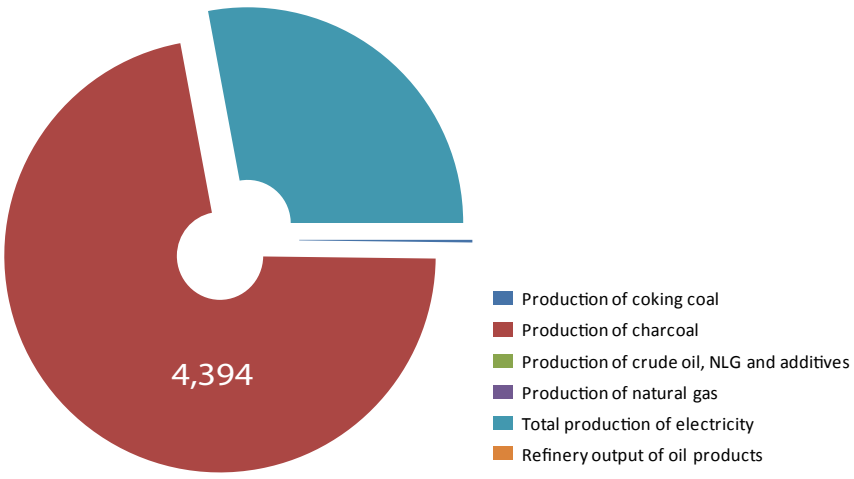
Ethiopia

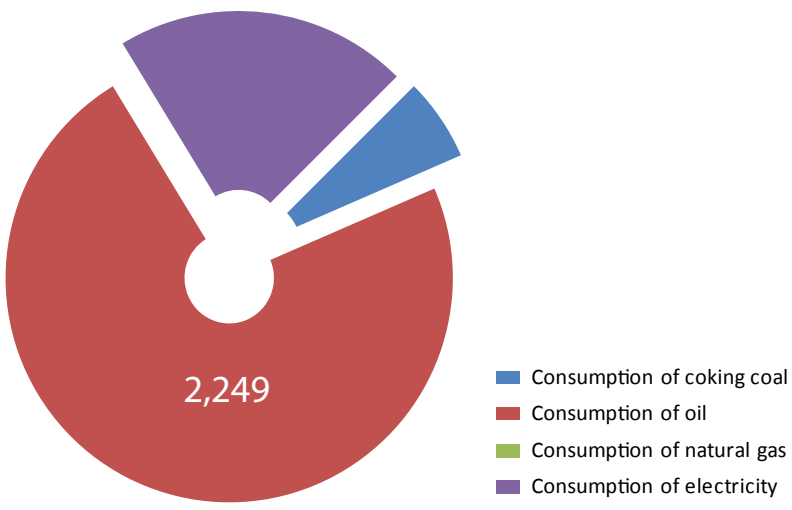
Figure 1: Energy profile of Ethiopia

Figure 2: Total energy production, (ktoe)



Source: (AFREC, 2015)

Figure 3: Total energy consumption, (ktoe)



Source: (AFREC, 2015)

Energy Consumption and Production

Ethiopia's population in 2013 was 94.1 million (Table 1) (IEA, 2016). Total production of electricity in 2015 was 1,708 ktoe with 82.7 per cent produced from hydro, 2.8 per cent from fossil fuels and 2.7 per cent from geothermal sources (Table 2). Final consumption of electricity was 654 ktoe in the same year (AFREC, 2015). Key consumption and production statistics are shown in Figures 2 and 3.

Table 1: Ethiopia's key indicators

Key indicators	Amount
Population (million)	94.10
GDP (billion 2005 USD)	27.74
CO_2 emission (Mt of CO_2)	8.50

Source: (World Bank, 2015)

Energy Resources

Biomass

Ethiopia has a huge biomass energy potential with estimates putting the national woody biomass stock at 1,149 million tonnes with annual yields of 50 million tonnes in the year 2000. Biomass distribution across the country is uneven, with the northern highlands and eastern lowlands having low biomass cover. Population growth is putting pressure on these resources.

Agro-processing industries, such as processing sugar-cane bagasse, cotton stalk, coffee hull and oil- seed shells, present an opportunity for biomass energy. But currently, there are no grid-connected biomass power plants. Municipal waste and biofuels have been underutilized, although the current Growth and Transformation Plan seeks to address this by stepping up the dissemination of domestic biogas plants, vegetable oil stoves and improved stoves (REEEP, 2014).

