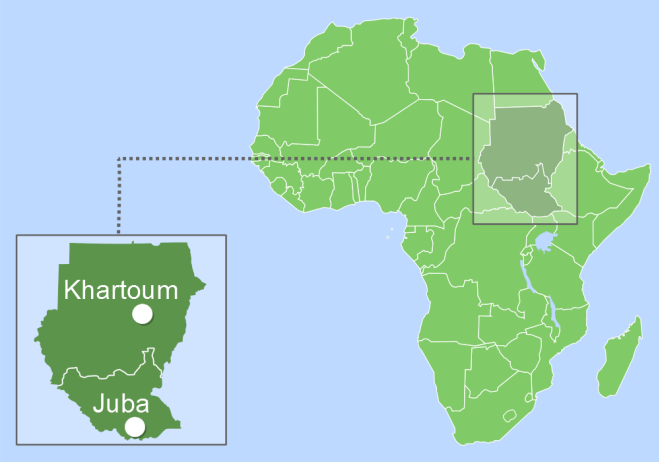


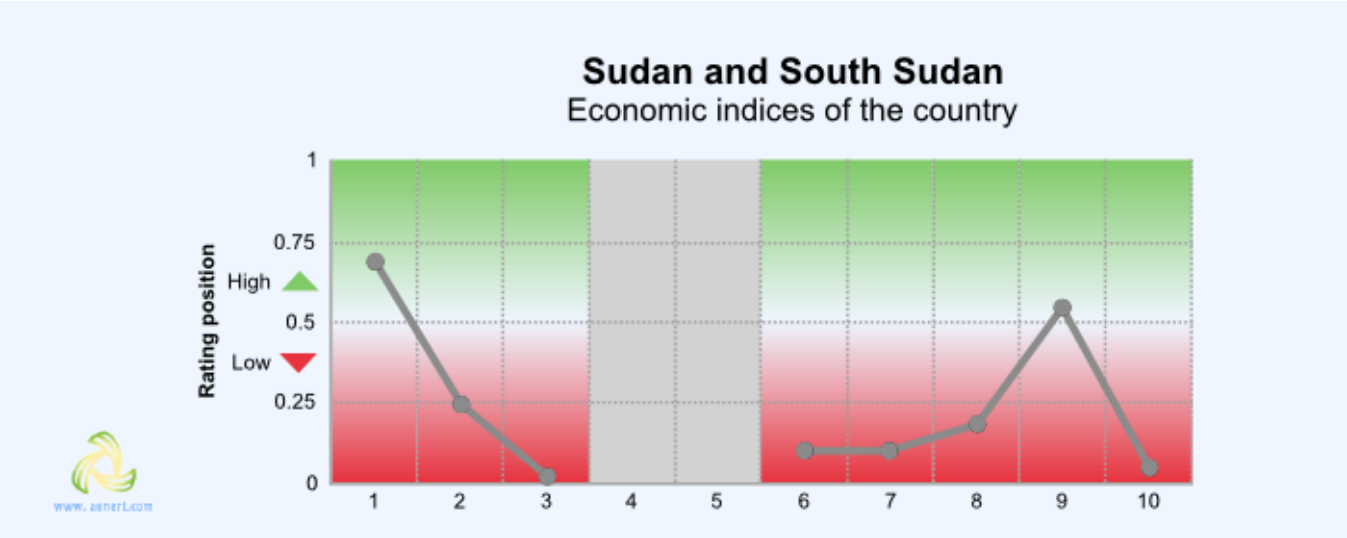
Energy Industry of **Sudan and South Sudan**

General State of the Economy

Sudan and South Sudan, situated in east Africa, became independent in July 2011 after a referendum in Southern Sudan. Sudan is located in the north-eastern part of Africa, and has access to the Red Sea. South Sudan is situated in equatorial Africa and has no access to the sea.

In terms of its size, Sudan and South Sudan are 15th and 41st, respectively, ahead of many countries in the region. However, according to population density, both countries are at the bottom of the list – at 161st and 164th[1,2]. The total length of the country's coastline is 853 km [3,4]. According to 2020 statistics, the countries are home to around 46 million people [3,4].

The economy of both countries is based on oil exports. Prior to separation, Sudan was the second largest oil producer in Africa, outside OPEC. For the majority of the selected indices Sudan and South Sudan are either not represented or are at the bottom of the diagram (Fig. 1)



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* Total number of countries participating in ranking

Figure 1. Economic Indices of Sudan and South Sudan

Although it lags far behind the global figures, Gross domestic product per capita in Sudan has been growing steadily over the last 30 years, and in 2017 amounted to $4300 [3,5]. This index in South Sudan made a sharp decline in 2012 and is now in the stage of growth, reaching $1 600 in 2017 [4,5]. The inflation rate in Sudan declined by more than 2 times compared to 2016 and totalled 17.8% in 2017 [3]. In comparison, inflation in Southern Sudan in 2017 reached 187.9% [4].
According to the Index of Economic Freedom, which is based on freedom of business, freedom from government intervention, property protection, and freedom from corruption, Sudan was 173rd in 2018, out of 180 countries considered. In terms of reserves of foreign exchange and gold, Sudan and South Sudan are 143rd and170th out of 176 countries.

