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The World Bank

SOUTH SUDAN ELECTRICITY SECTOR DIAGNOSTIC

DRAFT

December 2021

Contents

Abbreviations and Acronyms

AfDB	African Development Bank
ASA	Advisory Services & Analytics
BAU	Business as Usual
BOOT	Build, Own, Operate and Transfer
DER	Distributed Energy Resources
EAPP	East Africa Power Pool
ESIA	Environmental and Social Impact Assessment
ESSN	Electricity Sector Strategy Note
ESTAP	Energy Sector Technical Assistance Project
FDI	Foreign Direct Investment
FY	Fiscal Year
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GoSS	Government of South Sudan
GWh	Gigawatt-hour
HDI	Human Development Index
IA	Implementation Agreement
ICRC	International Committee of the Red Cross
IFC	International Finance Corporation
IMF	International Monetary Fund
IOM	International Organization of Migration
IPP	Independent Power Producer
JEDCO	Juba Electricity Distribution Company
KAPECO	Kapoeta Electric Cooperative
LPG	Liquefied Petroleum Gas
kW	Kilowatt
kWh	Kilowatt-hour
kWp	Kilowatt peak
MECO	Maridi Electric Cooperative
MEDIWR	Ministry of Electricity, Dams, Irrigation, and Water Resources
MIS	Management Information Systems
MoED	Ministry of Energy and Dams
MoFEP	Ministry of Finance & Economic Planning
MoU	Memorandum of Understanding
MW	Megawatt
MWh	Megawatt-hour
MWp	Megawatt peak
NBS	National Bureau of Statistics
NDS	National Development Strategy
NELSAP	Nile Equatorial Lakes Subsidiary Action Program
NGO	Non-Governmental Organization
NRECA	National Rural Electric Cooperative Association

PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PV	Photo-voltaic
R-ARCSS	Revitalized Agreement on the Resolution of the Conflict in the Republic of South Sudan
RISE	Regulatory Indicators for Sustainable Energy
RSS	Republic of South Sudan
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SCADA	Supervisory Control and Data Acquisition
SDG	Sustainable Development Goal
SHP	Small Hydropower
SHS	Solar Home System
SME	Small and Medium Enterprises
SSA	Sub-Saharan Africa
SSDP	South Sudan Development Plan
SSEC	South Sudan Electricity Corporation
TGoNU	Transitional Government of National Unity
YECO	Yei Electric Cooperative

Executive summary

Background: Following independence from Sudan in 2011, South Sudan's electricity sector showed some encouraging signs of early development but suffered significant physical and institutional damage during the country's civil war. Most power plants and isolated grids were destroyed or shut down due to operational challenges and many key sector institutions became essentially defunct amid critical staffing and resource shortages. Most of the Government of South Sudan's (GoSS) ambitious reform agenda articulated in the pre-war years had to be suspended or abandoned, and what little sector investment was made came largely from private sector actors. As such, though GoSS has taken steps to rejuvenate the sector and achieve stability, including through increased engagement with multi-lateral development banks and foreign investors, limited sector progress has been made since independence.

Power sector institutional landscape: South Sudan's power sector policy framework is weak and many of the country's limited number of institutions lack both capacity and clear mandates. The Ministry of Energy and Dams (MoED) is the apex policy-making institution of the government and also functions as a regulator in absence of an independent regulatory body. The South Sudan Electricity Corporation (SSEC), an autonomous public institution, is the main national power utility in country that is mandated with expanding and operating generation and distribution assets. However, SSEC's role in the sector has become increasingly uncertain following the decommissioning and destruction of many of its assets as well the de facto privatization of the Juba power system after formation of the Juba Electricity Distribution Company (JEDCO) joint venture with a private IPP as a majority shareholder. Some official sector policy and strategy documents were developed soon after independence, including the South Sudan Electricity Corporation Act 2011 and the National Electricity Policy 2013, but these only provided a partial sector management framework and have suffered from diminished relevance in a sector shaped more by conflict than policy. A National Electricity Bill was drafted in 2015 and was passed by the cabinet but has yet to be ratified.

Despite few formally codified policies and targets, consultations with various sector institutions indicated an ambitious power sector infrastructure agenda, including increasing generation capacity, development of a transmission system, and investments in regional interconnection to link up to other East African markets. The National Development Strategy 2018-2021(NDS), which was updated in 2021 and extended to 2024, also prioritizes the development of grid and off-grid energy sector under the government's overall infrastructure development goals. The NDS prioritizes renewables development, particularly hydro, with a target of adding 1,080MW of hydro generation capacity by 2024.

Electricity supply & demand: South Sudan suffers from significant levels of suppressed demand as well as well as one of the world's lowest access rates – 6.7% as of 2019. About 70% of the population depends on traditional biomass fuels such as wood-fuel, charcoal, crop residue, and animal dung to provide their cooking and heating energy needs. Grid power, meanwhile, is expensive, carbon-intensive, and in short supply. GoSS estimates total demand in the country at around 300MW compared to only around 130MW of supply, of which only around half is both operational and available to the general public. South Sudan's electricity mix is currently 100% thermal, though the country possesses significant renewable potential. Five identified high-potential hydropower sites along the Nile could add up to 2,600MW, while a 20MW solar + storage project is currently under construction near Juba.

Most of the country's operational power infrastructure is concentrated in and around Juba, where a 33MW thermal IPP supplies around 29,800 connections through the local distributor, JEDCO, at an average tariff of USD 0.40/kWh, among the highest in SSA. With few exceptions, most other public generation and distribution infrastructure elsewhere in the country has fallen into disrepair or is no longer operational due to inadequate maintenance and fuel supplies. A handful of small rural

cooperatives are attempting to revive USAID-funded mini-grids built prior to independence. There is no transmission infrastructure in the country, though several proposals for transmission lines and interconnectors are at various stages of development.

Summary of sector challenges: South Sudan's electricity sector is among the least developed in SSA and will require significant investment in infrastructure and institutions if it is to enable rather than impede post-conflict recovery and growth. Some of the most pressing challenges identified in this Diagnostic include:

(a) A massive lack of generation, transmission, and distribution capacity as critical infrastructure was either destroyed, abandoned, or never available to begin with. As a result, only a small fraction of South Sudanese have any sort of interaction with the formal electricity sector, and many instead have to rely either generators or non-modern forms of energy consumption.
(b) An absence of formalized long-term planning to establish a least-cost framework for sector development. There are currently no master plans for generation, transmission, distribution, or overall sector development. As a result, power sector development is generally ad-hoc and heavily influenced by individual developer solicitation.
(c) High tariffs and connection costs due to high price of imported fuel and parts which has made electricity service unaffordable to a significant portion of the population and poses a major constraint to economic development.
(d) Insufficient legal and regulatory frameworks, including for policies for public-private partnerships (PPPs), that have led to a lack of responsibility for some sector functions such as regulation and electrification while created overlapping mandates for other sector functions such as power distribution.
(e) Key sector institutions suffer from significant gaps, both in terms of technical and strategic planning capacity, even while headcounts in some cases do not appear justified by actual services delivered. Capacity gaps are compounded by a severe lack of sector data, including for utility and sector operational and financial performance.

Recommendations: A more complete set of recommendations for sector development will be prepared once the other activities under this ASA have been completed (notably, geospatial electrification analysis and an off-grid market assessment and demand survey), but some initial options identified for this Diagnostic include:

<u>Infrastructure investment</u>

- Development of new renewable energy resources, in particular hydro and mini-hydro projects along the Nile, for many of which feasibility studies are already in place;
- Refurbishment or upgrading of existing SSEC / Ezra thermal plants to restore operations or improve efficiency, though the extremely high cost of these and unreliability of fuel and spare parts make this a stopgap solution only;
- Development of isolated grids for urban centers, in particular in state capitals. In some cases, this would need to involve building local generation and distribution infrastructure from scratch, ideally with lower-cost renewable or renewable-hybrid generation options, in other cases, these could leverage existing defunct generation and distribution infrastructure. This could be a precursor to interconnection with a national transmission grid;
- Development of a national transmission grid to better connect renewable supply centers (in particular hydropower along the Nile) with demand and population centers;
- Development of high-potential planned regional interconnection projects including with Uganda, Ethiopia, and Kenya once adequate transmission infrastructure is in place to transport power from national borders to demand centers;
- Rehabilitation of community-led mini-grids in Yei, Kapoeta, and Maridi.

Sector planning

- Preparation of robust generation and transmission master plans based on rigorous demand forecasts, localization of demand and supply centers, interconnection options, technological and cost evolution, government objectives and other local considerations to develop a blue-print to guide least-cost sector expansion over the next 10-15 years;
- Preparation of a detailed geospatial analysis, drawing on satellite imagery, generation and transmission master plans, and other geographic and socioeconomic data layers to determine which areas of the country can be most effectively and inexpensively electrified by which grid, mini-grid, and off-grid technologies, and how best to sequence these efforts;
- Inclusion of power sector and achieving power sector targets as key development priority and engine of economic and human capital growth in national policy and strategy documents;
- Update of National Electricity Policy & Strategy to refresh and elaborate on the 2013 Policy and create a detailed guiding document for GoSS's vision for sector development and post-conflict investment.

Consumer affordability

- Conduct JEDCO cost of service and tariff studies to identify opportunities for operational efficiencies and cost reductions;
- Develop lower-cost sources of power, in particular renewables, to reduce dependency on expensive imported refined fuel;
- Explore opportunities to enhance affordability for residential customers through tariff optimizations and/or financing schemes.

Legal & regulatory framework

- Review existing PPP arrangements and establish clear PPP policies and processes to both provide comfort to private investors and protect GoSS from taking on excessive risk. These would need to cover more traditional generation projects as well as more innovative partnerships with mini-grid operators;
- Review and enactment of 2015 Electricity Law to develop a broad legal underpinning for the power sector, including the establishment of an independent regulator and assignment of key sector responsibilities such as electrification;
- Establishment of an electricity regulator. While the Electricity Law will set out the basic contours of regulation, additional effort will be required to define day-to-day regulator operations and procedures, map out current and future resource requirements, and provide adequate staff and capacity;
- Designation and empowerment of appropriate sector entity to develop bankable projects for power generation, transmission, and distribution sectors, taking responsibility for preparation of robust feasibility studies, economic and financial analysis, environment and social impact assessments, etc.
- Designation and empowerment of appropriate sector entity for rural electrification;
- Development of business plans for SSEC, JEDCO, and other commercial or quasi-commercial sector entities to untangle the overlapping institutional mandates, assess their financial viability, and develop forward-looking investment and financing strategies;
- Development of policies and mechanisms to support or at least limit obstruction of market growth for standalone solar and other distributed energy technologies.

Capacity building

- Review staffing at sector institutions to take stock of capacities and resources against institution mandates and efficiency benchmarks;

- Develop staff capacity, both technical and managerial, across all functions at apex sector institutions to ensure adequate implementation of sector policy.
- Implement data production, acquisition, management and dissemination systems and procedures across entire electricity value chain to allow for data-driven, fact-based policy making and planning.

1. Introduction

The aim of this Diagnostic is to take stock of the current state of the electricity sector in South Sudan and identify key barriers and opportunities for electricity access expansion. This study is part of a broader World Bank ASA (Advisory Services & Analytics) – Pathways to Electricity Access Expansion in South Sudan – which develops a suite of energy sector analytical studies to lay the foundation for future sector dialogue and re-engagement, as well as a roadmap for the expansion of electricity access to households, health facilities, schools, and enterprises.

