CSPS
SOUTH SUDAN

# ELECTRICITY IN JUBA

*An Assessment of the Recently Launched Grid Electricity*

**JABE A. ROMAN**

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South Sudan Center for Strategic and Policy Studies (CSPS) was established in July 2011 in Juba as a national think-tank, just a week after the independence of South Sudan. Since then the CSPS has been aspiring to inform and shape the path taken by the new country with regard to progress on the noble path of good governance in the human rights and democratic tradition, under the aegis of which the available resources are utilized sustainably for the well-being of the citizenry and humanity at large. CSPS aims at enabling the participatory development and nation-building as guided by applied research, which makes it possible to either influence or predict the best or worst possible future options with strategies and policies that are drawn out of objectively balanced critical thinking. CSPS operates with no compromise on core values and guiding principles of accountability, competence, confidentiality, dialogue, diversity, equity, integrity, professionalism, transparency and trust. See more details about projects, departments, publications and news about CSPS on https://csps.org. ss

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# ACRONYMS

| | |
|---|---|
| **AfDB** | African Development Bank Group |
| **BOOT** | Build Operate Own Transfer |
| **CPA** | Comprehensive Peace Agreement |
| **DFI** | Developmental Finance Institutions |
| **EPC** | Engineering Procurement and Construction |
| **GOSS** | Government of the Republic of South Sudan |
| **HEP** | Hydro Electric Power |
| **HFO** | Heavy Fuel Oil |
| **IPP** | Independent Power Producer |
| **JEDCO** | Juba Electricity Distribution Company |
| **JPDSRE** | Juba Power Distribution System Rehabilitation and Expansion |
| **MED** | Ministry of Electricity and Dams |
| **SCADA** | Supervisory Control and Data Acquisition System |
| **SSA** | Sub Saharan Africa |
| **SSDP** | South Sudan Development Plan |
| **SSEC** | South Sudan Electricity Commission |
| **SSIAP** | South Sudan Infrastructure Action Plan |
| **SSP** | South Sudanese Pound |
| **PAH** | Polycyclic Aromatic Hydrocarbons |
| **PSP** | Private Sector Participation |
| **PPP** | Public Private Partnerships |
| **UN** | United Nations |

## EXECUTIVE SUMMARY

South Sudan's infrastructure was underdeveloped during both the colonial era and subsequent Khartoum rule. Consequently, its electricity sector remained rudimentary. After independence of South Sudan in 2011, the electricity generation capacity in the country through diesel generators was about 30 MW. Transmission lines were non-existent and the distribution system consisted of isolated 11kV distribution lines in the state capitals of Juba, Wau and Malakal. As a result, only about 1% of the South Sudanese population had access to grid-based electricity. Per capita electricity consumption was about 16 kwh per year. The incumbent state utility, South Sudan Electricity Corporation (SSEC), was in charge of the generation, transmission and distribution of electricity. It was faced with several challenges, including a non-cost reflective tariff, high technical and commercial losses and low revenue collection. Consequently, the Corporation was not financially viable, leading to poor maintenance and an inability to expand its sector. As a result, the supplied electricity was highly unreliable. The challenges were further compounded by a lack of both spare parts and fuel in 2015, leading to the shutdown of operations for 3 years. The operations resumed in 2015, but with an operational capacity of only 4.5 MW and fewer customers.

The limited electricity network and the period of no operation meant that most people had to either rely on self- and captive-generation to meet their electricity needs or go without electricity. The high cost of generators meant high cost of doing business, which in turn contributed to a hike in the prices of commodities and services. The limited capacity and unreliability of electric supply also impaired the quality of services provided. For households, the high cost also meant a huge proportion of the income is spent on electricity consumption. Diesel generators have also become a troubling source of noise and air pollution which damage the environment and health of the citizens.

The government commissioned the rehabilitation of Juba electricity distribution system through funds from the African Development Bank Group (AFDB). Ezra Group, a private firm, complemented the distribution project by a 100 MW diesel generation power plant through a BOOT scheme. Hence, Ezra Group will operate the plant for 17 years before transferring ownership back to the government. The project is being rolled out in phases that would be

completed by 2021. The first phase of about 30 MW was completed and electricity in Juba came online on 21st November 2019. Households and businesses have been in the process of being connected to the grid ever since.

The availability of reliable electricity supply is expected to provide benefits such as improved services in institutions, improved security and increased use of appliances, among others, leading to poverty reduction, economic growth and improvement of living standards in Juba.

This study aimed to assess the accessibility of the new electricity and to evaluate its impact on residents and businesses in Juba.

We collected data from 150 individuals who responded to our questionnaire in the three main Payams of Juba, Muniki and Kator. The data was collected from February 2020 to April 2020.

Nearly 65% of the respondents have access to the new electricity, which they credit for increased security, reduced noise from generators, convenience of the use of more electric household appliances, among others. However, they decry the high cost of electricity. More importantly, respondents are concerned about safety issues, including numerous accidents related to power lines. Lack of adequate electricity retail points in the neighborhoods is a source of inconvenience to many of the respondents.

One limitation of the study is that the impact on businesses/institutions was not extensively studied. Out of the 150 respondents, 30 were institutions and there is a disproportion in the types of institutions sampled. Further, the benefits of electricity to businesses such as improved quality of services may take some time to be materialized but the study is conducted parallel to the electricity connections hence not enough time to see such benefits.

Future research can investigate the impact of the electricity on institutions. The research can focus on key institutions such as hospitals, schools, Juba Airport, hotels, water bottling companies etc. The research should focus/emphasize on how having the new electricity has influenced the services they deliver.

# CHAPTER ONE

## INTRODUCTION

Electricity plays a central role in all aspects of human welfare and economic growth, including access to water, agricultural productivity, health care, education, job creation, climate change and environmental sustainability. However, 940 million people or 13% of the world's population lack access to electricity. This lack of access to sustainable electricity supply forces some to pay high prices for poor quality substitutes or go without electricity all together. Lack of access to electricity does not only impose significant constraints on the provision of social services, but it also impedes economic growth, damages human health, increases vulnerability to climate change and traps many in abject poverty (UNDP 2009).

South Sudan's electricity supply chain has been limited since the colonial era and subsequent Sudanese regimes. Following South Sudan's independence from Khartoum in 2011, electricity generation capacity was increased from 5MW to about 30MW through the use of diesel generators (Whiting, et al. 2015). The transmission and distribution networks were also severely underdeveloped. Hence, only about 1% of the population had access to grid electricity (UNDP and MED 2013). The incumbent state utility, South Sudan Electricity Corporation (SSEC), faced a multitude of challenges in supplying electricity to its consumers. The situation was made worse by frequent power outages. In 2015, the challenges of supplying electricity were compounded by a lack of spare parts and fuel shortage, forcing SSEC to cease operations for 3 years (Tiitmamer and Anai 2018). SSEC resumed operations in 2018, but with an even smaller generation capacity and subsequently, even fewer customers.

The challenges with grid electricity prompted most residents in Juba to rely on self- and captive-generation through solar panels and diesel generators. While solar panels only require a one-time capital cost and don't need regular maintenance, the initial cost is quite high, especially when increased accessary appliances and storage requirements are put into consideration. On the other hand, the use of diesel generators is more widespread in the capital. It is estimated that more than 70% of businesses in Juba rely on diesel generators for their operations (Radio Tamajuz 2019).

Diesel power generation comes with a number of challenges, major among which are the high cost of electricity occasioned by exorbitant fuel prices and costly operation and maintenance of the generators (IFC 2019). In addition, startup challenges and regular purchase of fuel result in frequent disruptions of electricity supply which in turn results in the disruption of services and business operations. The high cost of electricity also contributes to the high cost of commodities and services, which means that a huge proportion of a household's income is spent on electricity.

Diesel powered generators are also not environment friendly as they are a source of noisy and air pollution. Air pollutants from diesel generation such as carbon emissions, Sulphur dioxide and nitrogen oxides damage the environment, leading to climate change. These emissions also have an adverse effect on human health as they cause respiratory problems. Although they suffer from the pollution generated by the transportation sector (i.e. exhaust emissions from buses, cars and trucks), Juba residents are at a far greater health risk from diesel powered generators due to their prolonged period of use and close proximity to the users (Awofeso 2011).

A new 100 MW diesel power plant (Radio Tamajuz 2019) was commissioned in South Sudan by a private firm, Ezra Company. The project is being rolled out in phases. The first phase of the new power plant was launched on 21$^{st}$ Nov 2019, and the remaining phases are expected to be completed by the end of 2021. The first phase has a capacity of 20 MW and is expected to supply electricity to about 30,000 homes and businesses. It is expected that upon completion of all the phases, the electricity from the power plant will serve about 100,000 homes and businesses (Toby 2019).

The new electricity is expected to benefit households and businesses in many ways, including improved security, lower electricity bills, lower pollution levels, and improved delivery of services in institutions, especially priority institutions such as schools, hospitals etc. Overall, the new electricity is expected to contribute to improved welfare of the citizens and economic development.

However, whether Juba residents have actually benefited since the launch of the power plant, accessibility attributes such as affordability, reliability, efficiency and arising issues of environmental effects and health hazards due to the new power plant, are yet to be comprehensively interrogated. Thus, the main aim of this study is to thoroughly and methodically

investigate the benefits, accessibility attributes as well as relevant issues associated with the new grid electricity.

1. **The objectives of the study are:**

    - To identify the stakeholders
    - To determine the number of people in Juba who have benefited since the launch of grid electricity.
    - To highlight the environmental effects and other hazards of the new electricity, and
    - To evaluate challenges and develop possible solutions.

2. **The report is structured as follows:**
    - **Chapter One i**ntroduces the study; its objectives and structure
    - **Chapter Two p**resents the methodology used to obtain data for the study
    - **Chapter Three o**utlines South Sudan's electricity supply chain from then to present. It highlights the challenges faced by SSEC during its operation, the contributing factors to SSEC ceasing its operations for three years and the two projects (rehabilitation of the distribution network and the new power plant) that have led to the availability of grid electricity in Juba.
    - **Chapter Four** presents the legal and regulatory framework governing South Sudan's electricity sector, the national institutions involved in the electricity sector and their roles and responsibilities.
    - **Chapter Five** presents the findings of the quantitative portion of the study.
    - **Chapter Six** discusses the findings of the study, compares the challenges experienced with other countries and gives recommendations on the challenges of the new electricity based on electricity strategies applied by other counties, and
    - **Chapter Seven** articulates the conclusion of the stud

# CHAPTER TWO

## METHODOLOGY

**Research design:** The research design used in this study is mixed methods. Because the research aims to assess the impact of the new power plant on the lives of residents of Juba, quantitative design is used to gather data from the residents of Juba. This research method allows the researcher to quantify opinions and attitudes, among others, which enables this study to arrive at evidence-based conclusions that are supported by solid data about the current status of the Juba electricity situation. Qualitative design gathers data from some of the key stakeholders in the electricity sector to back up the primary data and give a more accurate overall picture of the current electricity situation in Juba.

**Setting and participants:** The city of Juba is the area of the study. The research focused on the three main Payams in Juba City; namely Juba, Muniki and Kator. Households and businesses/institutions in the three Payams constituted the pool of the participants on the study.

**Instrumentation:** The study utilized questionnaires to glean data from respondents of diverse social and economic backgrounds. Questionnaires were chosen because they are a reliable and efficient method for the researcher to gather data from respondents within a short time period. One type of questionnaire was used in this study to collect data from respondents with access to the new electricity and another type for those who were not yet connected to the new electricity. The aim of the questionnaire for those respondents with access to the new electricity was to gauge the electricity situation of households/institution before and after connecting to the new electricity. For those not connected, the aim was to gauge their current situation and reasons for their lack of access to electricity.

As a complementary tool, interviews were also conducted with representatives from SSEC and Juba Electricity Distribution Company (JEDCO). The interviews consisted of brief open ended questions.

