishing this objective will require a number of sector reforms and associated institutional changes. South Sudan needs to ensure the security of power supply through diversification of primary energy sources. Private sector participation in power generation and public-private collaboration in the distribution and transmission sectors should be encouraged. Management efforts to reduce system losses, especially non-technical losses have become a necessity. South Sudan can also ensure energy efficiency through use of energy efficient equipment and appliances, and adopting energy saving building codes.

63. The country should also make concerted efforts to harness renewable energy sources. South Sudan should also explore options to import electricity from neighboring countries for the reduction of the supply-demand gap. Coordination and optimization of the development and operation of electricity and petroleum sectors is also required to provide reliable electricity. Another pressing concern is to develop an Electricity Sector Framework with clear division in responsibility among policymakers, regulators, and operating entities. These issues are discussed below.

B. Role of the Public Authorities

64. Public bodies and local authorities will have a key role to play in ensuring that a sound foundation can be created for the growth of the sector. The leadership demonstrated by the GRSS in the electricity sector can lead to greater overall economic growth. Some key elements of the interventions that the GRSS can lead are discussed below.

Government and Institutional Arrangement

65. As mentioned before, the capacity of all of the sector institutions (MOED, SSEC, and SEDC) is severely lacking. The South Sudan Electricity Act is yet to be approved by the council of ministers and it is hoped that the updated Electricity Act and other regulations will help in proper organization of these institutions. In the absence of an Electricity Act, it is going to be

difficult for South Sudan to develop the sector and attract private investors. The Electricity Act must identify broad categories of operators-policymakers, regulators and operational entities-in the electricity sector. The Act must provide a clear division of the duties and responsibilities of policymakers, regulators and operational entities. This Act must be developed in a manner which ensures that policymakers, regulators and operational entities are autonomous entities with due attention paid to proper corporate governance. Effective separation of policy and regulatory functions implies that regulators should be independent from operators when they regulate.

66. Operational autonomy will ensure protection from political interference. Rules governing conflicts of interest as well as measures to ensure that these agencies are able to attract and retain staff with the required expertise must be formulated. Roles of these entities in the areas of licensing, interconnection and access (ensuring fair competition), consumer protection and settlement of disputes should not be influenced by any external forces. Ensuring proper coordination amongst operators is also necessary. The licensing systems for the generation, transmission, distribution and supply of electricity should be elaborated. The Act should specify the ways the licensee can employ to recover charges and investment expenditure. Licensee's security, terms of supply, special agreement for supply and dispute resolution in respect of supply must be discussed. The Electricity Act should be developed in a manner to provide simple mechanisms in order to attract private investors. The Electricity Act should encourage private sector participation in the electricity sector and thus, ensure allocation of sufficient resources for the electricity industry.

Legal and Regulatory Framework and a Sustainable Energy Policy

67. A consequence of the delay in institutional arrangements is the lack of sound legal and regulatory framework for the energy sector to function properly. Furthermore, regulations such as feed-in tariffs (FITs) could be a great way for RSS to attract private investment in small to medium scale distributed generation based on renewable energy sources.

68. However, at the moment, no legal and regulatory framework exists for FITs. Power Purchase Agreement (PPA) is also essential in attracting private sector investment as well as for RSS. SSEC has no experience in negotiating such complex contracts or an oversight regime to enforce such deals.

69. RE and EE are said to be the twin pillars of sustainable energy policy and should be supported by the legal framework. In many countries energy efficiency is seen to have a national security benefit because it can be used to reduce the level of energy imports from foreign countries and may slow down the rate at which domestic energy resources are depleted.

Sector Master Plan with Balanced Short Term and Long Term Goals

70. A deep diagnostic of the sector issues has not been carried out and there is no formal long term master plan for the sector (and associated resource mapping and feasibility studies). There have been some small studies conducted by various donor organizations (NRECA in 2007, Norfund in 2009, etc.) and there are also elements of the sector strategy included in the SSDP, 2011. This report presents an analysis of key sector issues possible elements of sector strategy; however, GRSS must carry out a technical sector master plan study. This would not only

strengthen investment plan for the sector but will also improve coordination between various donor agencies, who often work in isolation of each other.

71. The GRSS must also realize that much of the outcome of the sector master plan would yield results in the long term. In the short term, GRSS needs to focus on foundational elements that would help realize the long term vision of the sector.