This Diagnostic draws on a variety of research approaches to shed light on the infrastructural, institutional, and regulatory landscape in South Sudan's electricity sector: (1) desktop research to take stock of existing policies, reports, and datasets; (2) surveys of personnel in key public institutions, non-government institutions, and the private sector to assess how institutions interact and how policies are being implemented on the ground; (3) key informant interviews with selected stakeholders to assess the major barriers and challenges in the sector; and (4) surveys and interviews with selected residential, commercial, industrial, and public consumers of electricity services in Juba.

The Diagnostic builds on the South Sudan Electricity Sector Strategy Note (ESSN) that was developed by the World Bank in 2013. The ESSN aimed to provide insight into key power sector issues and development challenges in South Sudan, and recommended a series of short, medium, and long-term strategic interventions to facilitate sector-wide growth. Key challenges identified in the then study included: i) a lack of long-term sector planning; ii) inadequate legal and regulatory frameworks to enable sound power sector growth; iii) a lack of institutional capacity; iv) an overdependence on oil and inadequate plans for fuel diversification; and v) limited physical generation, transmission, and distribution infrastructure.

The ESSN's short-term recommendations included the formulation of a sector plan and the reform of laws and regulations to help the Government of South Sudan lay a foundation of growth in the power sector. Medium-term recommendations focused on addressing key sector infrastructure gaps, including generation resource diversification, increasing access to electricity, and expanding distribution and transmission networks. Long-term goals involved scaling-up, continuation, and refinement of these.

In addition, the ESSN recommended the following capacity-building actions:

- Create effective capacity within government, particularly Ministry of Energy and Dams (MoED), to put in place electricity sector planning and regulatory strategy and policies;
- Strengthen the management of the South Sudan Electricity Corporation (SSEC) to operate urban electricity systems;
- Develop coordination mechanisms between MoED and SSEC;
- Strengthen the management of off-grid utilities to operate decentralized and off-grid electricity systems;
- Develop renewable energy (RE) and energy efficiency (EE) plans;
- Implement organizational restructuring to improve personnel capacity and productivity at sector institutions;
- Improve the internal financial and managerial controls within the electricity sector; and
- Provide relevant training opportunities to different levels of employees in the electricity sector.

As this Diagnostic will show, very little progress has been made on these recommendations, and South Sudan's sector challenges are as pressing then as now.

2. Country Context

South Sudan is a land-locked country in East Africa covering an area of 644,329 km², sharing its borders with Sudan to the north, Ethiopia to the east, the Central African Republic to the west, and Kenya, the Democratic Republic of Congo, and Uganda to the south. The country is divided into ten states, which are in turn sub-divided into counties, payams, and finally bomas at the village level. The White Nile cuts across the length of South Sudan but is only navigable along short stretches. The country's current (2020) population of 11,313,970[1] is made up of more than 60 tribes, of which the Dinka, Nuer, Azande, Shiluk, and Bari are the largest.[2] South Sudan's population growth rate has gradually declined since its independence from Sudan in 2011, falling from 3.33% in 2011 to 1.18% in 2020.[3] Around 80.1% of people live in rural areas. Of the country's ten states, Central Equatoria, home to the capital Juba, has the highest population density (48 people/km^2), followed by Warrap (31 people/km^2), and North Bahr-al-Ghazal (22 people/km^2).[4] The overall population density in South Sudan is 18/km^2(47/mi^2).[5]

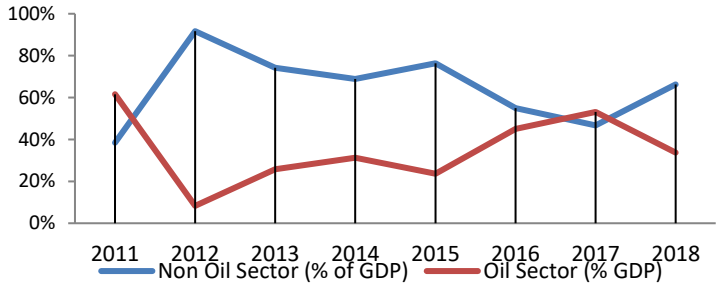
South Sudan gained independence from Sudan in 2011 following a 22 year-long war. However, conflict arose in 2013 between South Sudanese government forces and opposition leaders, which eventually ignited a multi-sided civil war that lasted for seven years and left hundreds of thousands of people dead and millions displaced from their homes. Although there were several ceasefires and peace agreements mediated by the Intergovernmental Authority on Development (IGAD), African Union and United Nations throughout the civil war, the conflict continued until a power sharing agreement was signed in 2018. The Revitalized Agreement on the Resolution of the Conflict in the Republic of South Sudan (R-ARCSS) was signed to call for the establishment of a Transitional Government of National Unity (TGoNU) that included members of the existing administration as well as members from rebel groups. A new TGoNU was formed on 22 February 2020 and now presides over an uneasy peace.

In part due to the lingering effects of conflict, South Sudan has become one of the poorest countries in the world. South Sudan ranks 187th out of 188 countries on the Human Development Index (HDI) with a life expectancy of only 57 years, and 82.3% of the population lived on less than USD 1.90 a day in 2016. More than one-third of the population does not have secure access to food.[6] Roughly 78% of South Sudan's working population earns a livelihood through subsistence farming or livestock rearing. Prolonged civil unrest and the lack of any domestic industry to absorb the working population have greatly limited the means for poverty alleviation.[7]

South Sudan's economic performance has been volatile since independence. The economy is highly dependent on its oil sector, which in 2011 accounted for 62% of GDP and was the country's sole exporter. Oil production was halted in 2012 while negotiations over oil-transfer tariffs were being carried out with Sudan. Since then, production and exports have been recovering gradually. Though the South Sudanese government has voiced enthusiasm for economic diversification in its annual national budgets, the contribution of non-oil sectors to GDP has been declining since 2012 (Figure 2.1).

[1]Worldometer elaboration of the latest United Nations data, retrieved on 26 May 2021
[2]https://en.wikipedia.org/wiki/Demographics_of_South_Sudan
[3]World Bank Indicators: https://data.worldbank.org/indicator/SP.POP.GROW?locations=SS
[4]Final Statistical Yearbook, 2018, National Bureau of statistics, South Sudan
[5]Worldometer, South Sudan Population: https://www.worldometers.info/world-population/south-sudan-population/
[6] World Bank documents report: https://openknowledge.worldbank.org/handle/10986/33453
[7]UNDP, South Sudan National Development Strategy 2021: https://www.ss.undp.org/content/south_sudan/en/home/presscenter/articles/2021/south-sudan-national-development-strategy-2021.html

Figure 2.1: Contribution of Oil and Non-Oil Sector to GDP in South Sudan, 2011-2018



The economic impacts of the COVID-19 pandemic on South Sudan have been profound. Falling global oil prices and lower oil demand reduced government revenues by 40%, increasing the fiscal deficit to 4.9% of GDP in 2020 compared to 2.5% in 2019. The situation was further worsened by the need to divert public funds from their intended uses to fight the pandemic. As a result, the Government of South Sudan's (GoSS) 2021-21 budget of SSP 218 billion (USD 1.67 billion)[8] contains a 37% budget deficit.

In response to budget challenges, the GoSS has tried to renegotiate some of its major debt obligations. In October 2020, South Sudan restructured its outstanding debt with Qatar National Bank, which accounts for 46% of the country's external debt. Debt restructuring and the clearance of arrears owed to Sudan also helped reduce external debt to an estimated 28.3% of GDP in 2020 from 38% in 2019. Commercial loans accounted for 81% of the total external debt as of June 2020, followed by multilateral (8%) and bilateral (11%) loans.[9]

GoSS policy is to maintain an official exchange rate against the USD, but a weaker black-market prevails throughout most international commercial activity. High rates of inflation have put steady downward pressure on the value of the SSP, though inflation has stabilized somewhat in recent years, down to 38% in 2020 from a high of 380% at the height of the conflict in 2016. Initial figures for 2021 indicate that the gap between the black market and official exchange rate narrowed from 250% in January to only 1 percent in August, following improvements to the GoSS foreign exchange planning and auction mechanisms. Key economic indicators for the period 2011-2020 are presented in table 2.1.

Table 2.1: Key Economic Performance Indicators for South Sudan, 2011-2020

Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019[a]**	**2020[b]**
GDP (USD Billion)	18.16	8.88	12.68	15.11	7.41	3.23	3.51	8.09	4.93	4.18
GDP Growth (%)	0.40	-50.8	29.80	22.10	3.60	0.20	-0.10	3.30	0.90	4.1
GDP per capita	1,934	908	1,245	1,427	674	282	296	656	369	303
Official exchange Rate SSP/USD	2.83	2.95	2.95	2.95	3.63	46.71	113.65	141.39	NA	NA
Black Market Rate (% over official)	3.70	4.38	4.33	4.74	13.74	55.53	167.30	249.12	301	405
Inflation Rate (%)	NA	45.10	0.00	1.70	52.80	379.85	187.85	83.5	51.19	37.99

Note: [a, b] IMF Estimates

[8]USD1 = SSP130.26

[9]South Sudan Economic Outlook: https://www.afdb.org/en/countries/east-africa/south-sudan/south-sudan-economic-outlook

Source: NBS Statistical Yearbook 2018, IMF[10], IMF: World Economic Outlook[11]

3. Energy Sector Institutions

3.1. Institutional Landscape

The main institutional actors in the South Sudanese electricity sector as follows:

Public

Ministry of Energy and Dams (MoED): MoED is in charge of developing and implementing GoSS policies and strategies in the energy sector and functions as a de-facto regulator in the absence of a separate regulatory body. Its main responsibilities are: i) formulating and developing policies, regulations, and strategies for the development and maintenance of the electricity sector; (ii) overseeing the various sector actors' compliance with relevant laws; (iii) setting tariffs, identifying electricity sources, and facilitating their development; iv) identifying potential business partners and enabling private participate in the development of the energy sector.

Ministry of Petroleum and Mining (MoPM): The MoPM is the government's policy-making and implementation body for petroleum affairs responsible for oil and gas exploration, production, and supply.

Ministry of Finance and Economic Planning (MoFEP): MoFEP is responsible for budgeting, resource mobilization, maintaining control over public spending, and setting the direction of the fiscal policy. Its role in the energy sector includes allocation and release of funds, monitoring and evaluating budget implementation, prescribing financial and accounting procedures, and providing fiscal oversight.

The South Sudan Electricity Corporation (SSEC): SSEC is an autonomous government organization that in theory serves as the main national power utility of South Sudan with the goal of expanding and operating South Sudan's generation and distribution assets. This includes setting up and managing electricity generation and transmission facilities; purchasing electricity from independent power producers (IPPs); selling electricity in bulk to distributors; promoting electricity imports and exports with neighboring countries. Founded in 2006, SSEC employs around 745 managers, engineers, administrators, technicians and support staff.[12,13] However, many staff do not have the necessary engineering or technical capacity to effectively support the utility's operations. Its role in the sector has become increasingly uncertain following the decommissioning and destruction of many of its assets as well as the de facto privatization of operation of the Juba power system (see below), though ownership of the Juba grid and other non-operational grid infrastructure in smaller cities remains with SSEC. At present, the only operational SSEC facility is the 30MW substation at Renk and the small number of connections it serves in Renk and nearby towns. SSEC also serves a small number of connections in Bor.

