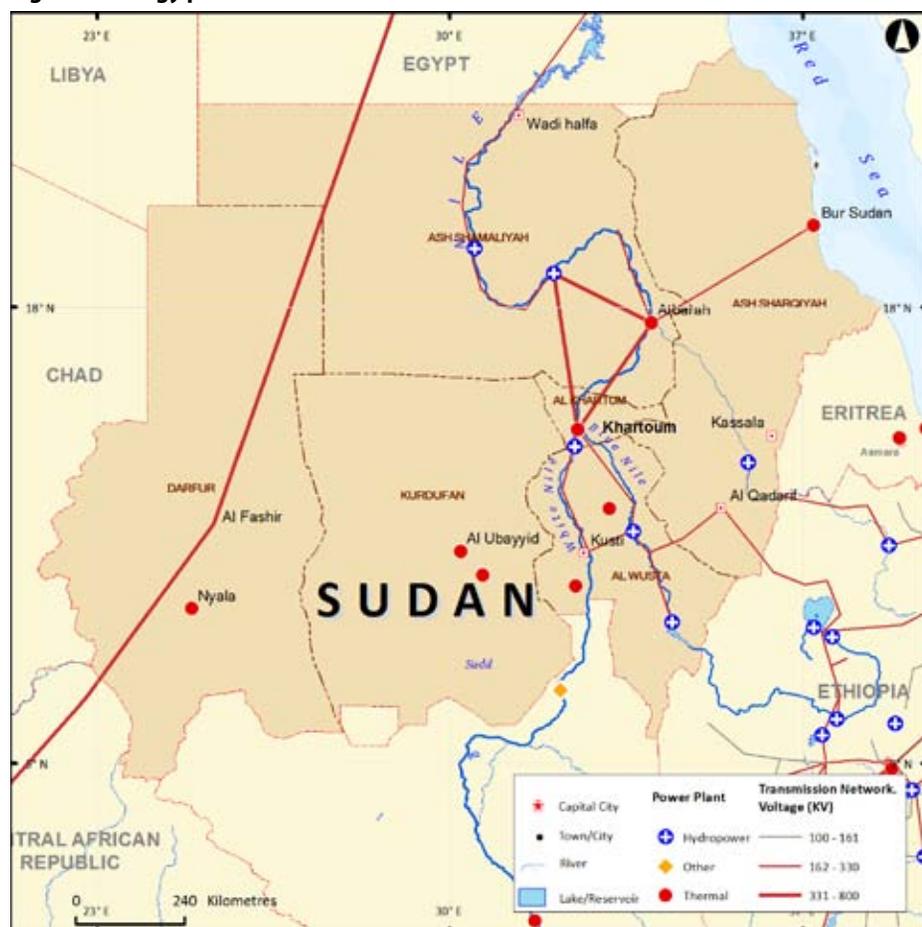




Figure 1: Energy profile of Sudan



Energy Consumption and Production

Sudan's population in 2013 was 37.96 million, as shown in Table 1. Total electricity produced in 2015 was 1,281 ktoe, with 64.9 per cent produced from hydro, 33.6 per cent from fossil fuels and 1.32 per cent from biofuels and waste. Final electricity consumption in 2015 was 1,087 ktoe (Table 2) (AFREC, 2015). Figures 2 and 3 show the energy statistics.

Table 1: Sudan's key indicators

Key indicators	Amount
Population (million)	37.96
GDP (billion 2005 USD)	29.27
CO ₂ emission (Mt of CO ₂)	13.58

Source: (World Bank, 2015)

