

International Switch Energy Case Competition

# Energy poverty in South Sudan

**Team members: Salma Khaled Shahwan- Abdelrahman Yasser Zaghloul- Aren Mosad- Ahmed Shokry Abdel Megeed Tawfik.**

**Team number: 133**

**Team name: ZAAS**

**Team leader: Salma Khaled Shahwan**

**Home Country: Egypt**

**Team mentor: Stephan Mutwari Muriuki**



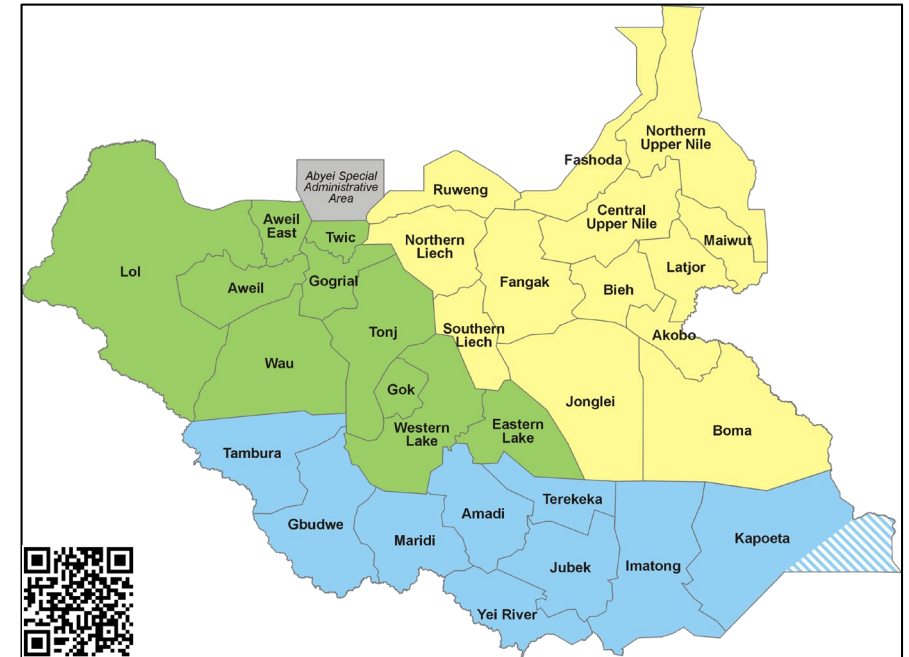
**SWITCH**  
ENERGY ALLIANCE

The background of the image is the flag of South Sudan, which features a blue triangle at the top left containing a yellow five-pointed star, a red horizontal band in the center, and a green triangle at the bottom right. The flag is set against a dark, textured grey background.

# **Introduction to South Sudan**



- South Sudan officially known as the Republic of South Sudan, is a landlocked country in east Africa. It is bordered to the east by Ethiopia, to the north by Sudan, to the west by the Central African Republic, to the southwest by Democratic Republic of the Congo, to the south by Uganda and to the southeast by Kenya. It has a population of **11.06 million**, of which **525,953 live in the capital and largest city Juba**.
- The States of South Sudan were created out of the three historic former provinces (and contemporary regions) of Bahr El Ghazal (northwest), Equatoria (southern), and Greater Upper Nile (northeast). The states are further divided into **180 countries**.

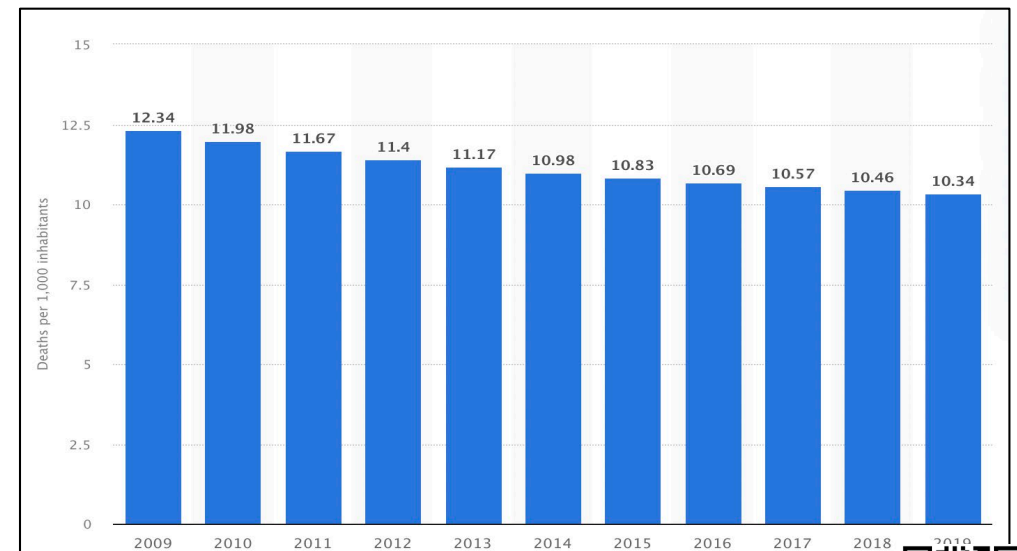


The 32 states of South Sudan grouped in the three historical provinces of the Sudan

- Bahr El Ghazal
- Equatoria
- Great Upper Nile



- South Sudan is one of the world's most divided and unstable countries. Since achieving statehood in 2011, the country has plunged into **civil war (2013-15)** and become the scene of some of the worst human rights abuses on the African continent.
- South Sudan has probably the worst social and economic indicators in the world. It is estimated that over **70 percent of the population is illiterate**, the mortality rate for children under five years old is 112 for every 1,000 children, and the maternal mortality is just over 2,000 for every 100,000 births. The ratio of physicians to the total population is alarming. For every 500,000 people there is only one physician. And shockingly, **more than 90 percent of the population of South Sudan lives on less than \$1 per day.**
- The state of infrastructure in Southern Sudan is also appalling. The communication and transportation networks in the region are incredibly poor. For a region with 619,700 sq km, Southern Sudan has **less than 50 km of paved roads.** This is possibly the worst in the world.

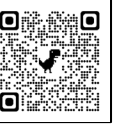
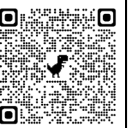


Death rate from 2009 to 2019(in deaths per 1,000 inhabitants)

