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South Africa – Energy Accounts: Data sources, classifications and statistics

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1. General Introduction

In the compilation of the Energy Accounts for South Africa, the international methodology as set out in the System of Integrated Environmental and Economic Accounting 2003 (SEEA 2003) was followed with regard to the definition of natural resource accounting as 'a system dealing with stock changes of natural assets, containing biota, subsoil assets, water and land'. The physical flows have been captured in the flow accounts structure, and a supply and use tables (SU- Tables) format is used. Energy use accounts are measured in physical units only, and the units are converted to Terajoules (TJ) to give total energy use and supply, since the monetary values are not easily available. The energy accounts use the Standard Industrial Classification of all Economic Activities (SIC) for economic activities as per the System of National Accounts (SNA). South Africa follows the SEEA 2003 to create the economic supply and use tables for environmental economic accounting. The first Energy Accounts for South Africa, 1995–2001 was published in 2005, based on the Department of Energy's (DoE) Energy Balance data and the adoption of an accounting framework used by Denmark, where energy supply sectors were reported in columns while energy products were reported in rows. Statistics South Africa (Stats SA) has updated the Energy Accounts for 2002–2006 published in March 2009 as a discussion document on the Stats SA website (http://www.statssa.gov.za).

The DoE and Stats SA is part of the Oslo Group which was formed in 2005 by the Bureau of the Statistical Commission. The main objective of the Oslo Group is to address issues related to energy statistics, and contribute to improved international standards and methods for official statistics.

The methodology used for the compilation of Energy Accounts for South Africa is as follows:

- Develop physical flow accounts, in the format of the 1993 SNA, using the DoE's Energy Balances. The four types of physical flows are:
    - Natural resource extraction (coal, crude oil, and natural gas);
    - Ecosystem inputs (oxygen combustion);
    - Products (energy fuels such as petrol and diesel, etc.); and
    - Residuals generated by the use of fossil fuels.
- Conduct classification of sectors to develop a framework that is consistent for both energy balances and economic supply and use tables.

2. Scope of energy statistics in South Africa

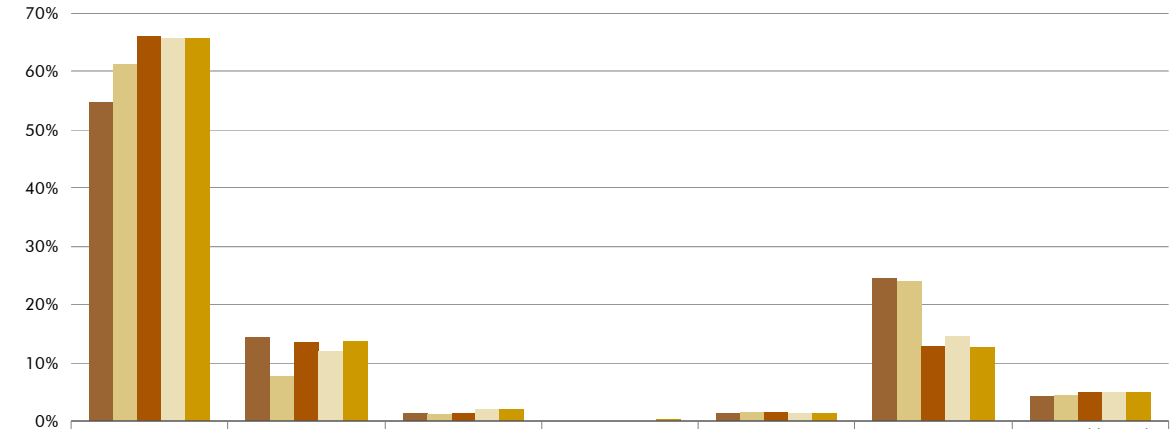
Statistics on reserves or deposits

South Africa has a well developed energy supply and production system. The country is well endowed with large resources of coal. Natural gas and crude oil production is very limited and consequently the bulk of South Africa's crude oil is imported. Uranium reserves are large. Renewable energy plays a limited but a significant role, particularly large hydroelectric power generation. The country generally has a low rainfall, which limits the exploitation of this form of energy. South Africa's abundant sunshine is only beginning to be tapped in more remote areas for electricity generation for domestic and institutional application. Wind energy is a potential source of commercial energy in some parts, but like other renewable energy technologies, it struggles to match the lower costs basis of conventional energy, in particular our cheap coal. With the setting of renewable energy targets and with carbon trading under the Kyoto protocol, the role of renewable energy is expected to expand.