In terms of GDP growth in percent over the past 10 years, in 2017 the countries were 92nd and 199th out of 200 countries. In terms of public debt, calculated as a percentage of the country's GDP, Sudan and South Sudan were ranked 194th and 148th, respectively, out of 202 countries considered in 2017.

*For more information on the economy of Sudan and South Sudan click **here**.*

Energy resources

For both countries, the main energy resource is oil, according to the BP statistical report 2019, oil reserves in 2018 were estimated to be 5 billion barrels [6]. According to information presented in [3,4], as of the beginning of 2017-2018, oil reserves in the countries amounted to 8.75 billion barrels, and gas reserves were 148.66 Bcm (Table 1).
Despite the proven natural gas reserves of 84.95 (Sudan) billion cubic meters and 63.71 (Southern Sudan) billion cubic meters, both countries do not consume and do not produce gas. Coal is not available in these two countries.

Table 1. Fossil energy resources of Sudan and South Sudan

Resource/ explanations	Crude oil	Natural gas	Coal	Solar Potential (GHI)*	Wind Potential (50 м)*	Hydro energy Potential**	Municipal Solid Waste
Value	8.75	148.66	-	5.5-6.6	5.0-7.0	19	0.79
Unit	BB	Bcm	-	kWh/m2/day	m/s	GWh/year	kg/per capita/ day
Year	2018	2018	-	2018	2018	2013	2012
Source	[3,4]	[3,4]	-	[7]	[8]	[9]	[10]

**for most of the territory of the country*
***gross theoretical capability*

Sudan and South Sudan have significant potential for renewable energy development (Table 1). The level of global horizontal solar radiation in most of the country is quite high and has a value of 5.5 - 6.6 kWh/m2/day. The maximum level of solar radiation can be observed in the northwestern part of the country, between Egypt, Libya and Chad around 6.6 – 6.8 kWh/m2/day.
Wind speed in most parts is 5.0-7.0 m/s, and over 8.0 m/s per year at 50 m/s in the northeastern part of the country, in the state of Red Sea, along the Red Sea coastline.
The main and most valuable resource for renewable energy in Sudan is hydro power. The gross theoretical hydropower potential of the country is 19 GWh/year.
The level of generation of municipal waste in Sudan was 0.79 kg per capita per day. By 2025, this index is projected to grow to a level of 1.05 kg per capita per day

*For more information about energy resources in Sudan and South Sudan click **here**.*

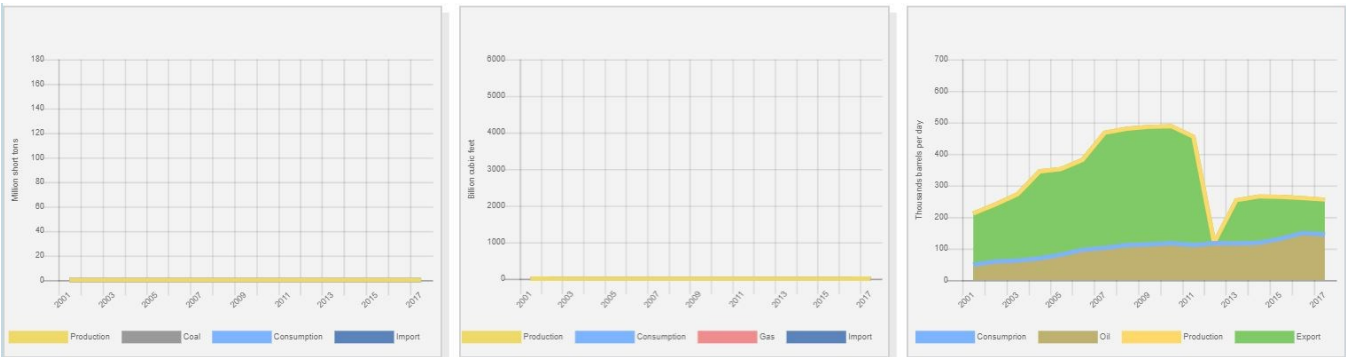
Energy balance

As noted above Sudan and South Sudan do not consume and do not produce gas; associated petroleum gas of the oil fields is mostly flared or reinjected.