Private

[10]IMF, n. d., *Republic of South Sudan:* Available at: https://www.imf.org/en/Countries/SSD#countrydata
[11]IMF: World Economic Outlook (WEO) Database, April 2021: https://knoema.com/IMFWEO2021Apr/imf-world-economic-outlook-weo-database-april-2021
[12](2014) Analysis of Juba Distribution Network and Capacity Building Needs in the Electricity Sector, Republic of South Sudan: The World Bank.
[13]NRECA International, "Support to South Sudan Electricity Corporation for Development of the Distribution Grid in Juba: SSEC Institutional and Juba Market Study Report", Prepared for: The Norwegian Water Resources and Energy Directorate and the Ministry of Electricity and Dams in the Republic of South Sudan, September 2013

Ezra Juba Power: Ezra Juba Power – part of the privately-owned Juba-based Ezra Group – is an Independent Power Producer (IPP) that currently operates the only functional power plant in Juba, a 33MW diesel plant launched as an IPP in 2019 following signature of an Implementation Agreement (IA) and a Power Purchase Agreement (PPA) with GoSS in August 2017. The term of the PPA is 17 years at an average tariff of USD 0.373 / kWh for a total contract value of USD $290 million, after which ownership will be transferred to the government. The agreement calls for a total of 100MW fossil fuel-based plant to be built and operated four phases of 30MW, 30MW, 20MW, and 20MW. Currently, the first phase is the only one in operation. The remaining phases are scheduled to be completed by 2023, though delays to this schedule appear likely at this time of writing.

As of 2021, this arrangement is the only PPP that exists in South Sudan's electricity sector, awarded after bilateral discussions between the developer and the government in the absence of a structured PPP procurement process.[14] While the PPA helped fill an essential power sector vacuum in Juba in the aftermath of the worst years of conflict, it has also resulted in a somewhat one-sided arrangement that continues to put pressure on public energy sector entities and electricity consumers. Some initial observations on the PPA and its potential challenges and gaps are as follows:

- **Exclusion of utility as contracting party:** Both the PPA and IA (concession agreement) are signed between the IPP and GoSS, whereas a PPA would typically be signed with the off-taking utility (SSEC). This has contributed to the ambiguous and diminished role of SSEC in the sector.
- **Absence of construction and operational agreements:** Typically, an IPP would sign separate agreements such as a Resource Supply Agreement, Construction Contract, Operational and Maintenance Agreements, etc. In the case of Ezra, these agreements are either missing or lumped into the PPA and IA. This has reduced incentives for Ezra to pursue cost-savings opportunities.
- **High degree of IPP protection:** the PPA affords the IPP a high degree of protection from various sector and financial risks. The PPA is structured as a take-or-pay contract, with deemed energy equivalent to close to the maximum theoretical output of the plant. GoSS is contractually responsible for provision of fuel and hard currency convertibility, while the IPP is granted extended tax holidays on corporate profits and equipment import duties. While this is not specified in the PPA, Ezra has achieved yet another layer of risk mitigation through the formation of a new joint venture Juba distribution utility – JEDCO (see below) – which is owned by both Ezra and SSEC and sells electricity to Juba consumers. This approach has eliminated utility/off-taker payment risk given that Ezra is the majority owner of JEDCO, but has also turned the IPP into a de facto vertically-integrated utility.
- **Internal ambiguities and inconsistencies:** there are numerous elements of the PPA that have potential to create ambiguity or confusion. These include: i) deemed energy is set at 72 GWh per month, but a separate provision indicates a deemed energy charge in the first two years of only 100MWh (around 3 hours of plant output), without specifying the time period this applies to; ii) the PPA mentions applicable capacity charges in an Annex, yet elsewhere payment is entirely based on deemed energy charges; iii) cross-references to sections or clauses that do not exist.

Nile Instrumentation and Controls Engineering (NICE) Systems: NICE is a private company operating a 1MW power station in Bor contracted and overseen by SSEC and MoED.

[14] Ezra Power Purchase Agreement and Implementation Agreement, South Sudan

Joint Public-Private

Juba Electricity Distribution Company (JEDCO): JEDCO was established in 2018 as a joint venture between SSEC, which holds 48% of shares, and Ezra, which holds 52%.[15] JEDCO is the only provider of electricity distribution services in the capital city of Juba, serving a total of around 29,800 consumers. The joint venture was formed in part as a risk mitigation mechanism for Ezra as it allows the company to directly manage revenue collection from customers in Juba without having to be dependent on transfers from the SSEC.

There is no separate transmission utility since South Sudan does not yet have an inter-connected grid system. However, the government plans to incorporate State Electricity Agencies in the 10 States to manage electric power distribution services in their respective states. There are rural electricity cooperatives, and community-owned and operated distribution entities, as approved and licensed by MoED.

3.2. Electricity Sector Policies & Objectives

The main GoSS policy and strategy documents relevant to the electricity sector of South Sudan are outlined below. Progress across policy commitments and targets has remained extremely limited as lack of funding and capacity combined with insecurity continue to constrain GoSS's ability to meet its objectives.

Vision 2040: South Sudan's Vision 2040 was published in February 2011 within one month of independence, laying out broad aspirations for post-independence development. The document mentions hydro-electric power development as a goal but does not contain specific provisions.

South Sudan Electricity Corporation Act 2011: The Act established the South Sudan Electricity Corporation and set out the responsibilities of SSEC in the electricity sector. The Act empowers SSEC to develop medium- and long-term power generation and transmission plans and operate the grid, including generation, transmission, and distribution.

South Sudan Electricity Sector Policy: The Policy was enacted in 2013 with the intention of defining key relationships between sector agencies and their roles and responsibilities. The Policy designated MoED as the main regulatory authority responsible for balancing consumer and electricity service provider interests and defined funding mechanisms to finance power sector investments in South Sudan. The Policy also stipulated that the sector shall consist of both public and private sector service providers that engage in generation, transmission, and distribution. MoED, through SSEC, was to also be responsible for defining licensing procedures, tariff setting processes, operating standards, and procedures required for efficient operation of the sector.

National Electricity Bill 2015: The purpose of this Bill is to enable the establishment of a regulatory framework and define the objectives and functions of various entities in the electricity sector, including establishment of a separate regulator, licensing for service providers, and specifying the functions of the MoED with respect to rural electrification.[16] This was accompanied by a draft Electricity Licensing Regulations document intended to regulate the licensing of the electric utilities. There have been significant delays in the ratification of the Bill since the first draft was developed in 2015. As of November 2021, a revised version of the Bill had been presented to Parliament and the President for

[15] https://www.jedcopower.com/about/
[16] Law of South Sudan, National Electrification Bill 2015

ratification and assent into law. A review of the draft South Sudan Electricity Bill 2015 is presented in Box 3.1.

South Sudan Development Plan: The South Sudan Development Plan (SSDP) 2011-2013 designates "development of energy, mineral and mining sectors, including oil and electricity" as a key public priority. The SSDP was extended to 2016 and included an economic development pillar that called for 700 million in electricity sector investment as a key driver of growth. To date, these targets remain largely unfulfilled and the status of the SSDP as a guiding policy document is unclear.

Infrastructure Action Plan: Prepared with support from AfDB in 2013 the Infrastructure Action Plan set the following targets for 2025:

- Expansion in generation capacity to about 580MW by 2025;[17]
- Extension of the national transmission and distribution grid to link all ten state capitals and link the South Sudan grid to those of Ethiopia, Kenya, and Uganda;
- 75% electricity access among urban households;
- Restructuring of SSEC to convert it into a sustainable state-owned enterprise with the capacity to enter into PPAs with IPPs;
- Strengthening of the enabling environment for private investment in power generation to attract IPPs, with the goal to mobilize USD 870 million in private capital
- Strengthening sector regulatory capacity.

The Plan appears to still be in force, but progress remains very limited.

National Development Plan/Strategy: The GoSS developed its first blueprint for development in 2013. The South Sudan National Development Plan (SSNDP) 2011-2013 designated "development of energy, mineral and mining sectors, including oil and electricity" as key public priority for the first three years after the country's independence. The SSNDP was extended to 2016 and included an economic development pillar that called for 700 million in electricity sector investment as a key driver of growth. The SSNDP was succeeded by the South Sudan National Development Strategy (NDS) 2018 - 2021, which was recently updated and extended to 2024 to allow for implementation of outstanding commitments under the original NDP and reprioritize activities in line with the peace agreement (R-ARCSS). The Revised NDS prioritizes the development of grid and off-grid energy sector under the government's overall infrastructure development goals. The NDS also notes that investments in renewables, particularly hydro energy sources, will be given high priority over the new few years, with a target of building and commissioning 1,080MW of hydro generation capacity by 2024.

Uncodified objectives: Through consultations, presentations, policy notes, and other informal sector documents, various sector institutions and actors have also expressed the following objectives:

- Increase generation capacity through and propose new sources of power generation;
- Build new transmission lines and substations (national grid);
- Invest in regional interconnection, including with the East Africa Power Pool (EAPP), to access wider power markets;
- Develop, expand and reinforce generation and distribution networks in the state capitals;
- Support rural electrification by off-grid renewable energy sources.

[17] An Infrastructure Action Plan for South Sudan-Part A (2013)

Box 3.1: Establishing a Regulatory Framework – the Draft Electricity Bill (2015)

The draft South Sudan Electricity Bill of 2015 attempts to create a legal and governance framework for the electricity sector. Specific provisions include:[18]

- Formation of an independent regulator – the National Electricity Regulatory Authority (NERA) – with powers to grant licenses to electricity service providers, review and approve electricity tariffs, monitor the functioning of the electricity market, implement standards, and resolve disputes;
- Specification of certain NERA governance, financing, and reporting requirements;
- Establishment of the objectives, powers, and functions of the MoED and its minister;
- Establishment of the functions of MoED with regard to rural electrification.

Potential gaps in the Bill include:

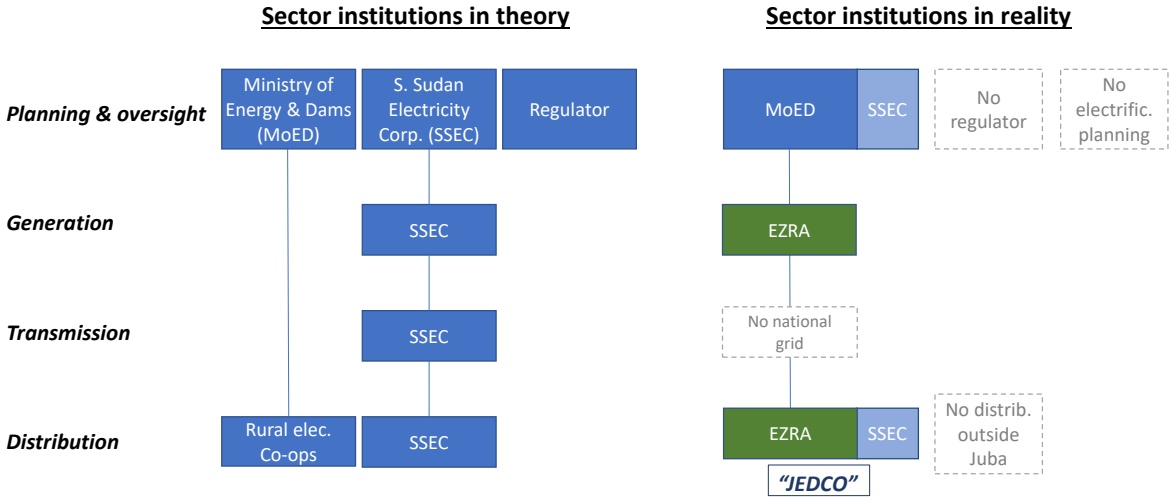
- Limited treatment of electricity sector development beyond rural electrification, including management and operation of generation, transmission, interconnection, and distribution;
- Limited treatment of issues pertaining to land acquisition, right of way, compensation, placement electricity lines and plants;
- Limited treatment of consumer connection and disconnection, billing, collections, etc.

