



Figure 1: Energy profile of South Africa

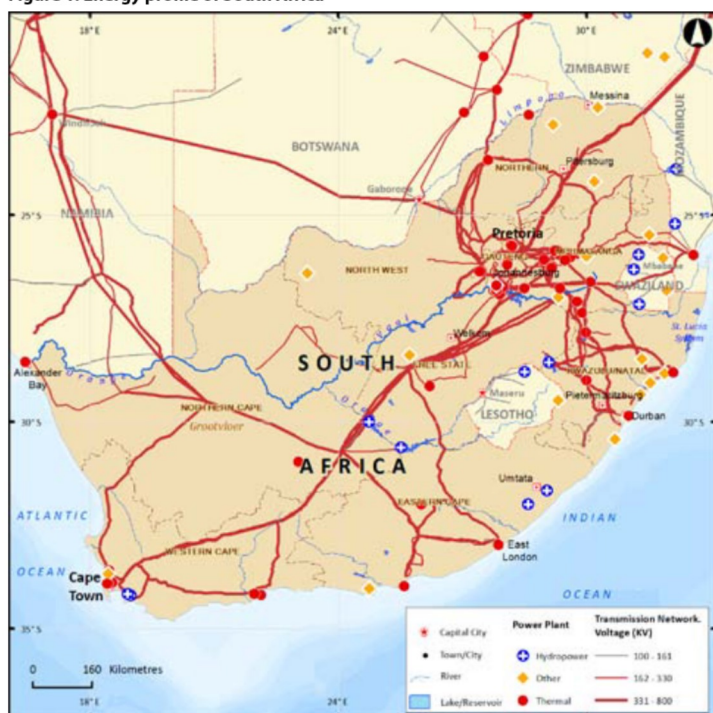


Figure 2: Total energy production, (ktoe)

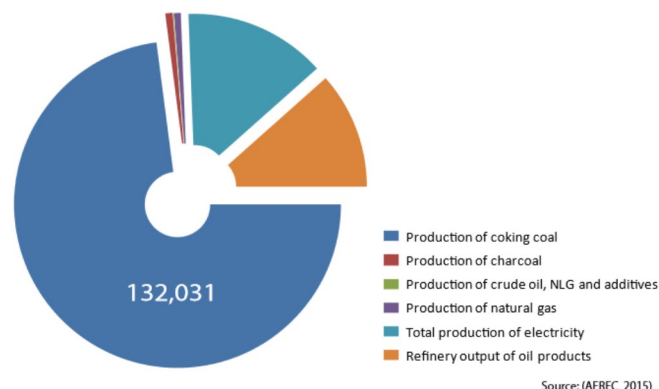
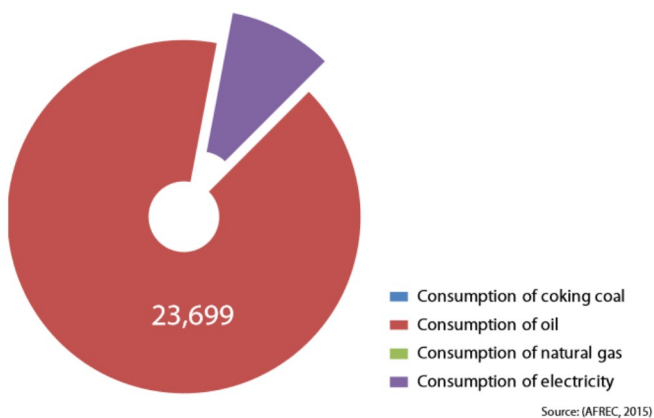


Figure 3: Total energy consumption, (ktoe)



## Energy Consumption and Production

South Africa's population in 2013 was 53.16 million, as shown in Table 1. In 2015, total electricity produced was 25,399 ktoe, of which 90 per cent was produced from fossil fuels, 4.8 per cent from nuclear and 4.3 per cent from hydro. Final electricity consumption was 20,877 ktoe in the same year (Table 2) (AFREC, 2015). Figures 2 and 3 show the key energy statistics

Table 1: South Africa's key indicators

Key indicators	Amount
Population (million)	53.16
GDP (billion 2005 USD)	323.75
CO <sub>2</sub> emission (Mt of CO <sub>2</sub> )	420.40

Source: (World Bank, 2015)

## Energy Resources

### Biomass

The use of biomass in electricity production is currently minimal, despite its actual potential. A futuristic outlook points to between 9 to 16 per cent of the total energy demand being met by biomass. The feedstock for this could potentially be agricultural waste including bagasse, forestry residues and other bio-energy crops such as jatropha (REEEP, 2014). There have been investments in biogas at a domestic and municipal level. For instance, in Durban, the third most populous town in the country, two waste-to-energy projects from landfill sites have been built (REEEP, 2014).

