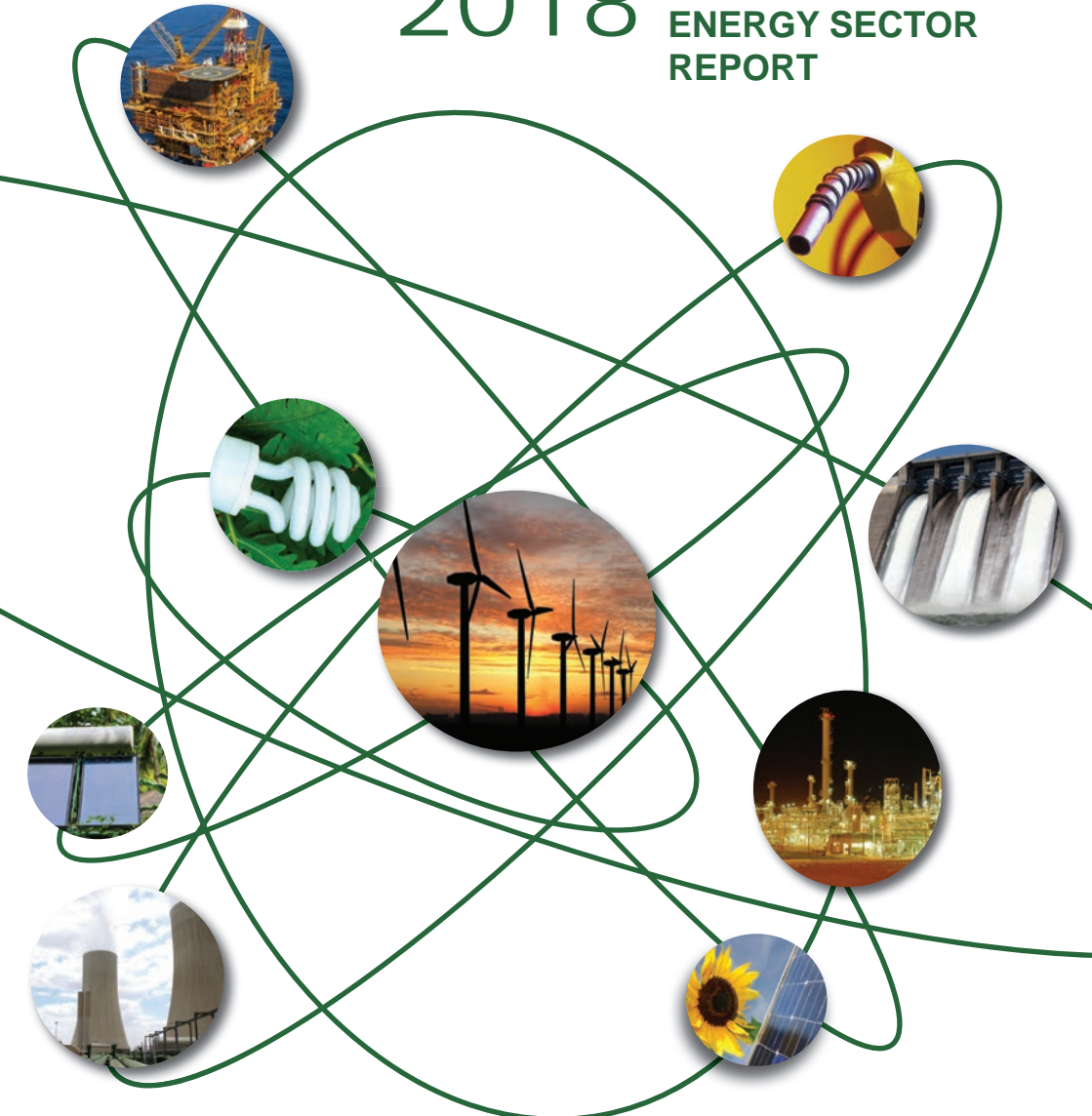


# 2018 SOUTH AFRICAN ENERGY SECTOR REPORT



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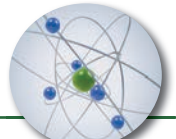
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# 2018 SOUTH AFRICAN ENERGY SECTOR REPORT

DIRECTORATE: ENERGY DATA COLLECTION, MANAGEMENT AND ANALYSIS

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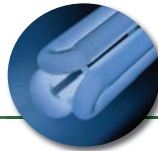
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<b>Contents</b>	<b>Pages</b>
FOREWORD .....	1
Introduction.....	2
List of Abbreviations .....	3
Key Energy Policies and Legislations.....	4
1. ENERGY SUPPLY.....	9
1.1 Crude oil and Petroleum Products.....	9
1.2 Natural gas .....	16
1.3 Electricity .....	18
1.4 Coal .....	26
1.5 Renewables.....	28
1.6 Nuclear .....	34
2. ENERGY DEMAND .....	35
2.1 Industrial Sector.....	36
2.1.1 Mining.....	37
2.1.2 Iron and steel.....	38
2.1.3 Chemicals.....	39
2.1.4 Non-Ferrous Metals.....	40
2.1.5 Non-Metallic Minerals .....	41
2.1.6 Food and Tobacco .....	42
2.1.7 Pulp and Paper .....	43
2.2 Commerce and Public Services Sector .....	44
2.3 Agricultural Sector .....	45
2.4 Transport Sector.....	46
2.5 Residential Sector .....	47
References .....	49

#### List of Tables

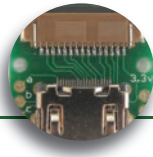
Table 1-1: Refinery production capacity.....	11
Table 1-2: Crude Oil imports volumes by country of origin, 2015 .....	15
Table 1-3: Electrification Statistics until December 2017 .....	23



## List of Figures

Figure 1-1:	Total primary energy supply, 2015 .....	9
Figure 1-2:	Crude oil primary supply, 2015.....	13
Figure 1-3:	Crude oil imports by region, 2015 .....	14
Figure 1-4:	Petroleum products supply, 2015.....	15
Figure 1-5:	Petroleum products imports by region, 2015 .....	16
Figure 1-6:	Natural gas primary supply, 2015.....	17
Figure 1-7:	Electricity supply, 2015.....	19
Figure 1-8:	Electricity Generation, Transmission and Distribution.....	20
Figure 1-9:	Power Station Maximum Generating Capacity Mix.....	25
Figure 1-10:	Coal primary supply, 2015.....	27
Figure 1-11:	Allocated capacity in windows 1, 2, 3 and 4, 2017.....	30
Figure 1-12:	SWH installations per province as at September 2015.....	32
Figure 2-1:	Energy demand by sector, 2015 .....	35
Figure 2-2:	Energy demand by industrial sub-sectors, 2015.....	36
Figure 2-3:	Energy demand in the industrial sector, 2015.....	37
Figure 2-4:	Energy demand in mining, 2015 .....	38
Figure 2-5:	Energy demand in Iron and Steel industry, 2015 .....	39
Figure 2-6:	Energy demand in Chemical and Petrochemical industry, 2015.....	40
Figure 2-7:	Energy demand in non-ferrous metals, 2015.....	41
Figure 2-8:	Energy demand in non-metallic minerals, 2015.....	42
Figure 2-9:	Energy demand in food and tobacco, 2015 .....	43
Figure 2-10:	Energy demand in the commerce and public services sector, 2015.....	45
Figure 2-11:	Energy demand in the agriculture sector, 2015.....	46
Figure 2-12:	Energy demand in the transport sector, 2015 .....	47
Figure 2-13:	Energy demand in the residential sector, 2015.....	48





## FOREWORD

It gives me a great pleasure to introduce the 2018 South African Energy Sector Report. This report is based on information collated from energy industry and research papers. This publication covers a broad overview and analysis of the South African energy sector and aims to keep stakeholders informed about developments as well as key issues affecting the industry.

This report primarily focuses on the primary energy supply and final energy consumption by the principal energy consumers which inter alia includes industry, agriculture, transport, households, public sector and commerce. This Report will be published annually with data and analysis based on the latest South African Energy Balances.

The Department of Energy is working hard to ensure accurate, timely and reliable provision of data in its publications and hopes that this report will become a source of reference among energy analysts in South Africa and abroad.

I extend my most sincere thanks and appreciation to the Energy Data Collection, Management and Analysis Directorate for the hard work that went into the compilation of this publication. I would also like to record my appreciation to all the energy data providers who have helped us to accomplish the compilation of this report. Comments and inputs are welcome and could be addressed to [Publications@energy.gov.za](mailto:Publications@energy.gov.za).

Mr. T. Zulu  
Director General  
Department of Energy

# Introduction

Energy is fundamental to any country's economy, because it makes a huge input into the economy, but most importantly, because without energy "the wheels of the economy" literally do not turn. Energy is the vital force that powers businesses, manufacturing, the transportation of goods and the delivery of services to the nation. It is the lifeblood of modern living, as it has an impact on everything we do and affects our very existence. Energy is therefore an enabler for economic growth and stability.

The energy industry contributes to economic growth as an important sector of the economy that creates jobs and value by extracting, transforming and distributing goods and services throughout the economy.

South Africa's steady economic growth, coupled with an increasing focus on industrialization and a mass electrification programme to increase access to electricity in the deep rural areas, has resulted in a steep increase in the demand for energy. The Department of Energy has, since its establishment in 2009, been responsible for ensuring secure and sustainable provision of energy for socio-economic development.

South African energy is dominated by coal, which is plentiful and cheap, and is ranked among the lowest energy costs in the world. Apart from coal, which contributes around 59% to the total primary energy supply, South Africa gets energy locally from biomass, such as wood and dung, natural gas, hydro-power, nuclear power, solar power and wind.

With South Africa's growing population and increasing need for energy, the Department of Energy is continuously working towards ensuring energy security, achieving universal access, transforming the energy sector and ensuring the optimal use of energy resources.

## List of Abbreviations

bb/d	Barrels per Day
CEF	Central Energy Fund
CTL	Coal To Liquid
DMR	Department of Mineral Resources
DoE	Department of Energy
GDP	Gross Domestic Product
GTL	Gas To Liquid
IEP	Integrated Energy Plan
INEP	Integrated National Electrification Programme
IRP	Integrated Resource Plan
JPoI	Johannesburg Plan of Implementation
LPG	Liquified Petroleum Gas
Mt	Megaton
MW	Megawatts
MYPD	Multi-Year Pricing Determination
NERSA	National Energy Regulator of South Africa
PetroSA	Petroleum Oil and Gas Corporation of South Africa
TJ	Tera Joules
R/t	Rand per Ton
REIPPPP	Renewable Energy Independent Power Producer Procurement
	Programme
ROM	Run-of-Mine
SAPIA	South African Petroleum Industry Association
StatsSA	Statistics South Africa
SWH	Solar Water Heaters
WSSD	World Summit on Sustainable Development

# Key Energy Policies and Legislations

## 1. *White Paper on the Energy Policy, December 1998*

The White Paper on the Energy Policy was developed so as to clarify government policy regarding the supply and consumption of energy for the next decade. It was intended to address all elements of the energy sector as practically as it could. This White Paper gives an overview of the South African energy sector's contribution to GDP, employment, taxes and the balance of payments. It concludes that the sector can greatly contribute to a successful and sustainable national growth and development strategy.