Energy Resources

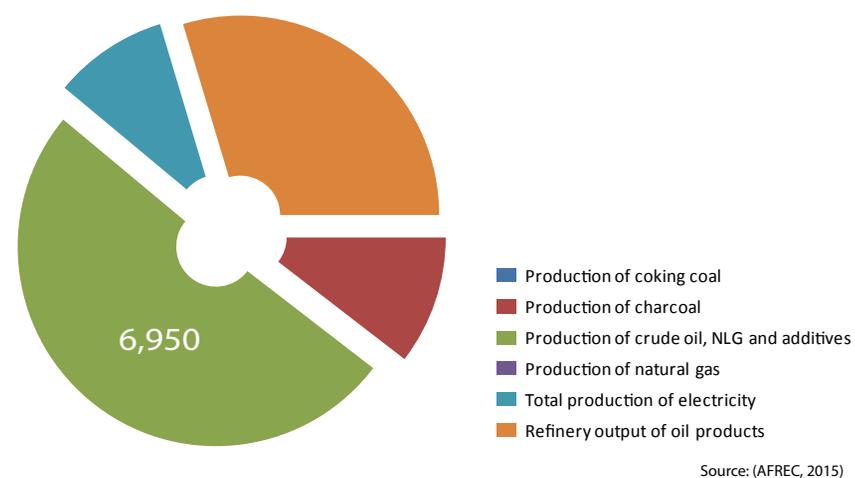
Biomass

Traditional biomass provides most of the energy needs of the local population especially those who live in the countryside with no access to electricity. Fuelwood and charcoal provide about 75 per cent of energy needs (USAID, 2012). Charcoal produced in 2015 amounted to 1,431 ktoe (AFREC, 2015). The alternative biomass fuel sector is a growth industry with some sugar industries already using bagasse for cogeneration to supply their energy needs. Installed cogeneration capacity is just over 56 MW REEEP (2012). In terms of biofuels, the alien invasive Mesquite shrub (*Prosopis* spp), agricultural wastes and livestock dung are both potential feedstocks. There are plans to use the alien invasive Mesquite shrub as a biofuel for domestic energy. In 2009, a bio-ethanol plant was established (REEEP, 2012) and in 2013 regulations to guide the biofuels industry were proposed.

Hydropower

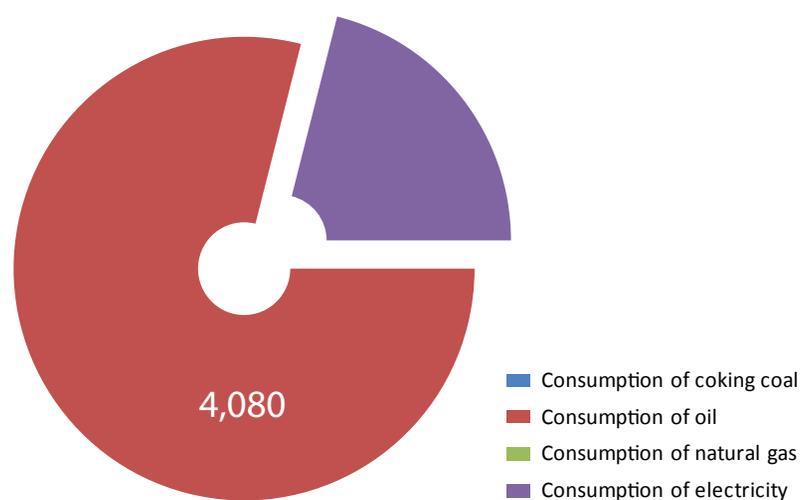
Total potential for hydropower in the country is estimated at 4,860 MW (REEEP, 2012) and in 2015 electricity from hydropower amounted to 832 ktoe about 65 per cent of total electricity produced (AFREC, 2015). Electricity is generated from an array of power plants around the country including Merowe in the north, Upper Atbara and Seteit in the east, Sennar and the Roseires in the south, among others. The capacity of Merowe hydropower plant is 1,250 MW (REEEP, 2012). There is also potential for small hydro from various sites around the country.

Figure 2: Total energy production, (ktoe)



Source: (AFREC, 2015)

Figure 3: Total energy consumption, (ktoe)



Source: (AFREC, 2015)

Table 2: Total energy statistics (ktoe)

Category	2000	2005	2010	2015 P
Production of coking coal	-	-	-	-
Production of charcoal	1,711	1,511	1,368	1,431
Production of crude oil, NLG and additives	8,380	13,700	21,555	6,950
Production of natural gas	-	-	-	-
Production of electricity from biofuels and waste	44	44	44	17
Production of electricity from fossil fuels	119	203	112	431
Production of nuclear electricity	-	-	-	-
Production of hydro electricity	102	95	533	832
Production of geothermal electricity	-	-	-	-
Production of electricity from solar, wind, Etc.	0	0	0	1
Total production of electricity	265	342	689	1,281
Refinery output of oil products	1,962	3,506	4,883	4,075
Final Consumption of coking coal	-	-	-	-
Final consumption of oil	1,358	2,526	4,480	4,080
Final consumption of natural gas	-	-	-	-
Final consumption of electricity	135	215	520	1,087
Consumption of oil in industry	207	286	1,206	777
Consumption of natural gas in industry	-	-	-	-
Consumption of electricity in industry	29	36	76	100
Consumption of coking coal in industry	-	-	-	-
Consumption of oil in transport	1,001	2,017	2,789	2,802
Consumption of electricity in transport	-	-	-	-
Net imports of coking coal	-	-	-	-
Net imports of crude oil, NGL, Etc.	-6,184	-4,876	-6,822	-931
Net imports of oil product	515	640	409	860
Net imports of natural gas	-	-	-	-
Net imports of electricity	-	-	-	-