**Procedure:** The study used non-probability sampling method because of limitations in available resources and due to the fact that the study is a small scale pilot project. It 150 respondents was deemed a good sample size for such a study. Convenience sampling have also been used to identify

respondents. The researcher went to public areas in the three Payams and asked willing respondents to participate in the questionnaire. The most accessible institutions in such areas are pharmacies and shops. Thus, of the 30 institutions sampled, 17 were shops and 9 were pharmacies. Some of the household respondents were also able to identify other respondents in their respective neighborhoods to answer the questionnaire.

**Data processing and analysis:** The quantitative data was analyzed using Excel Software. The qualitative portion of the data was analyzed manually, where the researcher identified common opinions and grouped them together. Interview results were also analyzed manually.

**Ethical considerations:** The researcher took several ethical issues into consideration. First was the informed consent of the participants in the study. Prior to answering the questions in the questionnaire, the respondents were first informed about the purpose of the research and their consent was sought before proceeding with the questionnaire. Secondly, the identity of the respondents as well as the names of their respective organizations and businesses have been kept confidential.

**Problems and Limitations:**

i. Due to limited resources and the use of nonprobability sampling methods, the findings of the study cannot be used to generalize the electricity situation of all the residents and business/institutions in Juba.
ii. The research period (January 2020 to April 2020) during which data was collected might have been too early and too short to conduct a full assessment of the impact of the new power plant on the lives of the respondents, considering the fact that the electricity was launched on 21st Nov 2019. Some neighborhoods and some households who participated in the survey were still being connected to the grid when the study was conducted.
iii. In order to overcome language barriers, the researcher had on several occasions to translate the questions in the questionnaire from English into "Juba Arabic." the common language in Juba, in order to ensure that the intended meaning of the question(s) was not lost or altered.

iv. The preconceived notion that one needs to be well-educated or knowledgeable in issues of electricity to be able to answer the questions contributed to unwillingness of many people to participate in the research.

v. That was a degree of bias as the researcher was the one collecting the data.

vi. Lack of access to some people, organizations or documents that could have widen the scope of the research and its findings.

## CHAPTER THREE

# HISTORY OF ELECTRICITY IN SOUTH SUDAN

South Sudan has never had a strong electricity supply chain backbone. During Khartoum rule, Juba was supplied by a 5MW power station (Tiitmamer and Anai 2018). Following the signing of the Comprehensive Peace Agreement (CPA) in 2005, the electricity generation capacity was increased to 12 MW through government purchased thermal generators (diesel and HFO) that lasted for 3 years (Tiitmamer and Anai 2018). After three years, the generators broke down and more were bought. As of 2013, the electricity network in South Sudan consisted of three isolated distribution systems located in the three urban centres of Juba, Wau and Malakal (UNDP and MED 2013), totaling about 55kms of 11kV lines in Juba (African Development Fund 2013). The total operational capacity of the South Sudan electricity network was less than 20 MW, yet the estimated demand at the time was 300 MW.

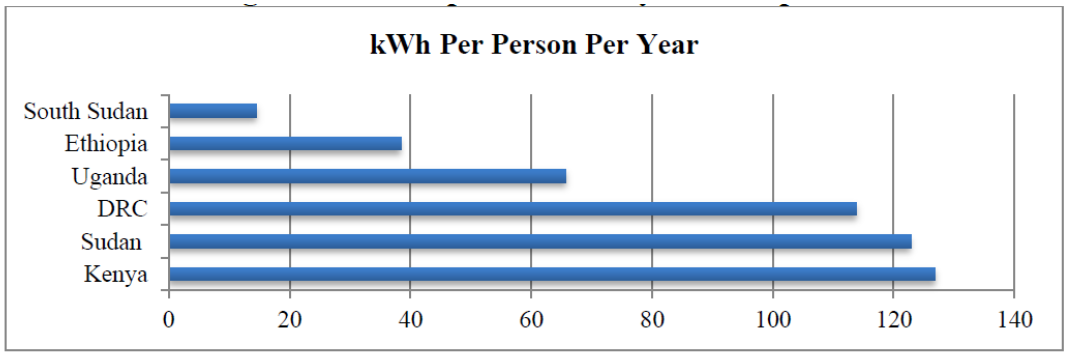
**Table 3.1 2013 Generator capacities in the three urban centres of Juba, Wau and Malakal**

*Source: Adapted from* (Whiting, et al. 2015)

| Area | Units | Capacity per Unit | Total capacity | Comment |
|---|---|---|---|---|
| Juba (Cummins) | 8 | 1.5 MW | 12 MW | Operational |
| Juba (Wartsila) | 5 | 1 MW | 8 MW | Not Operational |
| Wau | 2 | 1 MW | 2 MW | Operational |
| Malakal | 6 | 0.8 MW | 4.8 MW | Operational |

The average electricity consumption per capita in South Sudan in 2013 was less than 20 KWh, which was the lowest amongst its neighboring countries and much lower than the average per capita consumption of 80 KWh in Sub Saharan Africa (World Bank 2013). Not only was South Sudan's electricity consumption one of the lowest in the world, it fell below the UN threshold for basic energy consumption. The UN electricity threshold consists of three levels: basic human needs, productive use and modern society needs (UN 2010). The first level is the basic level where

an average yearly consumption of 50-100 KWh per person per year is needed to meet the basic energy needs of cooking, heating, lighting, communication, healthcare and education. Productive use involves the usage of modern energy to improve productivity in sectors such as agriculture whereas modern society involves a consumption of 2000KWh per person per year for many more domestic appliances, increased cooling and heating requirements and private transportation.




*Source: World Bank estimates*

**Figure 3.2 2013 Per Capita Electricity Consumption of South Sudan and its neighbors**

SSEC was responsible for the generation, transmission, distribution and sale of electrical energy to consumers. As of 2013, there were 11,200 SSEC customers in Juba and a total of around 17,000 SSEC customers in all South Sudan, representing a national access rate of about 1% of the population, (UNDP and MED 2013) (Whiting, et al. 2015) and an urban access, rate of about 7% (Africa Infrastructure Country Diagnostic 2011). While electricity access rates are generally the lowest in Sub Saharan Africa, South Sudan has one of the lowest access rates in Sub Saharan Africa. In comparison, in 2011, East African countries of Kenya and Uganda had an access rate of 10% and other low income countries had an access rate of 33% (Africa Infrastructure Country Diagnostic 2011).

The electricity sector in South Sudan was heavily subsidized by the government. Fuel, spare parts, salaries of SSEC staff, among others. was paid through the budget of the Government of South Sudan (GoSS) (UNDP and MED 2013). The average tariff rate in 2013 was $ 0.22 per KWh, whereas the cost of generation was $0.70 per KWh (UNDP and MED 2013). Thus, the tariff was not cost reflective as the difference was covered by government subsidies. In addition, the cost of

connecting each household to electricity supply system was ranged between $500 and $600 (World Bank 2014). The tariff was adjusted to $0.36 per KWh and $0.43 per KWh in in 2014 and 2017 respectively (Deng 2018). Tariff adjustments were intended to allow SSEC to operate at break-even point with zero profit but the scheme failed to achieve its intended goals because the South Sudanese pound (SSP) began to depreciate against the United States dollar (Deng 2018).

Electricity tariffs are generally higher in Sub Saharan Africa than in the rest of the world. The average tariff in Sub Saharan Africa is $0.18 per KWh (Africa Infrastructure Country Diagnostic 2011). Thus, South Sudan has one of the highest tariffs in the region. One of the reasons for the high tariff cost is that small scale power system tends to sabotage the system's ability to benefit from economies of scale (International Monetary Fund 2013). Sub Saharan countries with small scale power systems similar to South Sudan's typically face generation costs that are thrice as high as those experienced by systems with capacity above 500 MW (Africa Infrastructure Country Diagnostic 2011). South Sudan's power system is well below the minimum efficient scale system of around 200MW.

Another reason for the high tariffs is the choice of fuel. The operation costs of thermal plants, which are powered by diesel and heavy fuel oil (HFO), are much higher than those powered by either natural gas or renewable sources such as hydroelectric power (HEP) (International Monetary Fund 2013).

In spite of being a landlocked oil exporting country, South Sudan lacks refineries and its physical infrastructure is severely underdeveloped. Thus, the country faces challenges that include the import of expensive fuel oil, variations in fuel price, exorbitant transportation costs and logistical challenges associated with the supply chain (Africa Infrastructure Country Diagnostic 2011), these challenges lead to higher operating costs. It is worth noting that one of the catalytic problems that led to the 2015-2018 shutdown of SSEC operations was the lack of fuel due to the country's sporadic fuel crisis of 2015-2017 (Tiitmamer and Anai 2018).

Technical and commercial losses also added significant costs to the state utility. Most of SSEC's customers were fed via a network of old and relatively large distribution transformers (World Bank 2013) leading to significant distribution losses. The system also consisted of postpaid meters and

some prepaid meters. The conventional A base mount prepaid meters were vulnerable to theft and the postpaid meters had not been calibrated, cleaned or maintained for over ten years. Meters were not functional in some houses. The challenges with the meters led to incorrect billing, delays in billing and irregular distribution of bills (World Bank 2013). Due to this lack of regular operational activities, consumers didn't pay bills and no remedial actions were taken against them (World Bank 2014). The average bill collection rate in South Sudan at that time was about 40% (Africa Infrastructure Country Diagnostic 2011). The technical losses were estimated to be about 30%, making it the sub Saharan country with one of the highest hidden costs based on its utility size.

The financial, technical and human capacity constraints faced by SSEC limited its ability to operate, maintain and expand generation facilities and distribution networks (African Development Bank 2014). Consequently, most residents and business owners had to rely on self and captive generation. Even for its few customers, the SSEC's electricity supply was weak, plagued by frequent outages and it was not available at times for a full 24-hour period (African Development Bank 2014). SSECs operational challenges were further exacerbated by the devaluation of SSP and fuel shortage crisis of 2015-2017, resulting in lack of fuel and spare parts. As a result, SSEC ceased to operate from 2015 to 2018. It resumed operations in 2018, with a capacity of only about 6 MW which was supplied to an even smaller select group of customers.

The South Sudan Development Plan (SSDP) of 2011-2013 and South Sudan Infrastructure Action Plan (SSIAP) identified infrastructure as a key priority for South Sudan. In response, GoSS requested funding from AfDB to finance the Juba Power Distribution System Rehabilitation and Expansion (JPDSRE) project. The project aimed to strengthen the distribution networks in Juba so as to provide reliable electricity supply from existing and future generation facilities to satisfy the suppressed and ever growing demand for electricity in the city. The upgraded and reinforced electricity supply, which was projected to contribute to improved quality of service provided by the national utility, was expected to improve the quality of life of the residents, promote businesses, and propel economic growth and reduce poverty in South Sudan (African Development Fund 2013).

The aging 55 km of medium voltage 11kV lines were replaced by 33kV lines while 90 km of the 33kV lines were deployed to new areas. New 370km of 415/230 volt lines were constructed. Old

0.415/11 kV transformers were also replaced by 195 overhead 33/0.415 kV transformers which are compatible with the new design (African Development Fund 2013). The 33kV system complies with international standards and regional practice. The replacement of the 11kV distribution system with 33kV distribution system will mitigate distribution losses.

Bare wooden poles were replaced by pre-stressed concrete poles. Furthermore, 20,000 prepaid meters were purchased and installed for new customers and for those with postpaid or non-functional meters. These measures will reduce commercial losses. The expansion also means that more customers, even those further away from generation stations/ and substations, will be connected to the grid. The project, once completed, will reduce power losses by 10% (African Development Fund 2013).

**Figure 3.3: Technicians working on Juba's Distribution Network in 2019**

*Source: African Development Bank*

The JPDSRE project is complemented by the new Ezra Group power plant, which was contracted under the Build-Operate-Own-Transfer (BOOT) scheme in 2017, and whose first phase was launched in Nov 2019. At its completion, the power plant is expected to have a generation capacity of 100MW. The ownership of the plant will revert to the government of the Republic of South Sudan after 17 years of operation. Located in Mangala County, the diesel-powered plant transmits

grid electricity to substations in Juba for distribution to customers through the new 33kV distribution system. Thus, grid electricity is now at long last available to Juba residents.