Building Sector Capacity

72. At the moment, SSEC and MOED suffer from a severe lack of capacity at technical and managerial levels. Despite employing a large number of people, skilled manpower base is not available. A training program that would focus on improving efficiency and capacity of the sector is urgently needed. Focused training should include areas such as planning and design of infrastructure project, project implementation, procurement management, financial management, management tools and systems, and environmental and social impact mitigation, etc. As the sector anticipates growth that would increase the size of the national utility in a very short period, it is important to plan for the future when implementing a capacity building program.

Improving Sector Efficiency (Technical and Non-Technical Losses)

73. In order to reduce both technical and non-technical losses to an acceptable limit, both management efforts and technical measures need to be strengthened. Adequately planned reinforcement of the transmission and distribution network is essential along with other technical measures. Adoption of demand side management, which reduces peaks in demand for electricity can contribute in the reduction of technical losses. GRSS must also enact and enforce stricter rules concerning theft of electricity and non-payment of bills.

Provision of Reliable Energy from Diversified Sources

74. Currently, ensuring reliable and efficient power supply is subject to uncertainty due to declining reserves of primary energy sources. No country can provide reliable power supply depending on a single source of energy. Hence, South Sudan must develop a diversified pool of energy sources for energy generation and facilitate its delivery through an interconnected grid system. These resources could include thermal power, hydropower, solar power, import of power from regional interconnections (such as the EAPP), as well as off-grid RE and EE programs.

Access Enhancement to Include Grid and Off-Grid Programs

75. As the GRSS is making plans for long term grid expansion throughout the country, it must also include off-grid RE and EE as part of those plans and take a comprehensive approach. Incorporation of program, such as, Lighting Africa and Africa Clean Cooking Initiative provides a practical short-term solution to South Sudan's energy challenges and contribute to increased affordability and access to modern energy technologies for the rural communities.

Ensuring Financial Viability of the Sector

76. To facilitate the ambitious growth program, GRSS must also take critical steps to ensure proper planning and financial health of the sector. These include: providing long-term affordable

financing for sector capital investments, improving the operational financial performance of SSEC and other institutions, reducing the cost of generation with strategic interventions, revising the electricity tariff structure to cost recovery levels over a period of time, and limiting the macro-fiscal vulnerability due to massive sector subsidies. Promoting private sector participation can also play a key role in reducing public financing burden.

Promoting Gender Equality

77. Increased access to energy sources in rural areas and the development of modern energy sources can contribute to achievement of the Millennium Development Goals relating to the eradication of extreme poverty and hunger, improvements in health, education, and environmental sustainability, as well as gender equality and the empowerment of women. GRSS's increased focus on gender issues is particularly important in this context in RSS since many of the poorest people in South Sudan are women living in rural areas who are currently dependent on subsistence agriculture to feed their families, and who are disproportionately affected by the lack of modern fuels and power sources for farming, household maintenance and productive enterprises.

C. Private Sector Participation

78. The objectives of having players other than governments implement the work are to: mobilize additional human and financial resources and reduce pressure on SSEC and the MOED. Alternative players could include private-sector companies or individuals, non-governmental organizations (NGOs), or community-based organizations (CBOs). Participation of these players is essential in South Sudan's energy sector, particularly in *energy generation* and *off-grid electrification* with possibilities of extending the participation in transmission and distribution network as licensed operators or concessionaires. The key is to develop a system of incentives sufficiently attractive for these players to do business.

Generation

79. IPPs are often the first private investors in a market dominated by state-owned power utilities. South Sudan currently is, and should continue to be open to all commercial proposals from IPPs. Options for sale of power (and possibly distribution) should be brought under a regulatory framework (through PPAs and FITs) which would ensure commercial returns for private participants. South Sudan has to develop a strategy for (a) enabling the existing thermal plant to be rehabilitated and maintained to reach acceptable availability standards, (b) introduce new thermal plants for existing electrified cities and for the capital cities, and (c) construct the new hydropower plants required to meet the longer term needs in the remaining regions.

80. In general, maintaining thermal plants in a public sector environment has been a major challenge to developing countries. There is also substantial interest in the international private sector to provide this type of service. Hence it is suggested that both improving and maintaining the existing generation plant and introducing new thermal plants be competitively bid out. With respect to hydro plants the same level of competitiveness is not always present among the private sector in view of the large capital investment needs and longer term needed to realize returns on investment. Hence, it is suggested that a majority of these schemes be pursued by the public

sector utilizing multi-lateral and bi-lateral lending arrangements while selecting one or two schemes for private sector development. While pursuing the latter, GRSS will be able to test the ground for the appetite of the private sector in hydropower development in South Sudan.