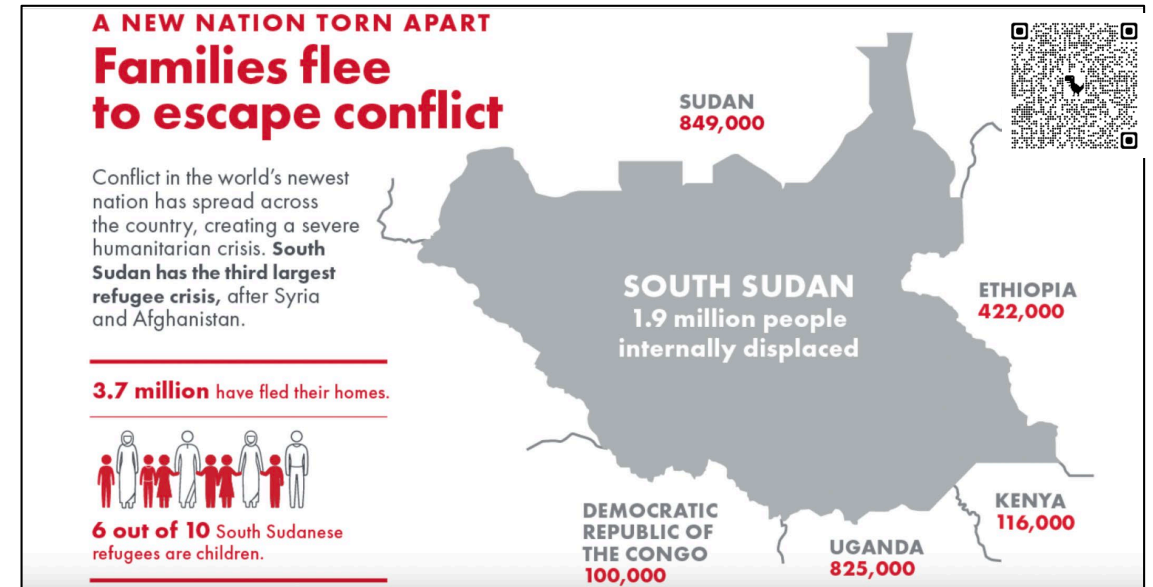




- **Lack of security** in rural areas and violence against foreigners are also commonplace in the region. There are regular reports of murders of businessmen and women from neighboring Kenya and Uganda. Human rights abuses are also rampant and there is low freedom of press enshrined by a media law with stringent licensing requirements.
- Like many other African countries, South Sudan is also rich in natural resources, especially oil. While this could be a great opportunity for Southern Sudan, it is also a major challenge for the country. About **85 percent of Sudan's oil output is located in South Sudan** and, according to the 2005 agreement, oil revenues shall be shared equally between North and South Sudan. The country also has large deposits of minerals, such as gold, copper, iron ore and zinc chromium, and game parks with diverse flora and fauna for tourism. There is also an abundance of forest reserves and fertile land watered by the Nile River.

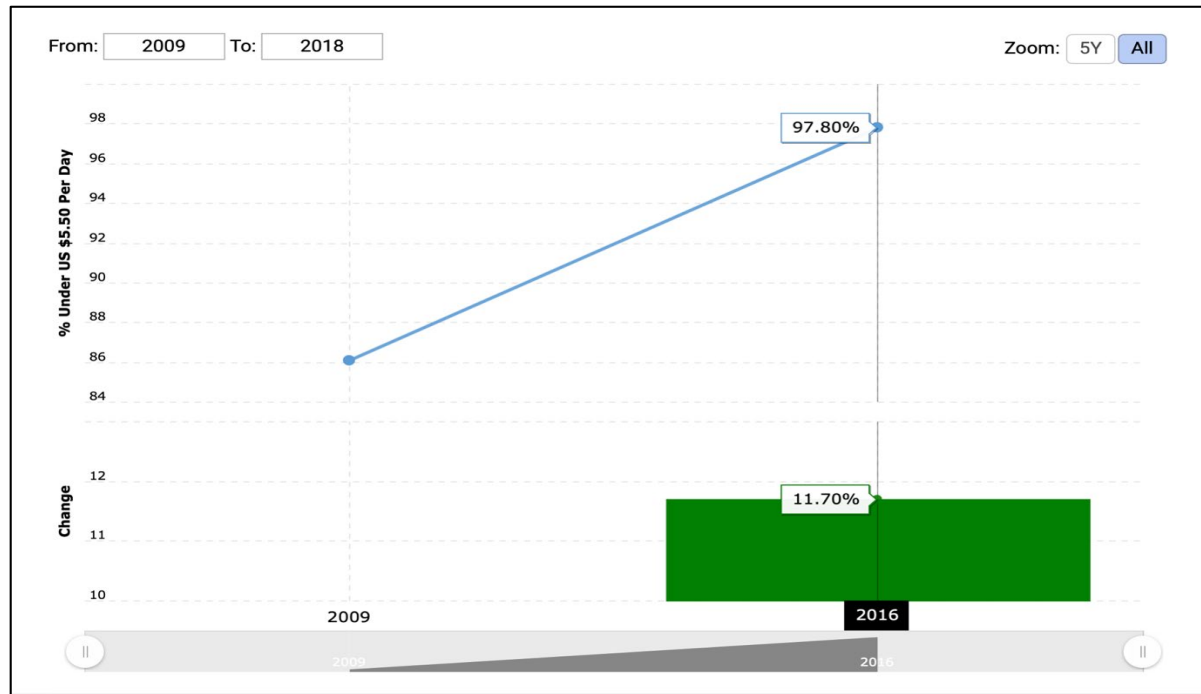


- Political conflict, compounded by economic woes and drought, has caused massive displacement, raging violence and dire food shortages. Over seven million people — about two thirds of the population — are in need of aid, including around **6.9 million** people experiencing hunger.
- Food security is expected to deteriorate more, with **7.7 million** people estimated to face crisis levels of hunger with the onset of the July to August lean season, the period of time between harvests when food stores are low.
- The ongoing conflict and insecurity have pushed millions to the brink of starvation for years. In 2017, famine was declared in two counties in South Sudan, and famine has remained a persistent threat since. Without peace and consistent humanitarian access, another famine this year is likely.
- As for the natural gas: Neither Sudan nor South Sudan produces natural gas for commercial use or domestic consumption. Natural gas in Sudan is mostly flared or re-injected into associated oil fields.





- Income **poverty in South Sudan was reported at 0.33333 in 2020**, according to the World Bank collection of development indicators, compiled from officially recognized sources. South Sudan - Income poverty - actual values, historical data, forecasts and projections were sourced from the [World Bank](#) on October of 2021.
- In 2016, poverty rate at national poverty line for South Sudan was **76.4 %**. Between 2009 and 2016, poverty rate at national poverty line of South Sudan grew substantially from 50.6 to 76.4 % rising at an increasing annual rate that reached a maximum of **19.06%** in 2015 and then decreased to **16.46%** in 2016.



### 1 USD to SDG - Convert US Dollars to Sudanese Pounds

Xe Currency Converter

Convert Send Charts Alerts

Amount: \$1.00 From: USD - US Dollar To: SDG - Sudanese Pound

1.00 US Dollar = **439.09334 Sudanese Pounds**

1 SDG = 0.00227742 USD

US Dollar to Sudanese Pound conversion - Last updated Oct 26, 2021, 17:34 UTC



- **Energy Consumption:** Domestic consumption of petroleum products grew rapidly with increased industrialization, car ownership, and access to electricity in the 2000s; however, the persistent instability in both states has dampened consumption. Lower production levels during the past few years have led to an increase of imported petroleum products to meet shortfalls in domestic demand, which had been traditionally met by domestically refined crude oil.
- South Sudan has one of the **lowest electrification rates in the world**. Those connected to the power network experience frequent blackouts or forced load shedding, making citizens rely on standby generators to meet energy needs.