## CHAPTER FOUR

# SOUTH SUDAN ELECTRICITY SECTOR

South Sudan currently lacks an adequate legal and regulatory framework for the electricity sector. Therefore, there is no formal Electricity Act, economic tariff structure, or power grid code (World Bank 2014). The only legal document for the electricity sector is the Southern Sudan National Electricity Sector Policy (NESP) 2007. It was developed by the Ministry of Housing, Lands and Public Utilities, and was approved by the Council of Ministers of the day on May 9, 2007. Its objectives were to define effective electricity sector's institutional relationships, to establish a new regulatory authority to balance the interests of the consumers and those of electricity service providers, and to identify funding mechanisms to finance electric investments by the now defunct government of Southern Sudan (GoSS). Although the policy has been passed, it has not realized its objective. NESP's successor, the draft Electricity Bill of 2013 is yet to be enacted. The draft Bill became the National Electricity Bill of 2015 after it was first passed by Parliament. It is in the process of ratification and will come into effect once signed by the President.

The purpose of the National Electricity Bill of 2015 is to provide for the establishment of a regulatory framework that governs the generation, transmission, bulk supply, distribution, supply, export and import of electricity, and system operation and related matters. The Bill will establish a regulatory authority called the National Electricity Regulatory Authority. The Bill specifies that the Authority shall be an autonomous corporate body with perpetual succession. Its responsibilities shall include:

(i) maintaining and securing stable electricity supply for South Sudan while continuing to improve the quality and enhancing electricity access;

(ii) protecting the interests of consumers and other users with respect to the prices charged, the quality, service levels, permanence and variety of services provided in the electricity industry;

(iii) encouraging PSP in the electricity market;

(iv) promoting safety and service quality and mitigating, wherever possible, any adverse impact of electricity; and

(v) encouraging and promoting energy efficiency and the use of renewable energy.

Towards discharging its responsibilities, the Regulatory Authority shall:

(i) review and approve tariffs and charges for the supply of electricity;

(ii) regulate the electricity market by granting licenses;

(iii) monitor and enforce the performance of regulated entities and the functioning of the electricity market;

(iv) facilitate the settlement of disputes between regulated entities;

(v) prevent the abuse of monopoly or market power in relation to the electricity in the ESI.

The national institutions involved in South Sudan's electricity sector include:

1. **The Ministry of Electricity and Dams** whose responsibilities include oversight of the institutions of the electricity sector, development of hydroelectric dams, formulation of the necessary legislation and regulatory policies related to the management and development of the electricity sector, including the development and implementation of strategies and policies related to electricity generation and transmission (African Development Bank 2014).

   Currently, there is no independent regulatory body. Therefore the Ministry of Electricity and Dams acts also as the regulatory body (UNDP and MED 2013) that determines the tariffs. This dual function of the Ministry of Energy and Dams as a policy maker and implementer and regulator of its own policies raises grave issues of conflict of interest (UNDP and MED 2013).

2. **South Sudan Electricity Corporation** (SSEC), which was established on 19 December 2006 vide Council of Ministers Order No. 30/2006 (African Development Bank 2014), is the vertically integrated state utility. It is to be involved in all access related projects as well as carrying out its current role of operations and equipment maintenance. It is mandated to purchase power from independent power producers (IPPs) and promote electricity interconnection with neighboring countries (African Development Bank 2014). The

Corporation was conceived as an autonomous national utility that functions as a public service undertaking (PSU) in accordance with the draft South Sudan Electricity Corporate Bill of 2010. However, it currently functions as a unit of the Ministry of Electricity and Dams (UNDP and MED 2013). All its expenditures and budgets are rolled into the ministerial budget (UNDP and MED 2013) (World Bank 2014).

Overall, both the Ministry of Electricity Dams and South Sudan Electricity Corporation are severely lacking in capacity (World Bank 2014). There is no clarity in the roles and responsibilities of the two institutions. Once enacted, the draft Electricity Bill of 2015 should clarify these institutional relationships as they are effectively defined in the draft Bill.

South Sudan encourages private sector participation in its electricity sector through private-public-partnership (PPP) projects such as independent power producers (IPPs), build-operate-own-transfer (BOOT) and engineering-procurement-construction (EPCs) (Kumba 2015). The legal and regulatory framework for the private sector involvement such as PPAs and FITs are in the process of being developed with a view to facilitate the effective participation of the private sector. One of the incentives for private sector participation is the Investment Act of 2012 that offers attractive rates of return and guarantees investors the repatriation of their profit (Kumba 2015).

## CHAPTER FIVE

# STUDY FINDINGS

### Access and Coverage

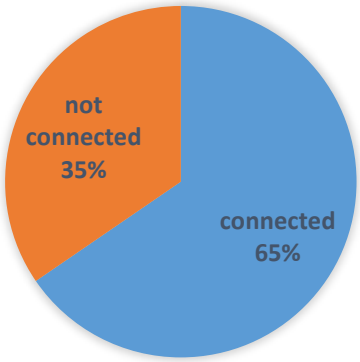



**Figure 5.1 Graph showing connectivity status of the respondents**

Nearly 65% of the 150 respondents have access to the new grid electricity whereas the other 35% do not have access to grid electricity. About 41% of those without access are waiting for the supply to be switched on in their respective neighborhoods. Considering that the study was conducted concurrently with the process of connecting household to the grid, it is assumed that these households would have been connected to the grid at the end of the scheduled launch. Thus, the new access rate among the respondents would stand at 79% with Juba, Kator and Muniki constituting 35%, 30% and 35% of the electricity access respectively. Thus, Kator Payam has the fewest number of connected respondents connected to the new grid electricity.

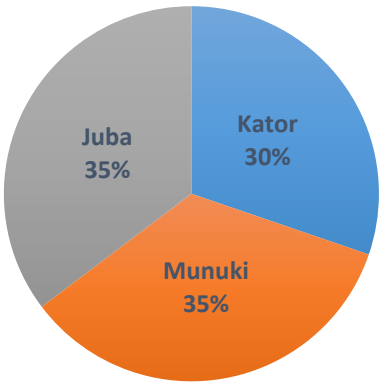


**Figure 5.2 Graph showing access rate by Payam**

Nearly 82.93% of household respondents from Juba have access to the new electricity, 79.07% in Munuki and 69.44% in Kator. Thus, Juba had the highest access rate while Kator had the lowest. A graph of the access rate by Payam, including those waiting to connect, is shown in Figure 5.2 below. The access rate at the household level of each Payam is plotted in Figure 5.3 below.

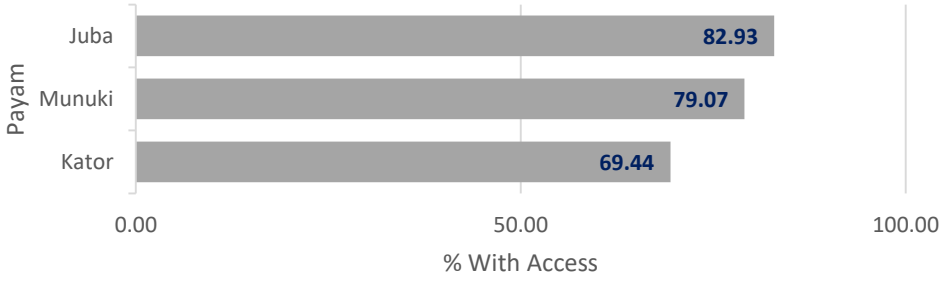



**Figure 5.3 Household Access rate in the three Payams**

**Reasons for Lack of Access to Grid Electricity**

Respondents expressed a wide range of reasons for their lack of access to the new grid electricity. Excluding respondents who are waiting to be connected to grid electricity, 6% of respondents without electricity cite lack of information, 10% point to high tariffs and infrastructure, 16% lack capital to connect at the present time, 39% have no grid coverage in their respective neighborhoods, 10% because of high cost to get grid coverage, and 19% because of other reasons.

The respondents residing within grid coverage but chose not to connect cited high tariff cost as the reason for their reluctance. Second are respondents living within coverage area but lack capital but plan to connect to the grid in the future. There are also those who have no grid coverage but are in close proximity to erected poles. They need a few poles in order to extend the coverage to their homes or businesses. However, this group of respondents need to purchase the poles themselves.

There are, therefore, three types of respondents who initially had no grid coverage. One group had no grid coverage but purchased their own electricity poles and they now have access to electricity. The second group had no grid coverage and is not willing or able to make attempts to access grid coverage. The third group include respondents who were initially willing to pay to extend grid coverage to their household or businesses but found the cost of grid extension inhibiting, causing them to change their minds. Although minor reasons for lack of connectivity such as the absence of head of the household when the technicians came to make the connection and the technicians wrongly skipping the household or business are also there, the main reasons for not being connected to grid electricity are lack of grid coverage and the high costs of installation and tariffs. Figure 5.4 is a graph showing the various reasons cited by the respondents who are not connected and are not waiting to be connected to grid electricity.

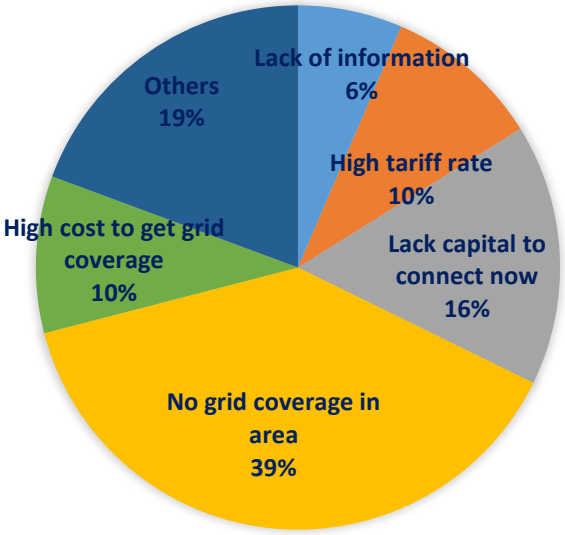



**Figure 5.4 Graph showing reasons why respondents are not connected (those waiting for connection or turn on of supply are excluded)**

**Sources of Previous and Current Electricity**

The study combines the source of electricity supply which respondents used prior to their being currently connected to the grid and the current source of electricity supply for respondents who are not yet connected for the purpose of providing a reflection of the common electricity sources in Juba before the launch of the new electricity.

The study has found that 41% of all the respondents used their own generators as the source of electricity supply, 21% utilized solar power, 14% were connected to neighborhood grids, 1% relied on government electricity, 4% used both solar and own generators while 19% had no electricity at all.

Neighborhood grids, which are usually powered by diesel generators, combine with privately owned diesel generators to constitute 55% of the most common electricity source in Juba prior to the launch of the new electricity.

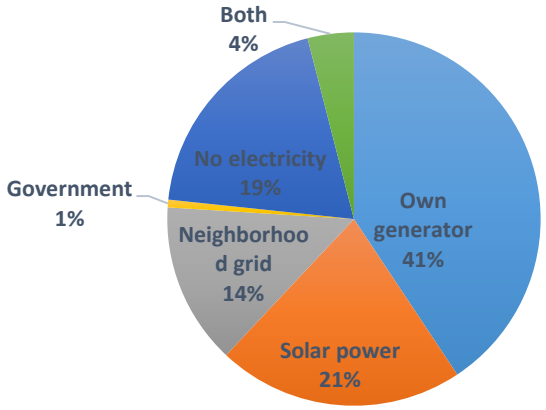



**Figure 5.5 Graphs showing the electricity sources used before the launch of the new electricity**

At the household level, 40% of the respondents previously used their own generators, 27% relied on solar power, 7% used neighborhood grids, 1% used government electricity, 3% used both solar and generators and 22% had no electricity. As for institutions, 43% of the respondents used their own generators, 40% relied on neighborhood grids, 7% had both solar and generators and 11% had no electricity at all. Although generators were the most common source of electricity for households, some of the households relied solely on solar power for electricity. On the other hand, no institutions relied on solar power alone for electricity. Institutions that used solar power also

had a backup generator. Hence, all institutions that had access to electricity either owned their diesel generators or were connected to a neighborhood grid. Figure 5.6 shows sources of electricity supply for households (A) and institutions/businesses (B) before the launch of the grid.