Oil production in the united Sudan, grew rapidly from 2001 to 2010 from 200 to almost 500 thousand barrels per day, then fell significantly in 2011, and in 2017 it reached the level of 255 thousand barrels per day [11] (Figure 2). According to BP, crude oil production in 2018 was 231 thousand barrels per day [6].

The volume of consumption of this resource demonstrated stable growth (Fig. 2), and in 2017 reached the level of 145 thousand barrels/day, compared to 117 thousand barrels/day in 2012

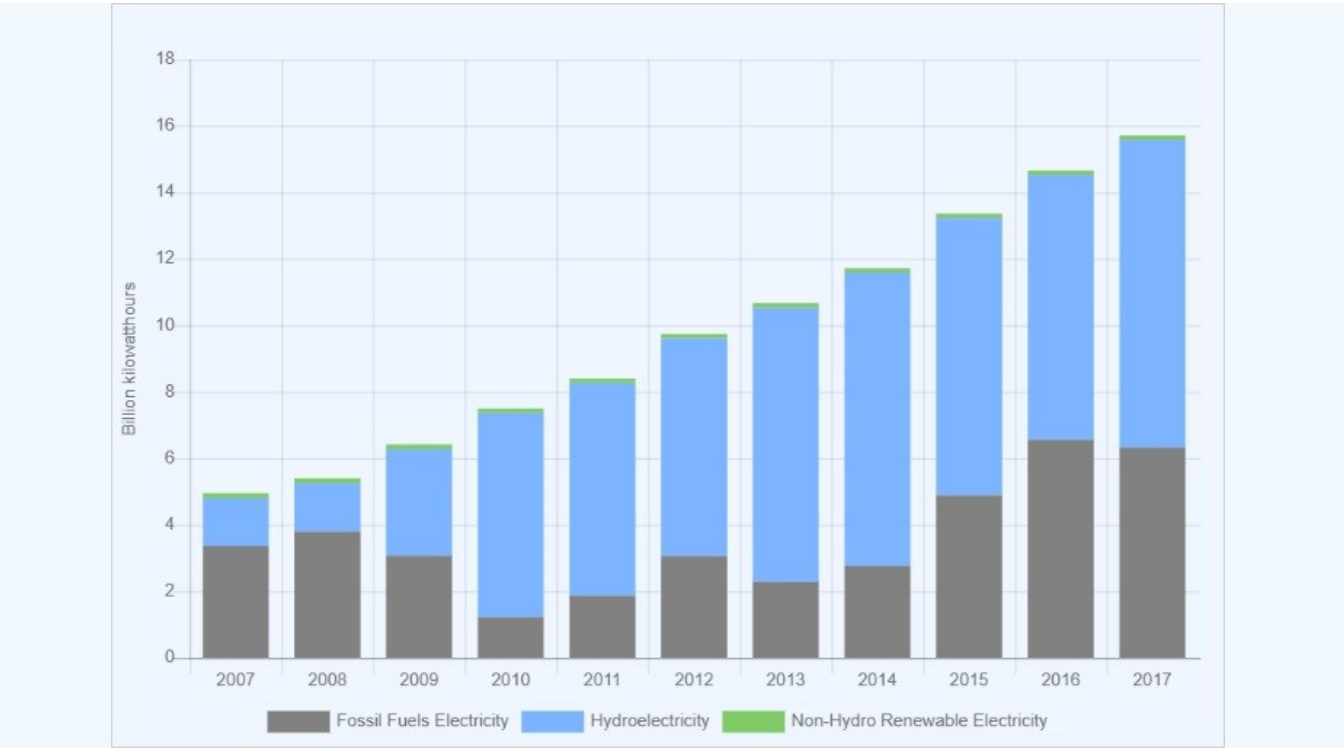
Sudan and South Sudan exported about 114 thousand bbl/day of crude oil in 2018, the largest oil importer is China, and its share is about 60% of total exports of oil from both countries [11].



Source: U.S. Energy Information Administration (Jan 2020) / https://www.eia.gov/

Figure 2. The production and consumption of fossil fuels in Sudan and South Sudan (coal-left, in the center-gas, oil-left)

Historically, Sudan and South Sudan have a high share of hydropower in electricity production. In 2017 these countries produced about 15.72 TWh of electricity, of which 58.8% was by hydropower and 40.3% by fossil fuels and 0.9% by other renewable sources (Fig. 5).