Off-Grid Electrification

81. Rural mini-grids are prevalent business models for off-grid electrification which involves organizing communities to become the owner and operator, providing maintenance, tariff collection, and management services. Understandably, such a community-based model requires substantial technical assistance in design and feasibility studies, training, and social organization. As part of its rural electrification program, GRSS may offer funding and invite proposals from private-sector or NGOs/CBOs. Alternatively, GRSS may establish a rural energy fund and offer to support such investments on a first-come, first-served basis. In either case, it is sound practice for GRSS to subsidize a portion of the capital cost, while the community or private sector covers the balance investment cost and full cost of operation and maintenance. A third approach is one where a public utility or government-contracted energy service company (ESCO) operates the mini-grid. In this case, tariffs are regulated (with lower consuming consumers charged a lifeline tariff). The utility or ESCO operator is provided a subsidy from a cross-subsidy fund or other public source of capital and perhaps a portion of operation-and-maintenance costs.

82. Furthermore, there are many opportunities for private sector to participate in the off-grid RE and EE market development using individual systems. Private sector participants can play a pivotal role in dissemination of such technologies using commercial practices. Modern lighting and efficient cooking technologies (Lighting Africa or Africa Clean Cooking Initiative) are the obvious choices in this regard. GRSS can foster greater entrepreneurship and allow the private sector to service the need of the market in the most efficient way possible.

83. Country conditions are important determinants of the role that the private sector would play in the energy sector. In South Sudan, the market is not only be economically attractive for the private sector in terms of the opportunity, scale, and geography, it is also very appropriate for providing cost-effective modern energy services to the masses.

VI. SECTOR STRATEGY AND WORLD BANK SUPPORT

84. The World Bank has been an active development partner for South Sudan. In April 2005, fourteen donors agreed to pool funds into the Multi Donor Trust Fund for South Sudan (MDTF-S) to advance the Comprehensive Peace Agreement (CPA). The Government of Sudan and the Sudanese Peoples' Liberation Movement (SPLM) requested the World Bank to act as MDTF-S Administrator. The MDTF-S was to serve as a channel for 'capacity building and institutional strengthening and quick start and quick impact programs' for an interim period of six years in the lead up to the January 2011 referendum on independence. The CPA also mandated that donor funds be linked to and employed for urgent recurrent and investment budget costs and urged that the funds flow through government systems.

85. Going forward, World Banks' South Sudan Country Partnership Strategy (CPS) will outline the strategic areas of partnership and support from the World Bank. As part of these broader objectives, the energy sector will also work with its South Sudanese counterparts to

identify the areas of possible partnerships in the future. Some of the possible elements of the sector strategy are described below.

Project Financing

86. During the Spring Meetings of April 2012, South Sudan became a member of the World Bank and starting from FY 2013 it has received IDA allocation of US$ 70 million. GRSS is planning to use this fund to finance projects in Health and Transport Sector. IDA allocations in future years could assist GRSS in financing of infrastructure projects in the energy sector as well as promote the overall development of the sector. Based on South Sudan's IDA overall and energy sector specific allocation, projects can be wholly or jointly financed by IDA in the areas of generation, transmission and distribution, access enhancement, as well as off-grid RE and EE programs and transmission interconnections. There are also opportunities to promote private sector participation through the International Finance Corporation (IFC) and the Multilateral Investment Guarantee Agency (MIGA). The World Bank Group can assist GRSS in increasing the participation of private sector companies in energy sector along their own supply chains and encourage the market for the provision of goods, finance and services.

Knowledge Bank

87. Due to the global nature of World Bank's work, opportunities for capturing and systematically organizing the wealth of knowledge, lessons learned, best practices and experiences are available in assisting the development of South Sudan's energy sector. Specific interventions designed to address challenges and needs for capacity building and technical assistance can be funded by IDA. Some of these efforts may include analytical exercises for identification of problems and bottlenecks, support for alleviating the identified issues, as well as strategic planning in order to lay a sound foundation for the sector.

Promoting Partnerships

88. World Bank can also play an effective role as a convener and catalyst for development of the energy sector in South Sudan. This could include collaboration and coordination with multilateral and bilateral donors and partners, providing a platform for private sector participation, public-private partnerships, etc. The World Bank's ability to effectively bring all stakeholders on the same forum in order to effectively develop the energy sector will be of critical importance. Under the leadership of the GRSS, the World Bank can help to mobilize all available resources to support the GRSS's public policy goals for the sector.