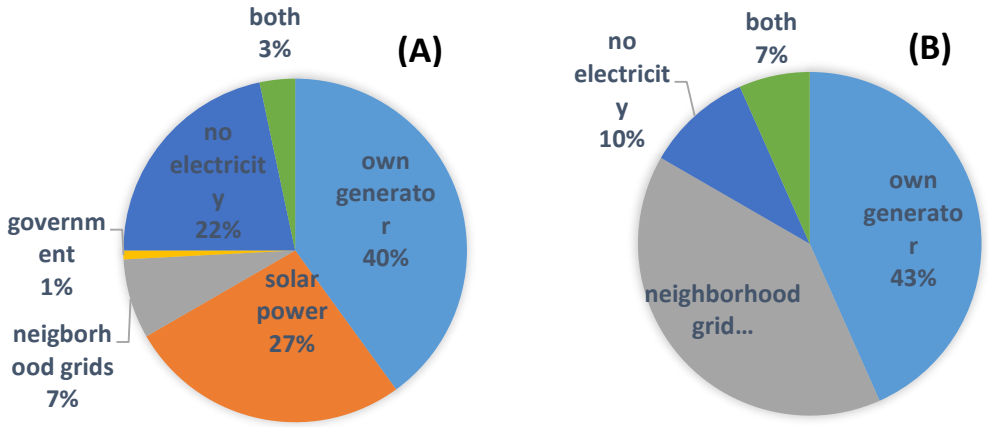



**Figure 5.6 Graphs showing the electricity sources for households (A) and institutions (B) before the launch of the electricity grid**

**Prepaid System**

The respondents were asked whether having a prepaid electricity supply system would make it easier for individual households and businesses to manage a budget that guide their consumption of electricity. Roughly 7% of respondents who are connected to the grid strongly agree that the prepaid system makes managing consumption easier. Nearly 66% agreed that the prepaid system makes managing consumption easier whereas 19% of the respondents were neutral and 8% of the respondents disagreed. The results are not very dissimilar for those who are not connected as 15% of them strongly agree that it will make managing consumption easier whereas 72% agree, 7% of the respondents are neutral and 6% disagree. The mean for those connected is 74% and those not connected is 79.2%.

While most respondents agree that the prepaid system is good for managing consumption, those respondents who are not yet connected agree more than those already connected. some of the neutral opinions among connected respondents come from those who were recently connected at the time of the questionnaire apparently because they were still observing the system. One of the reasons cited by some of the connected respondents for their disagreement was the inefficiency of

the system which allows the consumption of electricity despite shutting off their electricity supply. The results are presented in Figure 5.7 below.

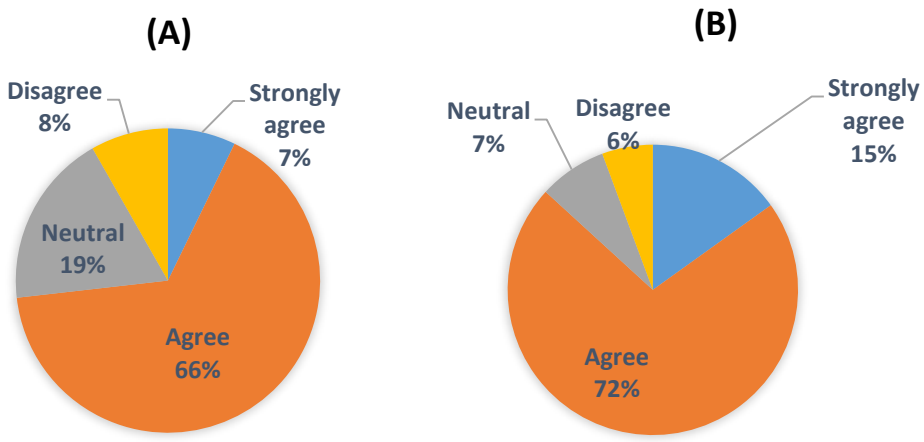



**Figure 5.7 Graphs showing opinion poll of those connected (A) and not connected (B) on the prepaid system**

**Affordability**

The respondents who are connected to the new electricity were asked to compare the affordability of the new electricity compared to their previous electricity supply. On the other hand, respondents who ae not yet connected to the new grid electricity were asked whether they think it would be more affordable than their currently electricity supply. The results are presented in Figure 5.8 below.

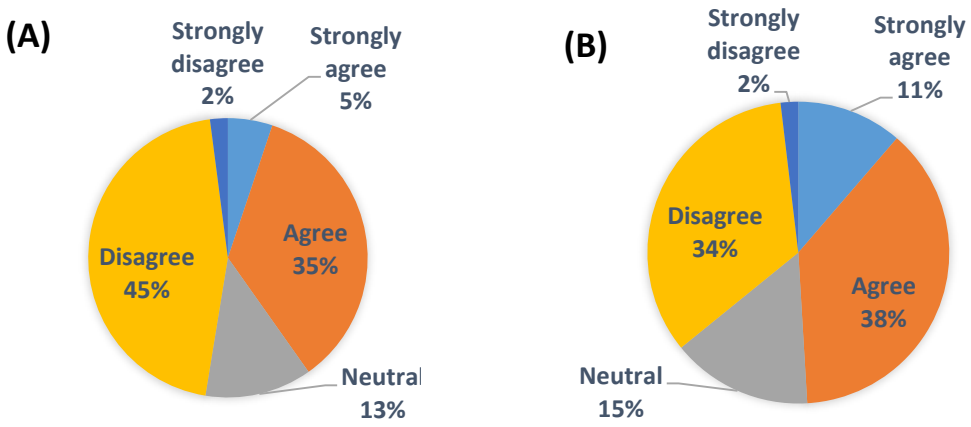



**Figure 5.8 Graphs showing opinion poll of connected (A) and not connected (B) respondents on affordability of new electricity compared to previous power supply**

Of the respondents who are connected to the new electricity system, 5% strongly agree that it is more affordable than the previous supply, 35% agree, 13% are neutral, 45% disagree and 2% strongly disagree. Of the respondents not connected, 11% strongly agree, 38% agree, 15% are neutral and 34% disagree and 2% strongly disagree.

The mean opinion poll for those connected to the grid is 59.8%, mostly neutral. Therefore, even though the new electricity is more affordable in comparison to previous sources, the cost difference between the new electricity and previous sources is not that significant. On the other hand, the mean opinion poll of respondents who are not connected to the new grid electricity is 64.4%. Hence, respondents who are connected to the grid anticipate that the new electricity will be more affordable than their current sources of electricity.

The result of affordability survey among respondents who are connected to the new grid electricity are plotted against the power supply previously used by the respondents. The results are shown in Figure 5.9 below.

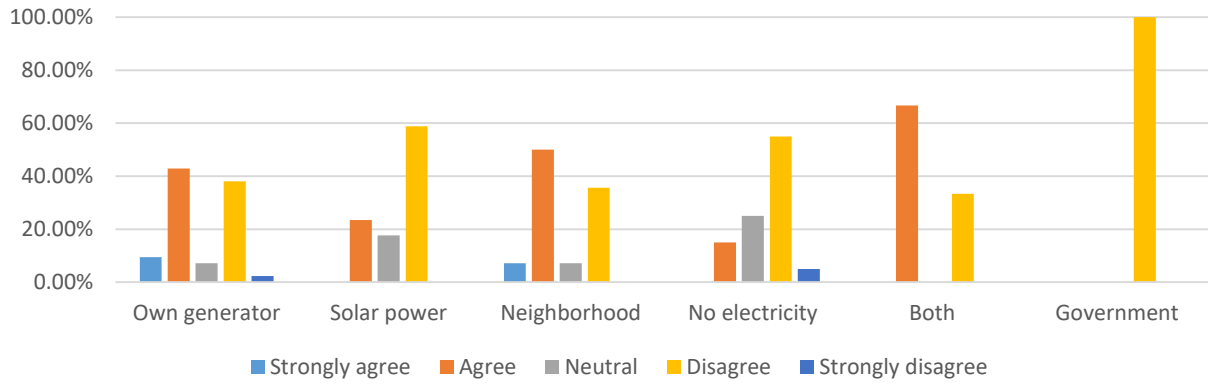



**Figure 5.9 Affordability Opinion Poll of Respondents Connected to Grid Electricity Based on Their Previous Electricity Source**

The mean polls are 63.8% for respondents who own generators, 53% for respondents who use solar power, 65.8% for respondents who use neighborhood grids, 50% for those respondents who had no electricity, whereas 66.6% for those respondents who rely on both solar and generators and 40% for those respondents who had access to government supplied electricity. Thus, the group of respondents who found the electricity more affordable were users of neighborhood grids, owners of generators and users of both solar and generators, respectively. Respondents who utilize solar power and those who had no electricity were mostly neutral, whereas those respondents who had access to government electricity found the new grid electricity less affordable. Hence, the new electricity is more affordable for those respondents who relied on diesel generators for electricity.

### Availability and Reliability of Electricity

The previous electricity hours for respondents who are connected to the new grid and the current electricity hours for respondents who are not yet connected are combined to provide a reflection of the hours of electricity prior to the new electricity system. 19% had no access to electricity so no hours of electricity usage, 51% had 3 to 6 hours of electricity, 17% had 6 to 12 hours, 8% had 8 to 12 hours and only 5% had more than 18 hours of electricity. Thus, most people in Juba had only 3 to 6 hours of electricity and only 5% had more than 18 hours of electricity. The results are shown in Figure 5.10 below.

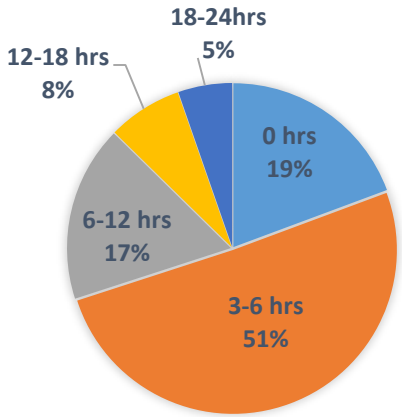



**Figure 5.10 Previous hours of electricity for households and institutions in Juba**

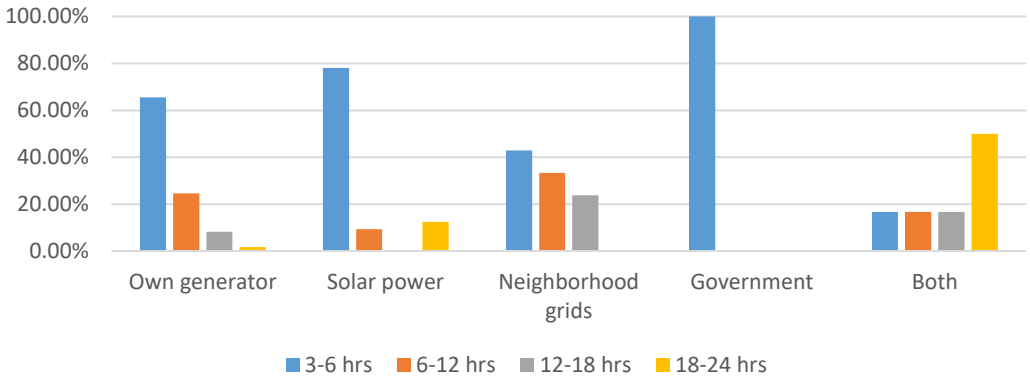



**Figure 5.11 Previous Hours of Electricity Based on the Power Supply Source**

The previous hours of electricity are varied for each source. However, for each source, the hours for most respondents were 3 to 6 hours, except for respondents with both generators and solar

power. Nearly 50% of respondents who own both diesel generators and solar panels had over 18 hours of electricity whereas 25% of respondents with access to neighborhood grids had more than 12 hours of electricity.