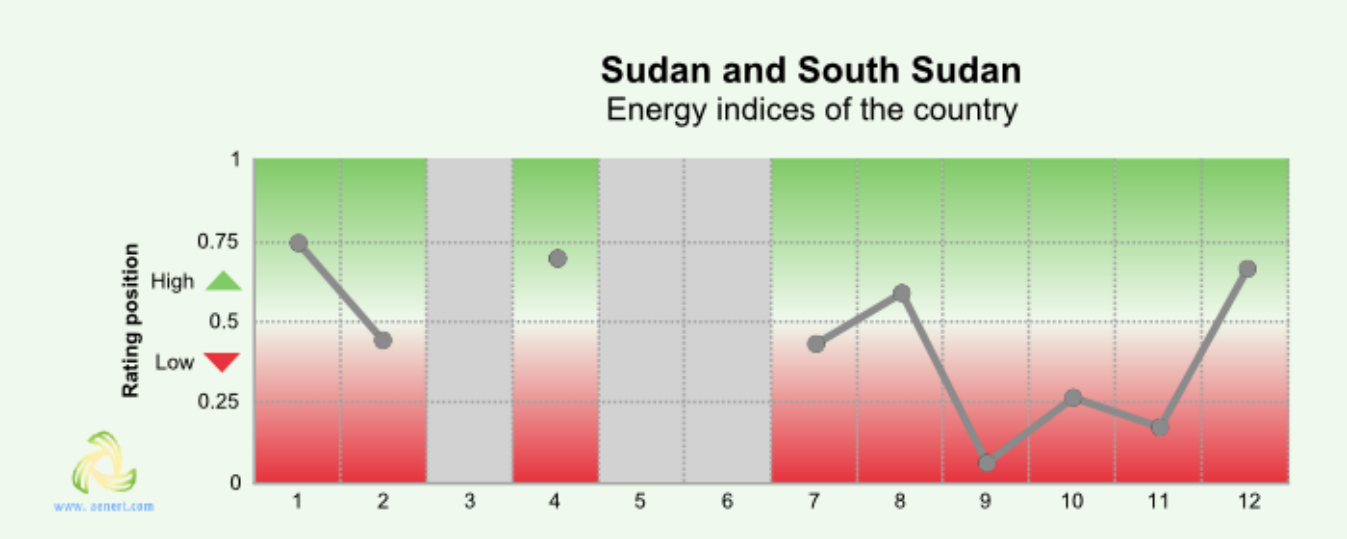


Source: U.S. Energy Information Administration (Jan 2020) / https://www.eia.gov/

Figure 3. Electricity production in Sudan and South Sudan

The role of hydropower has increased in recent years, while the share of fossil fuels has declined substantially.

Positioning of Sudan and South Sudan on the diagram of energy indices is shown on Figure 2.



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* Total number of countries participating in ranking

Figure 4. Energy indices of Sudan and South Sudan

Sudan and South Sudan indices, based on reserves of oil and gas and their production-consumption ratio, are higher than the world's average. However, other indices look less convincing.

In the Global Energy Architecture Performance Index 2017, which is based firstly on the level of economic growth, environmental safety, and energy independence of the country, including access to energy, both countries are 93rd in the world.

GDP per unit of energy use in 2014 is higher than the world average - 52nd out of 130 countries considered, while energy consumption per capita is much lower - 127th out of 135 countries.

In terms of electricity consumption per capita, Sudan and South Sudan are 172nd in the world, however, for the indicator of combination of electricity production-consumption -71st in the ranked list of 216 countries.

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*More information about the energy balance of Sudan and South Sudan can be found in the documents from our reference library **here**.*

Energy Infrastructure

The main oil fields in Sudan and South Sudan are situated in Muglat basins (blocks 1, 2 and 4, block 5A, block 6 and block 17) and Melut (blocks 3 and 7) on the border between the countries (Figure 5). Blocks 2, 4, 6 and 17 belong to Sudan, while the field units 1, 5A, 7, 3 belong to Southern Sudan. Up until 2011, oil exploration was carried out mainly in the central region, due to civil unrest [12].