Primary energy supply

The South African energy sector is dominated by coal (see Figure 1 below), which is abundant and relatively cheap by international standards.

Figure 1: Primary energy supply in Terajoules (TJ) 2002–2006



	Coal	Crude oil	Gas	Hydro	Nuclear	Petroleum products	Renewables and waste
2002	54.5%	14.3%	1.2%	0.1%	1.3%	24.4%	4.2%
2003	61.2%	7.7%	1.0%	0.0%	1.4%	24.1%	4.5%
2004	66.0%	13.5%	1.4%	0.0%	1.6%	12.7%	4.8%
2005	65.5%	11.8%	1.9%	0.0%	1.4%	14.5%	4.8%
2006	65.6%	13.6%	2.0%	0.1%	1.2%	12.6%	4.8%

Source: Statistics South Africa, 2006. *Energy Accounts for South Africa, 2002 – 2006*.

Most of South Africa's liquid fuel requirements are imported in the form of crude oil. Approximately thirty five percent is sourced from coal through South Africa Coal and Oil (SASOL) and hundred percent of the natural gas production from the Petroleum, Oil and Gas Corporation of South Africa (PetroSA) is converted into liquid fuels, supplying about seven percent of liquid fuel requirements. Renewable energy comprises biomass and natural processes that are replenished and can be used as an energy source. Biomass is used commercially in the pulp and paper mills and sugar refineries by burning bulk from logs, black liquor and bagasse[1] to produce process heat. The energy produced is used by the industries concerned to meet their needs. In future, some of this energy could be sold to the national grid (depending on electricity prices and environmental regulations). However, given the limited potential for agricultural expansion (lack of water and arable land), it is unlikely that this would be a major contribution. In households, biomass is used for cooking and heating. It is very difficult to get an estimate of the total biomass reserves. Biomass is estimated to comprise eight percent of South Africa's primary energy supply.

3. Classifications used in South Africa for energy statistics

Both the DoE and Stats SA depend on the Electricity Supply Commission of South Africa (Eskom) as the source and provider of electricity data. The DoE uses the data to compile the Energy Balances, while Stats SA uses a survey and the Energy Balances to compile statistical release P4141 (Electricity Generated and Available for Distribution Survey), and the SU- tables for the energy accounts.

[1] Bagasse is the biomass remaining after sugarcane or sorghum stalks are crushed to extract their juice and is currently used as a renewable resource in the manufacturing process.

3.1 Energy sectors used in compilation of energy accounts for South Africa: 2002–2006

For the purpose of energy use, the South African economy consists of five major sectors as classified by the DoE:

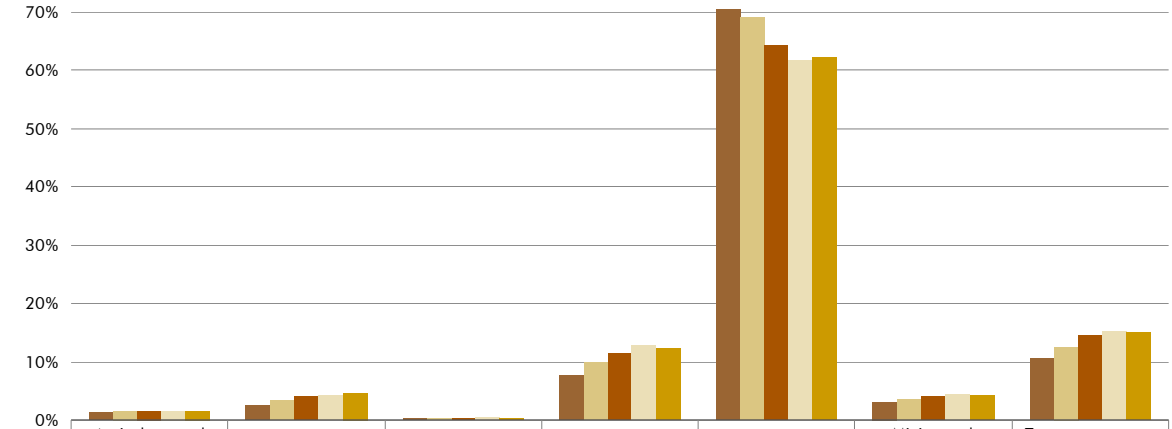
Industrial sector

The industrial (manufacturing) sector is divided into eight sub-sectors:

- Chemicals and petrochemicals;
- Food and tobacco;
- Iron and steel;
- Mining;
- Non-ferrous metals;
- Non-metallic minerals;
- Pulp and paper; and
- Other.

The industrial (manufacturing) sector is one of the three biggest users of energy and electricity in South Africa, the other two being transport and residential.

Figure 2: Final sectoral consumption of energy in Terajoules, 2002–2006



	Agriculture and fishing	Commercial sector	Construction	Domestic	Manufacturing	Mining and quarrying	Transport, storage and communication
2002	1.2%	2.4%	0.3%	7.7%	74.7%	3.1%	10.6%
2003	1.4%	3.3%	0.3%	9.8%	69.1%	3.5%	12.6%
2004	1.6%	4.0%	0.3%	11.4%	64.2%	3.9%	14.4%
2005	1.5%	4.2%	0.4%	12.7%	61.7%	4.4%	15.2%
2006	1.4%	4.6%	0.3%	12.3%	62.3%	4.1%	14.9%

Source: Statistics South Africa, 2009. *Energy Accounts for South Africa, 2002 – 2006*.

Commercial sector

The commercial sector consists of:

- Financial institutions;
- Government;
- Office buildings;
- Recreation and education; and
- Shops.

The energy for the commercial sector is used mainly for lighting, heating, and air conditioning. Office machines such as computers, fax machines and printers are said to be the biggest users of electricity. Electricity is likely to take an even bigger share of energy for this sector.

Agricultural sector

As economies mature, agriculture uses a smaller share of the national employment, large farmers replace smaller ones and agriculture produces a smaller fraction of gross domestic product (GDP). With land reform, many new small farmers are likely to arise, and these will almost certainly use traditional farming methods on small plots, including the use of vegetable wastes for energy. Globalisation and commercialisation of farming is likely to lead to fewer commercial farmers with bigger farms and increased exports and imports. This will lead to a search for more energy efficiency. The latter trend is almost certain to prevail for agricultural energy demand and it is expected that the importance of diesel and electricity will increase, while that of vegetables wastes will decline.

Residential sector

The residential sector can be sub-divided into urban and rural areas. Rural areas are defined as squatter camps or informal settlements, where people live in shacks made of tin and wood. People in urban areas rely on the use of electricity, while residents in rural areas use mainly wood for their energy source.

Residential energy falls into three categories:
- Traditional – consisting of wood, dung and bagasse;
- Transitional – consisting of coal, paraffin and liquefied petroleum gas (LPG); and
- Modern – consisting of electricity.

There are five main uses of residential energy:
- Cooking;
- Lighting;
- Space heating;
- Water heating; and
- Other (such as domestic appliances).

Transport sector

The transport sector deals with transport of people and goods by land, sea and air. Energy for transport is completely dominated by liquid fuels, such as petrol, diesel and jet fuel. It is very difficult to switch from fossil fuels to other sources of energy in this sector. Land transport is dominated by petrol and diesel with some electricity used by trains. Air transport uses jet fuel for gas turbine engines and aviation gas for piston engines. There are however, very few piston engines in the air today and marine engines are nearly entirely diesel.