Electricity from neighborhood grids was available to household and business in neighborhoods such as Konyo Konyo market in Kator and Suk Libya in Munuki. While neighborhood grids provided electricity during business hours, their electricity supply was intermittent. For example, a neighborhood grid in Muniki provided electricity between 9am and 2pm but there was no electricity between 2pm and 5pm, and then there was again electricity between 5pm and 7pm.

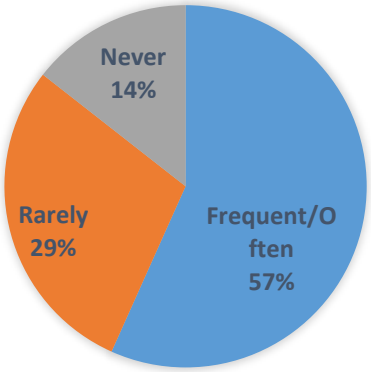



**Figure 5.12 Graph Showing the Frequency of Outages of the New Electricity System**

On the other hand, the new electricity system is available for 24 hours daily. Nearly 57% of the connected respondents said that power outages are frequent, 29% of the respondents reported that the outages are rare whereas 14% of the respondents opined that power outages don't ever occur. Respondents, therefore, believe that outages in the new system are frequent. However, respondents who are commented to the new grid said that power outages occur only for brief periods ranging usually between 5 to 30 minutes, at most 1 hour. The outages usually happen when the technicians are connecting households/businesses in that area. Once connections in a certain area have been completed, the frequency of outages in that area becomes rare and occur usually during a heavy downpour. The new grid system does not only provide 24 hours of electricity but it also ensures a more reliable electricity supply to customers.

Before connecting to the new electricity, 9% of households used electricity at home only for lighting and charging electronic equipment and 60% of the households used electricity for lighting, charging equipment and low consumption appliances whereas only 31% used high consumption appliances. Thus, most households used electricity for low consumption appliances such as TV and fans. However, after connecting to the new electricity, only 9% of households used electricity only for lighting and charging equipment whereas 35% of households used electricity for low consumption appliances and 56% of households used the new electricity for high consumption appliances. There is, therefore, a significant increase in the proportion of households using high consumption appliances, increasing electricity consumption. Some respondents commented to the new grid electricity said that they used high consumption appliances such as the refrigerator and iron box when they first gained access to the new electricity but said that they had to forego the use of high consumption appliances due to the high cost of electricity.

**Electricity consumption of households**

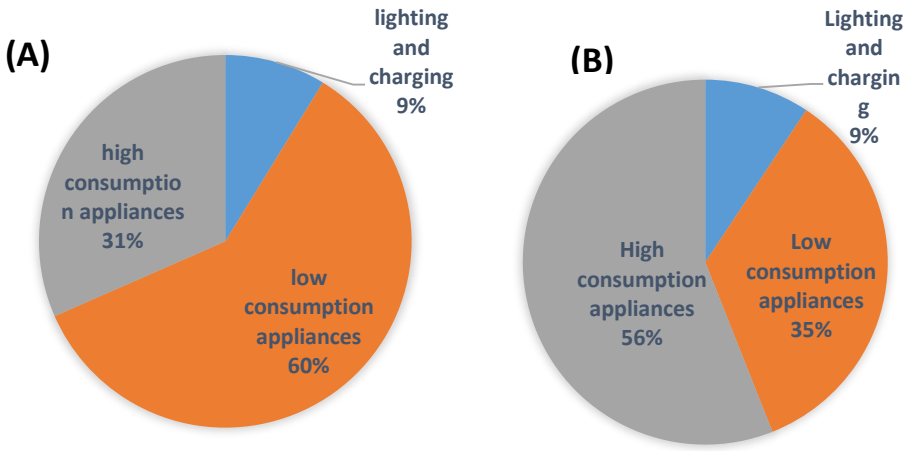



**Figure 5.13 Comparison of households' electricity consumption before the new electricity (A) and now after the new electricity(B)**

**Environment, Health and Safety**

All the respondents were asked whether having an electricity source that is environmentally friendly is as important as having one that is affordable and available. Nearly 7% of the respondents strongly agreed that environmental sustainability is as important the availability of electricity whereas 85% agreed. In the meantime, 7% of the respondents were neutral and 0% disagreed while only 1% strongly agreed. The mean opinion poll is 3.97, which means that most respondents agreed that environmental sustainability is as important as the affordability and availability of electricity. **Figure 5.14** shows the results of this section of the questionnaire.

The question on environmental sustainability was the most misunderstood question in the whole questionnaire. Both the setup of the question and the use of the phrase "environmental sustainability" compelled the researcher to paraphrase the question most of the time. Consequently, most respondents tended to agree that environmental sustainability was important when the researcher paraphrased the question to read "apart from affordability, is it important that the source of electricity does not harm the environment?"

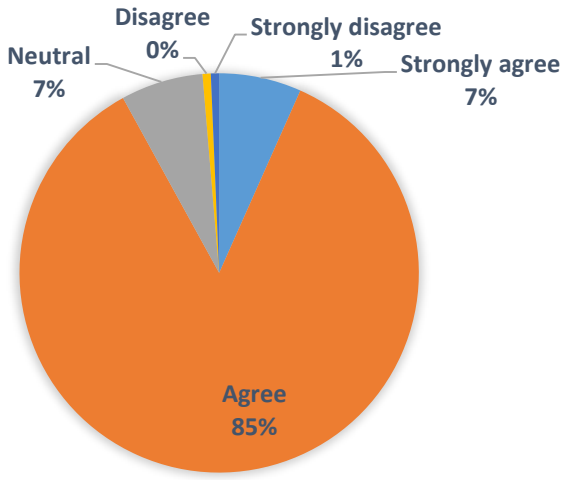



**Figure 5.14 Opinion poll on Environmental sustainability**

When asked whether there had been electricity safety incidents in their neighborhoods, 18% of the respondents who use the new electricity since its launch had experienced or witnessed electricity

safety incidents within their respective neighborhoods. These safety incidents include burning wires and electric poles; burning of houses and transformers; and wrong connections, among others. The results are shown in **Figure 5.15 below**.

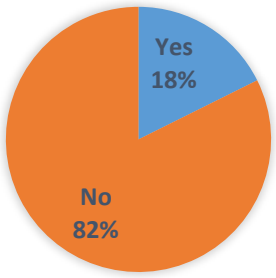



**Figure 5.15: Safety incidents in Respondents' Neighborhoods**

Among the respondents who are connected to the new electricity, 79% had a fuse box while 21% do not have one. Of those with a fuse box, 47% already had a fuse box prior to connecting to the new electricity while 53% purchased one after connecting to the new electricity. Of those who purchased a fuse box recently, they either knew beforehand that they needed a fuse box or were subsequently informed by the technicians who connected their household or institution to grid. Respondents who do not have a fuse box did not know that they needed one. The results are shown in **Figure 5.16 below**

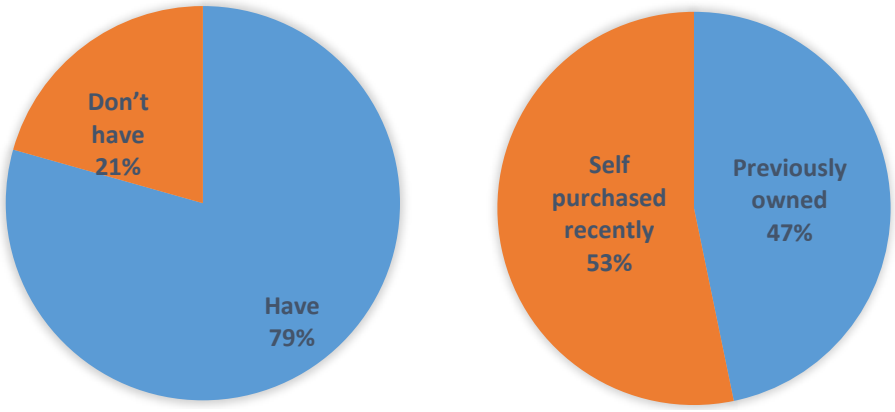



**Figure 5.16 Fuse Boxes in Households and institutions Before and After Electricity Supply**

**Benefits of the New Electricity**

Respondents connected to the new electricity were asked whether the new electricity has been beneficial to their respective households and institutions.

Ten percent (10%) of connected respondents strongly agreed that the electricity has been beneficial, 84% agreed, 3% were neutral and 3% disagreed. The mean opinion poll is 80%. Therefore, the majority of the connected respondents have benefited from the new electricity. **The results are shown in Figure 5.17 below**.

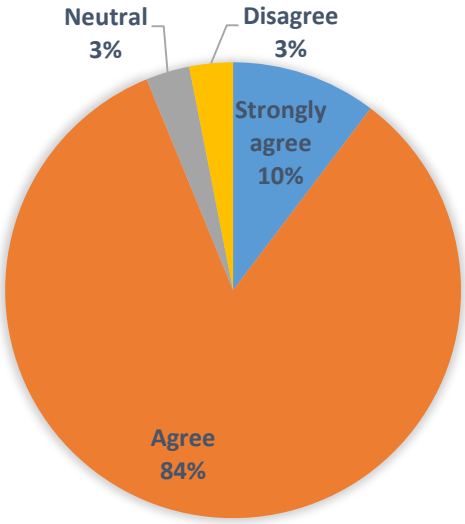



**Figure 5.17 Opinion poll on whether new electricity has been beneficial**

i. Benefits to households

Roughly 88% of household respondents cited improved security as the most benefit to households from the new electricity. It is to be noted that an important part of the Juba Rehabilitation Project was the installation of street lights on the main streets of the city. In addition, because the electricity is available for 24 hours, some households have been able to install security lights outside their compounds that stay on during the night, resulting in improved security against petty neighborhood crimes.

The second highest benefit is increased hours of electricity supply, enabling respondents to study or work at night. Previously, most people used electricity for three (3) to six (6) hours in a 24-hour cycle, mostly at night. Increased hours of electricity supply mean that customers can also use the electricity during the day. This is most beneficial, especially now that the Coronavirus pandemic has forced children to stay at home, instead of going to school, and many working-adults work from home on some days of the week. The rest of the respondents who did not benefit from increased hours of electricity are those who limit their electricity hours per day because of the high cost of electricity.

Other benefits of the new electricity include reduced noise from generators, more reliable electricity supply and ability to use more household appliances. Only 13% of the respondents benefit from a lower electricity cost.

One of the benefits of the new electricity for some female respondents is that electricity provides small scale business opportunities for women entrepreneurs to operate gainful business from home. One of the entrepreneurs admits that although electricity is generally expensive, she pays for it using profits from the sales of her homemade "freezies/ice pops". Thanks to the new electricity, the entrepreneur said that her household income has increased. Therefore, another benefit of the new electricity is a potential increase in household income for entrepreneurs who are able to take advantage of the availability of electricity to create business and income-generating opportunities.