### Hydropower

There is potential to increase electricity supply by expanding hydropower generation. There has been a preference for pumped storage hydropower plants with electricity being generated from the following plants: Lima (1,500 MW), Ingula (1,332 MW), Drakensberg (1,000 MW) and the Palmiet (200 MW) (WEC, 2013). Typically, South Africa is a dry country with most of the rivers suitable for hydroelectricity generation located in the eastern part of the country. It is estimated that there could be up to 8,000 potential sites for the generation of micro hydropower (each between 5 and 100 kW) in the Eastern Cape and KwaZulu Natal provinces, but river seasonality in the face of climate change may place some barriers in developing this potential. In 2015, out of a total 25,399 ktoe of electricity produced, 1,114 ktoe of electricity was produced from hydro sources (AFREC, 2015).

### Oil and natural gas

Oil production figures at the end of 2011 were 700 thousand tonnes (or 5,131 thousand barrels); 27.1 bcm of natural gas was also produced (WEC, 2013).

### Peat

There is about 300 km<sup>2</sup> of peatland (WEC, 2013).

### Coal

In 2011, South Africa had 30.2 billion tonnes of proven reserves of coal (bituminous, including anthracite) and produces about 0.25 billion tonnes of coal (WEC, 2013). It holds 95 per cent of Africa's total coal reserves and the ninth biggest recoverable coal reserves in the world (US Energy Information

**Table 2: Total energy statistics (ktoe)**

Category	2000	2005	2010	2015 P
Production of coking coal	114,541	125,161	130,138	132,031
Production of charcoal	1,064	1,159	1,251	1,304
Production of crude oil, NLG and additives	253	4113	173	156
Production of natural gas	1,553	2,572	1,401	1,170
Production of electricity from biofuels and waste	26	23	24	136
Production of electricity from fossil fuels	16,631	17,767	19,566	22,862
Production of nuclear electricity	1,119	971	1,101	1,221
Production of hydro electricity	314	503	438	1,114
Production of geothermal electricity	-	-	-	-
Production of electricity from solar, wind, Etc.	0	48	92	65
Total production of electricity	18,090	19,312	21,221	25,399
Refinery output of oil products	25,387	27,859	21,948	20,943
Final Consumption of coking coal	12,098	12,856	9,807	10,546
Final consumption of oil	15,944	36,265	22,934	23,699
Final consumption of natural gas	1,544	2,058	1,928	1,847
Final consumption of electricity	15,307	18,550	20,005	20,877
Consumption of oil in industry	1,464	1,377	1,446	1,731
Consumption of natural gas in industry	0	0	1,927	1,862
Consumption of electricity in industry	8,336	9,719	10,356	9,584
Consumption of coking coal in industry	9,893	7,357	8,026	5,835
Consumption of oil in transport	11,440	14,022	15,572	15,087
Consumption of electricity in transport	463	477	309	312
Net imports of coking coal	-35,716	-36,499	-33,921	-34,439
Net imports of crude oil, NGL, Etc.	17,109	16,904	17,981	19,577
Net imports of oil product	-5,894	-7,336	4,435	3,988
Net imports of natural gas	0	2,055	2,904	3,732
Net imports of electricity	61	-201	-213	-457

(AFREC, 2015)

- : Data not applicable

0 : Data not available

(P): Projected

Administration, 2013). South Africa obtains 92.7 per cent of its electricity from coal; and given the very high carbon content of coal makes the country a chief emitter of greenhouse gases. For example, emissions of carbon dioxide in 2011 were 420.4 mt of CO<sub>2</sub> (IEA, 2016). This makes South Africa the leading emitter of carbon dioxide in Africa and number 14 in the world (US Energy Information Administration, 2013). More than 25 per cent of the coal produced is exported. Eskom, the electricity utility, consumes about two-thirds of coal consumed in the country (WEC, 2013).

The three main areas where coal is found in South Africa as cited directly in WEC (2013) include:

- The shale Volksrust Formation in central and northern Mpumalanga province;
- The sandy Vryheid Formation of the northern part of the main Karoo basin and by far the most commercially important deposits; and
- The Molteno Formation, limited to the northeastern Cape.

### Coal to liquids

Coal liquefaction is a process by which coal is used as the feed stock to produce an alternative petroleum fuel allowing coal to be substituted for oil. South Africa has been producing coal-derived fuels for over 60 years and daily production now stands at about 160,000 bbl (WEC, 2013). These fuels are used in motorized vehicles and commercial jets among others. About a third of the country's petrol and diesel needs are produced from local coal. Coal is a contentious fuel with air pollution and its impacts on health driving the process for the development and use of clean cooking fuels and replace traditional biomass or solid fuels with liquefied petroleum gas (LPG). Emerging coal technologies such as the production of dimethylether (DME) are gaining prominence as it can be used as a domestic fuel allowing the country to be free of the price volatility of crude oil (WEC, 2013).