- : Data not applicable

0 : Data not available

(P): Projected

(AFREC, 2015)

Oil and natural gas

As in the case of South Sudan, oil plays a major role in the economy of the Republic of Sudan. In 2005, production of oil was 13,700 ktoe increasing to 21,555 in 2010. In 2015, however production had declined to a mere 6,950 ktoe (AFREC, 2015). This can be attributed to the fact that after 2011, most of the oil producing blocks were located in the newly independent South Sudan; and the Republic of Sudan remained with the oil infrastructure including pipelines and refineries. Most of the oil producing areas are on, or near, the border with South Sudan. Net imports of oil increased from 409 ktoe in 2010 to 860 ktoe in 2015 (AFREC, 2015). The government recently opened exploration bids for some new blocks hoping that new finds will help boost the oil sector (EOE, 2013). In 2015, 33.6 per cent of electricity produced was from fossil fuels (AFREC, 2015).

Wind

Although the use of wind energy is not widespread there is potential for rural electrification especially through off-grid solutions. This would strengthen energy security and enhance access to electricity. The Northeast Trade winds blow over the Red Sea in northern Sudan with speeds to a high of 6 m/s (REEEP, 2012). Current small-scale uses of wind energy include phone charging, domestic water pumping, and irrigation. But the government is keen to upscale generation of on-grid electricity from wind. Omene Energy, an IPP, is currently developing 500 MW of wind power along the Red Sea coast (REEEP, 2012) (Omer, undated).

Geothermal

There is about 400 MW of potential geothermal energy in Sudan (REEEP, 2012). Geothermal potential is located in different regions around the country. For instance, in the Darfur region

the Jabel Marra volcano and the Tagbo and Beidob hills have registered good measurements; while further north towards the Red Sea there is geothermal activity near the Bayud volcano. Although there is currently no electricity from geothermal sources, the government is looking to neighbouring Kenya which has much experience in exploiting geothermal energy for guidance in this area (REEEP, 2012).

Solar

In 2015 electricity generated from solar and wind was only 1 ktoe (AFREC, 2015). However, there is potential for solar energy use to increase. The mean solar insolation in the country is 6.1 kWh/m²/day, which implies good potential for solar energy (REEEP, 2015). Solar is used in a variety of settings to provide energy for water pumping in agriculture, lighting and others in a variety of rural and peri-urban settings (REEEP, 2012).

Tracking progress towards sustainable energy for all (SE4All)

The national electrification rate in Sudan is 32.6 per cent (Table 3 and Figure 4) (World Bank, 2016). In rural areas, 17.8 per cent have access to electricity, while in urban areas, the rate is higher at 62.1 per cent (World Bank, 2016). In 2010, Sudan had an electricity access deficit of 30.9 million people (World Bank, 2013a).

In 2012, only 27.9 per cent of the Sudanese people were using non-solid fuels; 16 per cent of these were in rural areas and 42 per cent in urban areas (World Bank, 2016); (World Bank, 2015).

The energy intensity (the ratio of the quantity of energy consumption per unit of economic output) of the Sudanese economy was 5.3 MJ per US dollar (2005 dollars at PPP) in 2012. The compound annual growth rate (CAGR) between 2010 and 2012 was 7.13 (World Bank, 2015).

The share of renewable energy in the total final energy consumption (TFEC) decreased slightly to 64 per cent in 2012 from 66.6 per cent in 2010. Traditional solid biofuels form the biggest share of renewable sources at 41.2 per cent of TFEC in 2012, while modern solid biofuels contributed 18.7 per cent and hydro only 4.1 per cent (World Bank, 2015). Renewable sources contributed 70.1 per cent share of electricity generation in 2012 (World Bank, 2015). The government plans to integrate renewable energy in the power system of the Sudan, with a target of 20 per cent by 2030.