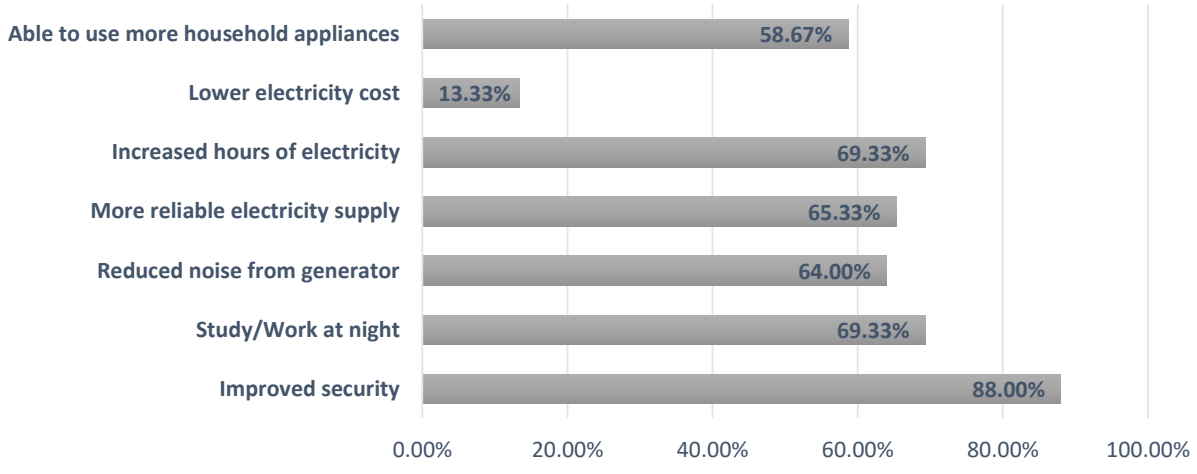



**Figure 5.18 Graph showing how households have benefitted from the new electricity**

### ii. Benefits to institutions

The common benefits to institutions include increased hours of electricity supply, increased reliability and convenience, compared to generators. For pharmacies, this means that refrigerators and fans can now run for 24 hours, keeping medicines at the appropriate temperatures at all times, which is especially critical for medicines that require freezers. The same is true for commodity shops where a cooler environment is needed to keep goods fresh for longer periods, especially perishable. Long term benefits such as increased sales profits are yet to be realized as the electricity is still new.

### Challenges

Connected respondents were asked about the challenges of the new electricity. Some had not experienced any challenges yet or did not foresee any challenge in the system. Nonetheless, 55% of the challenges identified by the respondents are cost related, 14% relate to the small amount of electricity apportioned in the token (KW), whereas 24% of the challenges are safety related, 4% are lack of sufficient retail points in the neighborhoods and 3% of the challenges are due other factors. Thus, the main challenge in the electricity system is due to the high cost followed by safety issues. However, KW units seem to run out quickly either in comparison to other countries or because the appliances in use are not as energy efficient as appliances used in neighboring countries. This issues, which constitutes 14% of the challenges cited by the respondents, might equally be due to faulty meters. The results of some of the challenges are summarized in **Figure 5.19 below**.

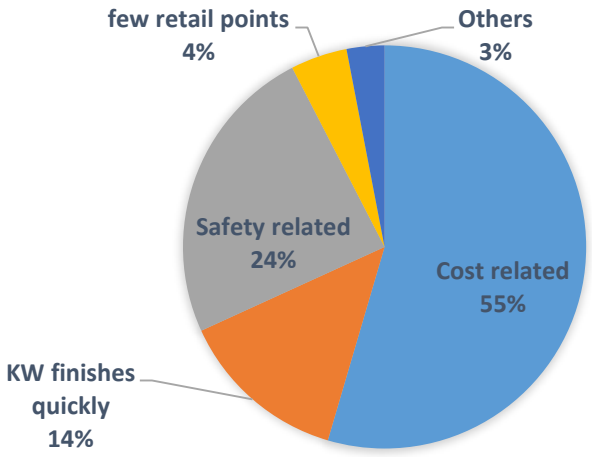



**Figure 4.19 Challenges of the new electricity**

## CHAPTER SIX

# DISCUSSION AND RECOMMENDATIONS

### 1. Who are the stakeholders of the current public electricity?

The national institutions involved in the electricity sector; namely the Ministry of Electricity and Dams and South Sudan Electricity Corporation (SSEC) have been involved in the implementation and execution of the Power Plant and Distribution Project. Whereas SSEC has been involved in the distribution project only and while its role was to supervise the consultants and contractors, the other key public institutions whose approval and/or compliance was necessary for the two projects include the following:

- The Head of State
- The cabinet
- The Parliament
- The Attorney General
- The Ministry of Finance
- The Ministry of Environment
- The Ministry of Land, and
- The Ministry of Labour

On the hand, developers are those who invested time and capital to develop the power project, include the following:

- African Development Bank Group (AfDB), the financial institution that provided $38 million to finance the Juba Distribution System Rehabilitation and Expansion Project.
- Ezra Group, the private investor that invested $285 million in the construction of the Ezra Power Plant.
- Power China, contractors and equipment suppliers for the distribution project and the power plant.
- SMEC Australia, consultant for the distribution project


**Figure 6.1: Power China staff training local staff in the control room of Ezra Power Plant, Mangala County**

*Source: Africa Utility Week*

Consequently, the electricity supply chain now consists of the following entities:

- Ezra Group, which is concerned with generation and transmission aspect of the supply chain and
- Juba Electricity Distribution Company (JEDCO), which handles the distribution and retail part of the supply chain to domestic, government, commercial and industrial customers in Juba.

**Figure 6.2 Journalists at Ezra Power Plant, Mangala County during first launch**

*Source: Eye Radio*

**Figure 6.3 Ezra's Transmission Lines in Mangala County**

*Source: African Utility Week*

2. **How many customers have benefited and how have they benefited from electricity supply?**

The number of customers connected to the current electricity system, as of April 2020, stands at 13,000 (JEDCO 2020). The scheduled connections are still ongoing, and it is expected that the number of customers will reach 28,000 at the end of the scheduled connections. This would mean an increase from the previous 11,700 SSEC customers in Juba. These customers include some of those who were using self- and captive-generation through diesel-powered generators and solar panels as well as those who had no electricity at all. Thus, a proportion of Juba residents who had no electricity at all now have access to modern electricity.

**Figure 6.4 Distribution network covering a neighborhood in Juba**

*Source: African Development Bank*

The immediate benefit of electrification to those who previously had no electricity is obviously manifested in proper lighting. This development has not only enabled children to spend more time studying in the evening, but had also afforded adults more time and flexibility to complete household chores and to conduct income-generating activities late into the night.

**Figure 6.5: A neighborhood in Juba at night**

*Source: Author*

Studies on the benefits of electrification of households have showed increased years of education and productivity and increased monthly income. The availability of home electricity has also done away with kerosene as a source of lighting, leading to improved quality of indoor air and health of individuals as well that of the environment. Access to electricity is an added benefit for customers who can afford to purchase and use a variety of household appliances. Electronic appliances such as ironing-box and refrigerators free up large amounts of time and labor, leading to comfort and

improved quality of life. Some of the people who had no electricity before are able now to use low and high consumption appliances. Studies have also shown that the use of electronic communication promotes better learning.

The electricity provided previously by South Sudan Electricity Corporation (SSEC) was unreliable as it was characterized by frequent outages. It was also available for only a few hours per day and only a few days in a given week.

Diesel generators did not fare better than the electricity supplied by SSEC. They, too, were quite unreliable and costly due to start up challenges and the need to regularly purchase fuel. Hence, most of those household and businesses that relied on diesel generators used them for less than six (6) hours daily and mostly for low consumption appliances such as television sets., due to high fuel cost and the limited size of affordable generators.

For most households that were using solar panels, they installed a limited number of solar panels which consequently afforded not only a few hours of electricity but also the use of only low consumption appliances.

In summary, although some residents of Juba previously had access to electricity, the electricity was quite unreliable and was only available for a few hours. On the other hand, the current electricity is available for 24 hours daily and is more reliable than the previous SSEC electricity and self-generation methods. Hence, those with access now have increased hours of electricity and reliable electricity. Increased hours of electricity and reliability is also the major benefit to institutions such as pharmacies and commodity shops as it enables uninterrupted usage of refrigerators and fans that preserve medicines and goods for longer periods. In fact, the reliability and 24 hours daily availability is the main reason why most people are connecting to the new electricity.

The limited electricity previously supplied through SSEC and self-generation methods showed that most households used electricity only for lighting, charging gadgets and powering consumption appliances. However, with the new electricity, more households are now able to use electricity for higher consumption appliances in addition to using it for basic activities such as lighting, charging gadgets, among others. While having proper lighting from modern electricity

is important and beneficial, being able to use even more appliances, including refrigerators and iron boxes, contributes to even more benefits such as increased productivity and increased leisure time, among others.

Hence, new developments, including the ability of the people who had no access to any form of electricity previously to access electricity today, the increased hours and reliability of electricity supply and the increase in the number of customers who use high consumption appliances, indicate that the per capita electricity consumption in Juba has increased. Furthermore, the levels of consumption are projected to increase for Juba as they will boost the aggregate percentage of electricity consumption in South Sudan as more households and institutions gain access to grid electricity in the weeks and months to come. More importantly, increased electricity consumption means increased short-term and long-term benefits in diverse and important aspects of life, including education, health, environment, women and youth empowerment, quality of life, leisure, among others, leading to economic growth and poverty alleviation.

### 3. What are the challenges and solutions in affordability, accessibility, coverage, reliability and efficiency?

The new electricity has already shown some short-term benefits for those customers connected, and it is anticipated to bring about long-term benefits that will lead to economic growth and poverty reduction. However, in order to realize long-term benefits, access to electricity needs to be widespread and the benefits needs to be maximized for consumers. Hence, there are two types of challenges facing the maximization of the spread and benefits of electricity. The first type of these challenges are those that prevent people without access from gaining access in the first place and second set of challenges include those that prevent some of the people with access to electricity from maximized its benefits.

The main reasons identified in the study as to why people are not connected are lack of grid coverage in certain geographical areas as well as the high cost of extending grid coverage to these localities.

At the launch of the new electricity, South Sudan encouraged most households in Juba to connect by rolling the connection charge into the electricity tariff. The connections were carried out based

on a schedule for a certain geographical area where technicians go from one neighborhood to another and spent about 3 days connecting households within that area to electricity. Hence, the households that only required the so-called drop line and was connected at the scheduled time did not need to pay an upfront connection charge to the distribution company. On the other hand, there were those prospective customers whose premises were situated at a greater distance than the drop line of the existing poles but were within the coverage distance of a transformer. Such customers had to purchase poles to extend coverage to their respective property. Some customers were able to afford the cost of the poles, enabling them to access the new electricity. Owing either to misinformation or inability to pay, other customers found the upfront cost of poles daunting enough to deny them access to the new electricity. The case of the latter group of individuals is consistent with the prevailing situation in most countries with low electrification rates. High up-front connection charges are one of the main barriers that deny low income households access to grid electricity.

Some countries have adopted different strategies to enable low income households to afford the connection charges. These include subsidies to lower the cost, credit schemes and spreading out the costs over a period of time (Gombeleanu and Barnes 2013). For example, in countries such as Liberia, Kenya and Uganda, subsidies are provided through World Bank's Global Output Aid Fund, lowering the connection cost and enabling access to electricity by houses that wouldn't be otherwise able to afford it. In Kenya, the state utility partnered with Equity Bank to provide loans for people who are located 600 meters away from a transformer in order to enable them to connect to electricity. Beneficiaries of this scheme pay only 20% of connection charge upfront and the rest in installments over a 3-year period. In Zambia, the utility receives subsidies in the form of materials from the World Bank, reducing the connection cost by 75%. Thus, making connection costs affordable for low-income households requires strong government commitment to universal electrification, including financing through support from donors, financially viable utilities or financially viable local financial institutions. Given most institutions in South Sudan including financial institutions are at the embryonic stage, some of these strategies may not be applicable right now.

There are people who reside or operate businesses within the original grid coverage but have not yet connected to the new electricity due inhibiting high tariff cost, taking into account that the average electricity tariff is $0.42 per KWh. While this tariff is, due to the rehabilitation project, more cost reflective than the previous SSEC tariff, (Wani 2020), it remains relatively expensive. It is much higher than the average tariffs in the neighboring countries where rates range from about $0.12 to $0.18 per KWh.

The use of diesel and the small scale of the system, as before, are some of the reasons for high cost. Coupled with this is the fact that the current grid electricity is provided by a private investor who needs to recoup and repatriate investment dividends accruing from the sale of electricity to consumers, bearing in mind that connection costs are rolled into the tariff**.**

Respondents using the new electricity identified high tariff cost as the main challenge. Some of them mentioned using higher consumption appliances initially but stopped when they found the cost to be too expensive. Thus, the high tariff rate, rather than the lack of appliances is the major obstacle to increasing household electricity consumption.