<b>Electricity</b>	<b>total</b>	<b>South Sudan per capita</b>	<b>USA per capita</b>
Own consumption	391.80 m kWh	35.00 kWh	11,842.76 kWh
Production	412.80 m kWh	36.88 kWh	12,428.52 kWh
<b>Crude Oil</b>	<b>Barrel/day</b>	<b>South Sudan per capita</b>	<b>USA per capita</b>
Production	150,200.00 bbl	0.013 bbl	0.033 bbl
Export	147,300.00 bbl	0.013 bbl	0.004 bbl







# Case Solutions



# Solutions Plan

Egypt has been steadily upgrading its relations with South Sudan in a range of fields from agriculture and irrigation to construction and security cooperation. Egypt is the important investor in South Sudan, so we are going to take a loan about 100,000\$ to start our project. After a year, we will return the money to Egypt. (300K)

## Biogas Generating System

Build a biogas generating system that generates electricity from cattle's dung. In addition to producing biogas and fertilizer.



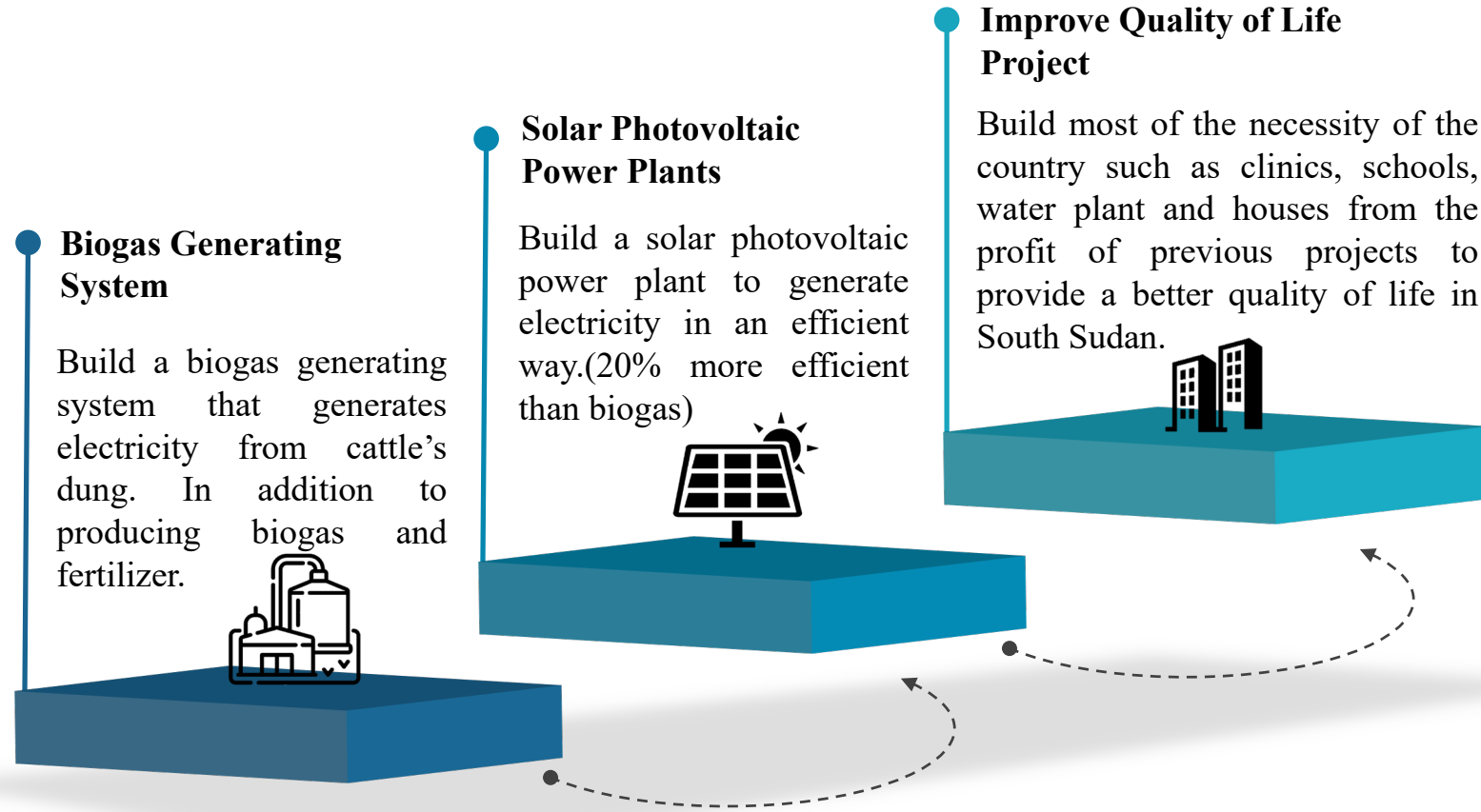
## Solar Photovoltaic Power Plants

Build a solar photovoltaic power plant to generate electricity in an efficient way.(20% more efficient than biogas)