The main objectives of the White Paper are the following:

- Increasing access to affordable energy services
- Improving energy governance
- Stimulating economic development
- Managing energy-related environmental impacts
- Securing supply through diversity

## 2. *White Paper on Renewable Energy, November 2003*

The White Paper on Renewable Energy supplements the Government's overarching policy on energy as set out in its White Paper on the Energy Policy (as stated above), which pledges 'Government support for the development, demonstration and implementation of renewable energy sources for both small and large-scale applications'.

This White Paper sets out Government's vision, policy principles, strategic goals and objectives for promoting and implementing renewable energy in South Africa. Additionally, it has the following two goals:

- to inform the public and the international community of the Government's goals, and how the Government intends to achieve them, and;
- to inform Government agencies and Organs of State of these goals, and their roles in achieving them.

## 3. *Nuclear Energy Policy, October 2008*

The nuclear sector in South Africa is mainly governed by the Nuclear Energy Act 1999, Act 46 of 1999 and National Radioactive Waste Disposal Institute

Act, Act 53 of 2008. National Nuclear Regulator (NNR) Act 1999, Act 47 of 1999. The Cabinet approved the Nuclear Energy Policy for South Africa in October 2008.

The Nuclear Energy Policy outlines the South African government's vision for the development of an extensive nuclear energy programme by ensuring that Government's objective on the prospecting and mining of uranium ore and the use of uranium (or other relevant nuclear materials) as a primary resource of energy must be regulated and managed in a manner that will be for peaceful purposes.

Through the Nuclear Energy Policy, Government aims to achieve the following objectives:

- Promotion of nuclear energy as an important electricity supply option through the establishment of a national industrial capability for the design, manufacture and construction of nuclear energy systems;
- Establishment of the necessary governance structures for an extended nuclear energy programme;
- Creation of a framework for safe and secure utilisation of nuclear energy with minimal environmental impact;
- Contribution to the country's national programme of social and economic transformation, growth and development;
- To guide in the actions to develop, promote, support, enhance, sustain and monitor the nuclear energy sector in South Africa;
- Attainment of global leadership and self-sufficiency in the nuclear energy sector in the long-term;
- Exercise control over unprocessed uranium ore for export purposes for the benefit of the South African economy;
- Establishing of mechanisms to ensure the availability of land (nuclear sites) for future nuclear power generation;
- Allow for the participation of public entities in the uranium value chain;
- Promoting energy security for South Africa;
- Improvement of the quality of human life and to support the advancement of science and technology;
- Reduction of greenhouse gas emissions; and
- Skills development related to nuclear energy.

#### 4. *Integrated Energy Plan (IEP)*

The IEP is a multi-faceted, long-term energy framework which takes into consideration the crucial role that energy plays in the entire economy and is informed by the output of analyses founded on a solid fact base. Integrated energy plan is undertaken to determine the best way to meet current and future energy service needs in the most efficient and socially beneficial manner, while:

The IEP has multiple objectives, some of which include:

- To guide the development of energy policies and, where relevant, set the framework for regulations in the energy sector;
- To guide the selection of appropriate technologies to meet energy demand (i.e. the types and sizes of new power plants and refineries to be built and the prices that should be charged for fuels);
- To guide investment and the development of energy infrastructure in South Africa; and
- To propose alternative energy strategies which are informed by testing the potential impacts of various factors such as proposed policies, introduction of new technologies, and effects of exogenous macro-economic factors.

The Draft Integrated Energy Planning Report was approved for publishing by Cabinet in November 2016. Subsequent to the approval, the IEP was widely consulted upon through public stakeholder workshops which were held in all nine provinces. Substantial input was obtained and stakeholders were also afforded the opportunity to submit written input. Extensive work has been done in order to address gaps identified in the Draft IEP report and the final Integrated Energy Plan will be presented to Cabinet for approval.

#### 5. *Integrated Resource Plan (IRP) 2010-30*

The IRP is an electricity infrastructure development plan based on least cost supply and demand balance taking into account security of supply and the environment (minimize negative emissions and water usage).

A number of assumptions used in the IRP 2010-30 have since changed which impacts on the scale and pace of the plans contained in the promulgated IRP. Changed assumptions include amongst others, electricity demand projection, existing plant performance, new capacity added into the grid as well as cost of new power generation technologies.

A demand projection for the period up to 2030 has decreased from about 450 thousand megawatt hours to around 300 thousand megawatt hours, which is a 33% decrease in demand projected. A total of about 18 000MW of new capacity has been committed to date.

The IRP update process undertaken consisted of 4 key milestones which are the development of input assumptions, the development of a credible basecase (starting point) and scenario analysis, the production of a balanced plan, and policy adjustments. Cabinet approved in November 2016 the publication for public consultations the assumptions developed to be used in the review and update of the IRP. Verbal and written comments received from the public consultation process were analysed and taken into consideration accordingly.

Following detailed studies, the Department has now developed a draft policy adjusted IRP which will be submitted to Cabinet for approval to publish it for public comments. Following public inputs the IRP will be finalised and submitted to Cabinet for final approval for promulgation.

## 6. *National Energy Act, 2008*

The National Energy Act, 2008 (Act 34 of 2008) ensures that diverse energy resources are available in sustainable quantities and at affordable prices in South Africa. In addition, the Act provides for the increased use of renewable energies, contingency energy supplies, the holding of strategic energy feedstock and carriers, and adequate investment in energy infrastructure.

## 7. *Petroleum Products Act, 1977*

The aim of Petroleum Products Act, 120 of 1977, is to:

- Provide measures in the saving of petroleum products and an economy in the cost of the distribution thereof, the maintenance and control of a price, for the furnishing of certain information regarding petroleum products, and for the rendering of services of a particular standard, in connection with petroleum products;
- Provide for the licensing of persons involved in the manufacturing and sale of certain petroleum products;
- Promote transformation of the South African petroleum and liquid fuels industry;
- Provide for the promulgation of regulations relating to such licences; and
- Provide for matters incidental.

## 8. *Nuclear Energy Act, 1999*

The aims of the Nuclear Energy Act, 1999 (Act 46 of 1999) are:

- To provide for the establishment of the National Energy Corporation of South Africa (Necsa) and defines its functions, powers, financial and operational accountability, governance and management;
- To provide for responsibilities for the implementation and application of the Safeguards Agreement and any additional protocols entered into by the Republic of South Africa and the International Atomic Energy Agency in support of the Nuclear Non-Proliferation Treaty acceded to by the Republic;
- To regulate the acquisition and possession of nuclear fuel, certain nuclear and related material and certain related equipment, as well as the importation and exportation of, and certain other acts and activities relating to, that fuel, material and equipment in order to comply with the international obligations of the Republic;
- To prescribe measures regarding the discarding of radioactive waste and the storage of irradiated nuclear fuel; and to provide for incidental matters.

## 9. *The Gas Act, 2001*

The aims of the Gas Act are as follows:

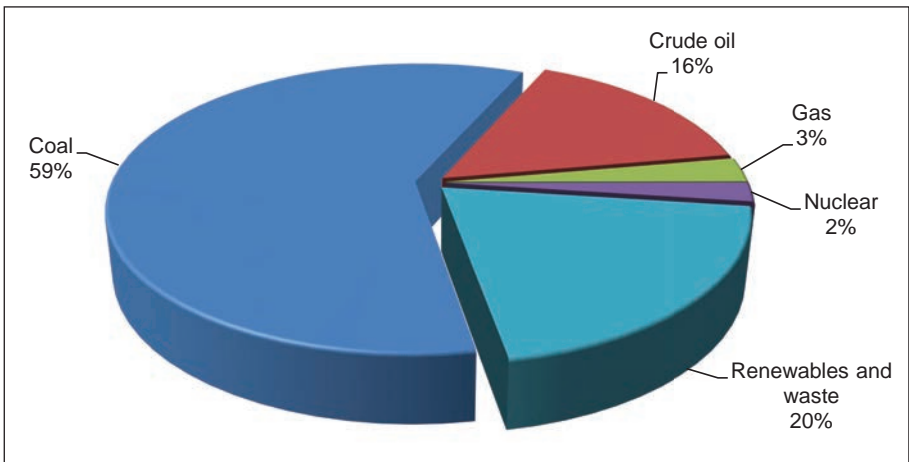
- To promote the orderly development of the piped gas industry;
- To establish a national regulatory framework;
- To establish a National Gas Regulator as the custodian and enforcer of the national regulatory framework; and
- To provide for matters connected therewith.

# 1. ENERGY SUPPLY

Primary energy is a form of energy found in nature that has not been subjected to any conversion or transformation process. Much of it is transformed into more useable forms of final energy, which is then consumed by the end users. Examples of such transformation are coal to electricity in power stations, crude oil to liquid fuels in oil refineries, coal to liquid fuels (CTL), and natural gas to liquid fuels (GTL).

The South African energy supply is dominated by coal with 59% of the primary energy supply followed by renewables with 20% and crude oil with 16%. Natural gas contributed 3% while nuclear contributed 2% to the total primary supply in 2015. The primary energy supply in this case includes indigenous energy production and imported energy sources.

**Figure 1-1: Total primary energy supply, 2015**



Source: DoE Energy Balances, 2015

## 1.1 Crude oil and Petroleum Products

### Overview

The fuel industry in South Africa is dominated by fossil fuels. The country has fairly limited oil and natural gas deposits, however, its abundance of coal reserves have led to the establishment of a well-developed synthetic fuels industry. Owing to the lack of

reserves, the country imports over 90% of its crude oil from Saudi Arabia, Nigeria and Angola. South Africa is one of the leading economies in Africa as well as a key player in the African petroleum industry.

During the transformation stage, the country produced approximately 5% of its fuel requirements from gas (GTL), 39% from coal (CTL), and 56% from crude oil (DOE, Energy Balance 2015). Majority of petroleum products such as petrol, diesel, residual fuel oil, paraffin, jet fuel, aviation gasoline, and liquid petroleum gas (LPG) are refined in the country. However, in order to meet the domestic demand, some petroleum products have to be imported to supplement the production shortfall.

The South African petroleum industry is comprised of a number of activities including extracting and importing of crude oil, coal and gas. The upstream level of the market involves the refining of the inputs to produce liquid fuels and chemicals which are by-products and co-products of the refining process. The upstream levels of the value chain (the refineries) are represented by the South African Petroleum Industry Association (SAPIA). The association represents the collective interests of its members which are AEMCOR, Afric Oil (Pty) Ltd, African Oxygen Ltd, BP Southern Africa (Pty) Ltd, Camel Fuels (Pty) Ltd, Chevron South Africa (Pty) Ltd, Easigas (Pty) Ltd, Elegant Fuels, Engen Petroleum Ltd, Gulfstream (Pty) Ltd, Imbizo Petroleum Traders (Pty) Ltd, Makwande Energy Trading (Pty) Ltd, MBT Petroleum (Pty) Ltd, Oryx Oil South Africa (Pty) Ltd, PetroSA (Pty) Ltd, Royale Energy Ltd, Sasol Ltd, Shell SA (Pty) Ltd, Total South Africa (Pty) Ltd, Totalgaz Southern Africa (Pty) Ltd and Wasaa Gasses (Pty) Ltd.