While low consumption can help households reduce their electricity cost, electricity consumption is important because of the socio-economic benefits associated with electricity. Additionally, consumption is important for the financial viability of the utility whereas low consumptions brings in low revenue to the electricity business. Hence, there is a need on one hand to address affordability so that more people can access the electricity and those with access can benefit from the electricity while also ensuring the financial viability of the sector on the other hand. This is a major challenge for utilities, especially those operating in sub-Saharan Africa, given the high cost of electricity in a region that features a large proportion of low-income households.

**Table 6.1 SWOT analysis of the Current Electricity Sector**

| Strengths | Weaknesses |
|---|---|
| • Rehabilitated distribution system and new generation plant, hence, reduced | • Lack of public financial resources (poor financial health of state utility)<br>• Very high tariff |

| | |
|---|---|
| technical losses due to poor maintenance and aging infrastructure<br>• Use of prepaid meters, hence, reduced commercial losses and consumption management for customers<br>• 24 hours of daily electricity that is more reliable than previous electricity supplies | • Limited distribution system and high connection costs to extend coverage<br>• Reliance on diesel only for electricity generation<br>• Limited generation capacity |
| Opportunities<br>• Public private partnerships<br>• Regional interconnection<br>• Huge hydropower capacity and other renewables | Threats<br>• General insecurity<br>• Economic situation of the country/people<br>• Underdeveloped infrastructure |

Based on the above SWOT analysis, the following are some recommendations to address access, affordability and financial viability of the sector.

**i. Expedite the establishment of the Independent Electricity Regulator**

The involvement of the private sector in the electricity sector means that there are several expectations to balance. These include the investor's anticipated revenue, affordability and liquidity on the part of the retailer to pay for the electricity delivered, value for the money to the government in choosing the route of procurement of power generation capacity from the private sector, retailer cost recovery of the electricity delivered from the end consumer and affordable electricity to the end consumer (Power Africa 2013). According to the National Electricity Bill of 2015, the independent regulator will be in charge of balancing these interests. Thus, it is important to establish the independent regulator so it discharge its duties.

**ii. Lifeline tariffs**

In their effort to make electricity affordable for low income households, many countries use a lifeline tariff through an increasing block tariff structure or volume differentiated tariffs. The

lifeline tariff is usually below the cost of supplying electricity and is cross-subsidized by the other blocks. For example, Kenya previously had a lifeline tariff for monthly consumption of below 10Kwh, and Uganda has a lifeline tariff of consumption below 50Kwh. However, many argue that lifeline tariffs are actually quite regressive (International Monetary Fund 2013) because the intended target population, including households that can afford and have low consumption benefit from lifeline tariffs as well as low income households that share a meter among them, do not benefit (Kojima, Bacon and Trimble 2014). While it is thought that direct subsidies might be a better approach, they are not applicable in the context of most sub-Saharan African countries, including South Sudan (applicable for countries with social programs). In addition, while subsidies are easy to implement, they are hard to get out of as shown by the quasi fiscal deficits in most SSA countries with subsidies (International Monetary Fund 2013). A lifeline tariff structure can be implemented in the short-term and in the medium- and long-terms, the sector should focus on having a uniform but affordable tariff by lowering the cost of supplying electricity through low cost generation technologies/strategies and more efficient transmission and distribution networks.

### iii. Diversify its generation mix to include renewables

Renewables have lower generation costs compared to non-renewable energy sources. South Sudan has plentiful of renewable energy resources that can be exploited, including hydropower, solar power, geothermal, wind and biomass. South Sudan has a hydropower potential of about 2590 MW, solar power potential of 6.9 GJ/$m^2$/year and wind density of 285-380 W/$m^2$ (Ministries, 2013).

The feasibility plans for most hydropower plants in South Sudan have been conducted. The government now needs to secure funding to commission and construct the plants. As a fragile country, where most aid is focused on humanitarian assistance, attracting investment from developmental partners can be challenging. Furthermore, private sector usually finds renewables too risky because of the high capital costs, long payback period and risks related to enforcement of Power Purchase Agreements (Eberhard, et al. 2008). However, small scale projects are also feasible e.g. Fula Dam, recently the cost of renewable energy has dropped globally, and having sound policies/frameworks can give investors' confidence to invest.

The new electricity source is currently reliable. However, previous experience has shown that reliance on one type of generation source leads to unreliability whenever there is a shortage in the supply of fuel or spare parts, which can lead not only to higher electricity prices or complete unavailability of the electricity, threatening the energy security of the country. Most of the plans to expand South Sudan's generation capacity are based on the use of hydropower, which was once viewed as a reliable and cheap source of power. However, climate change has resulted in prolonged droughts which limit the supply capacity of Dams, leading to increased prices and unreliability of electricity. Hence, in order to lower current prices as well as to protect against increases in electricity pricing and to ensure continued reliability, South Sudan needs to diversify its electricity generation sources through a hybrid use of hydropower and several other renewables.

**Box 6.1: Zambia's overreliance on hydropower for electricity generation**

The Kariba dam on the Zambezi River supplies 50% of Zambia's electricity and a portion of electricity need of Zimbabwe. It has one of the world's largest reservoirs with an installed generation capacity of about 1626 MW. However, climate change has led to prolonged droughts, lowering the output of the dam. Zambians have had to face rolling blackouts and higher electricity pricing which have in turn led to the shrinking of the economy. The country is now looking into diversifying through wind and solar powers to address the situation.

### iv. Expand the electricity sector through least cost strategy

South Sudan needs to expand its electricity sector in order to meet the electricity needs of all its population, and it is currently working on doing so. The expected 28,000 customers in Juba is an increase from the previous 11,200. However, 28,000 customers constitute only a small proportion of the population in Juba in need of electricity, let alone the whole of South Sudan. Furthermore, increased electricity demand occasioned by population growth and increased economic opportunities will outpace the rate of this electrification expansion. While expanding its electricity sector, South Sudan can ensure that electrification remains affordable for most of its population

by using a least cost expansion strategy. This can be accomplished through the exploitation of its renewable resources, regional interconnection and energy efficiency practices.

**Box 6.2: Kenya's least cost expansion strategy**

Kenya has one of the fastest growing electrification rates in sub-Saharan Africa. It plans to develop into a middle income country by 2022. It identifies universal electricity access as a key plank in realizing its vision therefore it is working on having universal access by 2022. The country has adapted a least cost expansion strategy by using geothermal energy to expand its electricity sector (Ministry of Energy 2018). Kenya's installed capacity doubled from 128 MW in 2007 to about 628 MW in 2015, mostly through geothermal, which now accounts for about 29% of its generation mix that includes hydropower (36%), thermal (33%) and other renewables (2%). The use of geothermal has led to lower generation costs, contributing to lower electricity rates for electricity consumers (Ministry of Energy 2018). In addition, electricity access rate increased from 16% in 2012 to 40% in 2016.

South Sudan plans to join East African Power Pool to participate in the regional electricity market. The fact that the cost of electricity is much cheaper in Eastern African countries compared to South Sudan would lead to more affordable electricity in South Sudan. In addition, most East African countries are generating surplus power above their demand capacity. South Sudan plans to have the interconnection through Ethiopia, which has a competitive advantage due to its low electricity prices (cost of generation is $0.09 per KWh) and surplus generation capacity. The country plans also to form an interconnection with Uganda. Hence, cross-border electricity would also yield savings on capital investment to build new power plants to meet increasing demand for electricity. However, South Sudan would need to invest in its transmission network so as to benefit from a regional interconnection protocol.

### v. Energy Efficiency

Energy efficiency is a critical least cost expansion strategy in increasing accessibility. Improving the efficiency of the supply chain through reduction of transmission and distribution losses evacuates more of the generated power to consumers, serving more consumers and reducing the

investment in generation to meet electricity demand. It is also the quickest strategy to move towards cost recovery for utilities.

The current rehabilitation project is expected to reduce power losses by 10% and the new generation and transmission network should keep the losses due to poor maintenance at a minimum. There should be sound policies to encourage a proper regular maintenance culture so that these losses continue to be kept at a minimum. There should also be policies to promote further reduction in the power losses and improve efficiency. For example, the regulator can incentivize actors in the supply chain to reduce losses by setting an appropriate efficiency benchmark. Whenever an actor in the sector achieves or surpasses the benchmark, that actor gets to keep extra profits. When expanding its sector, South Sudan should strive to use more efficient components as the cost of replacing components is much higher than the cost of initial installation.

**Box 6.3: How Uganda's energy efficiency strategies have paid off**

Uganda was the first country in Africa to unbundle generation, transmission and distribution into separate utilities and to offer separate, private concessions for power generation and distribution. In spite of ongoing challenges, its power sector reforms are bearing fruit, especially in distribution. It is one of the only two countries in Sub-Saharan Africa whose utility has a full cost recovery tariff. Umeme Ltd. is the major electricity distributor in Uganda. It is a privately owned company that won the concession to operate the distribution network for 20 years (Eberhard, Anton; Gratwick, Katharine; Antmann, Elvira Morella and Pedro 2016). At its start, distribution losses were at 38.5%. But 13 years into its operation, and losses are now only at 16.5% (Umeme Ltd 2018). In this period, it has invested $600 million and has used innovative technological practices and human capacity development to reduce power losses. For example, it introduced prepaid system, which increased bill collection rate from 80% to 95-99% (Eberhard, Anton; Gratwick, Katharine; Antmann, Elvira Morella and Pedro 2016). It also uses Supervisory Control and Data Acquisition System (SCADA) to monitor all equipment on the grid for the prompt rectification of faults in real time. The use of SCADA has accelerated loss reduction and increased reliability. Hence, power outages have reduced from 25000 hours in

2005 to only 114 hours in 2017 (Eberhard, Anton; Gratwick, Katharine; Antmann, Elvira Morella and Pedro 2016). Umeme Ltd. is regulated by Uganda's Electricity Regulatory Authority, independent body which sets benchmark loss targets for Umeme Ltd and other actors in the electricity supply chain.

Energy efficiency can also be practiced through demand-side management. This involves encouraging consumers to use energy efficient appliances through strategies such as labelling of appliances, awareness campaigns/programs to promote energy efficient practices and distribution of energy-saving lightbulbs to low income household. Demand-side management reduces the demand capacity that the utility needs to meet, which in turn reduces generation investment. For example, Ghana adapted an appliance labelling program that led to an estimated peak energy savings of 120 MW, displacing the need for $105 million in generation investment. The use of energy efficient appliances is also beneficial to households as it is more cost effective, which enables households to use savings from lower electricity cost purchase and use more household appliances.

**What are the possible environmental issues and other hazards that may arise once the supply system becomes stable?**

Power is generated in the power plant through diesel combustion. Diesel exhaust consists of gases and particulate matter. The main gases released are carbon dioxide, carbon monoxide, Sulphur-dioxide and nitrogen oxides. Carbon dioxide is a major greenhouse gas, contributing to global warming and subsequently, climate change. The other main gases are also detrimental to the environment. They are also toxic substances that have adverse effects on human health and are sources of serious or chronic ailments, namely respiratory illnesses. The minor gases released by diesel exhaust are substances such as formaldehydes, aromatic compounds, polycyclic aromatic hydrocarbons (PAH), among others, which, addition to being carcinogens and mutagens, they cause respiratory illnesses. In the US, 70% of lung cancer attributed to toxic air pollutants is from diesel exhaust (Awofeso 2011). Particulate matter affects the heart and lungs, leading to decreased lung function.