3.2 Electricity data collection

Electricity data is collected by the Trade and Industry division in Stats SA through the Electricity Generated and Available for Distribution Survey, statistical release P4141. The Survey follows the regulation stated under section 16 of the Statistics Act, 1999 (Act No. 6 of 1999), and the requirement of the information is compulsory to all energy sectors. Data is collected on a monthly basis (in physical units), using a questionnaire that is sent via post or fax, and returned not later than ten days of the month concerned.

Data is collected from a sample of 22 industries following the Standard Industrial Classification of all Economic Activities (SIC). Electricity, Gas and Water supply are categorised under the SIC code 4. Electricity data are collected for SIC 41111 (generation of electricity) and 41113 (distribution for own use) respectively.

Table 1: Standard Industrial Classification of all Economic Activities (SIC) for South Africa

SIC Codes		Classification
Major Division	4	Electricity, Gas and Water Supply (1-digit level)
Division	41	Electricity, Gas, Steam and Hot Water Supply (2-digit level)
Major Group	411	Production, Collection and Distribution of electricity (3-digit level)
Group	4111	(4-digit level)
Subgroup	41111	Generation (5-digit level)
	41112	Distribution of purchased electric energy only (5-digit level)
	41113	Generation for own use (5-digit level)

The following industries (power stations) participate in the survey and make up the electricity sector (see Map 1 in Annexure A):

- Arnot;
- Camden;
- Duvha;
- Hendrina;
- Kendal;
- Koeberg;
- Kriel;
- Lethabo;
- Majuba;
- Matimba;
- Matla;
- Tutuka; and
- Other sources (hydro electric, gas and pumped storage)

State energy company Eskom is one of the largest utilities in the world and generates 95 percent of South Africa's electricity as well as two-thirds of the electricity for the African continent. It owns and operates the national transmission system. Eskom has 36 200 megawatts (MW) of net generating capacity, which is primarily coal fired (32 100 MW). Eskom's network is made up of more than 300 000 km of power lines, 27 000 km of which constitute the national transmission grid.

Since about 90 percent of South Africa's electricity is produced from coal, the main generating stations are located in Mpumalanga, where there are vast coal reserves. In addition, Eskom operates the nuclear power station at Koeberg (1 800 MW), two gas turbine generators (340 MW), six conventional hydroelectric plants (600 MW), and two hydroelectric pumped-storage stations (1 400 MW). Eskom has been producing adequate electricity for domestic use and export of surplus power to Botswana, Lesotho, Mozambique, Namibia, Swaziland, and Zimbabwe. Additional electricity is generated by South African municipalities (2 400 MW), and private companies (800 MW).

Questions used when collecting electricity information

1. Electricity generated in kilowatt-hours (kWh).
2. Electricity consumed in power station(s) and energy storage systems in kWh.
3. Net quantity of electricity generated and sent out from power station(s).
4. Purchases outside the Republic of South Africa, e.g. Mozambique (specifying supplier).
5. 'Consumed in synchronous condenser (CSO), Department of Water Affairs (DWA) and Assets' (Applicable to Eskom)).

The main source of electricity data (95 percent of total power generation) is Eskom, followed by municipal power stations, manufacturers in the sugar, paper and petroleum industries, as well as one mine (5 percent of power generated as an additional activity to their main activity).

4. Data compilation

The supplier of the Energy Balances is the DoE, who conforms to the international standards by following the framework of the International Energy Agency (IEA-Eurostat).

Table 2: Energy commodities and its source covered by the Department of Energy

Data Source	Type of data or energy commodity
Department of Energy (DoE)	Information on wind, solar, natural gas liquid, natural gas, and all data related to coal except coking coal imports which are either from South African Revenue Services (SARS) or Mittal Steel.
Oil companies	Electricity used in petrochemical industry and by oil refineries.
South African Coal and Oil (SASOL)	Petroleum products from non-crude sources and gas works.
Electricity Supply Commission of South Africa (Eskom)	Electricity production and consumption figures excluding the 5 percent electricity produced by municipalities.
National Energy Regulator of South Africa (NERSA)	• Export of electricity; • Imports of electricity; • Own use in electricity; • Electricity used in pumped storage; • Distribution losses; • Electric output from public plants and auto-producing electric plants; • Electricity from pumped storage; and • Electricity production and consumption for the whole country, including Eskom and municipalities.
South African Revenue Services (SARS)	Imports and exports of oil and coal data.
Mittal Steel	Imports of coking coal, production and consumption of blast furnace gas from iron and steel.
South African Petroleum Industry Association (SAPIA)	Oil consumption or sales data by sector.