Hydropower

There are enormous resources for hydro generation; the gross theoretical potential (650 TWh/yr) is second only to that of the Democratic Republic of the Congo (WEC, 2013). Despite this, only about 3 per cent of the country's hydropower potential is being exploited (REEEP, 2014). Currently, domestic demand is insufficient to justify its full development. Neighbouring countries of Kenya and Sudan, however, could benefit from the electricity provided by hydropower development in Ethiopia (WEC, 2013).

Some of the hydroelectric projects include Tekeze (300 MW in 2009), Gibe II (420 MW in 2010), Tana Beles (460 MW in 2010) and Amerti Nesha (97 MW in 2011). Additionally, four more projects (Gibe III, Ashegoda expansion, Adama II and the Grand Ethiopian Renaissance Dam) are under construction. However, these developments are constrained by the inadequate power transmission system (REEEP, 2014).

Oil and natural gas

Ethiopia has few proven hydrocarbon reserves, although there is potential for oil and gas exploration. By the end of 2011, the proved recoverable reserves of natural gas were 25 bcm (WEC, 2013). There is no in-country refinery so all petroleum products are imported.

Table 2: Total energy statistics (ktoe)

Category	2000	2005	2010	2015 P
Production of coking coal	0	0	0	12
Production of charcoal	686	778	3 530	4 394
Production of crude oil, NLG and additives	0	0	5	0
Production of natural gas	-	-	-	-
Production of electricity from biofuels and waste	0	0	0	26
Production of electricity from fossil fuels	2	4	3	48
Production of nuclear electricity	-	-	-	-
Production of hydro electricity	154	245	420	1413
Production of geothermal electricity	0	0	2	47
Production of electricity from solar, wind, Etc.	0	0	0	173
Total production of electricity	156	249	424	1 708
Refinery output of oil products	-	-	-	-
Final Consumption of coking coal	0	0	26	184
Final consumption of oil	1,099	1,692	1,911	2,249
Final consumption of natural gas	-	-	-	-
Final consumption of electricity	121	207	385	654
Consumption of oil in industry	294	411	587	804
Consumption of natural gas in industry	0	0	0	0
Consumption of electricity in industry	47	85	120	149
Consumption of coking coal in industry	0	0	26	184
Consumption of oil in transport	642	1 050	1,333	997
Consumption of electricity in transport	0	0	0	0
Net imports of coking coal	0	0	13	168
Net imports of crude oil, NGL, Etc.	0	0	0	0
Net imports of oil product	1,064	1,518	2,313	2,563
Net imports of natural gas	-	-	-	-
Net imports of electricity	0	0	0	-34

- : Data not applicable
0 : Data not available
(P): Projected

(AFREC, 2015)

Peat

There are about 200 km^2 of peatlands (WEC, 2013).

Coal

Ethiopia is known to have some coal deposits in the Dilbi-Moye basin in the southwest of the country. Deposits are estimated at 14,016,730 tonnes (MME, 2009). Other areas with coal deposits include the Geba basin (250,000,000 tonnes), Chilga basin (19,000,000 tonnes) and Chida Waka (9.38 million tonnes) (MME, 2009).

Wind

Ethiopia has one of the most ample wind resources in Eastern Africa, with velocities ranging from 7 to 9 m/s. At the end of 2013, 171 MW of wind energy was installed (GWEC, Various years). It installed another 90 MW in 2013 (Table 3), in line with the government's very ambitious plans for build-out of up to 7 GW by 2030 (GWEC, Various years).

Two wind farms are in operation: the 51 MW Adama I wind farm, which began production in 2011, with a second phase (150 MW) under construction; and the 120 MW Ashegoda wind farm, which came on line at the end of 2013. The Ethiopian government is keen to use renewables to mitigate the seasonal availability of hydropower. To that end, a solar and wind power master plan has also been prepared.

Table 3: Installed wind power capacity in Ethiopia, (MW)

	End 2007	End 2008	End 2009	End 2010	End 2011	End 2012	End 2013
Ethiopia						81	171

Source: (GWEC, Various years)

Geothermal

By the end of 2011, the installed capacity of electricity from geothermal sources was 7.3 MW and the annual output was 10.0 GWh (WEC, 2013). The Ethiopian Rift Valley and the Afar depression have considerable geothermal resources and are thought to be able to generate more than 5,000 MWe of electricity. A 7.3 MWe geothermal pilot power plant has been installed at Aluto Langano Geothermal plant and is generating 4 MWe; there are plans to expand this project to 70 MWe. Other promising sites include Teo, Danab, Kone and others (REEEP, 2014). Ethiopia is also pursuing a $4 billion private sector investment to develop its geothermal power resources and produce 1,000 MW from steam (REEEP, 2014).