## Improve Quality of Life Project

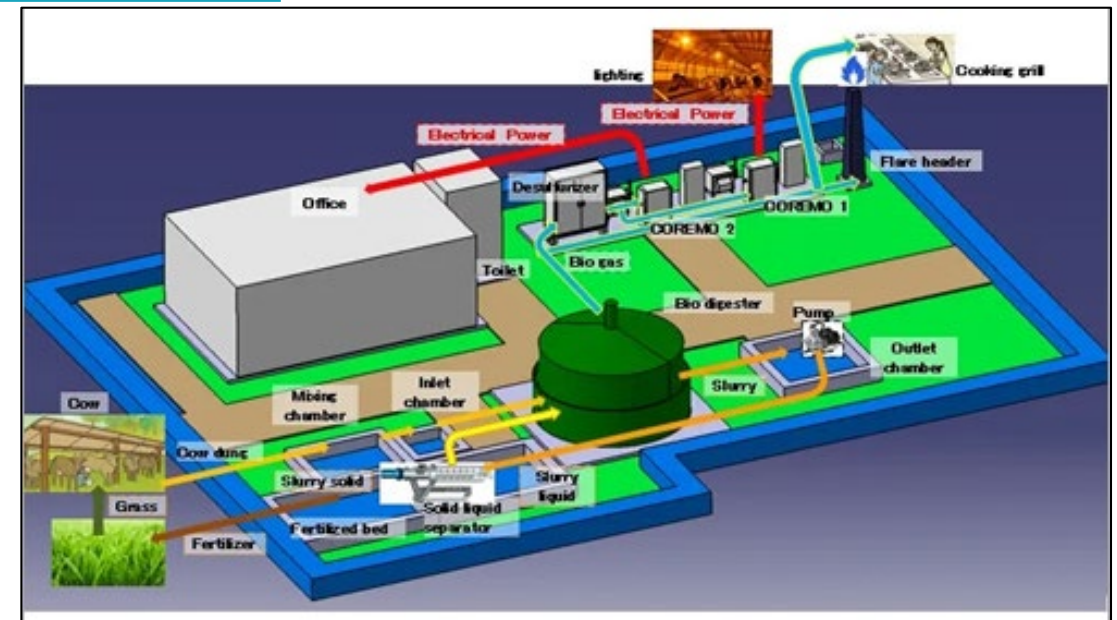
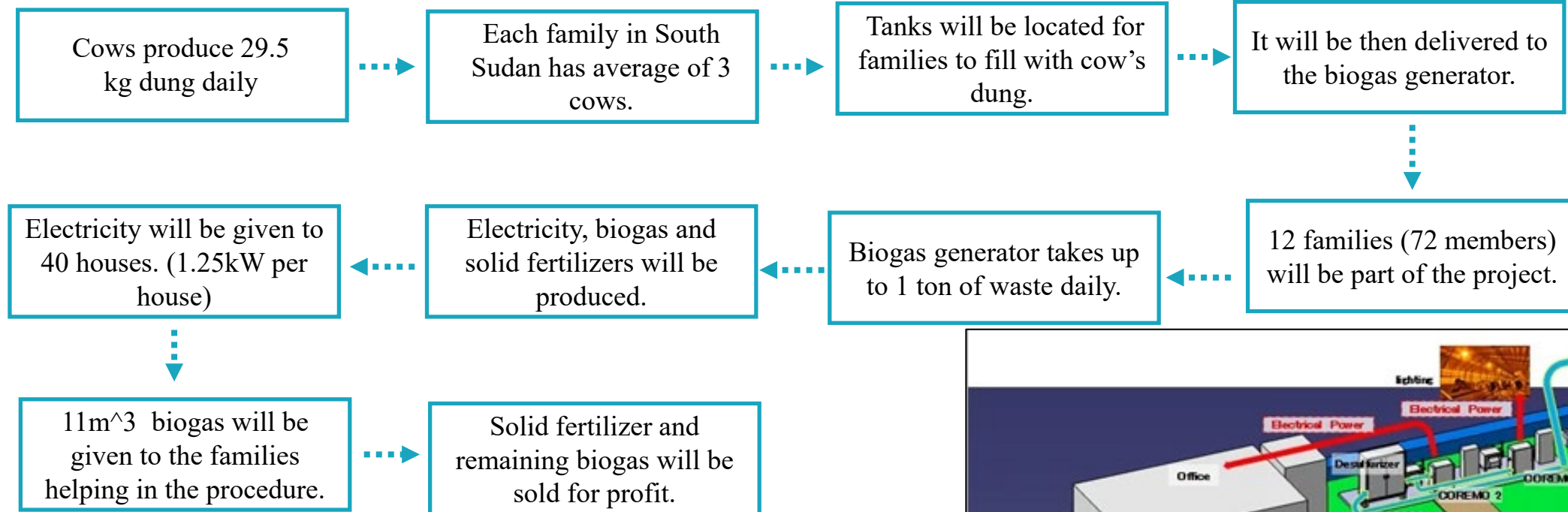
Build most of the necessity of the country such as clinics, schools, water plant and houses from the profit of previous projects to provide a better quality of life in South Sudan.



# I- Biogas Generating System



## a) Procedure Info and System Diagram.



# I- Biogas Generating System



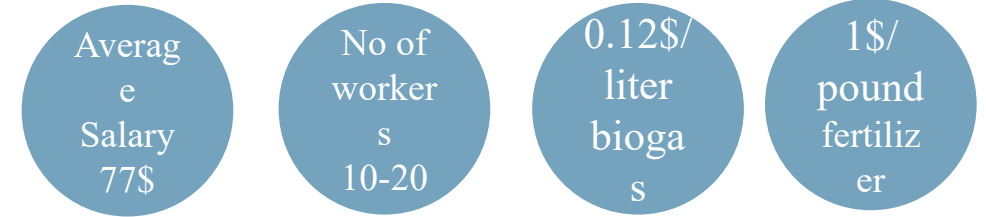
## b) Site Biogas Generating System Cost Analysis in Dollar :

Digester Tank	2 Gas Engine Generator	SS Vertical Desulfurizer	Generating System	Shipping Estimating 100 kg	Storage tanks	Transport
24002.08	14667.94	5000	26668.98	2000	90 dollar / tank	100 dollars / month

No of cows	Cows dung produced (kg/day)	Produced biogas m <sup>3</sup> /day	Electricity from 2 engines	Fertilizer
30-40	900	40	60 kw/day	200 kg/day

Once cost	Fixed total cost / month	Total cost	Fertilizer selling cost	Biogas selling cost	Total revenue
72,609	7000	81,609	661 dollar / day 20,491 / month	3,480/day 104,400 /month	124,800 per month

## c) Extra Data for Cost Analysis:



## d) Project Timetable:



## e) Project Location:

Warrap, South Sudan

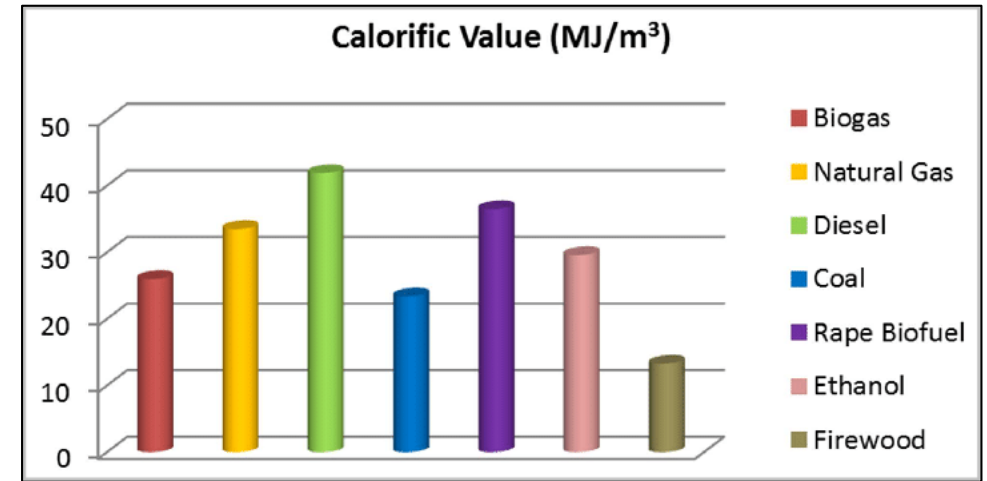
Population of 972,928





## f) Sustainability and Safety of biogas :

- Biogas is renewable, as well as a clean, source of energy. Gas generated through bio digestion is non-polluting; it reduces greenhouse emissions (i.e., **reduces the greenhouse effect**).
- The by-product of the biogas generation process is enriched organic digestate, which is a perfect supplement to, or **substitute for chemical fertilizers**, whereas commercial fertilizers contain chemicals that have toxic effects and can cause food poisoning.
- Biogas generators save women and children from the daunting task of firewood collection. **4.3** million people a year die prematurely from illnesses attributed to the household air pollution caused by the inefficient use of solid fuels for cooking.
- Waste collection and management significantly improve in areas with biogas plants. This in turn, leads to **improvements in the environment, sanitation, and hygiene**.





### g) Comparison with neutral gas:

#### Neutral gas

Increase in cost to \$0.19 and predicted to continue increasing.

Harmful to the environment.