Data capturing and calculation

There is no specific format for supplying data. The DoE receive data electronically or by fax, after which it is then captured into Excel spread sheets that are labelled with the specific year the data applies to. These spread sheets are then used to compile the Energy Balances. There are no complex mathematical calculations employed in the compilation of Energy Balances, only simple arithmetic rules are used.

5. Institutional arrangement in the compilation of energy statistics

The DoE entered into confidentiality agreements with some of the data providers when it comes to the way their data should be disseminated. Some of the data that are used in the balances is gathered from studies that were done by consultants appointed by the DoE. It must be highlighted that the DoE do not conduct any surveys for its data collection but solely rely on the data providers mentioned under point 4, and the reports that are published by Eskom and the National Energy

Regulator of South Africa (NERSA). Since the Statistics are collected outside the National Statistical Office, the DoE Energy Statistics are not regarded as 'official statistics'. The DoE has entered into a memorandum of understanding with Stats SA to make the energy statistics qualify as 'official statistics' in future, once the quality assessment framework has been implemented. There is no legal mandate that is forcing any sector to supply energy data to DoE, only mutual cooperation. The DoE is in a process of making the supply of energy data mandatory through the Energy Security Bill.

6. Units of measurement and conversion factors

Table 3: Conversion tables used by the Department of Minerals and Energy

Calorific Values			
Fuel type	Calorific value	Units	Density
Avgas	37.0	MJ/l	0.730
Bagasse (wet)	7.0	MJ/kg	
Bagasse fibre (dry)	14.0	MJ/kg	
Biomass (wood dry typical)	17.0	MJ/kg	
Blast furnace gas	3.1	MJ/m^3	
Coal (coking)	30.1	MJ/kg	
Coal (Eskom - average 1994)	24.3	MJ/kg	
Coal gas (Sasol - methane rich)	38.0	MJ/m^3	
Coal gas (Sasol)	18.0	MJ/m^3	
Coke	27.9	MJ/kg	
Coke oven gas	17.3	MJ/m^3	
Diesel	41.6	MJ/l	0.839
Electricity	3.6	MJ/kWh	
Heavy furnace oil (HFO)	20.1	MJ/kg	0.984
Illuminating paraffin	37.5	MJ/l	0.788
Jet fuel	38.1	MJ/l	0.793
Liquefied petroleum gas (LPG)	34.2	MJ/l	0.541
Natural gas	41.0	MJ/m^3	
Petrol	33.9	MJ/l	0.723
Power Paraffin	34.3	MJ/l	0.813
Refinery gas (estimate)	20.0	MJ/m^3	

From / to	Joule (J)	Kilowatt hour (kWh)	Ton oil equivalent (toe)	British thermal unit (Btu)
1 J	1	0.278×10^{-6}	0.2388×10^{-6}	0.948×10^{-3}
1 kWh	3.6×10^{6}	1	0.86×10^{-6}	3.412×10^{3}
1 toe	42×10^{9}	11 630	1	39.68×10^{6}
1 Btu	1.055×10^{3}	0.293×10^{-3}	0.252×10^{-9}	1

Prefix	Symbol	Power
Kilo	K	10^3
Mega	M	10^6
Giga	G	10^9
Tera	T	10^{12}
Peta	P	10^{15}
Exa	E	10^{18}

7. Energy balances

There are four Excel files that are very dependent and linked to each other by formulas for calculating energy balances. These are:

Basic file (the commodity balance)

The basic file (viewed as raw data) is a file where actual capturing of the energy commodity data is done. It consists of 60 columns with disaggregated data (e.g. hard coal is disaggregated in to nine columns where brown coal, peat, coking coal, bituminous coal, sub-bituminous coal, and lignite are included).