Conclusions

89. Based on the analysis provided in this report, it is recommended that the GRSS take a holistic and longer term perspective of strategic interventions in order to establish an efficient electricity sector in a cost-effective manner. While the note has divided some outcomes into short term and medium term, the government should start the implementation in parallel to achieve the targets within the expected time period. For example, along with capacity improvements, short term goals for expansion of network should focus on the 10 state capitals that are likely going to be the next load growth centers (given GRSS's focus on a decentralized approach). In terms of associated resource exploitation, the focus would be on identification of co-located resources

(possibly renewable) that could service these sites. The implementation of these programs should be carried out in a phased approach of short-term, medium-term, and long-term programs as described below. Some immediate next steps should focus on certain "low-hanging fruits" that can create an impact in the sector performance. For example, improving technical and commercial losses in the distribution system, carrying out studies for resource mapping, project preparation, etc. This report also divides the proposed phased strategy into *cross-cutting* and *sector vertical* themes (Figure below). The World Bank will continue being an active partner for sector development.

Short Term Strategy (1-2 Years)

90. GRSS should focus on *laying the foundation for growth* of the sector. These may be divided to three sections as follows:

A. The cross-cutting efforts for sector planning, institutional development, and providing an enabling framework for future activities. These should include:
   (i) Formalization of the Ministries and the utilities and enactment of the Electricity Act;
   (ii) Enactment of a sound legal and regulatory framework including measures to promote and regulate grid and off-grid programs in collaboration with private sector;
   (iii) Comprehensive sector-wide capacity building to address the severe constraints;
   (iv) Carrying out studies on distribution system improvement requirements;
   (v) Identifying the transmission development plan (to be coordinated with (iv) above);
   (vi) Developing feasibility studies for the identified hydro power plants and preparing a long term generation investment program;
   (vii) Identifying plans for regional interconnections with Ethiopia, Sudan, and Uganda and negotiating suitable power trade arrangements;
   (viii) Carrying out tariff and financial viability studies to enable each institution to operate in a self-sufficient manner when operational efficient standards are complied with.

B. Sector verticals - investment and operational improvement activities. These would include:
   (i) Bid out thermal generation plant in all regional capitals to IPP;
   (ii) Carry out an intensive program of system loss reduction and revenue collection;
   (iii) Depending on the success or failure of item (ii) above initiate Management Contracts for the operation and maintenance of these distribution systems;
   (iv) Launch off-grid individual supply programs for solar lighting and efficient cooking, introduce a loan program for individual consumers to purchase the equipment and develop an enabling environment for the participation of the private sector in this activity. Also, test out the efficiency of the programs developed.

Medium Term Strategy (3-4 Years)

91. GRSS should focus on *implementing the major activities* identified during the short term phase and consolidating the gains made during this period.

A. Sector verticals - investment and operational improvement activities. These would include:
   (i) Finalization of a generation development plan;
   (ii) Bidding out at least one hydro-power plant;
   (iii) Finalization of the transmission development plan;

(iv) Bidding out at least one transmission line related to regional power trade and one transmission line connected with the generation plant being bid out;
(v) Finalization of at least one power trade agreement with a neighboring country;
(vi) Completion of the installation of thermal plant in all regional capitals;
(vii) Distribution systems in regional capitals operating efficiently with low losses;
(viii) Broadening of the off-grid individual supply program and broad implementation.

B. Policy and cross-cutting issues. Major activities would include:
(i) Adjustments where required to legal and regulatory reforms;
(ii) Continued sector wide planning in generation, transmission and distribution taking account of adjusted load forecasts;
(iii) Continued capacity building efforts;
(iv) Developing a focused energy efficiency program on the supply and demand sides.

Long Term (5+ Years)

92. GRSS should focus on *scaling-up* the program to ensure wide coverage of modern energy services. While continued oversight and efforts will be needed for the policy, regulatory and cross-cutting issues major achievements to be targeted include:
(i) Commissioning of hydropower projects;
(ii) A stage wise development of a transmission grid system;
(iii) A functioning regional power trade;
(iv) Distribution systems that operate efficiently with a target level of 15% losses;
(v) Access enhancement by grid and off-grid programs that provide electricity to a wide section of the country. Target access levels should be around 4% at the beginning increasing by 3% each year to reach a target of around 20% in an additional 5 years.