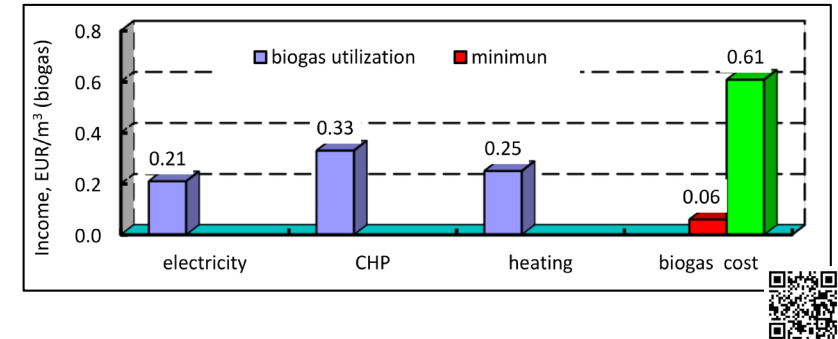
Available in limited amounts.

#### Biogas

Relatively cheap to produce.

Eco- friendly gas.

Available in unlimited amounts.



### h) Comparison with countries producing biogas:

#### Other countries

Sells in average \$0.27 - \$0.33 per liter biogas.

Extra cost and difficulty for delivery to countries located in Africa.

#### South Sudan

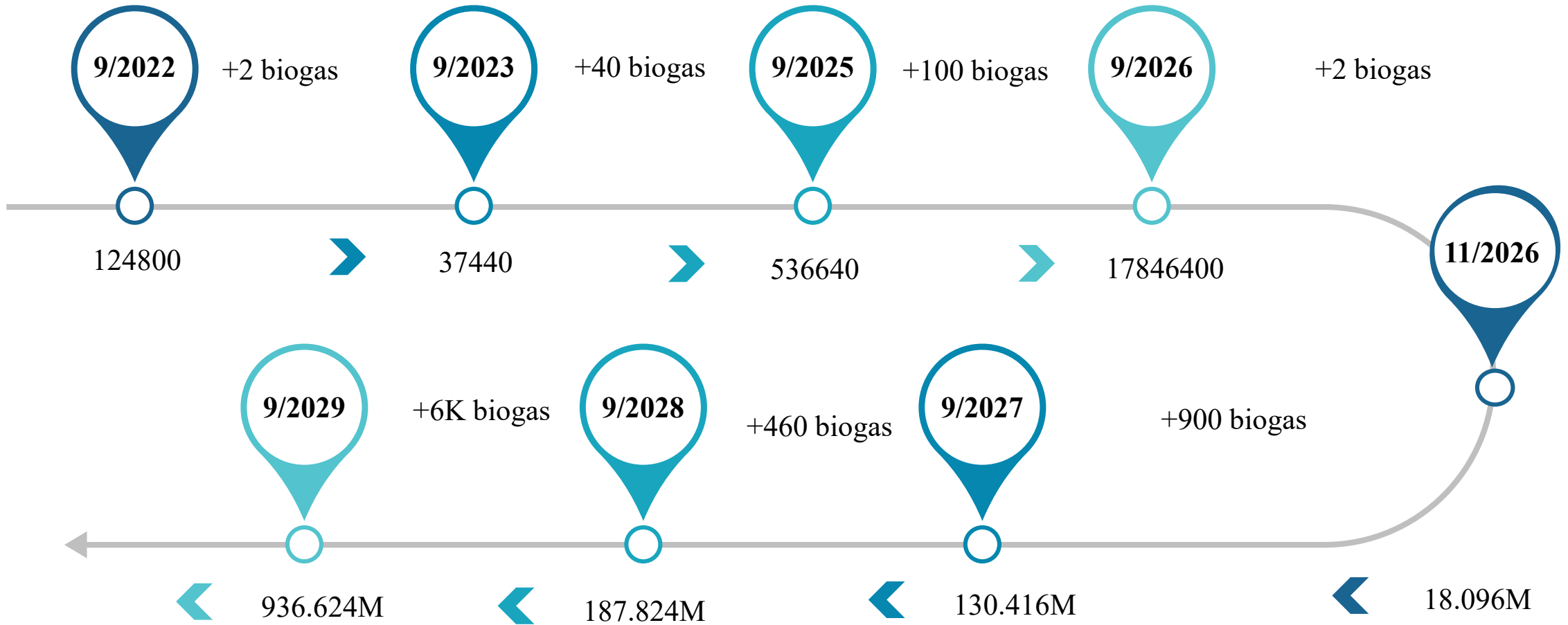
Sell for \$0.12 per liter biogas.

Less cost and difficulty for delivery to countries located in Africa.



In 2020 number of cows in South Sudan was higher than number of people.

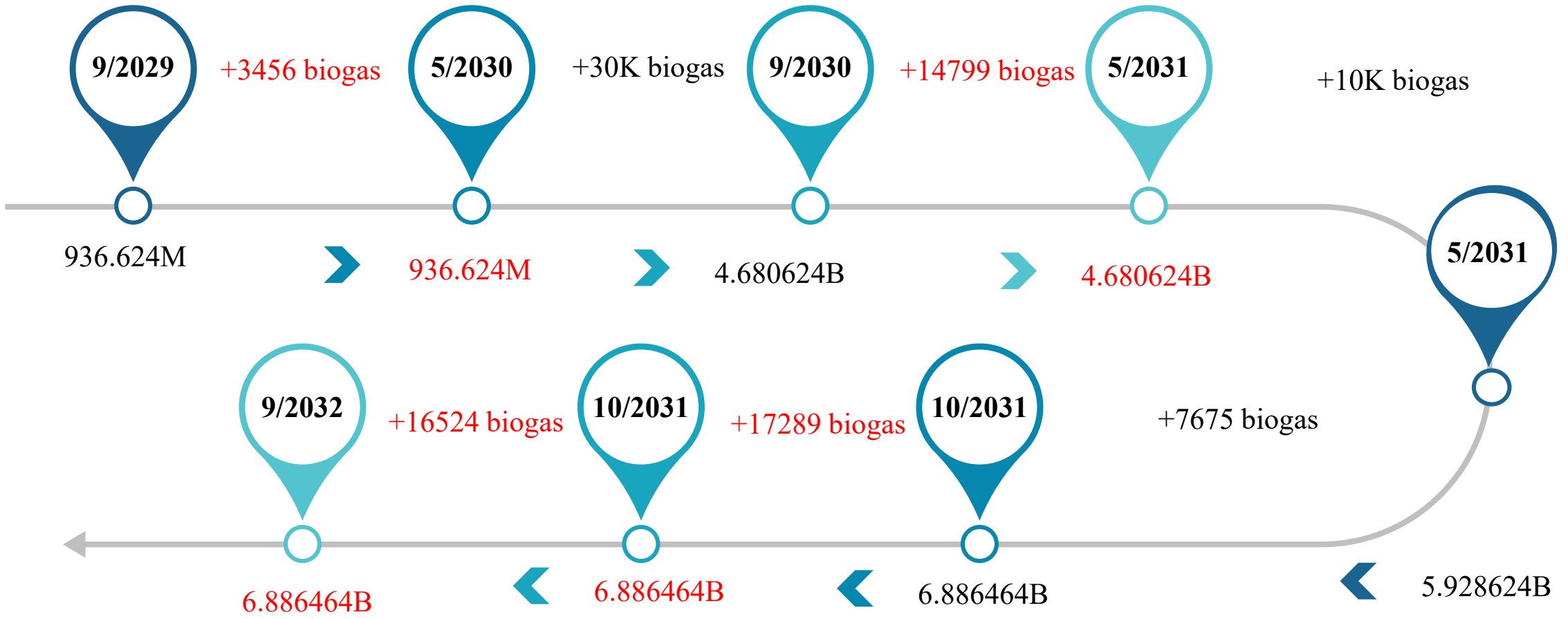
# Biogas Timeline



■ Biogases without profit.  
■ Biogases with profit.