Solar

Ethiopia has great potential for solar energy as it receives a solar irradiation of 5,000-7,000 Wh/m^2 depending on the locale and the season. The solar radiation averages 5.2 kWh/m^2/day. The values vary with the seasons, ranging from 4.55 to 5.55 kWh/m^2/day, and over space, ranging from 4.25 kWh/m^2/day in the extreme western lowlands to 6.25 kWh/m^2/day in Adigrat area (REEEP, 2014). Installed solar capacity in 2011 was 5 MW (WEC, 2013).

Tracking progress towards sustainable energy for all (SE4All)

Ethiopia is one of the top 20 countries with a deficit in access to electricity, with 63.9 million people without access to electricity in 2010 and 81.1 million people lacking access to non-solid fuels (Table 4 and Figure 4) (World Bank, 2013). The vast majority of the Ethiopian population (83.2 per cent as of 2010) lives in rural areas, where modern energy services are rarely available. But there has been some progress. The World Bank (2016) indicates that by 2012, 7.6 per cent of the rural population had access to electricity while the urban population had reached 100 per cent . Access to modern fuels is low. In 2012, only 2.19 per cent of Ethiopians were using non-solid fuels; 2 per cent of these are in rural areas and 18 per cent in urban Ethiopia (World Bank, 2016).

The Ethiopian economy energy intensity (the ratio of the quantity of energy consumption per unit of economic output) was 17.0 MJ per US dollar (2005 dollars at PPP) in 2012, down from 28.6 MJ per US dollar in 1990. The compound annual growth rate (CAGR) between 2010 and 2012 was -4.34 (World Bank, 2015).

The share of renewable energy in the total final energy consumption (TFEC) was 94.49 per cent in 2012 (World Bank, 2016). Traditional solid biofuels form the biggest share of renewable sources at 92.6 per cent of TFEC in 2012, while modern solid biofuels contributed only 0.8 per cent and hydro 1.1 per cent (World Bank, 2015). Renewable

Table 4: Ethiopia'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	10	13	23	26.6		
	7.1.2 Per cent of population with primary reliance on non-solid fuels	4	6	3	2.19		
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	95.6	94.3	94.5	93.5		
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)			2.8	3.1 (2011)		2.62 (2013)
	Level of primary energy intensity(MJ/$2005 PPP)	28.6	18.6		17.0	17.69	17.04