3.3. Institutional Landscape Gaps and Challenges

While the 2011 Electricity Act and 2015 Electricity Bill lay out a theoretical basic framework for sector structure and operation, the unique stresses caused by years of conflict have generally led to a power sector development trajectory that has been ad-hoc, unstructured, and poorly aligned with sector policies and laws. For one, there is a significant overlap of roles among energy sector stakeholders. SSEC has in effect become a defunct utility, with its mandate for power sector operations taken over by JEDCO/Ezra and its mandate for power sector planning taken over by MoED. Since MoED has primarily been focused on generation expansion and JEDCO/Ezra is mostly concerned with power generation and revenue collection in Juba, this has left an institutional gap on issues such as access expansion, service quality improvement, and power affordability, especially outside of Juba. The fate of SSEC's non-operational generation facilities across the country and community-operated mini-grids also remains unclear. Figure 3.1 compares institutional mandates and arrangements in theory and in practice.

[18](2015) Law of South Sudan- National Electricity Bill, 2015, Juba: Ministry of Justice.

Figure 3.1: Institutional Structure of the Electricity Sector



- ✓ 2011 SSEC Act establishes SSEC as vertically integrated utility with mandate to develop power sector under MoED policy objectives and regulatory oversight
- ✓ Rural cooperatives provide electrification services in remote areas under MoED guidance and planning
- ✓ Regulator balances interests of GoSS, SSEC, and consumers

- × SSEC has effectively become sub-department of MoED, with no budgetary independence
- × MoED has concentrated on generation, with very little focus on electrification planning
- × 2015 Electricity Bill establishes regulator, but is still stuck in parliament
- × MoED signed PPA with EZRA but SSEC generation facilities have fallen into disrepair
- × EZRA/SSEC (JEDCO) joint venture management and decision making dominated by JEDCO
- × Very little power sector development outside of Juba

The lack of a robust PPP framework and the reliance on a single private IPP for both generation and distribution in Juba has created several operational vulnerabilities in the JEDCO joint venture arrangement. While SSEC in theory has a 48% shareholding in JEDCO, JEDCO's management team is dominated by Ezra staff and Ezra effectively runs JEDCO as an extension of its generation activities. In the absence of a sound regulatory process, this has created very little incentive for service or cost improvements in the Juba network. JEDCO sets customer rates based on a USD-denominated tariff that is converted to SSP at the unofficial rate. Through the Ezra IPP, GoSS is then contractually obliged to exchange SSP to USD based on the Central Bank's official rate, creating an extracontractual mismatch between revenues and expenses to Ezra's advantage. When hard currency reserves are not available to meet these obligations, disputes between GoSS and Ezra have affected power service delivery to consumers. During the first quarter of 2021, hard currency shortages and delays in currency conversion led to repeated blackouts as Ezra curtailed or suspended power sales until these issues were resolved.[19]

Thus while Ezra's willingness to invest in a high-risk post-conflict situation filled an urgent post-conflict electricity sector need, it has also led to a high degree of concentration of power in the hands of a single private actor with limited regulatory checks and balances and without robust structures for

[19] "Lights back on in Juba after days of total outage" Juba echo, 2021.

dispute resolution. This not only makes the sector vulnerable to operational issues but has also called into question the proper role of the country's national utility and left several key sector functions, including planning and national access expansion, largely vacant.

3.4. Development Partner Activity

Though several development partners, including the World Bank, were quick to provide support to the South Sudanese energy sector after independence in South Sudan, most activities had to be suspended, postponed, or canceled as the country descended into conflict. As of 2021, the single active energy investment project by a major development partner is the AfDB's USD 38 million Juba Power Distribution System Rehabilitation and Expansion Project, which aims to strengthen distribution networks in Juba to improve reliability and increase access in the city. The main physical works included are the construction of 145km of 33kV lines, 195 transformer stations of 33/0.415kV; 370km of 415/230V lines; and service drops for at least 20,000 new customers.[20] AfDB has also provided USD 1.5 million for the feasibility study of the South Sudan section of the 382km 400kV Olwiyo (Uganda) to Juba (South Sudan) interconnector project. Other development partners maintain ongoing sector dialogue but with limited investment to date. Chinese SOEs have been highly active in the energy sector, though mostly through the financing and operation of oil sector projects.

[20]African Development Bank. South Sudan- Juba Power Distribution System Rehabilitation and Expansion Project- Appraisal Report, December 2013

4. Electricity Supply

4.1. Current Generation Capacity

The current generation mix is made up entirely of thermal sources (mainly diesel), which makes the electricity supply expensive, dirty, and unreliable. Though South Sudan is an oil producing country, it only recently took initial steps toward developing domestic refining capacity,[21] so that that fuel for power plants has to be re-imported at considerable cost. Total installed generation capacity stands at approximately 141MW compared to GoSS demand estimates of over 300MW, and much of even this limited capacity is either non-operational or serves the country's oil fields and is largely unavailable to the public. In all, it is estimated that less than 70MW of capacity is currently serving the general public, around half of which is concentrated in Juba. There is no strategic fuel reserve or a policy to enable stockpile this,[22] which has caused frequent disruptions from fuel shortages.

The supply situation in South Sudan fluctuates as infrastructure falls in and out of commission, but can roughly be summarized as follows:[23]

- **A 33MW diesel-fired power plant became operational in 2019 in Juba**, built and operated by IPP Ezra Group. The agreements between Ezra and GoSS include construction of a total of 100MW of thermal power in phases of 30MW, 30MW, 20MW, and 20MW. So far, only the first phase has come online. The remaining phases are scheduled to come online by the end 2023, though ongoing delays cast doubt on the proposed timeline. The cost of power from this plant stands at USD 0.373/kWh, reflecting the high cost of fuel in South Sudan.
- **Six diesel generators installed in Juba, Wau, Malakal, Bor, Rumbek and Yambio** with an installed capacity of 17MW, 9.5MW, 5MW, 3MW, 3MW and 3MW, respectively, owned and operated by SSEC. Most of these were either damaged during the conflict or shut down due to lack of fuel and spare sparts. The 17MW diesel power station in Juba was briefly restored in 2018 but shut down again in 2019 due to operations and maintenance problems, and remains nonoperational as of November 2021.[24] While operational, the generation cost of this plant stood at around USD 0.70/kWh.[25] Operation of the Bor system was recently resumed by NICE Systems, though it is unclear at what scale.
- **Three smaller rural mini-grid systems installed in Yei, Kapoeta, and Maridi** with an installed capacity of 1.5MW, 0.8MW, and 0.8MW respectively. These were operated by rural electric cooperatives but were damaged during the conflict. The rural cooperatives are reportedly making attempts to restart the grids, though their status remains unclear at this time of writing.

[21] South Sudan started refining oil at a small scale in March 2021. The Bentiu oil refinery, a joint venture between Russia's Safinat and state-owned Nile Petroleum Corporation, is located in Unity State and currently produces 3,000 barrels per day. The government aims to expand the refinery capacity to 10,000 barrels per day over a medium term, although, plans and timelines for the scale up are unclear. It is expected that the refined products will initially be used to meet domestic demand for electricity generation.
[22] ECA - Economic Commission for Africa, 2013, Enhancing Energy Access and Security in Eastern Africa, 17th Meeting of Intergovernmental Committee of Experts, Kampala, Uganda 18-22 February 2013: http://www.uneca.org/sites/default/files/uploaded-documents/ ice2013/EA/9_-_energy_-_summary-17thice.pdf
[23] GoSS- Government of the Republic of South Sudan, 2011, Opportunities for Investors in Infrastructure: http://www.southsudanankara.org/docs/SOUTH%20SUDAN%20INFRASTRUCTURE%20OPPORTUNITIES
[24] IEEE, Transitioning to Renewable Energy: An Analysis of Energy Situation in Juba, South Sudan, 2018: https://spectrum.ieee.org/energywise/energy/policy/south-sudan-rebuilding-grid-from-scratch
[25] Hon. LAWRENCE LOKU MO'YU, Undersecretary, Ministry of Energy and Dams

- **Thermal power plants with a capacity of 42MW in the Paloch oil field** (Upper Nile region), which have been operational since 2006 except for a brief hiatus in 2012 when the government suspended oil production while negotiations over oil-transfer tariffs were being carried out with Sudan. These plants do not serve the general public.
- **A substation in Renk (220/11/0.415kV) which receives 32MW of power from an interconnector with Sudan**. The substation has remained operational and serves a small number of households and commercial customers nearby, but progress on a planned additional transmission line from Renk to Malakal that would transport this power to population centers remains very limited. Furthermore, SSEC is in arrears on payments for power received from Sudan, which might affect future availability.

Name of power station	Fuel type	Total Capacity (MW)	Status	COD
Juba (Ezra)	Diesel	33	Operational	2019
Renk	Interconnector substation	32	Operational	2007
Paloch	Diesel	42	Operational	2006
Bor (NICE Systems)	Diesel	1.5	Operational	2009
Wau Power Station*	Diesel	2	Non-operational	2008
Juba (Wärtsilä)*	Diesel	12	Non-operational	2012
Juba (Cummins)*	Diesel	5	Non-operational	2007
Malakal*	Diesel	4.8	Non-operational	1982
Kapoeta Power Station*	Diesel	0.9	Non-operational	2011
Maridi Power Station*	Diesel	0.9	Non-operational	2011
Yei Power Station*	Diesel	1.2	Non-operational	2008
Total Installed Capacity		141		
Operational Capacity		108.5		
Operational Capacity Serving the public		66.5		

4.2. Planned Generation Capacity

Thermal power

The GoSS is exploring plans to install an additional 250-300MW in thermal power at Therjath in Unity State in the country's north with an evacuation line to Bahr-el-Ghazal. An additional 250MW in thermal power at the Paloch oil fields is also under consideration.[26] However, these plans are at an early stage and are not based on any broader national long-term generation analysis. Several of the thermal plants that were destroyed or abandoned have also been earmarked for rehabilitation. Potential thermal power construction and rehabilitation projects are shown in Table 4.2.

[26]South Sudan Oil & Power 2018, SOUTH SUDAN ELECTRIC POWER DEVELOPMENT Presentation

Table 4.2: Thermal Power Plants under Rehabilitation and Construction in South Sudan[27]

Name of power station	Status	No of units	Capacity per unit (MW)	Total Capacity (MW)
Bor Power Station	Under rehabilitation	2	1	2
Rumbek Power Station	Rehabilitation planned	2	1	2
Yambio Power Station	Rehabilitation planned	2	1	2
Juba Thermal Power Station (*33MW commissioned out of total 100MW planned*)	Under construction	4	30/20	67
Therjath thermal power plant	Construction planned	Unknown	Unknown	250-300
Paloch thermal power plant	Construction planned	Unknown	Unknown	250

Renewable power

South Sudan has abundant renewable energy resources and potential that is almost entirely unexploited to date, including an estimated 5,583MW in hydropower potential along the Nile. South Sudan also enjoys more than 10 hours of sunshine per day year-round, with horizontal incident radiation at a minimum of 5kWh/m^2/day, as well as moderate wind and geothermal resources. Initial efforts have been made to develop some of these resources, as described below.