Table 3: Sudan's progress towards achieving SDG7 – Ensure access to affordable, reliable, sustainable and modern energy for all

Target	Indicators	Year					
		1990	2000	2010	2012	2000-2010	2011-2015
7.1 By 2030, ensure universal access to affordable, reliable and modern energy services	7.1.1 Per cent of population with access to electricity	23	25	29	32.6		
	7.1.2 Per cent of population with primary reliance on non-solid fuels	2	8	25	27.9		
7.2 By 2030, increase substantially the share of renewable energy in the global energy mix	7.2.1 Renewable energy share in the total final energy consumption	73.3	81.6	66.6	63.97		
7.3 By 2030, Double the rate of improvement of energy efficiency	7.3.1 GDP per unit of energy use (constant 2011 PPP \$ per kg of oil equivalent)						10.27 (2013)
	Level of primary energy intensity(MJ/\$2005 PPP)	9.3		4.6	5.3	4.76	5.29

Sources: (World Bank, 2015); (World Bank, 2016)

Figure 4: SDG indicators

Percentage of population with access to electricity	Access to non-solid fuel (% of population)	GDP per unit of energy use (PPP \$ per kg of oil equivalent) 2013	Renewable energy consumption (% of total final energy consumption), 2006-2011, 2012
32.6%	27.9%	10.61	63.97%
			

Table 4: Sudan's key aspects/key mitigation measures to meet its energy Intended Nationally Determined Contributions (INDCs)

INDC
*Integrate renewable energy in the power system of the Sudan with a target of 20 per cent by 2030 including Wind energy – 1,000 MW (grid connected);
Solar PV energy – 1,000 MW (on- and off-grid); Solar CSP technology - 100 MW (grid connected);
*Waste to Energy: -80 MW (grid connected); Biomass Potential - 80 MW (grid connected); Small Hydro Plants - 50 MW (grid connected).

Source: (MEM, 2015)

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Oil installation on the road from Bentiu to Yida

Table 5: Sudan's institutional and legal framework

Basic Elements	Response
Presence of an Enabling Institutional Framework for sustainable energy development and services (Max 5 institutions) most critical ones	<ul style="list-style-type: none"> • Ministry of Energy and Mining • Ministry of Petroleum (MOP)
Presence of a Functional Energy Regulator	Electricity Regulatory Authority (ERA)
Ownership of sectoral resources and markets (Electricity/ power market; liquid fuels and gas market)	
Level of participation in regional energy infrastructure (Power Pools) and institutional arrangements	
Environment for Private Sector Participation	
Whether the Power Utility(ies) is/are vertically integrated or there is unbundling (list the Companies)	<p>The National Electricity Corporation (NEC) was the sole generator, transmitter and distributor of electric energy in Sudan. It was been unbundled in 2010 into the following companies:</p> <ul style="list-style-type: none"> • Merowe Dam Electricity Company Ltd • Sudanese Hydropower Generation Company Ltd • Sudanese Thermal Power Generation Company Ltd • Sudanese Transmission Lines Company Ltd • Sudanese Electricity Distribution Company Ltd
Where oil and gas production exists, whether upstream services and operations are privatized or state-owned, or a mixture (extent) e.g., licensed private exploration and development companies)	Sudanese Petroleum Cooperation (SPC)
Extent to which Downstream services and operations are privatized or state-owned, or a mixture (extent)	
Presence of Functional (Feed in Tariffs) FIT systems	
Presence Functional IPPs and their contribution	
Legal, Policy and Strategy Frameworks	
Current enabling policies (including: RE; EE; private sector participation; & PPPs facilitation) (list 5 max) most critical ones	<ul style="list-style-type: none"> • National Strategic Plan for Sudan 2007-2011 • Sudan Renewable Energy Master Plan 2005
Current enabling laws/pieces of legislation (including: RE; EE; private sector participation; & PPPs facilitation) – including electricity/grid codes & oil codes (5 max or yes/no) most critical ones	<ul style="list-style-type: none"> • Petroleum Wealth Act, 1998 • Regulations for Protection of the Environment in the Petroleum Industry 2001

This table was compiled with material from (REEEP, 2012)

Intended Nationally Determined Contributions (INDC) within the framework of the Paris climate Agreement

Sudan aims to follow a low carbon development pathway in the three sectors of energy, forestry and waste, in line with national development priorities. The Intended Nationally Determined Contributions (INDC) were articulated in November 2015 and those related to energy are listed in Table 4.

Institutional and Legal Framework

The Ministry of Energy and Mining and the Ministry of Petroleum are in charge of the energy

sector (Table 5). There are three energy regulators for electricity, oil and mining, as follows: Electricity Regulatory Authority (ERA), Sudanese Petroleum Cooperation (SPC) and Public Geological Research Authority (PRA), respectively. The National Electricity Corporation (NEC) is the sole generator, transmitter and distributor of electric energy in Sudan. On a regional level, Sudan is a member of greater East African Power Pool. The main sector policy is the National Strategic Plan for Sudan 2007-2011 and there is a Sudan Renewable Energy Master Plan 2005. The legal framework is provided by the Petroleum Wealth Act 1998, the Regulations for the Protection of the environment in the Petroleum Industry 2001 and subsequent amendments.