The petroleum industry was licensed for the first time in 2005, in terms of the Petroleum Products Amendment Act, 2003. Government limits the total number of site and their corresponding retail licences in any period. Manufacturers and wholesalers are prohibited from holding a retail licenses except for training purposes.

The petrol retail price is regulated by the government, and changed every month on the first Wednesday of the month. The calculation of the new price is done by Central Energy Fund (CEF) on behalf of the Department of Energy (DoE). Crude oil prices combined with the Rand/Dollar exchange rate therefore have a major impact on petrol prices. A crude-oil refinery's biggest input cost is crude oil.

## Refinery Production Capacity

South Africa has, following Egypt, the second largest refining capacity in Africa amounting to 703 000 barrels per day. There are six refineries in the country; four of the refineries are on the coast and two are inland. Two of the refineries are synthetic fuels production facilities that produce liquid fuels from coal and gas, which are owned by Sasol and PetroSA respectively.

Sasol uses both the Coal-To-Liquids (CTL) and Gas-To-Liquids (GTL) technologies to produce up to 150 000 barrels per day (bbl/d) equivalent of product. The Petroleum Oil and Gas Corporation of South Africa (PetroSA) produce up to 45 000 bbl/d of synthetic products using GTL technology. Most transport fuel in South African is produced in the coastal areas even though most of it is consumed in the inland region of Gauteng.

Major refineries include Sapref and Enref in Durban, Chevron in Cape Town, and Natref at Sasolburg. The liquid fuels are manufactured by six refineries as shown in Table 1-1 below and the shortfall is met through imports.

**Table 1-1: Refinery production capacity**

Refinery	Area and Province	Type	Capacity*
Chevron Refinery	Cape Town, Western Cape	Crude	100 000
Enref	Durban South, KwaZulu Natal	Crude	120 000
Natref (Sasol Oil owns 64% and Total SA 36%)	Sasolburg, Free State	Crude	108 000
PetroSA	Mossel Bay, Western Cape	Synthetic (GTL)	45 000
Sasol Synfuels	Secunda, Mpumalanga	Synthetic (CTL)	150 000
Sapref (BP owns 50% and Shell 50%)	Durban South, KwaZulu Natal	Crude	180 000
<b>Total</b>			<b>703 000</b>

Source: SAPIA, 2017

## Crude oil refining

Natref is South Africa's only inland crude oil refinery. The refinery is a medium sized technologically advanced facility, highly efficient in refining heavy crude oil. The Natref refinery is a joint venture between Sasol Oil (Pty) Ltd and Total South Africa (Pty) Ltd.

Chevron South Africa has a crude oil refinery in Cape Town with a crude oil input capacity of 110,000 barrels per day. The Engen Refinery, which is located in Durban, has crude refining capacity of 120 000 barrels per day. Sapref is a joint venture between Shell SA Refining and BP Southern Africa, and Southern Africa's largest crude oil refinery with a design capacity to process between 180 000 and 190 000 barrels per day depending on the type of crude oil processed (Sapref, 2018)

The products of the refineries are petrol, diesel, residual fuel oil, paraffin, jet fuel, aviation gas, LPG and refinery gas. The ratios of petrol to diesel can be altered slightly by changing operating conditions.

### **Synthetic fuels operations**

South Africa leads the world by far in converting coal to liquid fuels. Sasol has two large units at Secunda. Secunda Synfuels Operations operates the world's only commercial coal-based synthetic fuels manufacturing facility, producing synthesis gas (syngas) through coal gasification and natural gas reforming (Sasol, 2018). The operations use their proprietary technology to convert syngas into synthetic fuel components, pipeline gas and chemical feedstock for the downstream production of solvents, polymers, comonomers and other chemicals. The fuel components are used for the manufacture of automotive fuels, aviation jet fuel, illuminating paraffin and liquefied petroleum gas.

The PetroSA GTL refinery at Mossel Bay is the world's first Gas-to-Liquids refinery and remains the third largest GTL refinery among the five now operating worldwide. Using Fischer Tropsch technology, the refinery converts natural, methane-rich gas into ultra-clean, low-sulphur, low-aromatic synthetic fuels and high value products (PetroSA, 2018). The refinery sources its feedstock from PetroSA's FA-EM and South Coast gas fields, as well as the Oribi and Oryx oil fields in Block 9, offshore South Africa. It is capable of producing a crude oil equivalent of 45,000 barrels per day.

### **Liquid fuels industry key role players**

This industry is dominated by seven oil companies which are affiliated to the South African Petroleum Industry Association (SAPIA) and regulated by the DoE. BP, Chevron, Engen Petroleum, PetroSA, Sasol Oil, Shell and Total are the main players in the South African oil industry. Interestingly, Sasol only joined SAPIA in 2000 followed by PetroSA in 2002. SAPIA plays a strategic role in addressing a range of common issues relating to the refining, distribution and marketing of petroleum products, as well as promoting the industry's 10 environmental and socio-economic progress. These companies operate storage terminals and distribution facilities throughout the country.

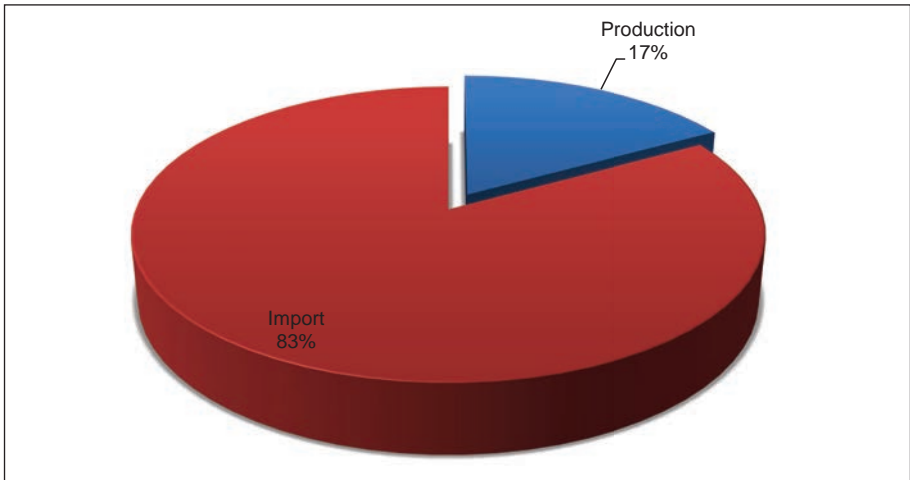
Initially, there were very few non-refining wholesalers supplying petrol and diesel in South Africa. Today, there are quite a number of those that are registered with the DoE.

The DoE oversees all policy directly relating to the liquid fuels industry and regulates prices and access of petroleum products. The National Energy Regulator of South Africa (NERSA) regulates access and tariffs to liquid fuels infrastructure including pipelines and storage facilities. On the other hand, Transnet owns petroleum pipelines and storage facilities. PetroSA manages the country's commercial assets in the petroleum industry, including one of the world's largest commercial Gas-To-Liquids plants at Mossel Bay in the Western Cape. PetroSA is engaged in two worldwide businesses, namely: - oil and gas exploration and production; and the production and marketing of synthetic fuels and petrochemicals. The company explores oil and gas in selected basins around the world, with a focus on Africa, and has producing fields off the coast of South Africa.

### Crude Oil

In 2015, South Africa imported about 83% of its crude oil requirements and 17% was produced from indigenous sources. All the total primary crude oil supply was used by refineries during transformation process for liquid fuels production. This reflects the country's vulnerability and dependence on imports for its petroleum requirements. The petroleum products produced by refineries are petrol, diesel, residual fuel oil, paraffin, jet fuel, aviation gas, LPG and refinery gas.

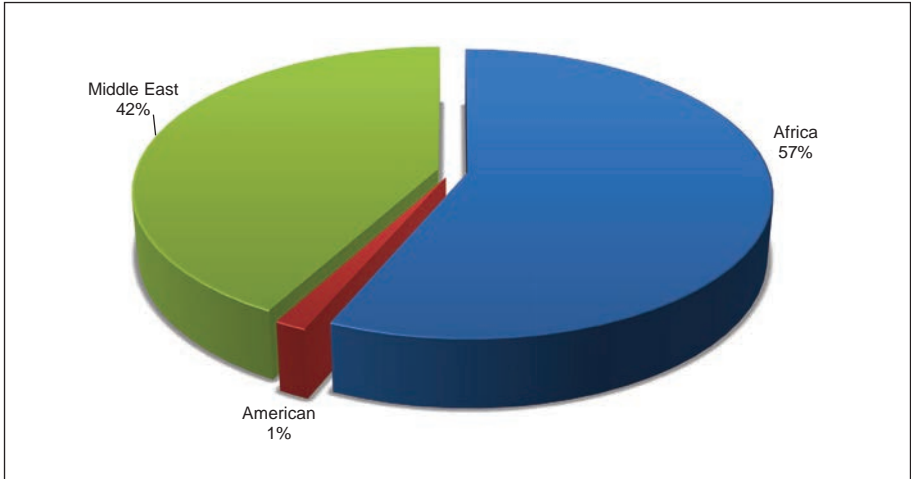
**Figure 1-2: Crude oil primary supply, 2015**



Source: DoE Energy Balances, 2015

As depicted in the table 1-2 and figure 1-3 below, a significant amount of crude oil volumes (57%) is imported from Africa, particularly Nigeria with total import volumes of 7.4 million tons in 2015. This was followed by Angola with import volumes of 3.3 million tons.

**Figure 1-3: Crude oil imports by region, 2015**



Source: South African Revenue Service (SARS), 2015

Crude oil imports by South Africa from the Middle East countries accounted for 42% of total crude oil imports in 2015. The greater portion of imports was sourced from Saudi Arabia with import volumes amounting to 4.9 million tons. Other insignificant volumes were procured from America.