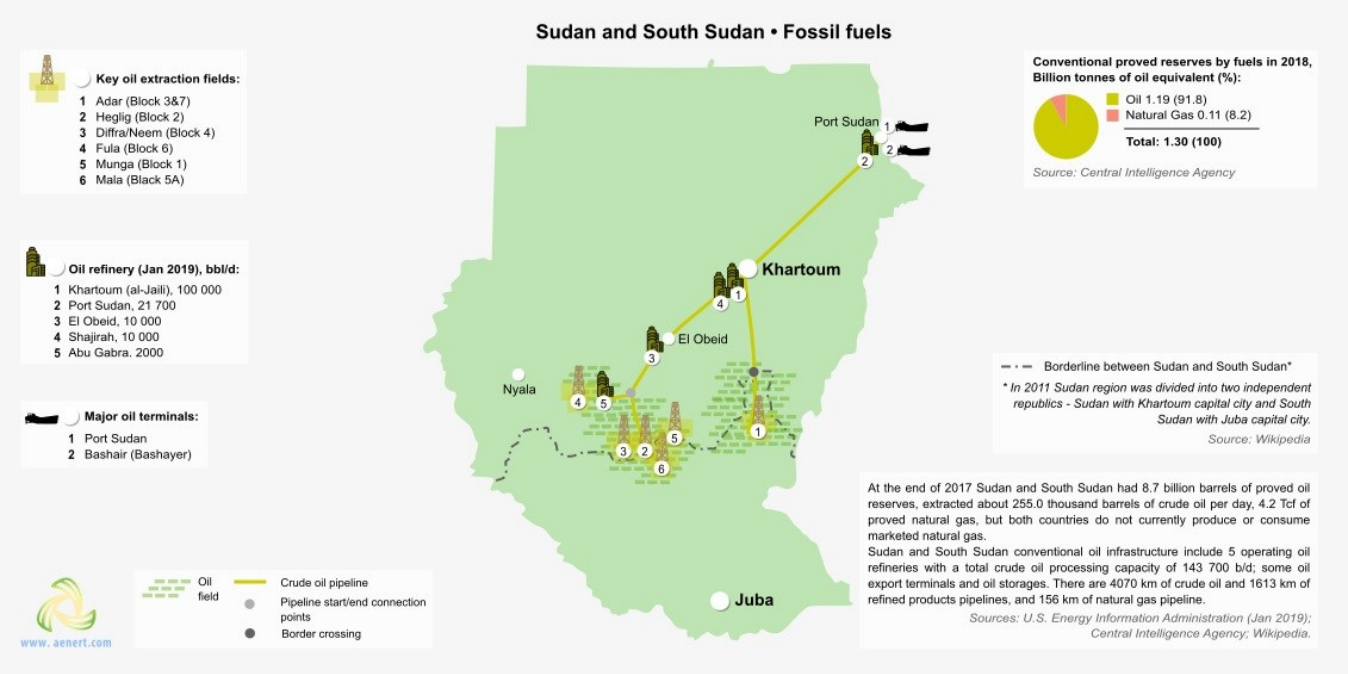


Figure 5. Basic Infrastructure facilities of the fossil fuel sector in Sudan and South Sudan

Petroleum industry in Sudan is represented by five plants in the central and northern parts of the country. The largest oil refineries are Khartoum and al-Jaili, located north of the capital, with an installed capacity of 100 thousand bbl/day (Figure 5) [13]. The modernization project of the oil refining industry involves the expansion of two plants Khartoum and Port Sudan (Figure 7). At this point there are no oil refineries on the territory of South Sudan, but the state plans to construct two plants in the vicinity of the fields (Figure 7) [12]. However, their construction is also complicated by the ongoing armed conflict between the two countries.

Two export pipelines, stretching from the south to the north of Sudan link the fields of both countries with the marine terminal, Bashayer, located about 15 miles south of Port Sudan. The Petrodar pipeline, with a capacity of 500 thousand bbl/day, transports oil from blocks 3 and 7. The GNPOC pipeline, with a capacity of 450 thousand bbl/day, transports oil from blocks 2 and 4 of Sudan 1 and 5 blocks of Southern Sudan [12]. South Sudan is considering the construction of an export crude oil pipeline which will bypass the current route through Sudan. Construction plans were discussed with the authorities in Kenya, Ethiopia, and Djibouti. Thus, it is possible to build a pipeline to a Kenyan port of Lamu or to the port of Djibouti through Ethiopia. South Sudan signed a Memorandum of Understanding with all governments [12]. The Toyota Tsusho Corporation has made a feasibility study for the construction of the pipeline to the port of Lamu and has expressed willingness to finance the construction, but the project has been frozen because of the civil unrest (Figure 7). [1]

There are 6 large oil power plants with a capacity of over 100 MW in Sudan, which are mainly concentrated in the northern and central parts of the country (Figure 6).