# Biogas Timeline

- 1 biogas= 124800 \$
- 55180 \$ for profit and 52068 \$ for people.
- Therefore, total= 107248 biogas





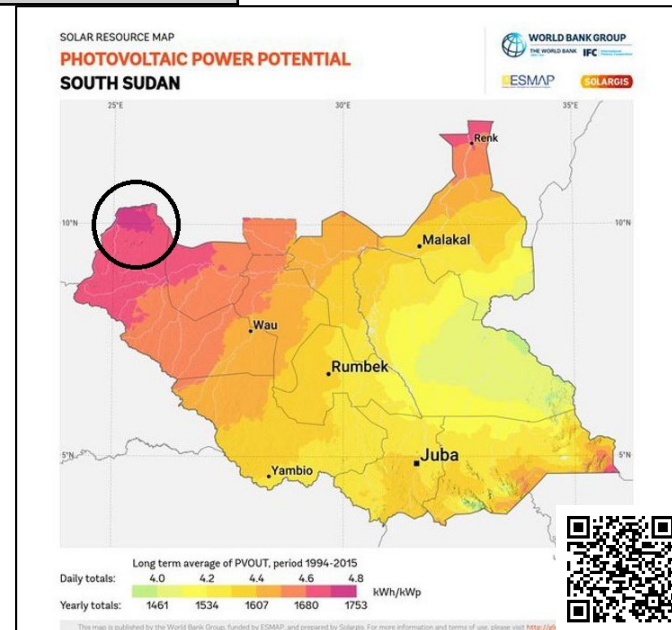
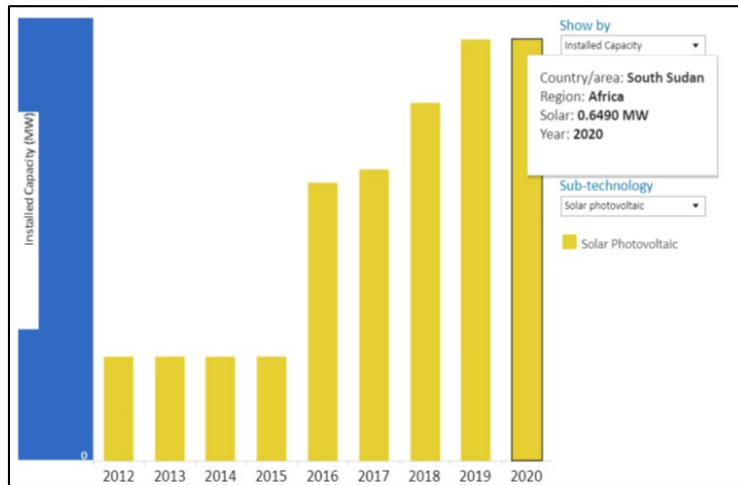
# II-Solar Photovoltaic Power Plants



## a) Solar in South Sudan:

It is sunny 83.6% of daylight hours. More than 10 hours of sunlight.

City	Pajok
Sunrise	5:33 am
Sunset	5:36 pm
Hours of daylight	12:03 hours



## b) Project Finance:

For an hour of sunlight, this solar panel able to generate 250 Watts so for 10 hours of sunlight, a single solar panel produces 2500 Watt. With a budget of 1 million dollars (includes shipping) and a cost of 88.19\$ per panel, we can purchase 10000 solar panels which in return produce 25MWatts.

## c) Project Time:

Installation time should be 4 months (+) or (-) 2 months as a tolerance range.

## d) Project place:

The upper part of Western Bahr El Ghazal (Lol).

After building all the solar panels system (83684 systems), 1.14% of the area will be covered “1358.7 Km square”.

# II-Solar Photovoltaic Power Plants



## d) Solar vs Nuclear vs Fossil Fuel



Renewable source of energy.

Cheapest fossil fuel alternative.

Safest source of energy to produce and use.

South Sudan is rich in sun hours.



Expensive fossil fuel alternative.

Dangerous and hazard energy to produce and use.

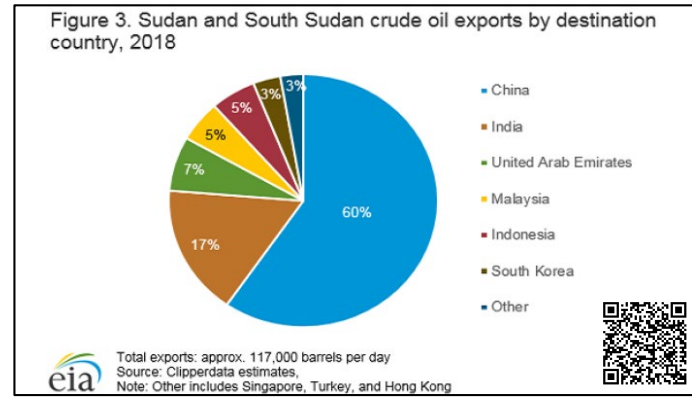
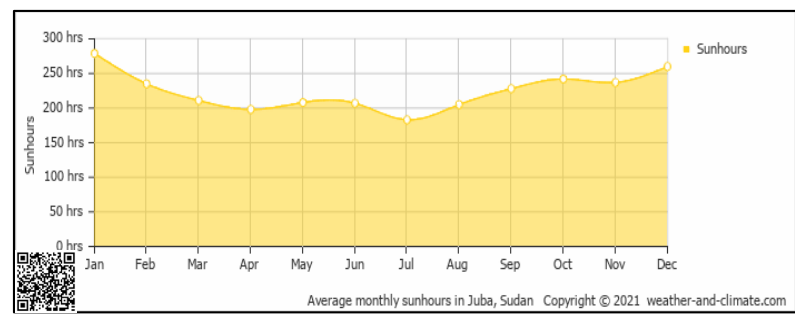
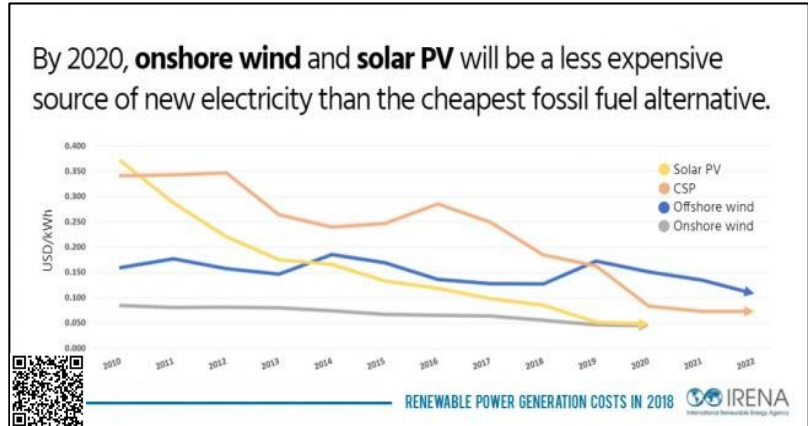
South Sudan is non-signatories in Participation in the Nuclear Non-Proliferation Treaty.