**Table 1-2: Crude Oil imports volumes by country of origin, 2015**

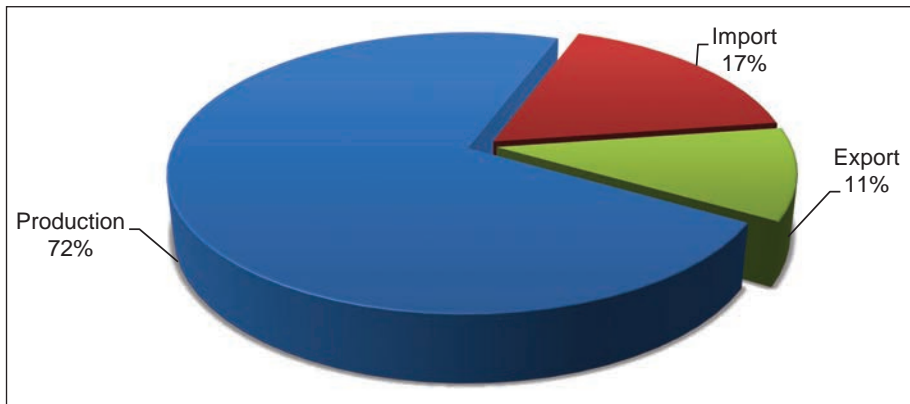
Country Of Origin	Import Volumes	
	Tons	Percentage
United Arab Emirates	1,337,205	6.8%
Angola	3,347,821	17.0%
Colombia	291,207	1.5%
Guinea	137,988	0.7%
Equatorial Guinea	222,743	1.1%
Iraq	410,598	2.1%
Kuwait	607,913	3.1%
Nigeria	7,407,611	37.7%
Oman	132,797	0.7%
Qatar	831,965	4.2%
Saudi Arabia	4,939,202	25.1%

Source: South African Revenue Service (SARS), 2015

### Petroleum products

Based on the 2015 Energy Balances, 72% of the total petroleum products supply was produced locally. Imports amounted to 17% to make up for the local production shortfall while exports amounted to 11%.

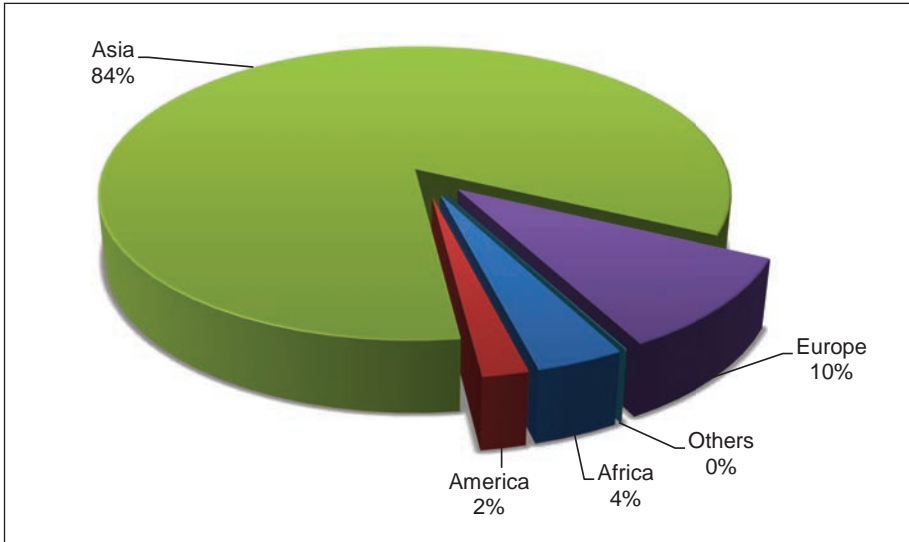
**Figure 1-4: Petroleum products supply, 2015**



Source: DoE Energy Balances, 2015

Majority of the petroleum products imported into South Africa was from Asia as depicted in figure 1-5 below. The Asian region was dominated by India, followed by Singapore and Oman, respectively. Europe accounted for 10% of the imported products, followed by Africa (4%) and America (2%), respectively.

**Figure 1-5: Petroleum products imports by region, 2015**



Source: South African Revenue Service (SARS)

## 1.2 Natural gas

South Africa has limited proved reserves of natural gas, at 27 million cubic metres. As a result, the country imports natural gas from Mozambique and produces a small volume of natural gas from the F-A field in the Bredasdorp basin located 93 km offshore of Mossel Bay.

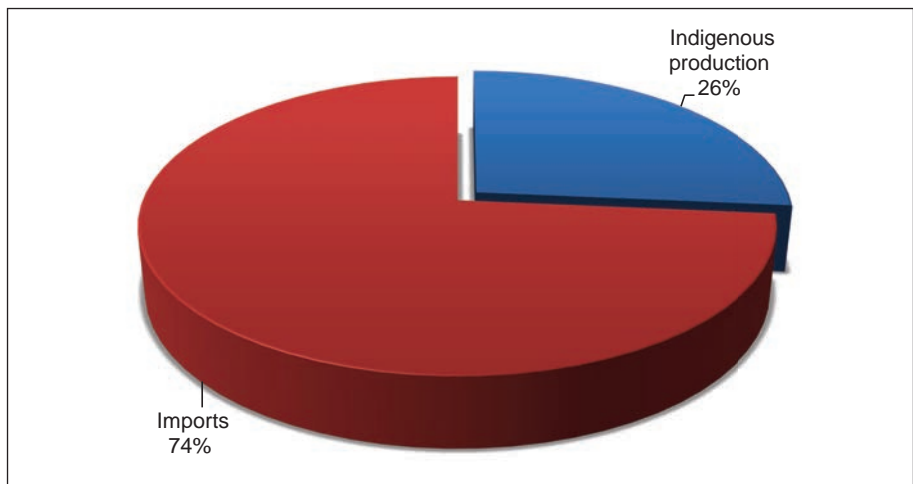
According to US Energy Information Administration (EIA), South Africa is estimated to hold 390 trillion cubic feet of technically recoverable shale gas resources in the Karoo basin and is ranked 8th place in terms of technically recoverable shale gas resources in the world. Currently, the South African government is working on a set of regulations that seek to ensure the responsible exploration of shale gas which minimises the threat to the environment.

In addition to shale gas, there is further onshore potential presented by coalbed methane (CBM) in the Waterberg region (PwC, 2012). Also, there are other conventional gas opportunities being explored in the Orange basin (west coast), Bredasdorp, Pletmos, Gamtoos, Algoa and Southern Quteniqua sub-basins (south coast) as well as the Durban and Zululand basins (east coast) (Sasol, 2013).

In 2005, the total primary gas supply in the country grew about 4 times the 2004 level due to an increase in imports. Currently natural gas is imported into South Africa by Sasol Gas via an 865-km pipeline from the Temane and Pande gas fields in Mozambique. Reserves in the Temane and Pande are estimated around 2,6tcf. The pipeline has a capacity of 240 million gigajoules (GJ) per annum. Approximately 120 million GJ is used annually by Sasol in the GTL and chemicals plant in Secunda, while the balance is distributed to commercial and industrial customers via a pipeline network covering more than 2 000km in the Free State, Gauteng, Mpumalanga and KwaZulu-Natal. In terms of the Gas Act (2001), Sasol was the primary gas supplier and distributor until 2014 for certain identified distribution areas.

In 2015, natural gas made up 3% of the total primary energy supply in South Africa. Natural gas domestic production amounted to 26% in 2015 whilst imports amounted to 74% during the same period.

**Figure 1-6: Natural gas primary supply, 2015**



Source: DoE Energy Balances, 2015

PetroSA owns the only producing indigenous offshore gas field in South Africa. This field is located in Block 9 in the Bredasdorp basin and provides feedstock for their GTL plant. The field is nearly depleted, resulting in the GTL plant being operated below capacity.

Further field development in this block is being undertaken by PetroSA to secure feedstock for the GTL plant.

The following are the main players in the natural gas industry in South Africa:

- i-Gas – A state-owned enterprise focussed on promoting the development of the piped gas industry in South Africa. i-Gas is a co-owner of the natural gas pipeline supplying natural gas from Mozambique to Sasol;
- The National Energy Regulator of South Africa (NERSA) – The gas regulator in terms of the Gas Act, NERSA is responsible for licensing gas transmission, distribution and trading activities and facilities;
- Sasol Gas – A subsidiary of Sasol Limited, a multinational petrochemical company based in South Africa, and co-owner and operator of gas fields in Mozambique, a natural gas pipeline from Mozambique to South Africa, and synfuel and CTL plants;
- The Petroleum Agency of South Africa (PASA) – The regulating authority responsible for promoting, regulating and licensing upstream exploration and production activities in South Africa; and
- The Petroleum Oil and Gas Exploration Company of South Africa (PetroSA) – The national oil company of South Africa and operator of a 36 000 bpd GTL plant in Mossel Bay.

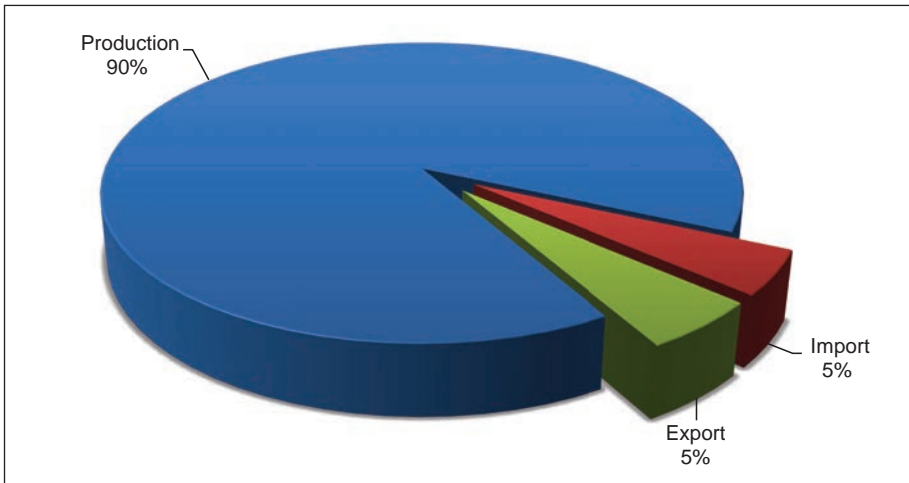
### **1.3 Electricity**

South Africa supplies approximately 40% of Africa's electricity and has until recently been one of the four cheapest electricity producers in the world. The electricity sector in South Africa is dominated by the national utility Eskom, a primary electricity supplier and generates approximately 90% of the electricity used in the country. The balance is supplied by municipalities and redistributors as well as private generator.

Eskom is the world's eleventh-largest power utility in terms of generating capacity, ranks ninth in terms of sales, and boasts the world's largest dry-cooling power station. The utility sells power directly to some 6 000 industrial, 18 000 commercial, 70 000 agricultural and 3 million residential customers. It owns and operates a number of coal-fired, gas-fired, hydro and pumped storage power stations, as well as one nuclear power station.

Its 26 000 kilometres of transmission lines span the entire country and extend into most Southern African Development Community (SADC) countries.