### Underground coal gasification

Sasol and Eskom have been conducting trials of Underground Coal Gasification (UCG) facilities for some time (WEC, 2013). UCG is a method

of transforming coal that is still in the ground (especially that which is difficult or uneconomical to extract) into a combustible gas that can be used for as a synthetic natural gas or diesel fuel.

### Wind

Wind energy industry in South Africa has been growing by leaps and bounds facilitated by the ample wind speeds that allow for electricity generation. In mountain areas wind speeds average 8 m/s at 10 m while at the coast it is about half that amount at the same height (REEEP, 2014). There are a number of operational wind farms and in 2014, wind power increased to 570 MW from a low of 10 MW in 2013 (GWEC, 2014). Given the country's struggles to meet growing energy demand in recent years, wind is a central part of the energy strategy going forward. The Integrated Resource Plan for Electricity aims to have 8.4 GW installed by 2030 with about 75 per cent of this online by 2025. Already 562 MW is under construction (GWEC, 2014).

### Nuclear

The first commercial nuclear power reactor became operational in 1984 and the government is committed to developing a further 9,600 MWe in the next ten years, despite financial challenges. The Koeberg Nuclear Plant located near Cape Town generated about 12.7 TWh or about 5.3 per cent of total generated power in 2008. The plant, which is owned and operated by Eskom, the power utility, has two 900 MWe Pressurized Water Reactor (PWR) units that were commissioned in 1984-1985. In the May 2011 budget speech, the energy minister reaffirmed that by 2030, 22 per cent of new generating capacity would be nuclear and 14 per cent coal-fired. The budget also provided R586 million (\$85 million) for the Nuclear Energy Corporation of South Africa (NECSA) for nuclear energy research and development (WEC, 2013).

### Geothermal

The dominance of cheap coal in the energy sector has meant that there is currently no large-scale geothermal production in the country

### Solar

South Africa has good solar resources with direct normal irradiance averages of over 7.0 kWh/m<sup>2</sup>/day in many areas of the country (REEEP, 2014). Recently, the sector has received a boost with Eskom promoting the use of solar-powered geysers for domestic hot-water needs (REEEP, 2014).

## Tracking progress towards sustainable energy for all (SE4All)

Access to electricity in South Africa was 85.4 per cent in 2012 (Table 3 and Figure 4) (World Bank, 2016). There is a disparity between rural and urban dwellers, with 66.9 per cent of those in rural areas having electricity compared with 96.6 per cent in urban areas (World Bank, 2015). The government aims to reach 97 per cent electrification — defined as universal access — by 2025 through a mix of on- and off-grid technologies (mainly solar home systems). Access to modern fuels was 86.7 per cent in 2012. In rural areas, 67 per cent use non-solid fuels compared with 96 per cent in urban areas (World Bank, 2016). In absolute terms, there was an increase in the population with access to non-solid fuels of 2.4 million (World Bank, 2015).

The energy intensity (the ratio of the quantity of energy consumption per unit of economic output) of the South African economy was 9.3 MJ per US dollar (2005 dollars at PPP) in 2012, down from 10.1 MJ per US dollar in 2010. The compound annual growth rate (CAGR) between 2010-2012 was -3.85 compared to -0.39 over the 20-year period 1990-2010. South Africa has an Energy Efficiency Plan, which had set a target of energy efficiency improvement of 12 per cent by 2015 (World Bank, 2015). A number of procedures and regulation plans are in place to ensure this, including the following:





- Minimum energy performance standards for appliances, equipment and lighting;
- The South African National Standards (SANS) 204 Energy Efficiency in Buildings, released for final comment in March 2011;
- The voluntary Energy Efficiency and Energy Demand Management Flagship Programme.

**Table 3: South Africa'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	65	66	83	85.4		
	7.1.2 Per cent of population with primary reliance on non-solid fuels	60	75	85	86.7		
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	16.6	18.2	18.7	16.9		
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)			4.3	4.5 (2011)		4.69
	Level of primary energy intensity(MJ/\$2005 PPP)	10.9		10.1	9.3	9.67	9.31

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
85.4%	86.7%	4.84	16.93%
			

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

INDC
*Establish a Renewable Energy Independent Power Producer Procurement Programme (REI4P).
*Implement approved 79 renewable energy IPP (Independent Power Producer) projects for a total capacity of 5,243 MW, with private investment totaling ZAR 192 billion (approx. US \$16 billion).
*Consider a package of projects totaling 6,300 MW in the public transport infrastructure.
*Support catalytic and demonstrative green economy initiatives.