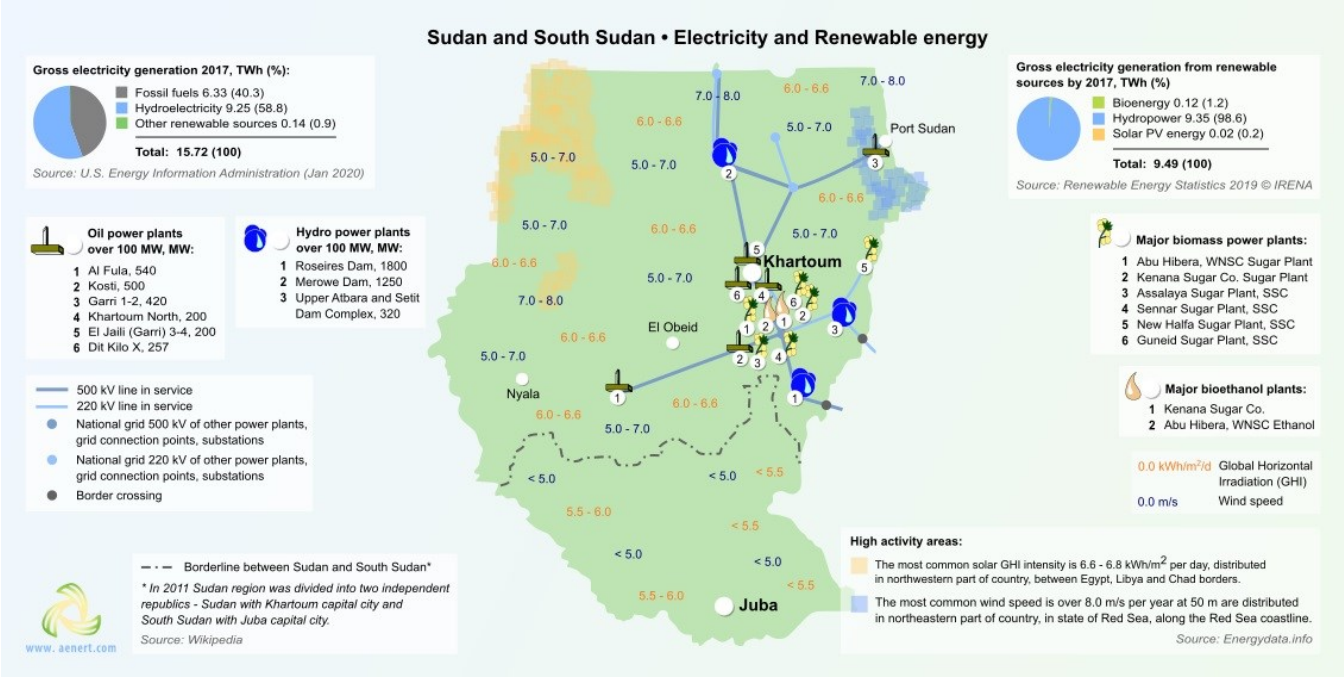


Figure 6. Basic Infrastructure facilities of the electricity and renewable energy in Sudan and South Sudan

As mentioned earlier, the basis of Sudan's electricity generation is hydropower, which is represented by two major stations, Roseires Dam and Merowe Dam. Installed capacity of Roseires Dam is 1,800 MW, Merowe Dam is noticeably smaller - 1250 MW [14,15]. There is also a project to construct five large hydroelectric power stations on the territory of Sudan, the largest of which is the Upper Atbara and Setit Dam Complex, with an installed capacity of 320 MW [16,17], and four large hydroelectric power stations on the territory of Southern Sudan, including Fula Dam (Figure 7) [18]. Sudan operates several plants for the production of biomass and two plants for bioethanol production. Bioenergy makes up 1.2% of the electricity generation of renewable energy in Sudan (Figure 6).