Available in limited amount.

Not sustainable source of energy.

South Sudan is working on several projects using fossil fuel (oil).



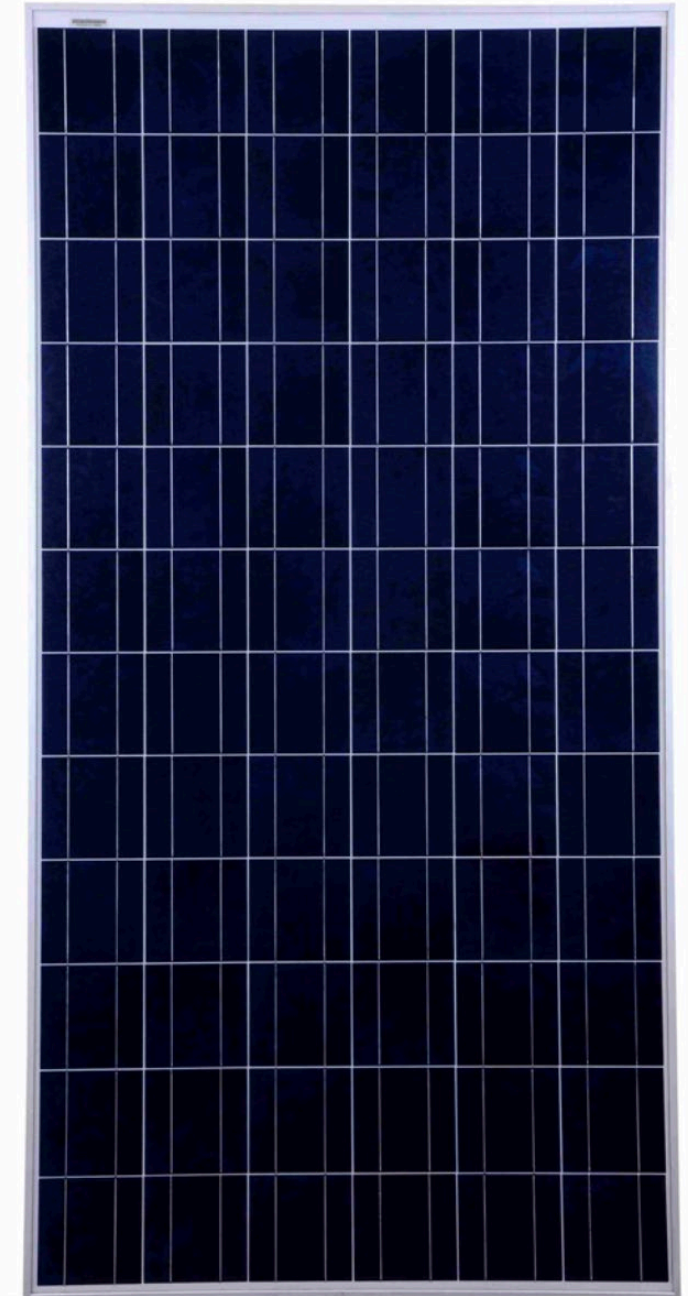
# RenewSys Deserv 250W Solar Panel

RenewSys manufactures Solar PV Modules in a wide range of configurations and power outputs, to suit applications from small home lighting to utility scale mega power plants. The PV modules come in configurations of 60 cells. Module dimension: 1640mm x 990mm x 40mm

The RenewSys Solar Modules are manufactured on state-of-the-art equipment, and use certified components from world class suppliers. The three most critical components - EVA Encapsulant, Back sheet and Cell - are manufactured in-house, ensuring highest quality and reliability.

## Why RenewSys Solar Modules?

- IEC 61215, IEC 61730 and IEC 61701 certified.
- UL 1703 certified.
- CE Mark.
- Proven Quality and Reliability – regularly monitored through in-house Environmental Test Facility.
- Rugged, built to meet the requirements of snow, wind load and harsh environments.
- Come with 10 years workmanship warranty.



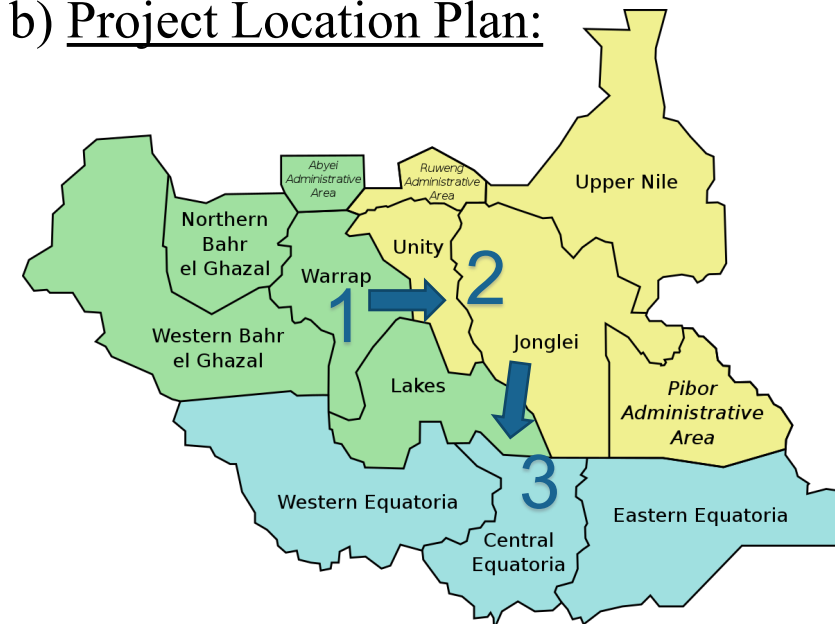
# III- Improve Quality Of Life Project



## a) Cost of basic community necessity in South Sudan:

	Price/unit	Time
House	\$521	2-3 months
Clinic	\$850K	18-24 months
25MW solar	\$1M	6 months
Biogas Generator	\$100K	9 months
K-12 School	\$130K	11-24 months
60 beds hospital	\$25M	3-6 years
Water treatment system	\$160K	7-8 months
Warehouse	\$2M	6-8 months
Electric lines system	\$1.6M	1-3 years
Sewer lines system	\$1.8M	1-2 years
150 beds large hospital	\$210M	5-7 years
Pipelines system	\$430M	18 months
3 room apart	\$293K	5-7 months
University	\$120M	14 months

## b) Project Location Plan:



The Project will start from Warrap then covering the rest of Bahr El Ghazal, moving to Greater Upper Nile then Equatoria, which are the three historical provinces of the country.

Water treatment system includes 130 units. (50000 LPH will be produced for each unit).

The Warehouse extended to 100,000 sq.ft



# **Solution Timeline Plan**



# 30 Years Timeline Plan

## Phase 1

No of./year	Biogas Generator	Houses	Clinic	Solar Plant	School	Electricity lines systems	Small hospital	Warehouse	Sewer lines systems	Water treatment system	Pipelines systems
2022	1	-	-	-	-	-	-	-	-	-	-
2023	2	284	1	-	-	-	-	-	-	-	-
2024	-	233	-	2	-	-	-	-	-	-	-
2025	40	1765	-	-	14	-	-	-	-	-	-
2026	102	10821	9	6	30	1	1	1	1	1	-
2027	900	-	-	-	-	-	-	-	-	-	1
2028	460	3100	-	300	29	-	5	-	-	-	-

- Phase 1 covers the entire region Warrap
- Starting from 2027 even after 2051, the homeless people will be vanished.