The commodities are measured as follows:

- Coal is measured in tons;
- Electricity in kilowatt hour; and
- Petroleum products in kiloliters.

The DoE collects coal data and fill in columns only if it is applicable to South Africa. Where there are values, it means that the column is applicable to the country, otherwise it contains zeros. An example: Peat is not applicable to South Africa, and the column therefore contains only zeros.

The basic file contain comments in each cell that has a value, and the comment highlights either the way the value has been arrived at or calculated, and/or the source of such value. The comments are called the 'matter data' as it gives explanations about the captured data. The file that has all these comments is available to the DoE staff working with energy balances only. The columns that exist in the high level file, also exist in the basic file, but are converted from base (native) to energy units in Terajoules (TJ), in order to compare how much energy was used.

Conversion file

The conversion file is linked to the basic file by some formulas and the disaggregated file. It is the file that deals with all the calculations for converting units of measurements. The file is only handled by the DoE, and is not in the public domain.

Disaggregated file

This is a file which is a direct result of the arithmetic calculations occurring between the basic file and the conversion file. The file resembles the basic file except for the units. All the units are in energy units. The South African Energy Balances use TJ as energy units.

High file (aggregated file)

This file is directly linked to the disaggregated file as its calculations are derived from it. The high file has fewer columns compared to the other two files because it aggregates the data belonging to

each commodity. In the aggregated file all the different types of coal are added together to give one single column of coal in TJ. It has 10 columns as compared to the almost 60 columns in the basic and the disaggregated files.

According to the DoE, there is a two-year period involved in compilation of the Energy Balances. The DoE would preferably like to reduce the interval period to release energy balances annually, but because of the late submissions from the data suppliers, it is still a challenge to actually achieve the target currently.

8. Data quality assurance and dissemination

Quality checks and data integrity

The DoE does not have any systems in place to do quality checks, but rely heavily on their suppliers for the quality of the data. Usually the DoE do manual checks comparing current data to previous data and when anomalies are picked up the supplier is contacted for explanations of such inconsistencies after which revisions are done.

Release and dissemination

Once the calculation of energy balances is done, an internal verification within the DoE takes place. If the Directorates that contributed the information agree with the figures in the Energy Balances an Energy Statistics Advisory Committee is summoned. This advisory committee consists of energy expects that are in South Africa, drawn from Academic Institutions, Industry, and Government Departments. The DoE sometimes experiences difficulties to convene such meetings because these specialists provide voluntary advice and guidance in extremely busy programmes. If a meeting cannot be convened, the Energy Balances are sent to some key energy specialists to look at these and give inputs and comments. This is a pre-requisite for release. For a particular year there might be a number of versions of energy balances due to new data that might come late and force revisions. In 2003, there is version 1 and version 2, with the latest version posted on the DoE website.

Once the DoE obtains approval to release the Energy Balances, the information is disseminated to a number of international organizations, such as the IEA, Southern African Development Community (SADC), Academic Institutions, Government Departments, and stakeholders interested in the Energy Balance of the country. The information that is disseminated is the aggregated files. A high level summary of the energy balances is done through a publication called the 'Digest of South African Energy Statistics'. The publication is posted to stakeholders and is another form of dissemination to the website. The digest collects, analyses energy statistics, and compiles Energy Balances, and is released bi-annually.

9. Uses of energy statistics

The main energy resources in the South African economy are coal, oil, gas, nuclear power, hydropower and renewable sources such as wind, solar energy, bio-mass and wave power.

Energy accounts are of considerable interest in their own right, especially for countries heavily involved in oil mining and processing. Also, every economy in the world depends on the availability of oil and other energy sources. The use of energy is critical to the economy, because almost all economic activities are connected either directly or indirectly to the consumption of energy.