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

Figure 4: SDG indicators

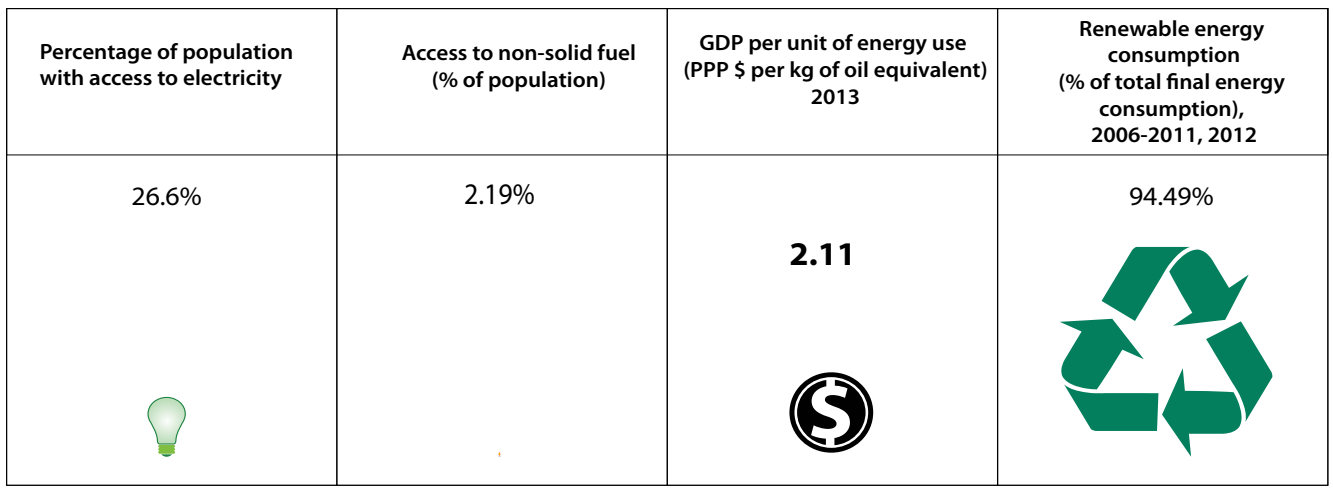


Table 5: Ethiopia's key aspects/key mitigation measures to meet its energy Intended Nationally Determined Contributions (INDCs)

INDC
*Expand electric power generation from renewable energy.
*Leapfrog to modern and energy efficient technologies in transport, industry and building sectors.
*Expand electric power generation from geothermal, wind and solar sources to minimize the adverse effects of droughts on predominantly hydroelectric energy sector.
*Build additional dams and power stations to further develop energy generation potential from the same river flow as well as develop new dam sites on parallel rivers in order to maintain the baseline hydropower electricity generation capacity to levels attainable under a 'no-climate change' scenario.

Source: (ROC, 2015)

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Addis Ababa, Ethiopia

Table 6: Ethiopia'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	• Ministry of Water, Irrigation and Energy (MWIE) • Ministry of Mines Rural Electrification Executive Secretariat (REES) • Regional Energy Agencies • Ethiopian Rural Energy Development and Promotion Centre (EREDPC)
Presence of a Functional Energy Regulator	• Ethiopian Energy Authority (EEA)
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	• East African Power Pool (EAPP)
Environment for Private Sector Participation	
Whether the Power Utility(ies) is/are vertically integrated or there is unbundling (list the Companies)	• Ethiopian Electric Utility (EEU) • Ethiopian Electric Power (EEP)
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)	• Ministry of Mines is in charge of upstream hydrocarbon and geothermal resources exploration
Extent to which Downstream services and operations are privatized or state-owned, or a mixture (extent)	
Presence of Functional (Feed in Tariffs) FIT systems	• Feed-in tariff legislation (still a Bill)
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	• National Energy Policy 1994 • Ethiopian Electric Power Strategy • Rural Electrification Fund • Off-grid Rural Electrification Master Plan • Alternative Energy Development and Promotion Programme
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	• Electricity Proclamation No. 86/1997 of June 1997 established the EAA • Proclamation number 691/ 2010 establishing the Ministry of Water and Energy (MWE) • Electricity Operations Regulations (49/1999) • Letter of power sector policy (2003) • Investment proclamation (280/2004) encouraging IPP • Electricity Feed-in-Tariff Bill, 2012

This table is compiled with material from (REEEP, 2014) and (Rai, Kaur, Fikreyesus, & Kallore, 2013)

sources contributed a 99.4 per cent share of electricity generation in 2012 (World Bank, 2015). Even in urban areas, half of households rely on traditional biomass (wood, dung and agricultural residues) for cooking, and in rural areas, virtually all do (except for 0.2 per cent who use kerosene and 1.2 per cent who use charcoal). While many nations in sub-Saharan Africa face similar challenges, Ethiopia ranks particularly low in terms of energy progress, with an EDI of 0.017 and a ranking of 62 out of 64, according to the IEA's 2011 Energy Development Index (EDI). Ethiopia has made big strides in recent years, however, with 48.3 per cent of towns and villages connected to the grid as of July 2012, according to the Ethiopia Electric Power Corporation.

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

By 2030, Ethiopia hopes to limit its net greenhouse gas emissions to 145 Mt CO_2e or lower as part of its contribution to the fight against climate change. The country has articulated its INDC in line with national energy and development policies as highlighted in Table 5.

Institutional and Legal Framework

The Ministry of Water, Irrigation and Energy (MWIE) is in charge of the energy sector. The energy regulator is Ethiopian Energy Authority (EEA) (Table 6). The Ethiopian Electric Power is charged with generation and transmission of electricity while the Ethiopian Electric Utility handles distribution and sales. On a regional level, the country is a member of East African Power Pool. The legal framework is provided by the Electricity Proclamation No. 86/1997. The main sector policy is the National Energy Policy 1994. Although it gives high priority to the development of hydropower, it also provides for a more diverse energy mix.