Next Steps

93. In terms of the immediate next steps, the World Bank would seek to support GRSS in carrying out an initial resource mapping, least cost generation expansion plan, and a master plan. Along with those priority items, the World Bank would also seek to provide technical assistance and capacity building support in areas such as: project preparation, contract and procurement management, fiduciary management, safeguards implementation, etc. The World Bank, along with the IFC, would also seek to assist the GRSS in developing an off-grid electrification program, initially focusing on Lighting Africa and other similar initiatives.

94. In the medium term, the World Bank will investigate programs to assist GRSS in improving efficiency of its distribution utilities and expanding the distribution network to promote business development. The World Bank can also help GRSS in financing the transmission interconnector and hydropower generation projects - starting initially by carrying out feasibility studies and, in due course, financing the investment requirement to increase the reliability and to improve the power generation mix in South Sudan.

Strategic Priorities and Roadmap

95. Based on the analysis and discussion provided in the report, the following table provides a summary of the identified strategic priorities identified by the World Bank and a possible roadmap for the development of the sector.

Figure 19: South Sudan Electricity Sector Strategy

Topic	*Short-Term (1-2 Years)*		*Medium-Term (3-4 Years)*		*Long Term (5+ Years)*	
Theme	**Action**	**Potential Financing**	**Action**	**Potential Financing**	**Action**	**Potential Financing**
1. Sector Planning (Cross Cutting)	1.1 Organization of Sector Ministries/Institutions	GRSS	1.1 Ongoing Planning Dialogue/Reform (TA)	GRSS/WB	1.1 Ongoing Planning Dialogue/Reform (TA)	GRSS/WB
	1.2 Finalize and Enact the Electricity Act - *underway*	GRSS				
	1.3 Master Plan (Study)	WB				
	1.4 Distribution System Efficiency (Study) - *underway*	IFC				
	1.5 Financial Viability Analysis Including Tariffs (Study)	WB				
2. Legal Regulatory Framework (Cross Cutting)	2.1 Review of Electricity Act & Law (Study) - *underway*	GRSS /Norway	2.1 Ongoing Reform Dialogue (TA)	GRSS/WB	2.1 Ongoing Reform Dialogue (TA)	GRSS/WB
	2.2 Review of Laws for IPPs, FITs, PPAs (Study)	WB				
	2.3 Review of Laws for Off-Grid Market (Study)	IFC/WB				
3. Capacity Building (Cross Cutting)	3.1 Identify Specific Capacity Constraints (Study)	WB	3.1 Ongoing Capacity Building Support (TA)	WB	3.1 Ongoing Capacity Building Support (TA)	WB
	3.2 Comprehensive Technical Assistance Program (TA)	WB				
	3.2.1 Project Planning and Design	WB				
	3.2.2 Project Implementation/Management	WB				
	3.2.3 Procurement/Contract Management	WB				
	3.2.4 Fiduciary Management	WB				
	3.2.5 Environmental and Social Issues	WB				
	3.2.6 Other Training/Technical Assistance	WB				

Source: SSDP and World Bank.
This table is indicative only and will be finalized by GRSS.
Legend: OT=Other Financing such as MDBs, Donors, Commercial, etc.; TA=Technical Assistance; SIL=Specific Investment Lending.
List continues below.