Source: (MEM, 2015)

The share of renewable energy in the total final energy consumption (TFEC) in 2012 was 16.9 per cent, similar to the share in 1990. In 2010, the share of renewable energy in the TFEC was 18.7 per cent. Traditional solid biofuels form the biggest share of renewable sources at 13.7 per cent of TFEC in 2012. Renewable sources contributed only 1 per cent share of electricity generation in 2012.

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

South Africa plays an active role in the global initiatives on climate change and is committed to addressing climate change based on science and equity. The government has articulated the Intended Nationally Determined Contributions (INDC). Those related to energy are listed in Table 4.

**Table 5: South Africa'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"> <li>• Department of Energy (DOE)</li> <li>• South African Nuclear Energy Corporation SOC Limited (NECSA)</li> <li>• National Radioactive Waste Disposal Institute (NRWDI)</li> <li>• Central Energy Fund (CEF) Group of companies under CEF (Proprietary) Limited</li> <li>• South African National Energy Development Institute (SANEDI)</li> </ul>
Presence of a Functional Energy Regulator	<ul style="list-style-type: none"> <li>• National Energy Regulator of South Africa (NERSA)</li> <li>• National Nuclear Regulator (NNR)</li> <li>• National Gas Regulator</li> </ul>
Ownership of sectoral resources and markets (Electricity/power market; liquid fuels and gas market)	ESKOM has monopoly of the power market but does not have exclusive generation rights in South Africa
Level of participation in regional energy infrastructure (Power Pools) and institutional arrangements	Southern African Power Pool (SAPP)
Environment for Private Sector Participation	
Whether the Power Utility(ies) is/are vertically integrated or there is unbundling (list the Companies)	Vertically integrated. But distribution activities were unbundled from ESKOM in 2003 and Regional Electricity Distributors (REDs) created operating under the Electricity Distribution Industry Holding Company (EDIH). However from 2010, the DOE took over the EDIH's mandate.
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)	<ul style="list-style-type: none"> <li>• Petroleum, Oil and Gas Corporation of South Africa (PetroSA), state-owned national oil and gas company, and has the monopoly in the oil, fuels and natural gas sectors (liquid fuels and gas market)</li> <li>• SASOL , private fuels and chemicals company, also operates Gas-to-Liquid facilities.</li> <li>• SASOL has the monopoly on the Coal-to-Liquid sector in South Africa.</li> </ul>
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	Renewable Energy Independent Power Producer Programme (REIPPP)
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"> <li>• Department of Energy Strategic Plan 2015 – 2020)</li> <li>• White Paper on the Energy Policy 1998</li> <li>• Integrated Energy Plan (IEP) 2003</li> <li>• White Paper on Renewable Energy 2003</li> <li>• Energy Efficiency Strategy 2005</li> <li>• Biofuels Industrial Strategy 2007</li> <li>• National Response to South Africa's Electricity Shortage 2008</li> <li>• Renewable Energy Policy Roadmaps</li> <li>• Integrated Resource Plan (IRP) (2010-2030) 2011</li> </ul>
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"> <li>• National Energy Regulator Act, 2004 (Act No.40 of 2004)</li> <li>• Electricity Regulation Act, 2006 (Act No. 4 of 2006)</li> <li>• National Energy Act, 2008 (Act No. 34 of 2008)</li> <li>• Petroleum Products Act, 1977 (Act No. 120 of 1977)</li> <li>• Central Energy Fund Act, 1977 (Act No. 38 of 1977)</li> <li>• Nuclear Energy Act, 1999 (Act No. 46 of 1999)</li> <li>• National Nuclear Regulator Act, 1999 (Act No. 47 of 1999)</li> <li>• Petroleum Pipelines Act, 2003 (Act No. 60 of 2003)</li> <li>• Petroleum Pipelines Levies Act, 2004 (Act No. 28 of 2004)</li> <li>• Gas Act, 2001 (Act No. 48 of 2001)</li> <li>• Gas Regulator Levies Act, 2002 (Act No. 75 of 2002)</li> </ul>

This table was compiled with material from (REEEP, 2012) and (Vreden, Wigan, Kruze, Dyhr-Mikkelsen, & Lindboe, 2010)

## Institutional and Legal Framework

The South African Department of Energy (DOE) is in charge of the energy sector. The energy regulator is the National Energy Regulator of

South Africa (NERSA). Eskom has monopoly of the power market but does not have exclusive generation rights. On a regional level, the country is a member of the Southern Africa Power Pool. The legal framework is provided by the National

Energy Act, 2008. The Integrated Energy Plan (IEP) and the 2011 Integrated Resource Plan (IRP) will address the issue of clean energy, energy efficiency and energy security (Table 5).