**Figure 1-7: Electricity supply, 2015**



Source: DoE Energy Balances, 2015

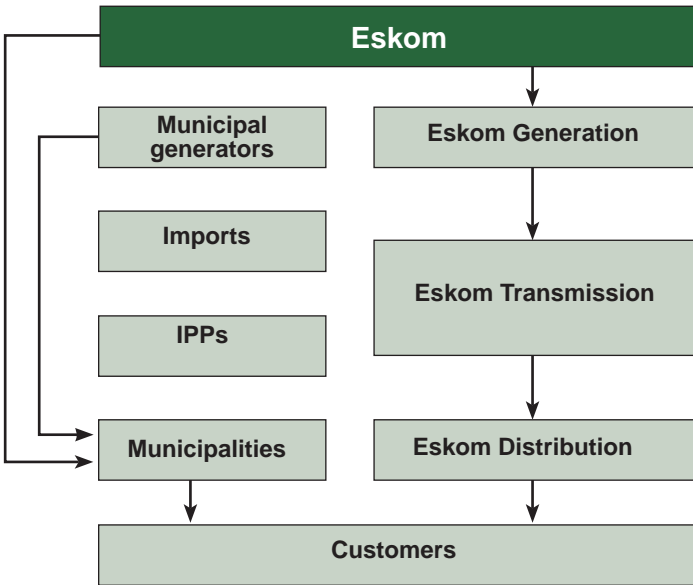
With effect from 1 July 2002, Eskom was converted from a statutory body into a public company as Eskom Holdings Limited, in terms of the Eskom Conversion Act, 13 of 2001. The two-tier governance structure of the Electricity Council and the Management Board was replaced by a Board of Directors. It is financed by net financial market liabilities and assets as well as reserves. Due to a sharp increase in the demand for electricity, the Eskom Board of Directors took a final decision in 2003 to decommission three power stations: Camden in Ermelo, Grootvlei in Balfour and Komati between Middelburg and Bethel, which were mothballed in the late 1980s and early 1990s.

The key drivers of continued coal-based power use in South Africa (in spite of the environmental concerns) are the abundance (locally and in the southern African region) and the relatively low direct cost of the resource. The most important reason, however, is the performance of coal-fired power stations in terms of availability and reliable output. They operate at base-load capacity, which is available continuously (for twenty-four hours) except during maintenance and technical outages, thus increasing the security of supply.

## Generation, Transmission and Distribution

Electricity infrastructure comprises of three sub-sectors, namely: - generation, transmission and distribution. In terms of generation, Eskom dominates the production of electricity, with a generation infrastructure comprising coal-fired power stations. Eskom generates, transmits and distributes electricity to industrial, mining, commercial, agricultural and residential customers in South Africa, and to municipalities, who in turn redistributes electricity to businesses and households within their areas. It also purchases electricity from Independent Power Producers (IPPs) in terms of various agreement schemes as well as electricity generating facilities beyond the country's borders. Most power stations are located in Mpumalanga, except for Lethabo and Matimba which are located in the Free State and Limpopo provinces respectively.

**Figure 1-8: Electricity Generation, Transmission and Distribution**



Source: Eskom

## **Generation**

South Africa has four groups of electricity generators, namely: - the national public electricity utility, Eskom; municipal generators; Independent Power Producers (IPPs) in partnership with Eskom; and the Autogenerators. The Autogenerators are industries which generate electricity for their own use. These include the pulp mills, sugar refineries, Sasol, Mossgas and metallurgical industries.

Eskom operates 29 power stations with a total nominal capacity of 44 134MW, comprising 36 441MW of coal-fired stations, 1 860MW of nuclear power, 2 409MW of gas-fired, 600MW hydro and 2 724MW pumped storage stations, as well as the recently commissioned 100MW Sere Wind Farm. The 3MW Klipheuvel Wind Farm was impaired during 2016 as it had reached the end of its useful life. All four units of Ingula, with a nominal capacity of 331MW each, were commissioned during 2016, supplementing the capacity added by Unit 6 of Medupi Power Station, commissioned in the previous year. Eskom maintain approximately 384 712km of power lines and substations with a cumulative capacity of 276 583MVA.

Africa's only nuclear station is at Koeberg, 30 kilometres north of Cape Town. There is modest hydro capacity on the Orange River, located on two dams – and two pumped storage schemes, one in the Drakensberg and the other on the Palmiet River in the Western Cape. Municipalities own 22 small power stations and back-up gas turbines, but these total only 4% of national generation capacity and generally run at low load factors. Private generators comprise the remaining 1% of capacity.

## **Transmission**

Transmission is part of the process of getting the electricity that is generated by Eskom's power stations to its distribution networks and end customers. Eskom owns and operates the national transmission system. The transmission grid of Eskom consists of 32 220km of power lines and substations with a cumulative capacity of 147 415MVA.

## **Distribution**

Eskom owns 48 805km of distribution lines, 296 188km of reticulation power lines and 7 499km of underground cables in South Africa, representing the largest power-line system in Africa.

Eskom and the 187 municipalities are responsible for the distribution of electricity to approximately 9 million customers. The municipal distributors buy bulk electricity from Eskom, with some also generating small amounts for sale in their areas of jurisdiction. The operation of distribution facilities varies between regions and municipalities.

Eskom sold 214 121GWh of electricity to about 802 municipalities in bulk, 2 706 industrial customers, 1 012 mining customers, 50 956 commercial customers and 81 806 agricultural customers in 2016/17. It also supplied electricity to more than 5.8 million residential customers (including prepaid customers).

## **Key Role Players**

### *Department of Energy (DoE)*

DoE has an oversight responsibility for the energy sector, including the electricity sector, which is governed mainly through the Electricity Regulation Act (4 of 2006).

### *National Energy Regulator of South Africa (NERSA)*

NERSA issues licences for the operation of generation, distribution and transmission infrastructure; regulates imports, exports and trading of electricity; determines and approves electricity prices, tariffs and the conditions under which electricity may be sold.

### *National Nuclear Regulator (NNR)*

NNR regulates the operation of nuclear power stations, such as Koeberg and all elements of the South African nuclear energy value chain. Its role is to protect people, property and the environment against nuclear damage.

### *Department of Public Enterprises (DPE)*

The Minister of Public Enterprises is the shareholder representative of the South African Government and has oversight responsibility for Eskom.

### *National Treasury (NT)*

National Treasury is responsible for financial and reporting oversight for Eskom (as a state-owned entity) and has played a pivotal role in providing government loans and guarantees in favour of Eskom.

*Department of Water Affairs (DWA)*

DWA oversees water allocations and ensures that there is adequate water supply infrastructure for the South African electricity sector.

*Department of Environmental Affairs (DEA)*

DEA ensures adherence to environmental compliance and protection of rights relating to the prevention of pollution, ecological degradation, promotion of conservation as well as securing ecologically sustainable development.

**Integrated National Energy Programme (INEP)**

The Government of South Africa, through the DoE, continues to fund the electrification of previously disadvantaged and farm worker households in its licensed areas of supply. While Eskom carries the ongoing operating costs for these connections, it receives the revenue for electricity sold. Municipalities are also responsible for the connections of electricity in the households within their jurisdictions.

**Table 1-3: Electrification Statistics until December 2017**

<b>Province</b>	<b>Electrified Houses: Municipalities &amp; Eskom</b>
Eastern Cape	1 473 355
Free State	780 832
Gauteng	3 527 003
KwaZulu Natal	2 247 498
Limpopo	1 484 310
Mpumalanga	1 065 610
Northern Cape	285 179
North West	997 484
Western Cape	1 608 147
<b>Total</b>	<b>13 469 418</b>

Source: Department of Energy (DoE), 2017

The DOE has identified 2.2 million of South African houses as being without electricity. The majority of these people live in the Gauteng, KwaZulu-Natal and Eastern Cape provinces. About 13.5 million out of a total of 15.6 million households were using electricity as a lighting source. About 86% of households had access to electricity for lighting purposes. Just above 5.8 million households were connected to the grid between 1994 and December 2013. In order to achieve the United Nation's millennium development goal of universal access to electricity by 2030, the DoE has accelerated the universal access programme. The DoE's integrated national electrification programme that commenced in 2001/02 increased its funding by 17%. Eskom implements the INEP on behalf of the DoE in the company's licensed supply areas. Electrification in municipal licensed areas of supply is carried out by the relevant municipality. At the same time, Eskom is pursuing construction efficiency opportunities in order to unlock savings to fund 50 000 extra connections per annum.

### **Southern African Power Pool (SAPP)**

Eskom (on behalf of South Africa) is a member of the Southern African Power Pool (SAPP) that provides the opportunity for the various utilities in the SADC region to ensure integrated planning and smooth and safe operation of the interconnected transmission system.

The Southern African Power Pool (SAPP) was created with the primary aim to provide reliable and economical electricity supply to the consumers of each of the SAPP members, consistent with the reasonable utilisation of natural resources and the effect on the environment. The members of the SAPP have undertaken to create a common market for electricity in the SADC region and to let their customers benefit from the advantages associated with this market. SAPP members comprise of Namibia, Lesotho, Mozambique, Lesotho, Namibia, Botswana, Zimbabwe, Mozambique, Swaziland, South Africa and Zambia.

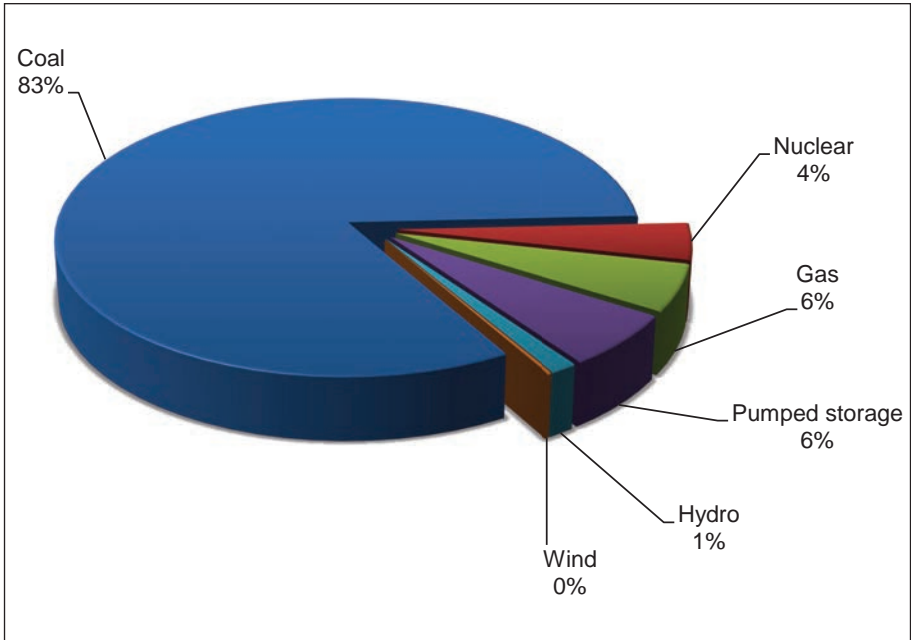
### **Electricity Pricing**

Amongst NERSA's roles in the energy industry, they are responsible for the regulation and determination of electricity pricing and tariffs. Such regulations involve inter alia setting of tariff guidelines and structure, tariff methodologies (e.g. Rate of Return, Multi Year Price Determination), evaluation of tariff applications from licensees and pricing frameworks. The electricity pricing scheme employed by NERSA is based on the multi-year pricing determination (MYPD). The MYPD was implemented based on Eskom's cost recovery requirements, such that the utility remains functioning and sustains itself economically.

## Eskom Generating Capacity

According to the Eskom's Integrated Results 2017, the net maximum generating capacity as at March 2017 amounted to 44GW slightly higher than in 2013 by 0.9GW.