Hydro: Hydroelectric power could potentially meet much of South Sudan's baseload energy needs at substantially cheaper cost than current generation and at much lower carbon-intensity. The most advanced of these is the 42MW Fula Rapids hydropower plant and associated 170km Juba evacuation line, which has been in planning since independence. A tentative agreement with the Norwegian government was reached to build the project, but funding was redirected to humanitarian aid following the outbreak of civil war and the project was suspended.[28] Feasibility studies have been completed for Grand Fula, Bedden, Lakki, Shukole, and Fula Rapids projects while Juba Barrage is at pre-feasibility stage (Table 4.3)

[27]South Sudan Oil & Power 2018, SOUTH SUDAN ELECTRIC POWER DEVELOPMENT Presentation
[28]South Sudan Is Building Its Electric Grid Virtually From Scratch, 2020. https://spectrum.ieee.org/south-sudan-rebuilding-grid-from-scratch

Table 4.3: South Sudan Planned Hydro[29]		
Sl. No.	**Description**	**Estimated Capacity (MW)**
1	Grand Fula	890-1,080
2	Bedden	540-780
3	Lakki	410
4	Shukole	235
5	Juba Barrage	120
6	Fula Rapids	42

Solar: A 20MW solar plus 35MWh storage IPP, funded by African Export-Import Bank and contracted to Egyptian manufacturer El Sewedy Electric at a total cost of USD 45 million, is under construction near Juba. The project was intended to come online in late 2020 but was delayed due to COVID-related supply and labor challenges.[30, 31] A separate PPA for a 10MW solar + 2MW storage project has been signed between SSEC and Gigawatt Global – an international power project developer, with construction expected to begin in February 2022.

Geo-thermal: GoSS has had initial talks with Keya's Geothermal Development Company (GDC) to support preliminary geo-scientific exploration studies, but these are still at an early stage.

Biomass and Biogas: Biomass energy, particularly wood-fuel, charcoal, crop residue, and animal dung remain the most used renewable energy in South Sudan. Biomass and biogas-fired power plants could be an option for increasing generation capacity in the future.

Wind Energy: Several locations in South Sudan have significant wind generation resources, including Kapoeta, Kidipo, Juba and Didinga Hills in South Sudan's Eastern and central Equatoria regions, but no steps toward developing these have yet been taken.

4.3. Cross-Border Electricity Trade

As a landlocked country with very little domestic oil refinement capacity and limited generation capacity, South Sudan could potentially benefit significantly from electricity trade with neighboring countries. An existing 32 MW line delivers power from Sudan to Renk substation, but most of this capacity is unused as no transmission line has yet been built from Renk to other demand centers in the interior of the country. Several new potential interconnection lines have been proposed, predominantly to Ethiopia Uganda, and Sudan, though none has moved beyond feasibility study stage to date as development of most of the lines was put on hold during the conflict. An overview of candidate interconnections between South Sudan, Sudan, Kenya, Ethiopia, and Uganda is presented in Table 4.4 and Figure 4.1.

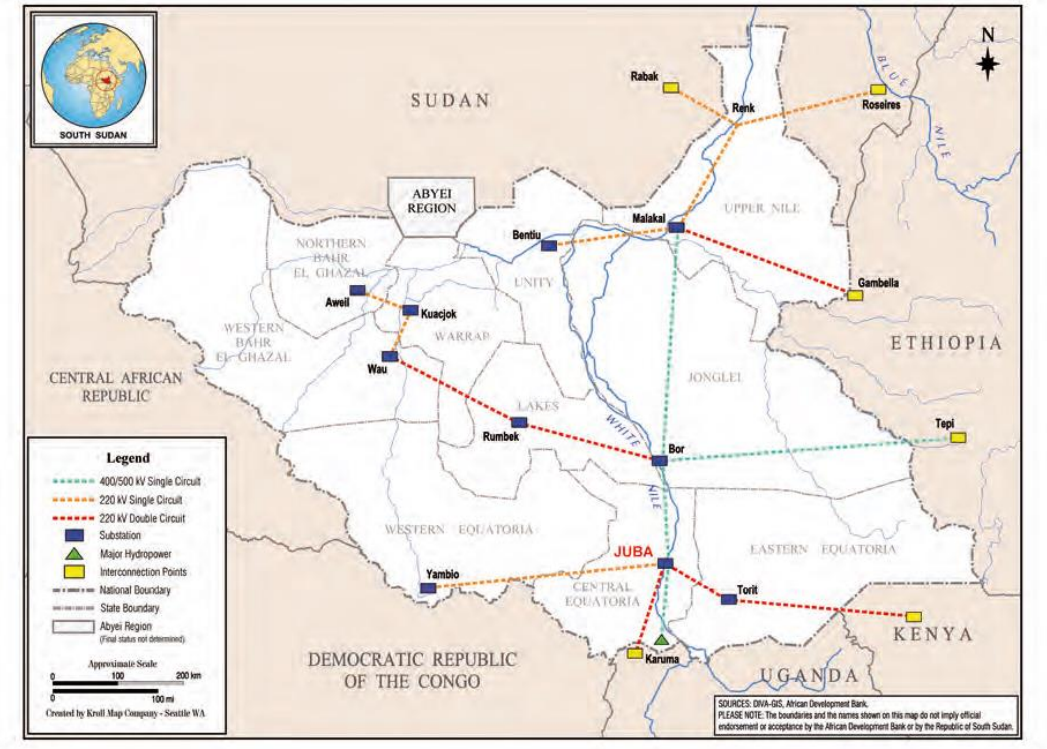
Table 4.4: Proposed interconnectors between South Sudan and neighboring countries						
(A)	**(B)**	**(C)**	**(D)**	**(E)**	**(F)**	**(G)**
Olwiyo (Uganda) – Nimule (South Sudan) – Juba, 400 kV	Uganda and South Sudan	NELSAP	Feasibility study expected Q3 22	1.5	170.0	AfDB

[29]Regional Motivation to Develop South Sudan's Hydro Power Capacity, ESI Africa (17 January 2019): https://www.esi-africa.com/industry-sectors/generation/regional-motivation-to-develop-south-sudans-hydro-power-capacity/
[30]PV Magazine, "South Sudan to get 20MW/35MWh solar-plus-storage plant", December 5, 2019
[31]MoED

Dedesa-Tepi (Ethiopia) – Bor (South Sudan) – Juba, 400 kV	Ethiopia and South Sudan	TBD	Feasibility study has been planned	3.0	420.0	-
Gambella (Ethiopia) – Malakal (South Sudan), 220 kV, 357 Km	Ethiopia and South Sudan	TBD	Feasibility study has been planned	3.0	102.0	-
Rabak (Sudan) – Renk (South Sudan) – Malakal, 220kV, 320km	Sudan and South Sudan	TBD	Operational since 2007 to Renk, feasibility study for Renk – Malakal has been planned	3.0	150	-
Juba – Torit – Kapoeta (South Sudan) – Lokichogio (Kenya), 220 kV, 480 km	South Sudan and Kenya	TBD	Feasibility study has been planned	3.0	86.0	-

Notes: (A) = Project Name; (B) = Countries; (C) = Project executing agency; (D) = Project status; (E) = Project preparation, study cost estimates (US$ million); (F) = Project investment cost (US$ million); (G) = Financiers/ donors
Source: NELSAP Pipeline Projects for Preparation Funds, Pre–selection, NELSAP Projects Pipeline 2016 – 2019

Figure 4.1: Overview of Interconnectors between RSS, Sudan, Ethiopia, Kenya, and Uganda[32]



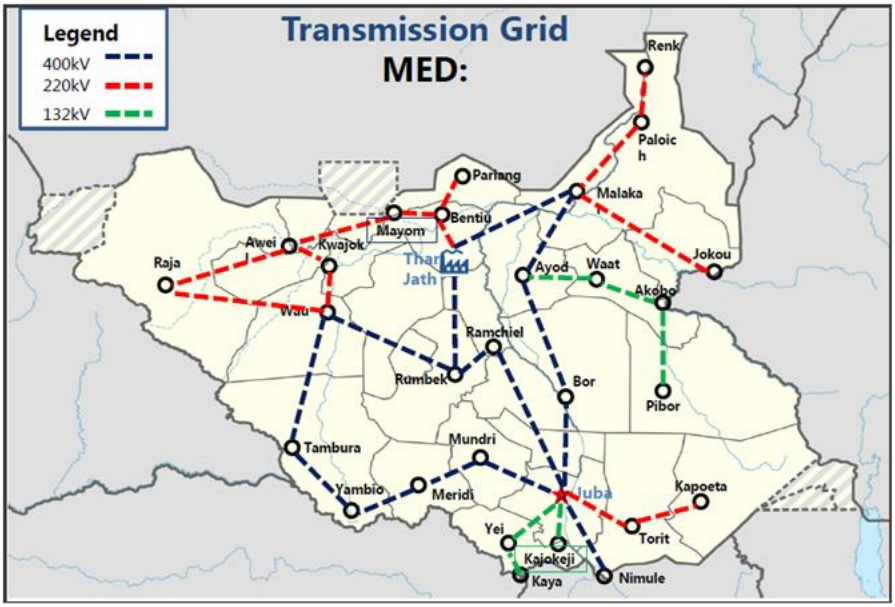
Source: GoSS

4.4. Transmission Network

There is no inter-connected grid system in South Sudan, although the government has indicated plans to develop a national grid. Candidate transmission projects are shown in Figure 4.2 and Table 4.5.

Figure 4.2: Planned Transmission Network in South Sudan

[32] ibid



Source: South Sudan Electricity Corporation (SSEC), 2021

Table 4.5: Proposed Transmission Lines in South Sudan	
Proposed Transmission Line & Length	**Region**
Juba-Yei- Kaya 160km 132kV	Central Equatoria
Yambio -Raja 520km 400kV	Western Equatoria-Western Bahr El Ghazal
Wau – Raja 271km 220kV	Western Bahr El Ghazal
Aweil-Abyei 170km 132kV	Northern Bahr El Ghazal-Abyei
Tharjath- Rumbek 268km 400kV	Lakes-Unity
Gambella (Ethiopia)- Jekow- Malakal 369km 220kV	Upper Nile
Tepi (Ethiopia)- Pibor- Bor 420km 400kV	Jonglei
Source: South Sudan Electricity Corporation (SSEC), 2021	

No studies have as yet been conducted on these lines, and their feasibility will require careful analysis. South Sudan's low population density and large size limits the technical and economic viability of developing a nation-wide grid, and more distributed or isolated systems might offer a higher return on investment and lower technical complexity in the near-term.

4.5. Distribution Network

Juba and isolated urban grids

Prior to South Sudan's civil war, there were six isolated distribution networks in the commercial centers of Juba (15km of distribution lines), Wau (12km), Malakal (13km), Rumbek (7km), Yambio (7km), Bor (8km), and Renk (11km) totaling about 73km of 11kV lines.[33]At present, only the systems in in Juba, Renk and Bor, operated respectively by JEDCO, SSEC and Nile Instrumentation and Controls Engineering Systems (NICE Systems) are still active. Most existing distribution infrastructure is concentrated in Juba, where electricity supply from the 33MW Ezra diesel power plant is transmitted through a 132kV network across the Nile (operated below its capacity at 33kV) to Juba sub-station.

[33] South Sudan Oil & Power 2017 Presentation, POWER SECTOR IN SOUTH SUDAN,2017

Power is then distributed through 33kV, 11 kV, and 415/230V lines, and serves around 29,800 connections (see table 4.6), while only a few hundred connections are being served in Renk and Bor. An AfDB project is adding additional distribution capacity to the JEDCO-operated system in Juba and intends to connect an additional 20,000 consumers. Power China has replaced a share of the city's 11kV with new 33kV lines, and also produced 13,450 concrete poles from a new facility in Juba. The remaining isolated grids were either destroyed during the conflict or have fallen into disrepair due to lack of maintenance.[34] All JEDCO consumers are connected through CONLOG or KEIN prepaid energy meters, which are managed by an ALTIMA PLUS MIS.