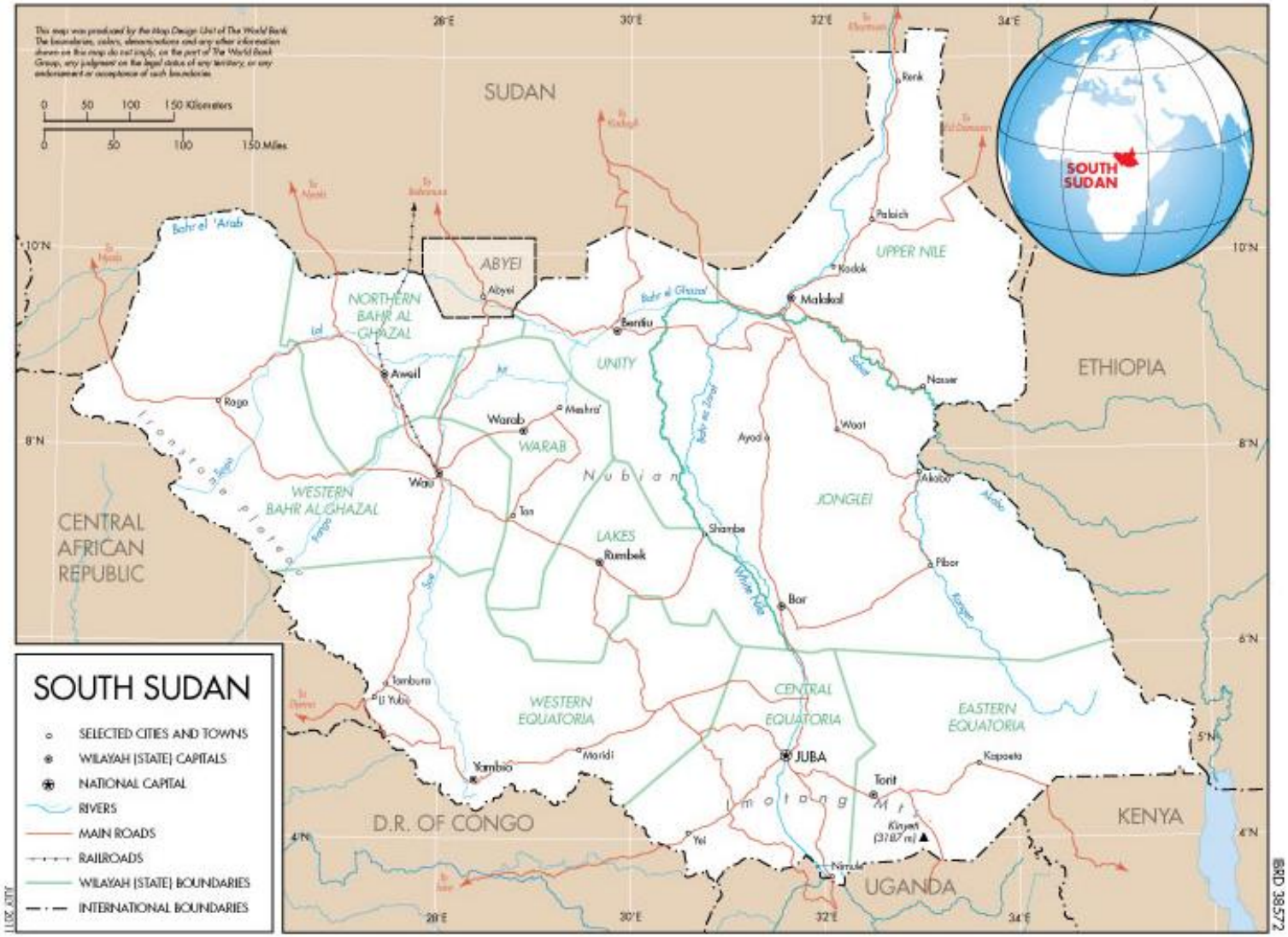
	Short-Term (1-2 Years)		*Medium-Term (3-4 Years)*		*Long Term (5+ Years)*	
Theme	**Action**	**Potential Financing**	**Action**	**Potential Financing**	**Action**	**Potential Financing**
4. Generation (Sector Vertical)	4.1 Least Cost Generation (Study) 4.2 Resource Mapping (Study) 4.3 Commission Thermal Power Plants, 14 MW (Juba, Bor, Rumbek,Yambio) 4.4 Feasibility Studies - Upcoming Projects (TA) 4.5 Project Preparation - Upcoming Projects (TA)	WB WB GRSS/OT GRSS/WB GRSS/WB	4.1 Commissioning of Thermal Power Plants, 60 MW (Juba, Torit, Kwajok, Aweil, Bentiu) 4.2 Commissioning of Mini-Hydropower Plants, TBD 4.3 Project Preparation - Upcoming Projects (TA)	GRSS/OT GRSS/OT GRSS/WB	4.1 Commissioning of Fula Rapids 30 MW and Fula Hydropower, 890 MW (SIL) 4.2 Commissioning of Bedden Hydropower, 570 MW (SIL) 4.3 Commissioning of Lakki Hydropower, 410 MW (SIL) 4.4 Commissioning of Shukoli Hydropower, 230 MW (SIL) 4.5 Commissioning of Other Projects, TBD (SIL)	GRSS/ Norway GRSS/WB/OT GRSS/WB/OT GRSS/WB/OT GRSS/WB/OT
5. Transmission /Distribution (Sector Vertical)	5.1 Expansion of Distribution Network (Juba, Bor, Rumbek,Yambio) 5.2 Possible Commissioning of Sudan Interconnector 5.3 Dialogue/studies on Regional Interconnections – EAPP/NELSAP (TA) 5.4 Project Preparation - Upcoming Projects (TA)	GRSS/WB/ OT GRSS WB GRSS/WB	5.1 Expansion of Distribution Network (Juba, Torit, Kwajok, Aweil, Bentiu) 5.2 Reinforcement of Ageing Distribution Network (SIL) 5.3 Project Preparation - Upcoming Projects (TA)	GRSS/WB GRSS/WB GRSS/WB	5.1 Erecting High Voltage Transmission Lines (SIL) 5.2 Erecting Regional Interconnections - EAPP/NELSAP (SIL)	GRSS/WB/OT GRSS/WB/OT
6. Access (Grid and Off-Grid) (Sector Vertical)	6.1 Increase Grid Customers by 19,000 (Juba, Bor, Rumbek,Yambio) 6.2 Launch of Off-Grid Solar Illumination Program (TA) 6.2.1 Lighting Africa (Solar Lanterns) 6.2.2 Solar Home/Institutional Systems 6.2.3 Other Solar Technologies 6.3. Clean Cooking Program 6.4 Other Off-Grid RE/EE Program (TA)	GRSS/OT WB/IFC WB/IFC WB/IFC	6.1 Increase Grid Customers by 14,000 (Juba, Torit, Kwajok, Aweil, Bentiu) 6.2 Project Preparation - Upcoming Projects (TA) 6.3 Scale-up of Off-Grid RE and EE Programs (TA/SIL)	GRSS/OT GRSS/WB GRSS/WB	6.1 Access Scale-up Program (SIL) 6.2 Scale-up of Off-Grid RE and EE Programs (TA/SIL)	GRSS/WB/OT WB/IFC