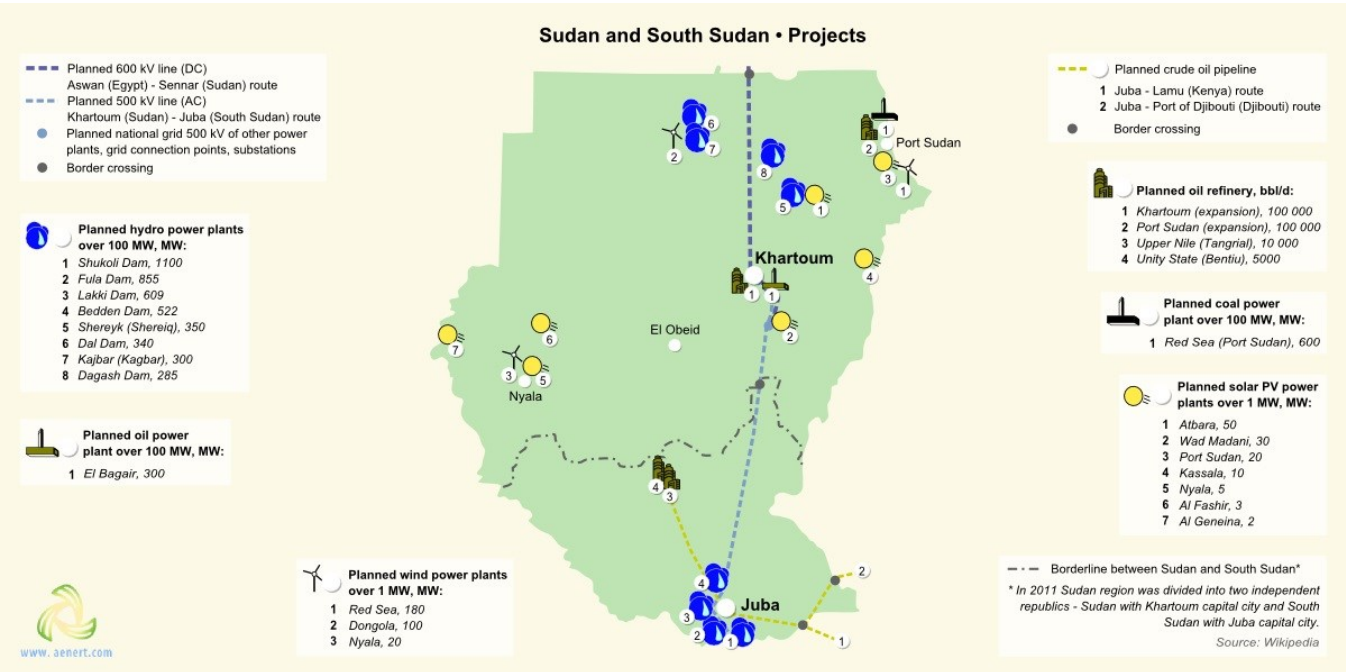


Figure 7. Some of the projects of energy infrastructure development in Sudan and South Sudan

The North South Transmission Line Project involves the construction of high-voltage transmission lines, with capacity from 3 000 to 17 000 MW from Egypt through Sudan, South Sudan and other African countries [19]. However, because of the loss of oil revenues after the separation of South Sudan, the funding of some projects remains questionable. The operator of the majority of power plants and the largest supplier of electricity in Sudan is the National Electricity Corporation. The company also plans to build a coal-fired power plant in Port Sudan with a capacity of 600 MW, and in El Bagair a combined cycle power plant with a capacity of 300 MW [20].

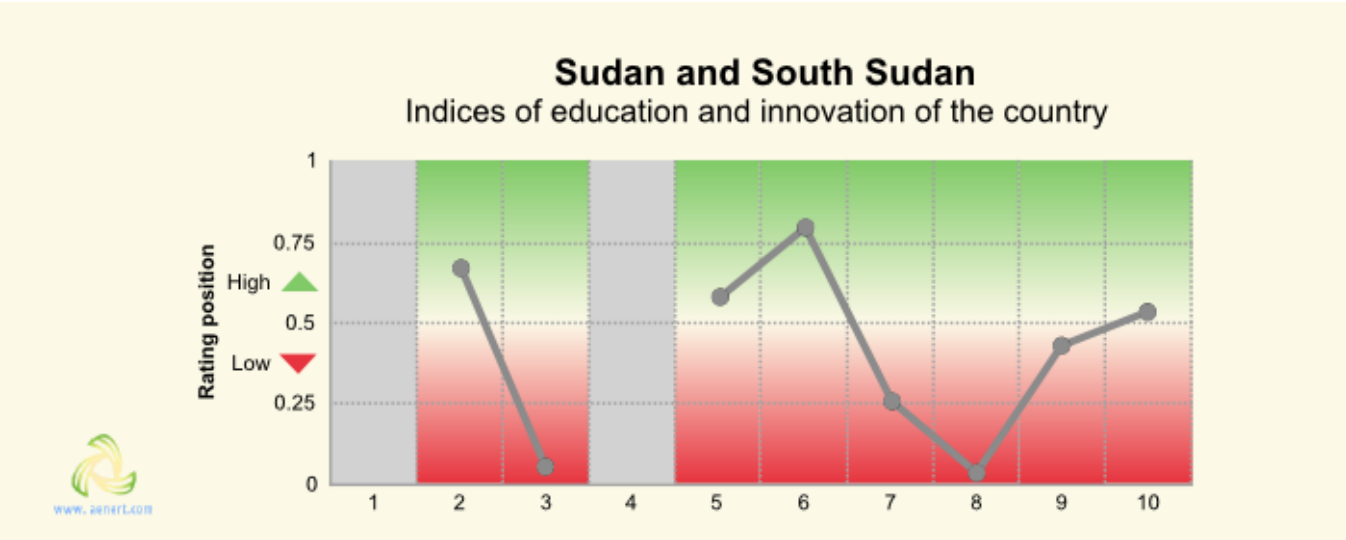
As mentioned earlier, the level of global horizontal solar radiation can reach over 6.8 kWh/m2 per day, and the level of wind speed - more than 8 m/sec, which is a good resource for the production of energy [7,8]. However, as already mentioned, this resource has not been actively capitalized. In Figure 7 you can see renewable energy projects among which are several solar stations and a wind farm. The largest solar power plant is the Atbara PV Solar Plant Project, with an installed capacity of 50 MW [21].

*For current information on the development of energy in the country see **here**. More information about energy infrastructure is also available **here**.*

Education and Innovation

The following data on education and innovation has a significant effect on the future development of Sudan and South Sudan energy (Figure 8).