Table 4.6: **Number of consumers in Juba, Renk, and Bor**

Tariff category	**No. of Customers**
Juba (JEDCO)	
Before AfDB project	
Government	292
Residential	14,104
Commercial	5,903
Industrial	9
Added by AfDB project as of end 2021	**~9,500**
Total Juba	**~29,300**
Renk (SSEC)	
Total Renk	700
Bor (NICE Systems)	
Total Bor	500
TOTAL NATIONAL	**~21,508**
Source: JEDCO; WB research	

Tariffs and affordability

JEDCO customers pay some of the highest tariffs in SSA at USD 0.40/kWh (figure 4.3). This is a considerable increase from tariffs under previous SSEC operations, which stood at USD 0.22/kWh in 2013 before being increased to USD 0.36/kWh the following year to allow SSEC to recover a greater share of its costs.[35] Given that the average cost of supply was of over USD 0.7/kWh, however, even these elevated tariffs fell well short of cost-recovery. Tariffs were increased to USD 0.43/ kWh with the formation of JEDCO to allow Ezra to directly recover its generating costs from power sales. In 2020, GoSS undertook another tariff revision in response to COVID-19 economic shocks, lowering the rates for domestic and commercial consumers to USD 0.31-0.34/kWh. Table 4.7 shows the JEDCO tariff structure before and after COVID-19 adjustments for different consumer categories.

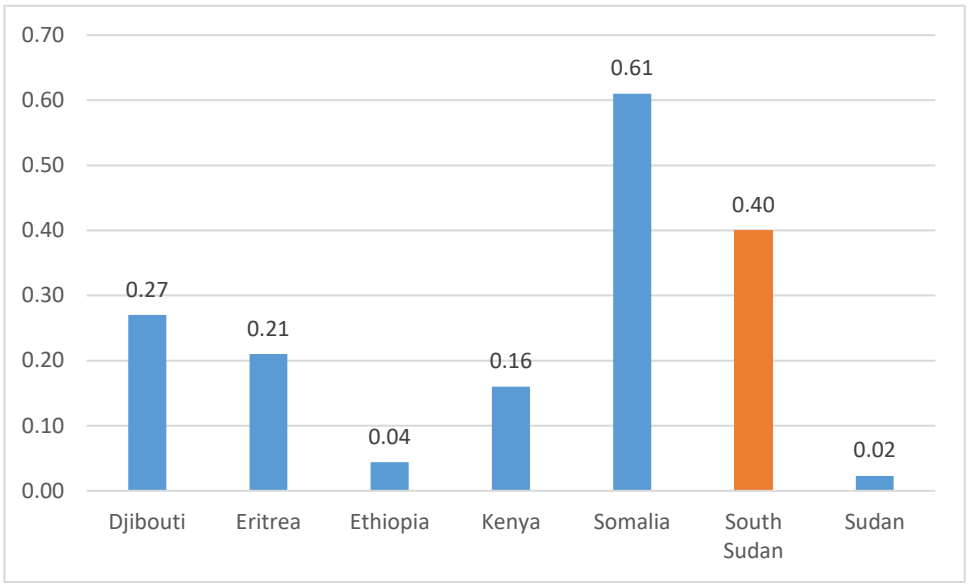
Table 4.7: Electricity Tariff Structure in South Sudan

Tariff Category		**Tariff Rate (USD/kWh)**	
		Pre-COVID-19	**Post-COVID-19**
Domestic	**Consumption < 100kWh**	0.395	0.316
	Consumption > 100kWh	0.42	0.336
Commercial		0.44	0.336

[34]MoED
[35]Africa Energy Series, 2020, Invest in the energy Sector in South Sudan, RSS: https://energycapitalpower.com/wp-content/uploads/AES_SR_SOUTH_SUDAN.pdf

Government		0.42	0.44
Industrial		0.45	0.45
Average		0.43	0.40
Source: South Sudan Power Sector Overview, JEDCO			

Figure 4.3: Average Electricity Tariff (USD per kWh) in Sub-Saharan Africa, December 2020



Note: Tariffs in Somalia can be as low as USD 0.15/kWh and as high as USD 1/kWh depending on the electricity service provider.

JEDCO's tariff covers its operating costs but creates significant affordability challenges, even in relatively affluent Juba. Taking the Regulatory Indicators for Sustainable Energy (RISE) definition of subsistence-level electricity consumption of 30kWh/month, the annual cost of subsistence electricity consumption of USD 114 (30 kWh X 12 months X 31.6c/kWh) is equivalent to almost 20% of household Gross National Income (GNI) for the poorest 40% of households.[36] High costs of connection further contribute to the relative unaffordability of grid power. JEDCO's connection costs can run to USD 3,000–4,000 including application fees, meter/wiring, poles, labor cost, and other charges.[37] In addition to the financial cost of a new connection, consumer surveys also pointed to convoluted administrative requirements that complicate and delay the connection process.

In addition to high electricity and connection costs, South Sudanese grid customers have to contend with frequent reliability issues and outages. Though anecdotal evidence suggests that the takeover of the grid by JEDCO resulted in a reduction in technical issues, contractual disputes between Ezra and the GoSS have led to episodes of sustained load shedding. A 2014 survey estimated that most businesses (93%) relied on generator power for their electricity needs, and 87% of firms identified the lack of electricity as a major impediment for their business at the time.[38] No system SAIDI/SAIFI data is available to quantify reliability.

Grid losses

[36]Tracking SDG 7, The Energy Progress report 2019
[37] JEDCO (2021)
[38] SOUTH SUDAN: MAPPING THE SUPPLY CHAIN FOR SOLAR LIGHTING PRODUCTS, 2014

JEDCO quotes aggregate technical and commercial loss of in the Juba system of 6%, of which 5.8% is technical losses and 0.2% is commercial losses.[39] Historical losses have been significantly higher, however, and it is difficult to assess the validity of these official figures. AfDB estimated SSEC's distributional losses (technical and non-technical losses) at 25% in 2010, and a World Bank study in 2014 estimated total system losses at 35-40%.[40] IEA production and consumption figures suggest total loss levels of 12.1% and 23.5% in 2013 and 2018 respectively.

Table 4.8: System Loss in Juba (2021)

Losses	Percentage (%)
Technical	5.80
Non-technical	0.20
Total	6.00
Source: JEDCO	

Utility financial performance

The only utility financial documents available for this report were the 2010 SSEC Audit Report and the 2014 SSEC Internal Audit Report, along with the 2015 Annual Report of Ministry of Electricity, Dams, Irrigation, and Water Resources (MEDIWR, now MoED). A more recent report is currently under review in parliament but has not yet been made available. As these documents are now over 5 years old and SSEC does not currently operate as an active utility, they have only limited bearing on the current state of the sector. Consequently, it was not possible to obtain a detailed current picture of the financial situation of the sector or its key entities.

In the JEDCO system, the average tariff of USD 0.40/kWh covers the average generation cost of USD 0.373/kWh. In 2020, 115 GWh were generated at the Ezra plant at a cost of around USD 43.0 million. Assuming a system loss of 6% as per 2020 JEDCO figures would imply end-user electricity sales of around 108 GWh, earning cost-recovering revenues of USD 43.3 million.

Table 4.9: Fiscal Impact of Electricity Sector in South Sudan in 2020

Fiscal Items (US$ million)	**With 6% system loss**
Sales	85.6
Purchasing Cost	104.4
Shortfall/ surplus	(18.8)
Government Budget	1,600
Shortfall (% of Budget)	1.175
Source: SSEC Data, Ezra Group Data, and WB estimates	

Electric cooperatives and mini-grids

Following the signing of the Comprehensive Peace Agreement in 2005, NRECA International with funding form USAID built a 1.5MW mini-grid to serve the 1,200 residents of the town of Yei, maintained and operated by the newly-formed Yei Electric Cooperative (YECO). In 2008, two additional market town electrification projects in Kapoeta and Maridi were launched under a similar model, resulting in the Kapoeta Electric Cooperative (KAPECO) and Maridi Electric Cooperative (MECO), each of which

[39]JEDCO lighting up South Sudan: www.jedcopower.com
[40]World Bank, Analysis of Juba Distribution Network and Capacity Building Needs in the Electricity Sector, Advisory Services Document, Consultant's Summary Report, June 30, 2014.

served approximately 650 customers residential and commercial customers with around 0.8MW of power. Due to civil unrest and armed conflict in the region, NRECA eventually evacuated its last employee from the cooperatives in July 2016, and operation of the mini-grids has been suspended ever since. Information available on social media and newspapers suggests that the YECO, KAPECO, and MECO have initiated efforts to resume electricity supply systems, though the exact status of this is unknown.[41]

4.6. Off-grid and Distributed Generation

There is a highly nascent and largely unstructured off-grid solar ecosystem to supply rural off-grid populations with basic electricity services as well as a more established urban market selling household and commercial solar devices and backup systems to larger consumers. A more detailed off-grid market assessment to be carried out subsequently to this Diagnostic will provide a much more comprehensive overview of the off-grid sector in South Sudan, but a preliminary list of example off-grid and distributed generation actors and activities includes:

- Two local pay-as-you go solar companies operate in South Sudan, Indigo and Eight19, though little was known about their offering and operations at this time of writing. Indigo units consist of a battery, a solar panel, lights, and a phone-charging device, with payments starting at around USD 1 per week.
- World Venture, an international NGO, deployed around 1,000 solar home systems in rural villages in Nimule in 2012.[42]
- OFGEN Africa, a Nairobi-based solar power developer, has commissioned a 340 kWp + 0.75MWh battery off-grid solar PV plant to power the UAP Equatorial Tower, Juba's tallest building.
- Various international NGOs and UN agencies operate small-scale solar networks to power their operations. For instance, Scatec Solar installed a 700kWp capacity solar PV plant combined with a battery storage system in 2020 to power refugee shelters in Malakal managed by the International Organization for Migration (IOM).[43]
- PowerGen, a Kenya-based mini-grid developer, is exploring sites for mini-grid projects in South Sudan with a local partner. PowerGen aims to launch a pilot micro-grid in 2022.
- Aptech Africa and AECOM, with USAID funding, developed a mini-grid for a radio station in Juba in 2019, consisting of 79kWp solar and a 125kWh battery.[44]

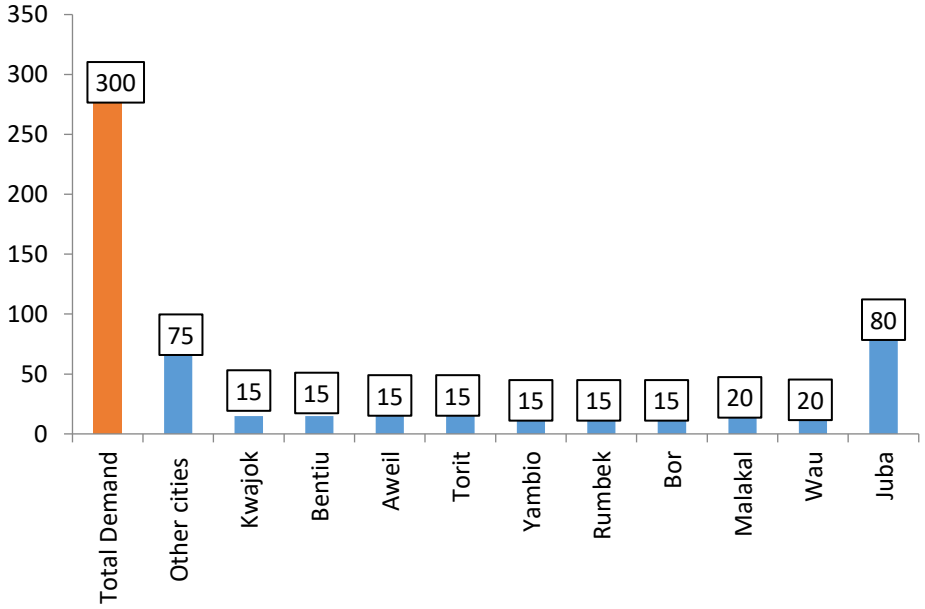
[41]YECO resumes electricity supply in Yei town (14 MAY 2021). https://radiotamazuj.org/en/news/article/yeco-resumes-electricity-supply-in-yei-town-users-demand-improved-services
[42]https://renewablesnow.com/news/eight19-rolls-out-pay-as-you-go-solar-systems-in-south-sudan-255260/
[43] PV Magazine, "Scatec Solar Completes Solar Hybrid Plant for IOM in Malakal, South Sudan
[44]https://www.afrik21.africa/en/southern-sudan-aptech-africa-offers-containerised-solar-mini-grids/