\* Houses = Traditional mud houses. \*Small hospital = 60 beds. \*School = 250 students. \*Plan include the start of building not the end.



# 30 Years Timeline Plan



## Phase 2

No of./year	Biogas Generator	Houses	Clinic	Solar Plant	School	Electricity lines systems	Hospital	Warehouse	Sewer lines systems	Water treatment systems	Pipelines systems
<b>2029</b>	6000+3456	97723	50	649	300	-	20/small	-	-	-	-
<b>2030</b>	40000+ 14799	12400	-	1493	4	5	13/large	5	5	5	5
<b>2031</b>	7675+ 17289	64096	55	19500	310	5	23/large + 25/small	5	5	5	5
<b>2032</b>	16524	66489	60	61284	320	4	15/large+ 30/small	4	4	4	4

- **3456** of the biogas will be fully used for the city of Warrap. **14799** biogas will be fully used for Bahr El Ghazal.
- **16524** biogas will be fully used for Equatoria. **17289** biogas will be fully used for The Greater Upper Nile.
- **12400** Standard number of houses every year in Bahr El Ghazal for increasing population and it will be **37200** every year for increasing population in South Sudan; starting from year 2032 till 2051.
- 2029 (start working in Bahr El Ghazal), 2031 (start working Equatoria), 2032 (start working in The Great Upper Nile)
- In 2032, solar plants had been built to cover the needs of citizens even after 2051. (standard average of a citizen: **1561** kwh/year)
- Biogas was provided to all citizens in 2032 ,and an average of 153 liters of biogas were saved.

## Phase 3



### From 2033 to 2047:

- Start replacing their regular hut houses by building with three rooms' appartement (no. of appartements: 3378824).  
**Note: each building will consist of 10 floors, and 5 appartements for each floor. (50 appartement per building, total 67577 buildings).**
- 10918 schools were built. (enough to 5M students)
- 515 large hospitals were built. (44 beds per 10000 persons, high human care)
- 2000 clinics were built.

## Phase 4

### From 2048 to 2051:

- Starting my marketing to the country to attract the investors to invest in the country, as: cars, companies .....etc.
- Make sure that every work is done in an advanced way in the country.
- The roads should be paved for the cars to move easily.
- 25 universities will be built.

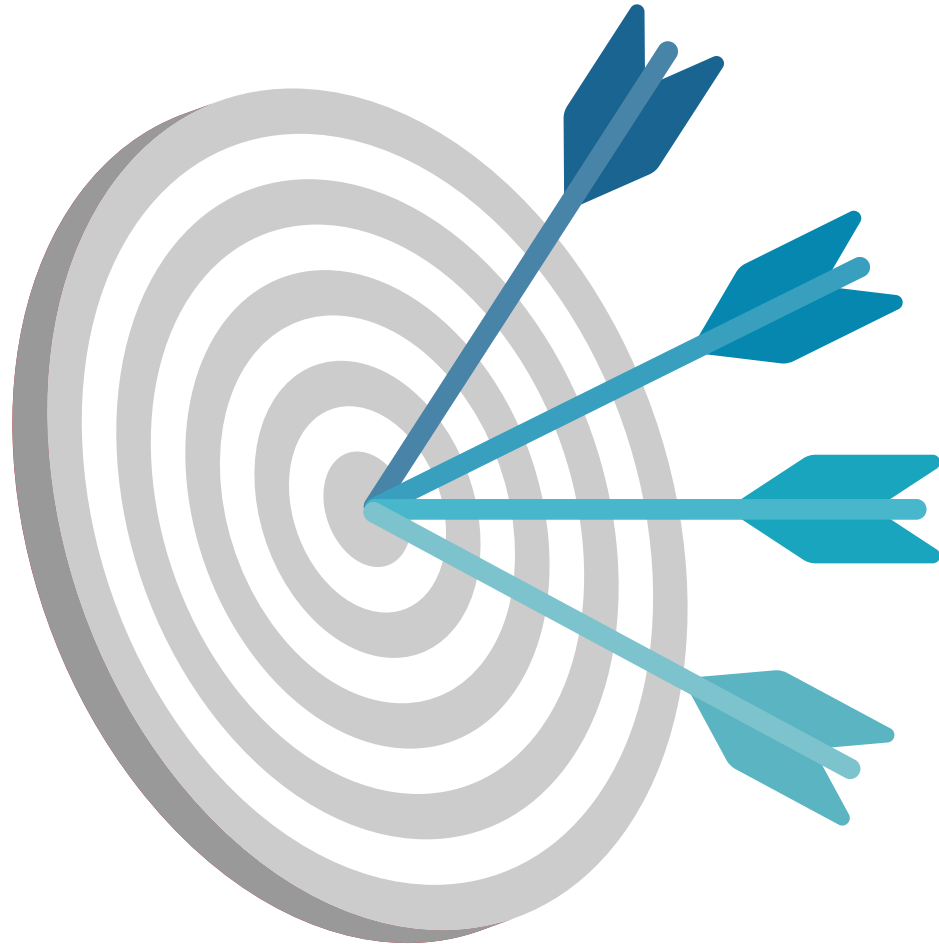




## Extra Details

- Most of the people suffer from lack of food and work. So, they were involved in the reconstruction of the country. The citizens will join the workers then, they will be able to farm some food.
- Solar panels and Schools includes services, and a fixed salary to the workers.
- Pipelines, water treatment system, warehouse, sewer lines and electricity lines are scaled to Warrap then, we took a ratio to build it in the three historical areas.
- Starting from 2034, the number of schools will be 20000 schools and the cost will be 1.2B dollar/year.
- Starting from 2033, the GDP will be 82.637B dollar, and it increase to 20 times from GDP of South Sudan in 2020 (4.07B)

# Solution Results



## Energy

Will increase access to electricity by from 6.25% in 2019 to 92% in 2051.

## Health

In 2051, the health care centers will increase 10 times to the numbers of health cares in 2019 (272).

## Quality of Life

Build 15 pipelines, water treatment, sewer lines, electricity lines and warehouses.

## Education

Provide education to the 5 million students by building 20,000 schools and 25 universities.



# Buildings Summary

Note: warehouse were built to store the water treatment plants

<b>Biogas</b>	<b>107248</b>	<b>University</b>	<b>25</b>
<b>Solar Systems</b>	<b>83684</b>	<b>Pipelines Systems</b>	<b>15</b>
<b>Apartements</b>	<b>3378824</b>	<b>Swer lines Systems</b>	<b>15</b>
<b>Schools</b>	<b>20000</b>	<b>Electricity Lines Systems</b>	<b>15</b>
<b>Hopitals</b>	<b>180 small 566 large</b>	<b>Water treatment systems</b>	<b>15</b>
<b>Clinics</b>	<b>2175</b>	<b>Warehouses</b>	<b>15</b>



*Thank you*



INTERNATIONAL  
**SWITCH ENERGY**  
CASE COMPETITION