**Table 6.2 Major diesel emission components with adverse health or environmental effects**

| Components | Environmental Effect | Health Effect |
|---|---|---|
| Carbon-dioxide | Global Warming | No adverse health effects |
| Carbon-monoxide | | Highly toxic gas that blocks oxygen uptake |
| Sulphur-dioxide | Acid rain | Respiratory tract irritant |
| Nitrogen-oxides | Acid rain | Respiratory tract irritant; Forms ozone when released. Ozone is also a major respiratory irritant |
| Particulate matter | | Decreases lung function |

Power plants usually employ technologies such as the use of filters and scrubbers to reduce the emission of these substances. The Ezra Power Plant plans to use scrubbers to reduce its emissions (Toby 2019). Because of the control measures, emissions from the Plant have lesser impact on the health and environment, compared to self-generation that use diesel generators placed at a closer proximity to people and without control measures. However, it is better to adopt electricity access strategies that have minimal environmental impacts because, despite the use of control strategies to reduce the amount of emissions, emissions released by power plants remain significant enough to have adverse effects on human health and the environment. Renewable energy technologies, on the other hand, have minimal environmental impacts, compared to diesel and other non-renewables. Energy efficiency also contributes to lower emissions. It will be the role of Regulatory Authority to lessen, wherever possible, any adverse impact of electricity generation.

There had been several safety incidents concerning the new electricity such as burning of equipment, burning of houses, shocking of technicians at the start of the connection, wrong connections etc. The government has since addressed some of this by implementing the policy on electricity safety. The purpose of this policy is to protect people (both technicians and consumers)

from accidental death or injury and also to prevent property damage by fire resulting from electricity. This has prompted the distribution company to adopt safer practices, such as supervision of technicians by qualified engineers during the installation of electricity equipment.

Based on the study, some electricity consumers in Juba have fuse boxes in their household or institution while others don't have. For those who have, they either purchased the fuses without prompting or were asked to do so. In the meantime, prospective customers who don't have fuse boxes didn't know the importance of the gadget to their own safety and that of their loved ones and were not asked to buy one during the connection of their household to the new electricity.

Given this disparity in the vital safety awareness, there is an obvious need for a standard safety awareness to ensure that all households and institutions understand the crucial function of a fuse box and the need to have it installed on their respective property when they connecting to the new grid electricity.

## CHAPTER SEVEN

# CONCLUSION

South Sudan is a low income country and electricity is a key input in bridging the gap in its human and economic development. The electricity sector is in the process of building itself up, practically from scratch. While the underdeveloped electricity sector is a major constraint, it can be transformed into an opportunity to build a sustainable electricity sector that benefits all its population by learning from its own experience and the experience of others. This study presents the reality of the actual end users of the electricity, giving some meaningful insight that can be taken into consideration to build an electricity sector that can have a significant impact on the South Sudanese population.

The purpose of the research was to evaluate the impact of the new electricity on households and institutions in Juba as well as to assess its sustainability by looking at possible challenges related to accessibility, affordability, reliability, efficiency, financial viability, environment, health and safety. But more importantly, the study makes recommendation to both improve the impact of the new electricity and to mitigate the challenges identified by the respondents.

The study has found that the electricity has had a positive impact on most of its consumers. The main benefits of the electricity have been improved security, increased hours of electricity, more reliable electricity supply and reduced noise from generators. However, respondents cited many challenges presented by the new electricity, chief among them is its affordability. It goes without saying that when electricity is not affordable, only fewer people would have access to it; and its positive impact on those with access, especially low income households, would most likely be limited.

In addition to cost and affordability challenges, safety related concerns featured prominently in the study. Therefore, the recommendations in this study aim to lowering the cost of electricity by tackling these challenges with a view to achieve access to a more affordable, reliable, safe and environmentally-friendly electricity.

The key findings of the study are:

i. 65% of the respondents have access to the new electricity. Of those who did not have access, 41% are not connected because they are waiting for a connection. The connection process is carried out following a schedule where technicians go from area to area. Since the study is conducted parallel to the connection, it is assumed that such respondents will be connected. The other reasons why people were not connected to the new grid, 23% is because lack of grid coverage in certain areas, 6% due to high connection costs for those without grid coverage but can extend coverage by purchasing poles,14% because of high electricity tariff rate, 4% because of lack of information and 11% for other reasons.

ii. Prior to the launch of the new electricity, 55% relied on generators either their own or neighborhood grids, 21% used solar panels, 4% had both, 1% had access to government electricity and 19% had no modern electricity services.

iii. The respondents were asked whether the electricity is more affordable compared to their previous sources. The mean poll is 59.8% for those connected and 64.4% for those not yet connected. The mean poll of those connected based on their previous supply is 63.8% for those with own generators, 53% for solar power, 65.8% for neighborhood grids, 40% for government and 50% for those who previously didn't have electricity. Hence, electricity was more affordable for those relying on generators and neighborhood grids, those with solar power and no electricity are mostly neutral, and those who had government supply find it less affordable.

iv. Previously, 51% of respondents had access to 3-6 hours of electricity while only 5% had access to more than 18 hours of electricity. The new electricity is available for 24 hours daily and is more reliable than previous sources.

v. Previously only 31% were able to use high consumption appliances such as refrigerators and iron while majority of people with electricity, 60%, used low consumption appliances such as television and fans. The consumption pattern has changed with the new electricity with 56% using high consumption appliances and 35% using low consumption appliances. The remaining 9% use it for lighting and charging only.

vi. 18% of respondents have had safety incidents in their area. These include burning of wire, houses etc. 21% of the respondents with electricity don't have a fuse box/circuit breaker.

vii. 94% of the respondents connected to the new electricity have benefitted from the new electricity. The benefits for households include improved security, increased hours of electricity, study/work from home, more reliable electricity, reduced noise from generators and use of more household appliances. The benefits to institutions include increased hours of electricity, increased reliability and convenience compared to generators.

viii. The main challenge of the new electricity is its high cost. Other challenges include safety issues, KW finishes quickly and few retail points.

The key recommendations to address challenges with accessibility, affordability, financial viability, efficiency, reliability, environmental sustainability and safety issues are:

i. Enactment of the Electricity Act so as to expedite the establishment of the Independent Electricity Regulatory Body.

ii. Use of lifeline tariffs in the short term to make electricity affordable to low income households.

iii. Diversify its generation mix, using renewables, to make electricity more affordable to all, energy security/continued reliability and environmental sustainability.

iv. Use least cost expansion strategy to ensure increased access while keeping it affordable.

v. Promote energy efficiency on supply side and demand side.

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**IMAGE SOURCES**

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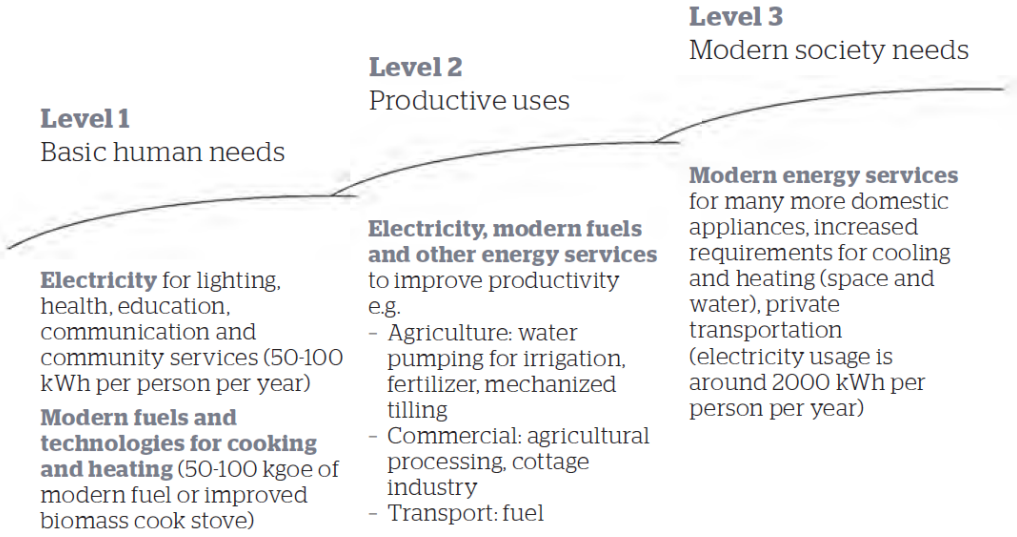
# APPENDIX

## A1: Incremental levels of access to energy services

**Exhibit 1** **Incremental levels of access to energy services**



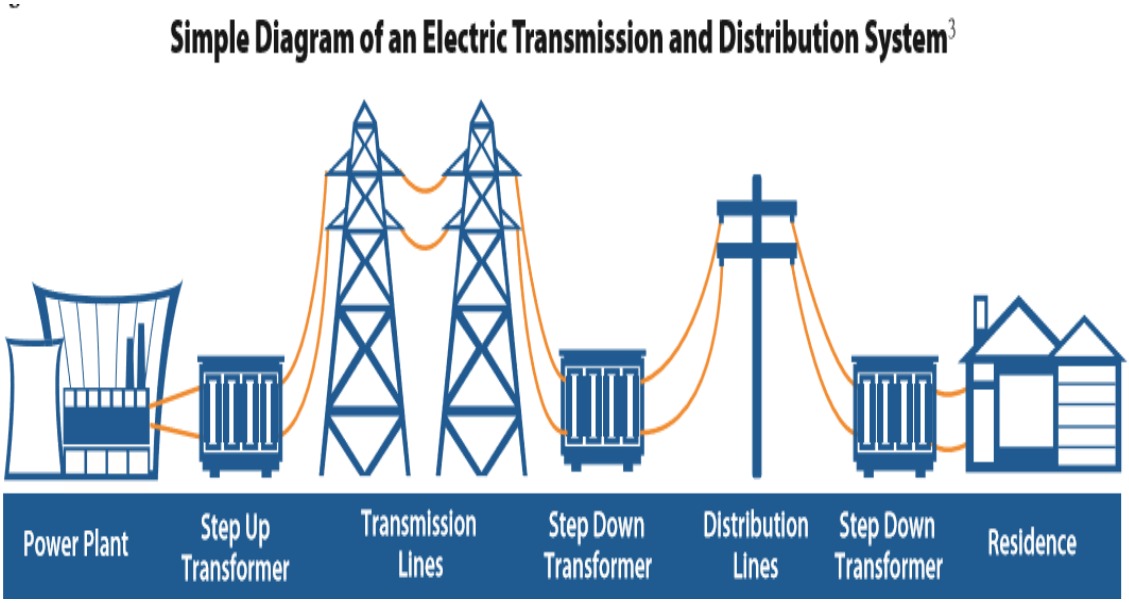

SOURCE: IEA

## A2: Benchmark indicators of electricity sector (2011) in South Sudan in comparison to other countries

| Indicators | Units | South Sudan | East Africa | Low-income, nonfragile countries | Middle-income countries | Resource-rich countries |
|---|---|---|---|---|---|---|
| Access to electricity (national) | % of population | 1 | 10 | 33 | 50 | 46 |
| Access to electricity (urban) | % of population | 6.67 | 44 | 86 | 72.8 | 79.4 |
| Access to electricity (rural) | % of population | 0 | | 12.7 | 26.3 | 28 |
| Installed generation capacity | MW | 25 | 1,169 | 651 | 36,971 | 4,105 |
| Installed generation capacity per million population | MW per million population | 3 | 23 | 20 | 799 | 43 |
| Power outages | Days/year | | 19 | 10.4 | 5.9 | 14.5 |
| Firms that find power a constraint for business | % of firms | >75 | 55 | 52 | 31 | 56 |
| Firms with own generator | % of firms | 70* | 50 | 41 | 18 | 63 |

**Source: AICD**

**A3: Electricity supply chain**




**A4: South Sudan Electricity Tariff Structure in 2013 and 2020**

| Type of consumer | 2013 Tariff rate per KWh (USD) | 2020 Tariff rate per Kwh (USD) |
|---|---|---|
| Domestic | 0.15 | 0.395 (0-100 Kwh)<br>0.420 (above 100 Kwh) |
| Commercial | 0.21 | 0.44 |
| Government institutions | 0.24 | 0.42 |
| Industrial | - | 0.45 |

**Source: SSEC**

# ELECTRICITY IN JUBA

*An Assessment of the Recently Launched Grid Electricity*

SOUTH SUDAN CENTER FOR STRATEGIC AND POLICY STUDIES (CSPS)

Tel: +211 920 310 415/+211 915 652 847
P.O Box 619, Hai-Jeberona, Juba South Sudan
https//csps.org.ss