5. Electricity Demand and Access

5.1. Demand

SSEC estimates total demand in South Sudan to be 300MW[45], not taking into account supply or affordability constraints, of which 80MW in Juba (Figure 5.1).[46]

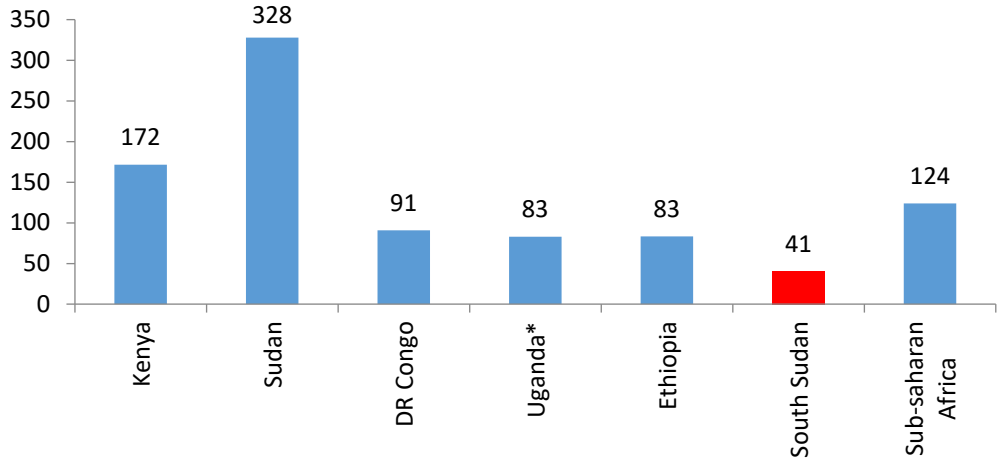
Figure 5.1: Demand estimation in different states of South Sudan in MW, 2018



South Sudan's average annual per capita electricity consumption is 41kWh (2018), which is much lower than the 124kWh SSA (excluding South Africa) average in the same year.[47, 48] It is also substantially less than in neighboring countries such as Kenya (172kWh), Sudan (328kWh), DR Congo (91kWh), Ethiopia (83kWh), and Uganda (83kWh), as shown in Figure 5.2.

[45]Oil & Power 2018, South Sudan Electric Power Development Presentation
[46]Terms of Reference for Feasibility Study, Detailed Design & Preparation of Tender Documents; Environmental and Social Impact Assessment (ESIA) & Resettlement Action Plan (RAP), November 2020
[47]Estimated from International Energy Agency energy data by category, indicator, country or region, 2018, and World Bank Population Data 2018: https://www.iea.org/data-and-statistics/data-tables/?country=WORLD&energy=Electricity, https://data.worldbank.org/indicator/SP.POP.TOTL?locations=SS-ET-KE-SD-CD-ZG
[48] Africa Energy Portal, Sub-Saharan Africa Power 2018.https://africa-energy-portal.org/events/sub-saharan-africa-power-2018

Figure 5.2: Per capita electricity consumption (Units in kWh) in South Sudan, neighboring countries, and sub-Saharan Africa (SSA), 2018[49]



Consumption growth has been erratic over the 2013-18 period, growing by almost 20% in some years but then dropping by similar amounts in subsequent years, most likely due to surging demand competing with destruction of infrastructure and operational challenges. The residential sector makes up approximately half of total electricity consumption (48% in 2018), with industry (35%), agriculture (12%) and the commercial sector (4%) accounting for the remainder.

Table 5.1: Total Production and Sector-wise Consumption (GWh) of Electricity in South Sudan

	2013	**2014**	**2015**	**2016**	**2017**	**2018**
Total Production	472	488	578	447	542	583
Final consumption	415	429	529	409	498	446
Industry	-	-	-	-	197	157
Residential	194	201	234	181	216	218
Commercial and public services	149	154	215	166	19	19
Agriculture/ forestry	72	74	80	62	66	52
Percentage loss (%)[50]	12.08	12.09	8.48	8.50	8.11	23.50

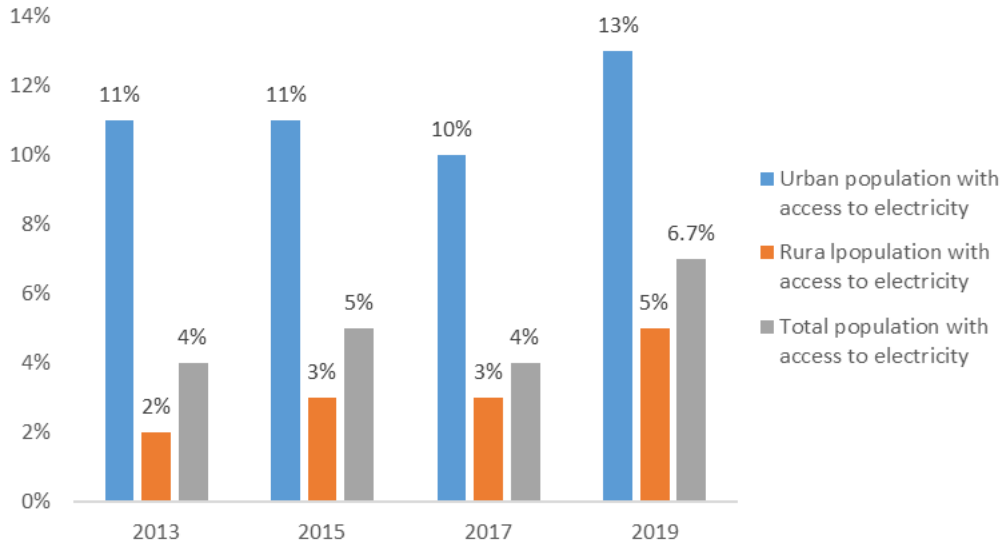
Source: www.iea.org

5.2. Electricity Access

The electricity access rate in South Sudan was 6.7% in 2019, representing a modest increase from 4% in 2013 (figure 5.3), consisting of an increase from 2% to 5% in rural areas and an increase from 11% to 13% in urban areas.[51] In absolute terms, this translates to a total of 10.32 million South Sudanese without access to electricity, 1.91 million of which are in urban and 8.41 million are in rural areas. This access rate also ranks among the lowest in SSA and neighboring countries (figure 5.3).

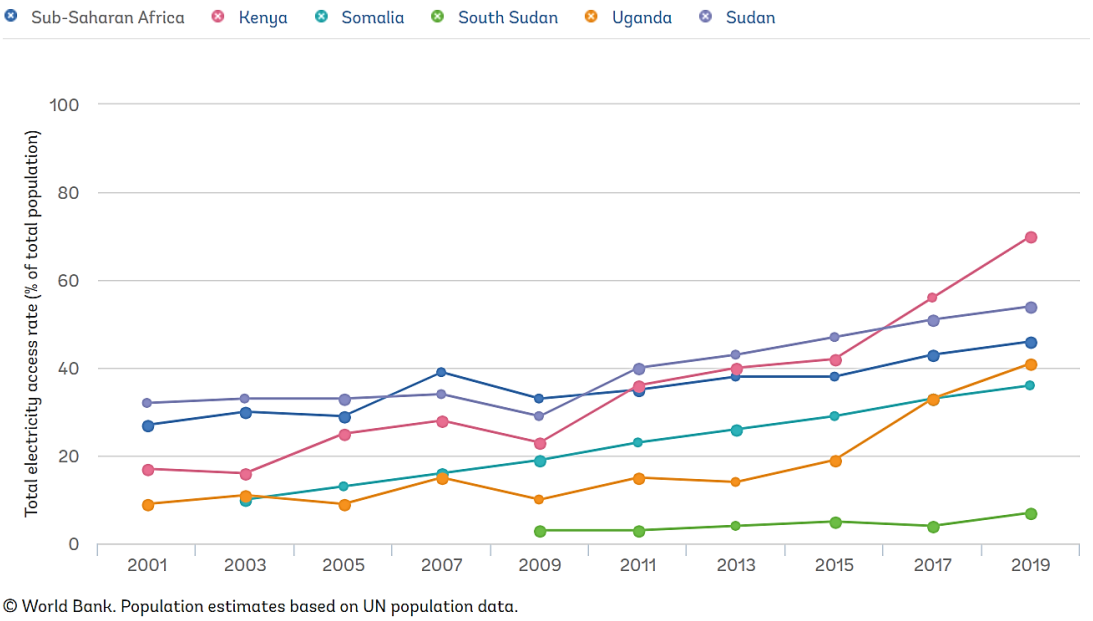
[49]International Energy Agency energy data by category, indicator, country or region, 2018, World Bank Population Data 2018 and https://countryeconomy.com/energy-and-environmen/electricity-consumption/Uganda (No IEA statistics available)
[50]T&D Losses = [{Energy Input to Feeder (kWh) – Billed Energy to Consumer (kWh)} / Energy Input to Feeder (kWh)] x 100
[51]Tracking SDG 7 South Sudan country data 2019. https://trackingsdg7.esmap.org/country/south-sudan

Figure 5.3: South Sudan percentage access to electricity



Source: South Sudan Country Data 2019, *Tracking SDG 7*

Figure 5.4: Change in electricity access rate in South Sudan and neighboring countries (2001 - 2019)



Source: Tracking SDG 7, The Energy Progress Report

Household energy needs in South Sudan are predominantly met by biomass, in particular burning of charcoal, wood, grass, cow dung, and agricultural residues. Most of the energy consumed at the household level is used for basic needs such as cooking and lighting. Over 96% of the population use firewood or charcoal as the primary fuel for cooking, which typically constitutes 90% of the energy used in a rural household. These energy sources are typically more expensive than cleaner

alternatives such as gas, but are also more readily available to rural populations.[52] 75% of households spend 10-15% of their average income on charcoal. Firewood is the most common fuel source for lighting in South Sudan, used by 35% of the population, followed by grass (15%) and paraffin lamps (13%). The distribution of household energy sources is shown in Table 5.2.

***Table 5.2:* Household fuel sources for Cooking in South Sudan**

Cooking Fuel	Urban Households (%)	Rural Households (%)
Electricity	0.5	0.1
Liquefied Petroleum Gas (LPG)/ Natural Gas/ Biogas	0.0	0.0
Kerosene	0.0	0.0
Coal/ lignite	0.3	0.0
Charcoal	54.3	8.6
Wood	41.3	88.0
Straw/ shrubs/ grass	3.2	2.7
Agricultural crop	0.0	0.2
Animal Dung	0.0	0.2
Other fuel	0.0	0.1
No food cooked in household	0.4	0.0
Total	**100.0**	**100.0**

Source: South Sudan Malaria Indicator Survey 2017

5.3. Demand Forecast Model

As part of this Diagnostic, a high-level model was developed to estimate the generation capacity required to meet demand and resulting investment needs under different scenarios through 2040, in line with GoSS estimates of reaching 1,400MW by 2040. The model assumes the following:

1. GoSS targets universal access to electricity by 2040;
2. Public funding for the energy sector remains constrained so that private sector participation will need make up a significant share of sector investment;
3. Development of South Sudan's abundant hydro and solar resources;
4. Domestic oil refining capacity remains limited and oil reserves are exported rather than used domestically;
5. Electricity imports become available from 2027 through the Olwiyo-Juba interconnector.