According to the number of patents granted to Sudanese residents, both inside the country and abroad, the country ranks 56th in the world. Similarly, by the number of valid patents, the country is 83rd in the world, which largely characterizes the country's patent attractiveness.



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* Total number of countries participating in ranking

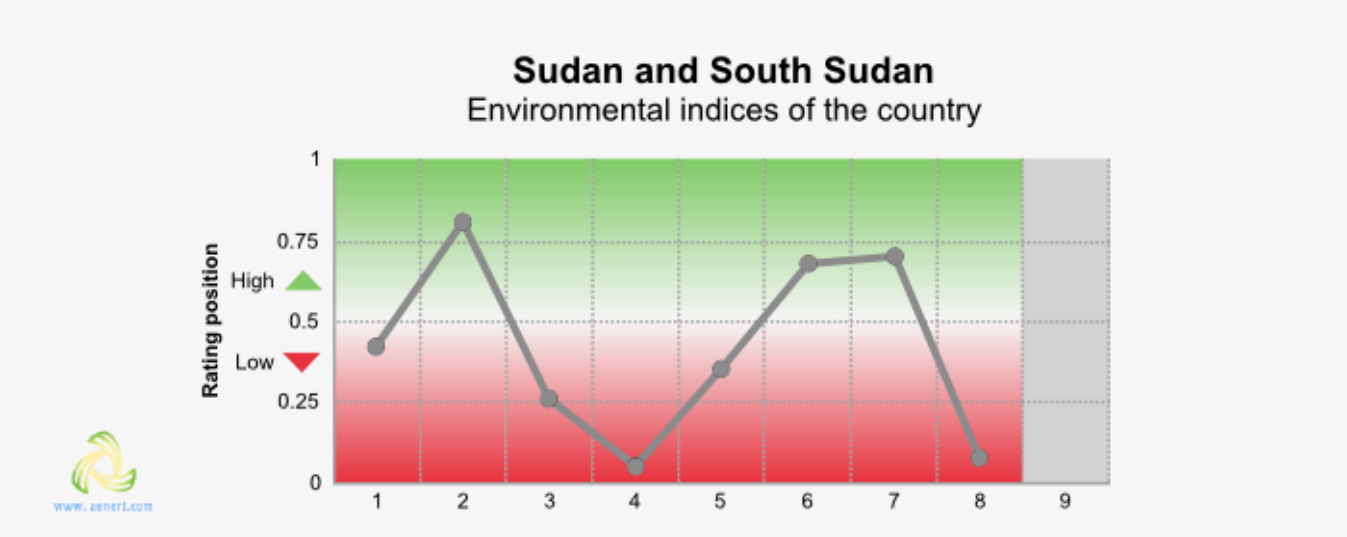
Figure 8. The indices of education and innovation in Sudan and South Sudan

The countries are well positioned when considering the number of publications of specialists in scientific and technological journals - placed 94th out of 196 countries considered. It is also highly regarded by the Scimago Journal and Country Rank (100th place).
In terms of government expenditure on education as a percentage of the country's GDP, the country demonstrates a negative result - 164th out of 169 countries selected for consideration. In terms of the amount of government expenditure on research and development as a percentage of GDP, the country is 68th in the world.
The University of Khartoum, Sudan University of Science and Technology and the Petro-Energy E&P Co. Ltd. are engaged in research in the field of non-traditional oil production, including directional drilling and hydro-cracking. Research and development in the field of bio-energy and solar energy are being carried out by the Sudan University of Science and Technology. In the field of synthetic fuel development -The University of Blue Nile.

*Additional information about education in the country can be obtained **here**, and the list of research institutes in the country **here**.*

Ecology and Environment Protection

A diagram of environmental indices is shown in Figure 9. According to the data, most of the indicators are in the red zone, indicating that there is an unfavourable ecological situation in both countries, which have high levels of methane emissions and CO_2 emissions. There is no positive trends in forest area change, in terms of the ecological footprint on a global scale, Sudan and South Sudan are debtors.



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* Total number of countries participating in ranking

Figure 9. Environmental Indices of Sudan and South Sudan

The situation is aggravated by a relatively low valuation in the Environmental Performance Index rankings (EPI) 2018, which focuses primarily on assessing the environmental performance of national governments. In this rating Sudan and South Sudan are below Egypt, and are 115th out of 180 member countries and demonstrate a positive trend. According to The Environmental Vulnerability Index, which is based on years of observations and 50 indicators, which include for example, changing climatic characteristics or the quality of water resources, waste volumes, oil spills and other hazardous substances, etc. Sudan and South Sudan are 73rd, and are characterized as "vulnerable".

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*Detailed information about the energy industry in Sudan and South Sudan is available **here**.*

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The sources of charts and curves are specified under the images.