**Figure 1-9: Power Station Maximum Generating Capacity Mix**



Source: Eskom Integrated Results, 2017

Coal fired power stations are still dominant in terms of power generating capacity until such a time other means of power generation like nuclear and renewables are ascertained. A significant contribution of the coal fired power stations makes up 83% to the maximum generating capacity mix in 2017 as depicted above. The combined contribution of maximum generation capacity by other power stations constituted 17% in total with gas turbines accounting for 6%, nuclear power stations 4% and pumped storage scheme 6%. Generation at the Sere wind farm at 100MW was quite insignificant compared to the others.

## 1.4 Coal

South Africa has the 5th largest recoverable coal reserves in the world, estimated at 66.7 billion tons (DMR, 2016). Coal deposits in the country are hosted in the Phanerozoic sedimentary rocks of the Karoo Super group. The Karoo Supergroup cover almost the whole of Free State, and large parts of the Eastern Cape, Northern Cape, Mpumalanga, Limpopo as well as KwaZulu-Natal Provinces of South Africa.

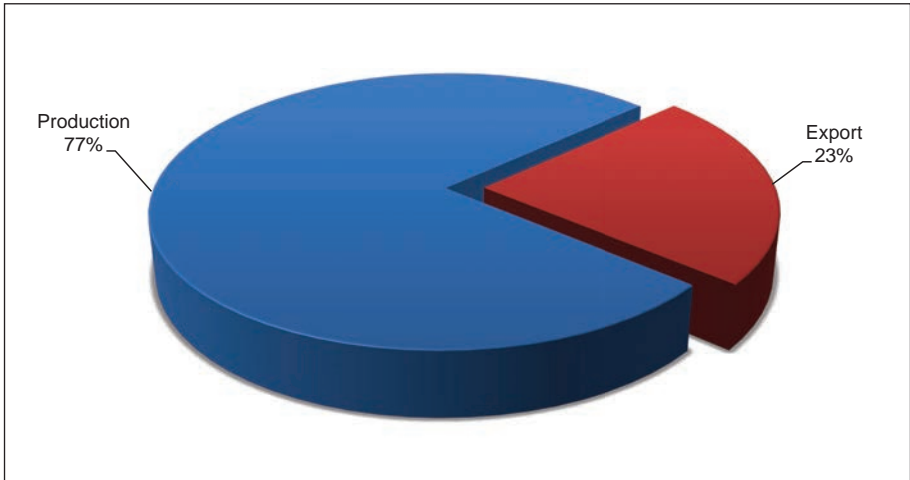
Currently, the main coal mining areas in the country are the Witbank, Ermelo and Highveld coalfields in Mpumalanga, Vereeniging in the Free State as well as in north-western KwaZulu-Natal, which hosts a number of smaller operations (Overview of the South African Coal Value Chain, 2011). Geology has determined that the Witbank coalfield is by far the most important source of South Africa's mined coal at present, accounting for 40% of South Africa's coal production. However, the Waterberg coal field in Limpopo is the focus of recent exploration efforts and has the potential to become a major coal field in the future, to replace the almost depleted Witbank field.

South Africa's indigenous energy-resource base is dominated by coal. Internationally, coal is the most widely used primary fuel, accounting for about 40% (World Energy Council, 2016) of the total fuel consumption of the world's electricity production. By international standards, South Africa's coal deposits are relatively shallow with thick seams, which make them easier and cheaper to mine. At the present production rate, it is estimated that there is more than 50 years of coal supply left. Over 50% of South Africa's primary energy needs are provided by coal. This is unlikely to change significantly in the next two decades, owing to the relative lack of suitable alternatives to coal as an energy source. Many of the deposits can be exploited at extremely favourable costs and, as a result, a large coal-mining industry has developed. In addition to the extensive use of coal in the domestic economy, about 30% of South Africa's production is exported, mainly through the Richards Bay Coal Terminal, making South Africa the fourth-largest coal exporting country in the world.

South Africa's coal is obtained from collieries that range from among the largest in the world to small-scale producers. About 51% of South African coal mining is done underground, while the rest is produced by open-cast methods. Production is concentrated in large mines, with 11 mines accounting for 70% of the output. South African coal for local electricity production is among the cheapest in the world.

The key role played by South Africa's coal reserves in the economy is illustrated by the fact that Eskom is ranked number one in the world as a steam coal user and 11<sup>th</sup> as an electricity generator. Sasol is also the largest coal-to-chemicals producer in the world.

**Figure 1-10: Coal primary supply, 2015**



Source: DoE Energy Balances, 2015

As shown in Figure 1-10 above, about 77% of the total coal primary supply was sold locally and 23% was exported.

### **Key Role Players**

The six major producers: Anglo Coal, BHP Billiton Coal South Africa (BECSA), Exxaro Resources, GlencoreXstrata Coal, Sasol Mining and Optimum Coal Holdings (OCH) accounted for 79.6% of the country's total production and junior coal producers accounted for the remaining 20.4%. The four largest Black Economic Empowerment (BEE) companies, namely:- Exxaro Resources, OCH, Umcebo Mining and Shanduka, accounted for 26.1% of the country's total production. Overall, BEE companies and junior coal miners accounted for about 41.3% of the country's total production. The Witbank coalfield outperformed all coalfields, accounting for 61.2% of the total production, followed distantly by the Highveld's 19.5% and Sasol-Vereeniging's 7.5%. The Mpumalanga Central basin, which comprises of Witbank, Highveld and Ermelo coalfields, accounted for 83.7% of the country's production.

## 1.5 Renewables

South Africa has an abundance of fossil fuels in the form of coal, hence the many existing and newly developed coal powered power stations. With the ever rising cost of traditional fossil fuels based energy, renewable energy is becoming a viable option. South Africa is presently rated as the 12<sup>th</sup> most attractive investment for renewable energy. The Renewable Energy Independent Power Producers Procurement Programme (REIPPPP) has to date, attracted investment (equity and debt) to the value of R201.8 billion, of which R48.8 billion (24%) is foreign investment (IPPPP An Overview, 2017). This augurs well for South Africa, as the programme has received international acclaim for fairness, transparency and the certainty of this programme.

With its abundant natural resources of sun and wind, South Africa is regarded as a prime candidate for increased use of renewable energy. The country is highly dependent on coal burning for power generation, but does have a number of small-scale hydroelectric plants and only one nuclear power station.

At the same time South Africa has an abundance of sunshine which lends itself very well for solar water heating and electricity generation. With increasing prices of coal powered electricity, solar powered electricity is becoming more attractive.

South Africa has one of the most successful renewable programmes, with the country becoming a sought-after energy investment destination. There has been a rapid increase in SMEs focusing on renewable energy; an influx of large scale energy project developers from many parts of the world, followed by a range of local and overseas investors keen to shape a new investment frontier; not to mention the construction of the country's first large scale commercially driven renewable energy projects.

The South African government has identified the green economy as one of 12 job drivers that could help contribute to creating 5 million additional jobs by 2020. In fact, the New Growth Path, in which the sectoral jobs targets are disaggregated, envisages that as many as 300 000 new direct jobs could be created in the areas of natural resource management and renewable energy construction.

## **Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)**

In 2003, Cabinet approved private-sector participation in the electricity industry and decided that future power generation capacity will be divided between Eskom (70%) and Independent Power Producers, or IPPs (30%).

The NDP required the development of 10 000MW additional electricity capacity to be established by 2019 against the 2010 baseline of 44 000MW. The Integrated Resource Plan (IRP) 2010 developed the preferred energy mix with which to meet the electricity needs over a 20 year planning horizon to 2030.

In line with the national commitment to transition to a low carbon economy, 17 800MW of the 2030 IRP target are expected to be from renewable energy sources, with 5 000MW to be operational by 2019 and a further 2 000MW (i.e. combined 7 000MW) operational by 2020.

The REIPPPP is aimed at bringing additional power into the electricity system through private sector investment in wind, solar, photovoltaic, concentrated solar power (CSP), biomass and small hydro technologies. The REIPPPP programme constitutes one of the energy mixes as outlined in the National Development Plan and the Integrated Resource Plan 2010.

In May 2011, the DoE gazetted the Electricity Regulations on New Generation Capacity (New Generation Regulations) under the Electricity Regulation Act (ERA) which enable the Minister of Energy (in consultation with NERSA) to determine what new capacity is required. Ministerial determinations give effect to components of the planning framework of the IRP, as they become relevant. The current new capacity determinations include 14 725MW of renewable energy, comprising of solar PV (6 225MW), wind (6 360MW), CSP (1 200MW), small hydro (1 95MW), landfill gas (25MW), biomass (210MW), biogas (110MW) and the small scale renewable energy programme (400MW);

The determinations have been implemented in rolling bid windows with seven (1, 2, 3, 3.5, 4, 1S2 and 2S2) bid windows successfully completed in the first five years. All projects in Bid Window 1 (BW1) and Bid Window 2 (BW2), and 10 projects in Bid Window 3 (BW3) are now operational.

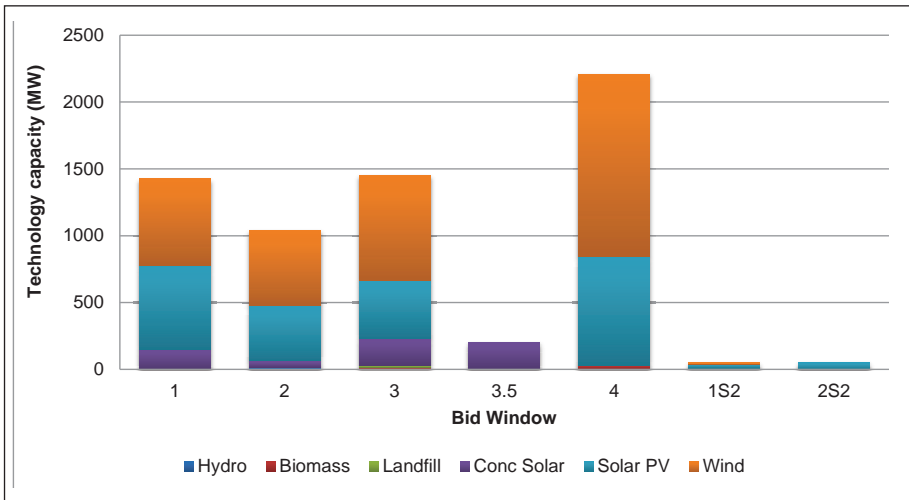
By the end of June 2017, the REIPPPP had made the following significant impacts:

Energy supply capacity impact:

- 6 422MW of electricity had been procured from 112 RE Independent Power Producers (IPPs) in seven bid rounds, that is, Bid windows 1, 2, 3, 3.5, 4 and smalls BW1 (1S2) & smalls BW2 (2S2)
- 3 162 MW of electricity generation capacity from 57 IPP projects has been connected to the national grid;
- 16 991 GWh of energy has been generated by renewable energy sources procured under the REIPPPP since the first project became operational. Renewable energy IPPs have proved to be very reliable. Of the 57 projects that have reached COD, 44 projects have been operational for longer than a year. The energy generated over the 12 month period ending June 2017 for these 44 projects is 5 462 GWh, which is 90% of their annual energy contribution projections(P50) of 6 081 GWh over a 12 month delivery period. Twenty four (24) of the 44 projects (55%) have individually exceeded their P50 projections.