The model considers three scenarios: a base case in line with GoSS forecasts, a downside scenario in which per-capita consumption does not change, and an optimistic case in which per capita consumption reaches IEA subsistence levels. Modelling results from the different scenarios are shown in Table 5.3.

Table 5.3: Three Cases Analyzed in the Forecast Model

	Downside case (MW)	Base case (MW)	Optimistic case (MW)
2021			

[52]South Sudan National Bureau of Statistics, National Baseline Household Survey 2009https://reliefweb.int/sites/reliefweb.int/files/resources/NBHS%20Final%20website.pdf

Demand	124	131[53]	142
Supply	48	61	78
Demand-Supply Gap	76	70	64
Investment Requirement (USD million)	77	89	105
Share of renewable energy in generation	0%	0%	0%
2040			
Demand	607	1,400	5,330
Supply	628	2,091	5,355
Demand-Supply Gap	(21)	(106)	(25)
Cumulative Investment Requirement (USD million)	2,255	3,463	8,915
Share of renewable energy in generation	59%	62%	63%
Note: a negative demand-supply gap indicates a supply surplus			

[53] Note this demand figure differs from the 300MW figure presented elsewhere in this document. The 300MW is a GoSS estimate for total demand, including latent demand that cannot be served due to supply and affordability constraints. The 131MW in this table refers to actual served demand.

6. Summary of Sector Challenges and Gaps

South Sudan's electricity sector faced many challenges at independence, most of which were only exacerbated by years of conflict and war, and the risk of renewed domestic or regional instability is high. The main barriers to sector development and expansion of electricity access, along with potential options to address these, are outlined below.

Lack of generation, transmission, and distribution infrastructure

The core challenge at the heart of the South Sudanese power sector is that there is not enough energy being generated and not enough infrastructure in place to deliver it to consumers. Willful destruction and lack of maintenance and investment have created an enormous generation infrastructure deficit in South Sudan's electricity system, even to areas that are nominally connected to a power grid. Less than 70MW in installed grid capacity is available to the public against estimated demand of 300MW. While new capacity has been added in Juba through an IPP arrangement, capacity in other cities and towns has decreased as infrastructure was destroyed, abandoned, or inadequately maintained. As a result, most urban centers in South Sudan, including 9 of the 10 state capitals, which host regional governments and health, educational, and other public infrastructure, are not currently served by any sort of organized power system. Coupled with the lack of a transmission grid and weak or non-existent distribution networks, the result is that only consumers in the capital city have access to public electricity, and even there it is often unreliable and expensive. Many households and businesses that can afford to do so instead resort to costly captive power generation, and many more do not have access to modern electricity at all.

Public infrastructure investment options:

- Development of new renewable energy resources, in particular hydro and mini-hydro projects along the Nile, for many of which feasibility studies are already in place;
- Refurbishment or upgrading of existing SSEC / Ezra thermal plants to restore operations or improve efficiency, though the extremely high cost of these and unreliability of fuel and spare parts make this a stopgap solution only;
- Development of isolated grids for urban centers, in particular in state capitals. In some cases, this would need to involve building local generation and distribution infrastructure from scratch, ideally with lower-cost renewable or renewable-hybrid generation options, in other cases, these could leverage existing defunct generation and distribution infrastructure. This could be a precursor to interconnection with a national transmission grid;
- Development of a national transmission grid to better connect renewable supply centers (in particular hydropower along the Nile) with demand and population centers;
- Development of high-potential planned regional interconnection projects including with Uganda, Ethiopia, and Kenya once adequate transmission infrastructure is in place to transport power from national borders to demand centers;
- Rehabilitation of community-led mini-grids in Yei, Kapoeta, and Maridi.

Absence of long-term planning

South Sudan requires urgent investment in both generation and transmission infrastructure, but lacks a coherent, formalized strategy to achieve this in a least-cost, forward-looking manner in line with overarching government objectives. Instead, generation and transmission planning is largely done on an ad-hoc basis and in response to private developer solicitation, which has made the sector vulnerable to inefficient planning and stakeholder capture. A least-cost generation and transmission plan (either jointly or as 2 separate plans) would create a much-needed roadmap on which to base future infrastructure investment. Similarly, South Sudan's low population density and lack of power grid infrastructure mean that large parts of the country and population are unlikely to be economically

connected to a power grid in the near to medium term, but there is no national electrification strategy to guide investment in access and new connections in a systematic manner.

More generally, power sector development and access expansion are not prioritized or even mentioned in most overarching national policy documents. The GoSS prepared a National Electricity Policy in 2013 to outline high-level sector priorities, institutional structure and responsibilities, and medium- to long-term sector development objectives. However, the Policy lacks depth on several important topics and does not reflect the new realities of a dramatically altered power sector landscape post-conflict.

Options for long-term planning and sector development strategies:

- Preparation of robust generation and transmission master plans based on rigorous demand forecasts, localization of demand and supply centers, interconnection options, technological and cost evolution, government objectives and other local considerations to develop a blue-print to guide least-cost sector expansion over the next 10-15 years;
- Preparation of a detailed geospatial analysis, drawing on satellite imagery, generation and transmission master plans, and other geographic and socioeconomic data layers to determine which areas of the country can be most effectively and inexpensively electrified by which grid, mini-grid, and off-grid technologies, and how best to sequence these efforts;
- Inclusion of power sector and achieving power sector targets as key development priority and engine of economic and human capital growth in national policy and strategy documents;
- Update of National Electricity Policy & Strategy to refresh and elaborate on the 2013 Policy and create a detailed guiding document for GoSS's vision for sector development and post-conflict investment.

High cost of supply and low affordability

Power consumption in South Sudan is not only constrained by lack of infrastructure and high costs on the supply side but also by low affordability on the demand side. Power tariffs in the Juba grid, at USD 0.40/kWh, are among the highest in SSA, but are already an improvement over the USD 0.7/kWh that used to prevail while SSEC-managed supply was still operational. As a result, high supply costs are a key obstacle to doing business and a large proportion of households, including urban households, are priced out of centralized power consumption altogether. These high costs are in large part a function of the high generation fuel costs as the country has no refining capacity and has to import generation fuels. Plans to invest in domestic refinement capacity as well as a lower-cost renewable energy generation would likely help to bring down the cost of supply. Though little data is available on JEDCO performance, technical and operational efficiency gains could also bring down the cost of supply which could benefit end-consumers. Finally, while the current tariff structure already favors residential over commercial and industrial consumers to an extent, additional refinements could promote accessibility to a broader customer base.

High connection costs that reach thousands of dollars preclude large numbers of households and businesses from power grid participation altogether. Experiences from other countries that have set up innovative financing mechanisms to spread out connection costs, such as in Kenya or Côte d'Ivoire, could potentially inform connection strategies in South Sudan in future, though will still require significant reductions in absolute connection and energy costs to be feasible.

Options for lowering cost of service and improving affordability:

- Conduct JEDCO cost of service and tariff studies to identify opportunities for operational efficiencies and cost reductions;
- Develop lower-cost sources of power, in particular renewables, to reduce dependency on expensive imported refined fuel;

- Explore opportunities to enhance affordability for residential customers through tariff optimizations and/or financing schemes.

Insufficient and ambiguous legal and regulatory framework

South Sudan's regulatory and legal framework for the energy sector is weak. Few laws or policies governing the sector are currently in place, and those that exist were largely developed in the immediate post-independence period and often have been overtaken by unplanned sector developments that have since occurred. The legal document developed most recently is the National Electricity Bill 2015, which has not yet been fully enacted and contains potential gaps. As a result, key sector responsibilities, mandates, and provisions, including project development, tariff setting, grid code, connection policies, rural electrification, and regulatory oversight are absent or ambiguous.

A particularly acute gap in the energy legal framework is the lack of guidelines or policies for PPPs. Even in cases where this has not deterred investment, it has created obligations and arrangements that may not be optimally aligned with long-term sector development. Thus, while the entry of Ezra into the sector and subsequent creation of JEDCO filled a critical institutional gap and resulted in the lights being turned back on in post-conflict Juba, it also effectively privatized a large portion of South Sudan's power sector, neutered the country's national utility, and created public obligations, including foreign currency convertibility, fuel procurement, and guaranteed off-take that the GoSS has oftentimes struggled to meet. The agreements, which were drafted and signed without any structured procurement process, contain several ambiguities that may cause conflict down the road.

Private sector participation will be especially critical in rural electrification, where electrification modalities such as mini-grids and standalone solar systems that rely heavily on private sector investment and operation are typically least-cost. To date these markets are extremely nascent, however, as private companies remain deterred by a combination of insufficient market opportunity, concerns around outbreak of conflict, and unclear electrification policy environment.

<u>Options for strengthening the legal and regulatory framework:</u>

- Review existing PPP arrangements and establish clear PPP policies and processes to both provide comfort to private investors and protect GoSS from taking on excessive risk. These would need to cover more traditional generation projects as well as more innovative partnerships with mini-grid operators;
- Review and enactment of 2015 Electricity Law to develop a broad legal underpinning for the power sector, including the establishment of an independent regulator and assignment of key sector responsibilities such as electrification;
- Establishment of an electricity regulator. While the Electricity Law will set out the basic contours of regulation, additional effort will be required to define day-to-day regulator operations and procedures, map out current and future resource requirements, and provide adequate staff and capacity;
- Designation and empowerment of appropriate sector entity to develop bankable projects for power generation, transmission, and distribution sectors, taking responsibility for preparation of robust feasibility studies, economic and financial analysis, environment and social impact assessments, etc.
- Designation and empowerment of appropriate sector entity for rural electrification;
- Development of business plans for SSEC, JEDCO, and other commercial or quasi-commercial sector entities to untangle the overlapping institutional mandates, assess their financial viability, and develop forward-looking investment and financing strategies;
- Development of policies and mechanisms to support or at least limit obstruction of market growth for standalone solar and other distributed energy technologies.

Low institutional capacity and efficiency, including lack of data

South Sudan's energy institutions are at once under-resourced and over-staffed. Major technical gaps are ubiquitous, exacerbated by a brain drain of technical staff from the public sector to more lucrative oil sector jobs. Retained staff face a dearth of professional development opportunities, and institutions are only able to provide little in terms of training programs and incentives to employees. At the same time, some sector institutions have large numbers of staff on their payrolls even as their mandates and responsibilities have shrunk and remain ambiguous following partial privatization of the sector.

Low capacity also takes the form of low volume and quality of sector data. As the old maxim goes, if it can't be measured it can't be managed, and much of the current understanding of the sector is based on extrapolation of old data and back-of-the envelope calculation. For instance, financial reports of SSEC more recent than from 2014 could not be collected for this report; neither could reliable commercial and technical loss data for the Juba grid, grid reliability indicators, or precise generation and consumption figures. The state of distribution grids outside of Juba could also only be imperfectly ascertained.

Options for enhancing institutional capacity and efficiency:

- Review staffing at sector institutions to take stock of capacities and resources against institution mandates and efficiency benchmarks;
- Develop staff capacity, both technical and managerial, across all functions at apex sector institutions to ensure adequate implementation of sector policy;
- Implement data production, acquisition, management and dissemination systems and procedures across entire electricity value chain to allow for data-driven, fact-based policy making and planning.