ANNEX 1: GOVERNMENT'S ELECTRICITY SECTOR TARGETS
EXERPTS FROM SSDP (AUGUST 2011)

Target	*2011*	*2012*	*2013*	*Detailed Activities*	*Financing Required (US$ million)*
Number of Customers Connected	31,500	41,000	48,000	1.1 Procurement and installation of distribution equipment (conductors, insulators, conductor support towers, electric poles, and transformers) (Wau)	8.9
				1.2 Procurement and installation of prepaid meters (single phase, three phase, and high currents)	13.9
				1.3 Operations & Maintenance (Fuel and Lubricants)	510.0
Installed Capacity (MW)	36.4	76.4	96.4	2.1 To complete construction and operation of Bor, Yambio, and Rumbek (3 MW each)	2.9
				2.2 Procurement, installation and operation of 40 Mw generators in Juba.	64.3
				2.3 Construction of 1X11/33 KV Step up sub-station in Juba	0.8
				2.4 Construction of 3X33/11 KV step down substations in Juba	0.8
				2.5 Construction of 3X33 KV/11 KV feeder lines in Juba.	3.9
				2.6 Extension of the existing distribution network system in Juba.	8.9
				2.7 Procurement, Installation & operation of a 5 MW plant at Torit, Kwajok, Aweil & Bentiu respectively.	32.1
				2.8 Construction of Distribution network systems at Torit, Kwajok Aweil & Bentiu	17.1
				2.9 Build 2 mini hydro on River Yei	TBD
				2.10 Feasibility study for Fula Rapids hydroelectric power plant	TBD
Import from Sudan Interconnection (MW)	40	80	140	3.1 Signing of Bulk Power Purchase Agreement (BPPA) with Northern Sudan Power Authority	0.1
				3.2 Procurement of materials (capacitors, Reactors, towers, three substations for Melut/Folouj, Jalhag and Malakal)	TBD
				3.3 Construction of (3X 60 MVA) substations in Melut/Folouj, Jalhag and Malakal	TBD
				3.4 Construction of a 220 KV transmission line from Renk to Malakal (320 Km).(3.2/3.3/&3.4)included	24.3
				3.5 Construction of distribution networks in 3 substations (Melut/Folouj Jalhag and Malakal)	13.9
				3.6 Extension of Malakal and Renk distribution networks	TBD
				Total	**702.0**

Source: SSDP

ANNEX 2: DETAILED MAP OF SOUTH SUDAN



Source: World Bank