In terms of national targets for renewable energy capacity, as defined by the IRP and National Development Plan, this represents 18% towards the 2030 target and 45% towards the 2020 target.

**Figure 1-11: Allocated capacity in windows 1, 2, 3 and 4, 2017**



Source: Department of Energy (DoE), 2017

## **Solar Water Heaters (SWHs)**

The Department of Energy (DoE) launched a solar water heater programme in 2009 aimed to equip 1 million homes with solar water heaters (SWHs) by the close of the 2014/15 financial year. However, the programme installed 417 135 units by 2016. Further to a 1 million target, the country envisioned an additional 4 million countrywide SWHs to be installed by 2030.

The original programme was managed by Eskom and was targeted at private and commercial installations that already had geysers and electricity, with the aim of reducing the demand by electric geysers on the grid (load reduction programme). The incentive used was a subsidy on the purchase price of installed SWHs, based on the reduction in peak demand and energy achieved. An additional programme of replacement of failed electric geysers with solar water heating system was implemented by the short-term insurance industry.

The rollout of low-pressure heaters (the social programme) was handled by municipalities, supported by Eskom, with full subsidies. Eskom ceased to be involved in the programme and officially handed it over to the DoE in May 2015, as its prime business was the generation and distribution of electricity, not solar water heaters.

In 2016, the Minister instructed the Independent Power Producers' (IPP) Office, to assist the Department of Energy in procuring and implementing the "repair and replace" component of the National Solar Water Heater Programme.

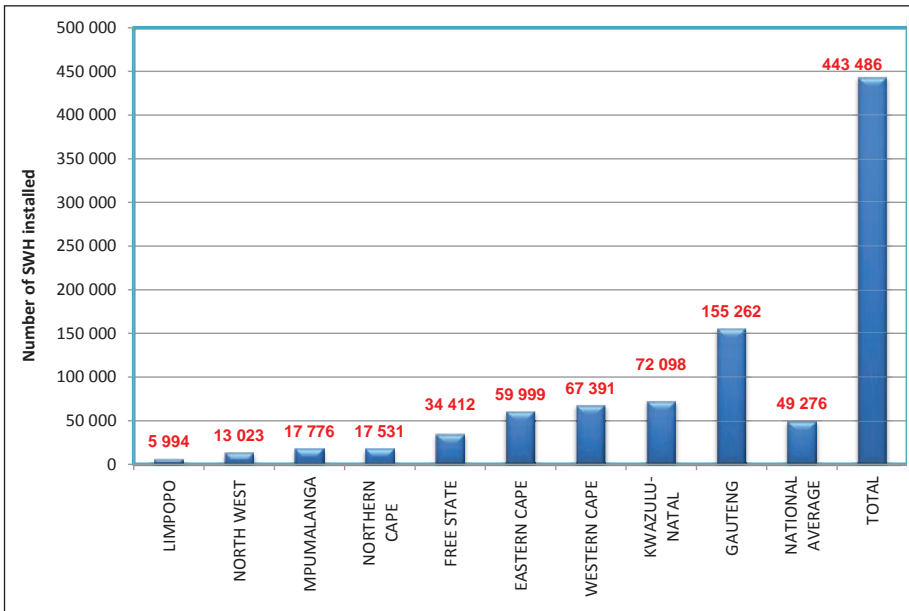
The IPP Office undertook an initial scoping of the National Solar Water Heating Repair/Replace SWHRR Programme in an attempt to use secondary information to cost the national programme and to gain an understanding of the challenges to be anticipated with a SWHRR programme. The desktop research indicated that the project should take a measured approach with a pilot programme, to determine the true cost and benefits of the Repair/Replace, in relation to the desktop conclusions found. This approach was approved internally and implementation commenced on 30 May 2016 (IPPPP, 2016).

The IPP Office has preselected the Northern Cape Province, and more specifically, the Sol Plaatje Local Municipality for the pilot SWHRR programme. The selection of this site was based on amount of current installed systems, known defects and existing training infrastructure, capacity and available budget, with the intention to rollout the IVS programme as a pilot site in Sol Plaatje from June 2016. The objective

of the pilot Solar Water Heater Repair and Replace (SWHRR) programme is to gain an increased understanding of the costs and benefits of a National programme and to develop a model for replication.

As a way forward, the IPP office planned that the approach and methodology developed in the pilot program will be scaled and implemented in other areas within South Africa in 2017. The continued support of public, private sector stakeholders and in particular the IPP's will be critical to its success as it moves into new areas.

**Figure 1-12: SWH installations per province as at September 2015**



Source: Department of Energy (DoE), 2017

The total number of SWH installations implemented across the country is 443 486, with Gauteng having the highest number of installations (155 262) above all provinces. This was quite expected considering the population size and the economic activities taking place in that province. The total installations did not make half the targeted figure of 1 million installations by 2014/15 financial year. Barriers experienced at first were high upfront-capital cost of systems coupled with limited funding currently available.

To address such barriers the Department of Energy pronounced a Standard Offer incentive scheme that will fund all Energy Efficiency and Demand Side Management (EEDSM) interventions. The scheme was aimed at creating opportunities for attracting the much-needed sustainable financial stimulus into the programme.

### **Other Renewable Energy Sources**

- 1) Solar energy can be used to generate electricity, heat water, and to heat, cool and light buildings. For example, photovoltaic systems capture the energy in sunlight and convert it directly into electricity. Alternatively, sunlight can be collected and focused with mirrors to create a high intensity heat source that can be used to generate electricity by means of a steam turbine or heat engine.
- 2) Wind energy uses the naturally occurring energy of the wind either directly as in windmills or to generate electricity, and can be used, for example, to charge batteries or pump water. Large modern wind turbines operate together in 'wind farms' to produce electricity for utilities. Small turbines are used to meet localised energy needs.
- 3) Biomass energy (from organic matter) can be used to provide heat, make liquid fuels, gas and generate electricity. Fuelwood is the largest source of biomass energy, generally derived from trees. However, fuelwood is used unsustainably when new trees are not planted to replace ones that are used. Fuelwood derived in this way cannot be properly defined as renewable. Other types of biomass include plants, residues from agriculture or forestry, and organic components in municipal and industrial wastes. Landfill gas is considered to be a biomass source.
- 4) Bio-fuels in liquid form can be produced from the conversion of biomass and used, for example, for transportation. The two most common bio-fuels are ethanol and bio-diesel. Fermenting any biomass that is rich in carbohydrate, such as maize, makes ethanol. Biodiesel is made using vegetable oils, animal fats and algae.
- 5) Hydropower uses the movement of water under gravitational force to drive turbines to generate electricity.
- 6) Wave power, tidal power and ocean currents can be used to drive turbines to generate electricity. Technologies to harness these forms of power are presently being developed to the stage of commercialisation.
- 7) Geothermal activity in the earth's crust derives from the hot core of the earth. Examples are the natural geysers and hot water sources employed for power generation and space heating or using deep hot dry rock as heat exchangers by pumping water through the natural rock fissures to produce steam for power generation.

## 1.6 Nuclear

South Africa is among the top countries in the world with uranium reserves, and accounted for a significant reserve base of an estimated 279 100 t of uranium, or around 5.2% of global proven reserves in 2012 (Chamber of Mines, 2012).

Uranium production in South Africa has generally been a by-product of gold or copper mining. Much of the productive and prospective ground for uranium as gold by-product is in the Witwatersrand Basin, an area about 330 km x 150 km south and southwest of Johannesburg. Klerksdorp, Welkom, Carletonville, Parys and Evander are towns also on its fringes, associated with gold mines.

Uranium is used in a nuclear power station to produce energy, which contributes about 2% to total energy supply. All the uranium used the Koeberg Power Station is produced locally. AngloGold Ltd is a key contributing figure in uranium mining in Africa. Currently, the largest project for uranium mining in Africa is the Randfontein mine in Gauteng, also known as the Ezulwini project. The Koeberg nuclear power station is the only nuclear power station in South Africa and contains two 900MW uranium pressurized water reactors. The station located 30 km north of Cape Town. The plant is owned and operated by the country's national electricity supplier, Eskom.

The South African Nuclear Energy Corporation (Necsa) is a state-owned company responsible for undertaking and promoting research and development in the field of nuclear energy and radiation sciences based in Phelindaba. It is also responsible for processing source material, including uranium enrichment, and co-operating with other institutions, locally and abroad, on nuclear and related matters. Apart from its main activities at Phelindaba, which include operation and utilisation of the 20MW SAFARI-1 research reactor, (NECSA) also manages and operates the Vaalputs National Radioactive Waste Disposal Facility in the Northern Cape on behalf of the National Radioactive Waste Disposal Institute (NRWDI). Also, the Company promotes the public understanding of nuclear science and technology and facilitates regular communication with the public and its stakeholders.

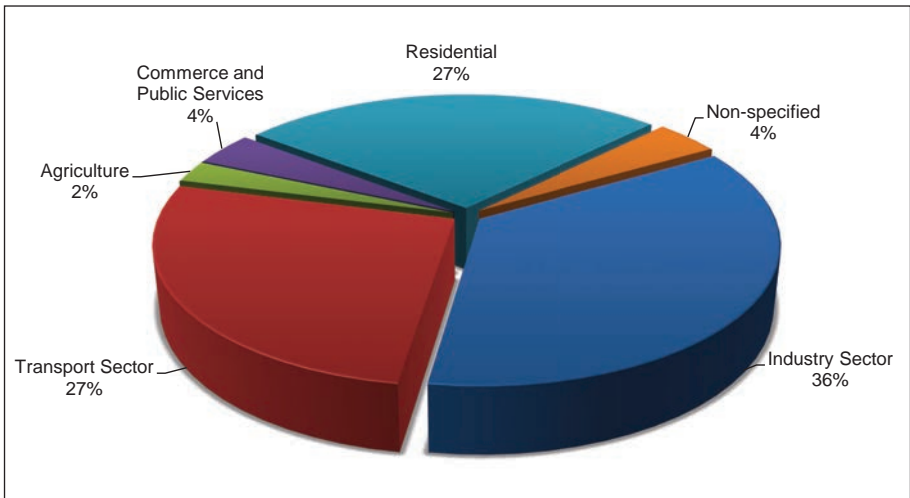
The National Nuclear Regulator (NNR) is a public entity which is established to provide for the protection of persons, property and the environment against nuclear damage through the establishment of safety standards and regulatory practices. It is responsible for granting nuclear authorisations and exercising regulatory control related to safety over the siting, design, construction, operation, manufacture of component parts, and the decontamination, decommissioning and closure of nuclear installations; and vessels propelled by nuclear power or having radioactive material on board which is capable of causing nuclear damage.

## 2. ENERGY DEMAND

Energy is the vital force that powers business, manufacturing, the transportation of goods and the delivery of services to the nation. It is the lifeblood of modern living, as it has an impact on everything we do and affects our very existence. South Africa's steady economic growth, coupled with an increasing focus on industrialisation and a mass electrification programme to take power into deep rural areas, has seen a steep increase in the demand for energy.