The environmental accounts, specifically in the case of energy accounts, are crucial in a sense that they reflect how significant our environment is in the economy. In South Africa, energy is sourced mainly from coal. The supply and use (in physical units) of energy should be reflected in a way that is understandable from its raw production to the residuals. Energy accounts provide information

about the levels of direct energy consumption of industries regarding their production process and private households. These accounts can also provide information on changes in the energy requirements of particular industries in relation to their output. This shows the macro level impacts of new technologies, and eco-efficiency measures and behavioural changes. They are also an indispensable prerequisite for reliable estimates of air emissions related to energy consumption. The accounts are currently not official, there are some institutional arrangements that need to be formalised with partners in the energy sector to achieve this. Stats SA's strategic plan is to start official energy accounts from 2014 onwards, and also the development of energy indicators that could provide answers to questions such as:

- What are the levels of energy consumption in South Africa?
- What are the levels of energy input (both direct and indirect) into the various categories of final demand (private household consumption, exports, etc.)?
- What is the energy intensity of particular industries taking into account both direct and indirect energy inputs?
- For future predictions and scenarios, what are the changes expected in the energy requirements of particular industries in relation to their output?

10. List of abbreviations

CSO	Consumed in synchronous condenser
DME	Department of Minerals and Energy
DWAF	Department of Water Affairs and Forestry
EEA	Environmental Economic Accounts
Eskom	Electricity Supply Commission
GDP	Gross domestic product
IEA	International Energy Agency
kWh	Kilowatt hours
LPG	Liquefied petroleum gas
MW	Megawatt
NERSA	National Energy Regulator of South Africa
PetroSA	Petroleum, Oil and Gas Corporation of South Africa
SADC	Southern African Development Community
SAPIA	South African Petroleum Industry Association
SARS	South African Revenue Services
SASOL	South Africa Coal and Oil
SEEA	System of Integrated and Economic Accounting
SIC	Standard Industrial Classification of all Economic Activities
SNA	System of National Accounts
Stats SA	Statistics South Africa
SU- tables	Supply and use tables
TJ	Terajoules

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Eskom, Power Stations and Storage Schemes.
http://www.eskom.co.za/live/content.php?Category_ID=82

Annexure A

Eskom power stations

Legend

- Coal-fired
- Coal-fired (RTS)
- Nuclear
- Hydroelectric
- Pumped storage
- Open cycle gas turbine
- National grid
- Windfarm

Base load stations

1	Arnot	2 100 MW
2	Duvha	3 600 MW
3	Hendrina	2 000 MW
4	Kendal	4 116 MW
5	Koeberg	1 930 MW
6	Kriel	3 000 MW
7	Lethabo	3 708 MW
8	Majuba	4 110 MW
9	Matimba	3 990 MW
10	Matla	3 600 MW
11	Tutuka	3 654 MW

Return-to-service

12	Camden	1 600 MW
13	Grootvlei	1 200 MW
14	Komati	1 000 MW

The return-to-service (RTS) stations were mothballed in 1990 and are in the process of being recommissioned to meet the growing demand for electricity.

Peak demand stations

Hydroelectric:

15	Gariep	360 MW
16	Vanderkloof	240 MW

Pumped storage:

17	Drakensberg	1 000 MW
18	Palmiet	400 MW

Peak demand stations

Open cycle gas turbine:

19	Acacia	171 MW
20	Port Rex	171 MW
21	Ankerlig	592 MW
22	Gourikwa	444 MW

The peaking stations can generate electricity within a few minutes of start-up, making them ideally suited to supply power during peak periods. They also assist in regulating the system voltage and frequency to ensure stability of the national transmission network.

Renewable energy

Windfarm:

23	Klipheuwel Windfarm	3.2 MW

New build

Base load:

24	Medupi	4 788 MW

Pumped storage:

25	Ingula	1 332 MW

Open cycle gas turbine

26	Gas 1	1 036 MW

Distribution

27	First Falls	6.4 MW
28	Second Falls	11 MW
29	Colley Wobbles	42 MW
30	Ncora	2.4 MW

These hydroelectric power stations fall within the Distribution Division's Southern Region and are used to stabilise the distribution network in that area.

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