The percentage contribution of energy consumed by various sectors in the economy is depicted in figure 2-1 below. The five sectors identified in this report are industry, transport, agriculture, residential, commerce and public services. The sector "non-specified (other)" refers to unaccounted energy (energy that has not been classified into a specific sector).

**Figure 2-1: Energy demand by sectors, 2015**

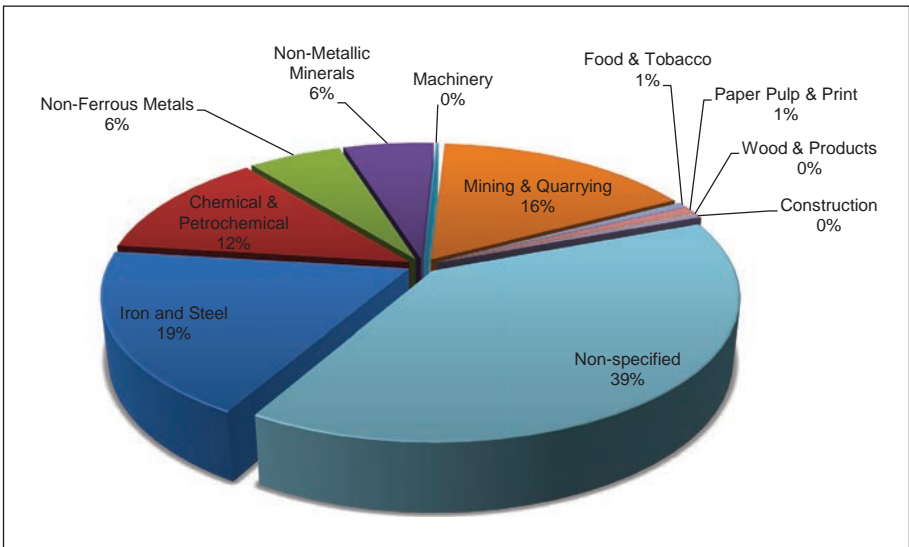


Source: DoE Energy Balances, 2015

## 2.1 Industrial Sector

Iron and steel (19%) as well as mining and quarrying (16%) remains to be the largest consumers of energy in the industrial sector as depicted in Figure 2.2 below. Chemicals accounted for 12% of the industrial consumption while non-ferrous metals and non-metallic both accounted for 6%. The remaining sub-sectors had insignificant energy consumption of 1% or less. The industrial sector consumed 36% of the final energy supplied in 2015.

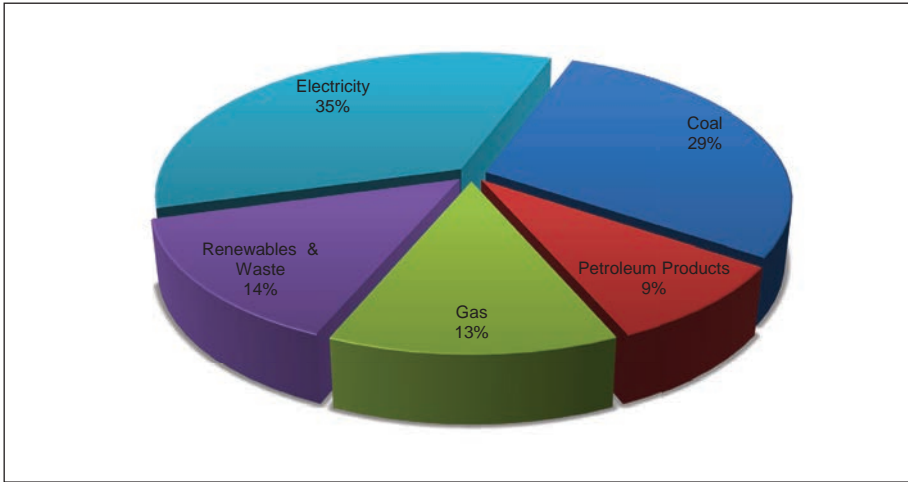
**Figure 2-2: Energy demand by industrial sub-sectors, 2015**



Source: DoE Energy Balances, 2015

As depicted below in figure 2-3, electricity was the most consumed source of energy in the industrial sector at 35%. This was followed by coal at 29% and renewables at 14%. Gas and petroleum products accounted for 13% and 9%, respectively, to the total energy consumption in the sector.

**Figure 2-3: Energy demand in the industrial sector, 2015**



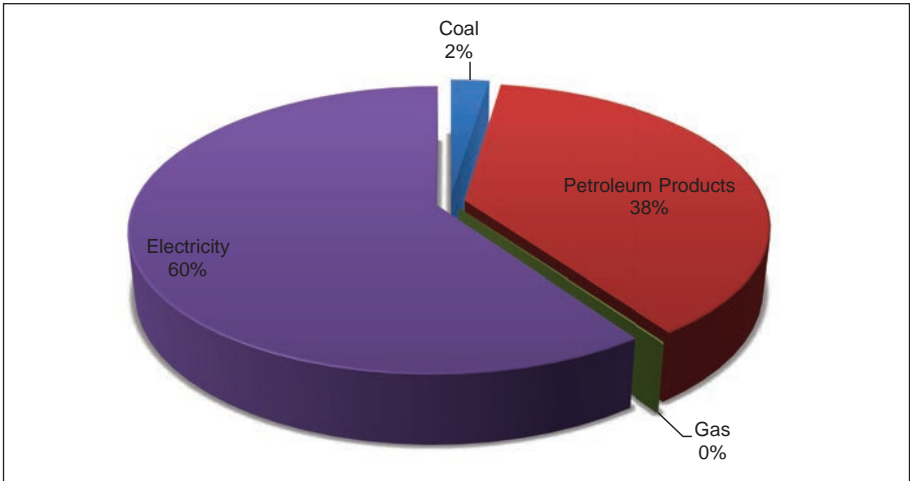
Source: DoE Energy Balances, 2015

### 2.1.1 Mining

The mining industry is a well-established and resourceful sector of South Africa's economy and continues to play a key role in the country's economy. South African mining GDP increased in 2015 from R284 billion to R304 billion in 2016 in actual (or nominal) rand value. The largest contributors to mining GDP were the coal, PGMs and gold sectors, which contributed 25%, 22% and 16%, respectively (Chamber of Mines, 2016).

The mining sector is one of the main consumers of energy in the country, particularly electricity. Of all the energy supplied in 2015, the industry used 60% of electricity, 38% of the petroleum products, 2% of coal and an insignificant amount of gas as depicted in figure 2-4 below. The total energy used by the sector is approximately 184 742TJ with electricity consumption of 110 272TJ.

**Figure 2-4: Energy demand in mining, 2015**

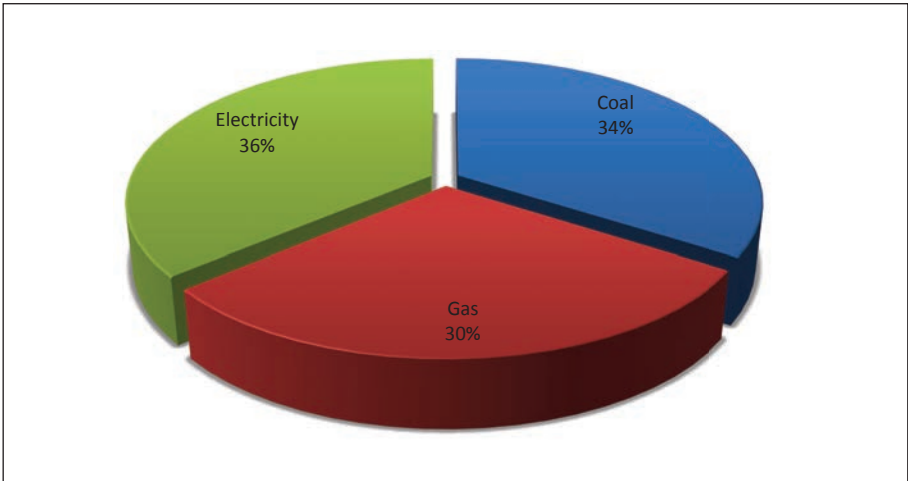


Source: DoE Energy Balances, 2015

### 2.1.2 Iron and steel

South Africa is a major producer and supplier of primary ferrous minerals and their alloys. With more than 85% of global consumption of iron ore, manganese, chrome and vanadium; steel manufacturing is by far the leading demand driver of ferrous minerals. The main energy carriers for iron and steel industry are electricity, coal and gas. In 2015, electricity contributed 36% towards the final energy demand of the sector whereas coal contributed 34% as depicted in figure 2-5. The remainder of its energy requirements was derived from gas contributing 30%. The total amount of energy used by the sector was 211 250TJ.

**Figure 2-5: Energy demand in Iron and Steel industry, 2015**



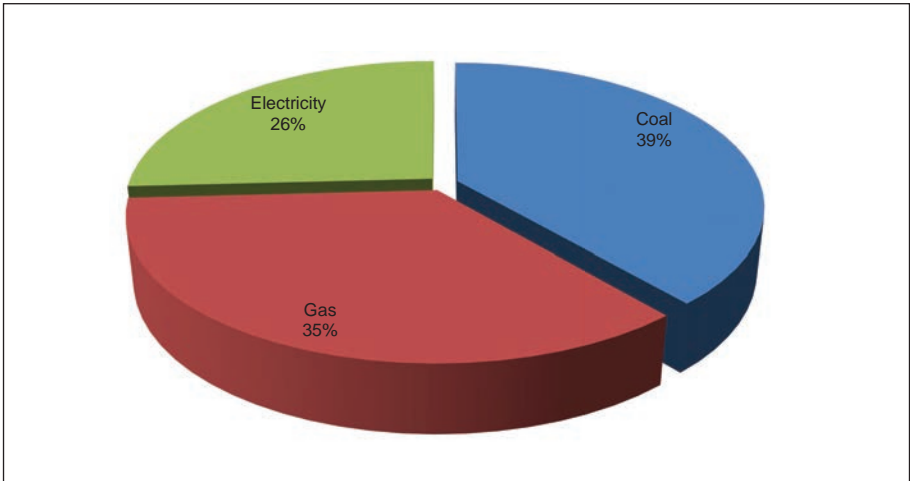
Source: DoE Energy Balances, 2015

### 2.1.3 Chemicals

South Africa's chemicals industry, the largest of its kind in Africa, is highly complex and widely diverse, spanning fuel and plastics fabrication to pharmaceuticals. It is a key component of the country's industrial base, with synthetic coal and natural gas-based liquid fuels and petrochemicals dominating the industry. Petroleum, chemical products, rubber and plastic products contributed 5% to the GDP in 2016, which is about 25% of total manufacturing sales.

South Africa is the world leader in coal-based synthesis and Gas-To-Liquids technologies. Consequently, this sector is coal and gas intensive thereby becoming the second most consumer of coal and gas, at 54,140TJ and 49,507TJ respectively, following the iron and steel industry. Electricity consumption by the sector accounted for 26% of the total energy supplied to the sector. Figure 2-6 depicts the energy demand in the chemical and petrochemical industry.

**Figure 2-6: Energy demand in Chemical and Petrochemical industry, 2015**



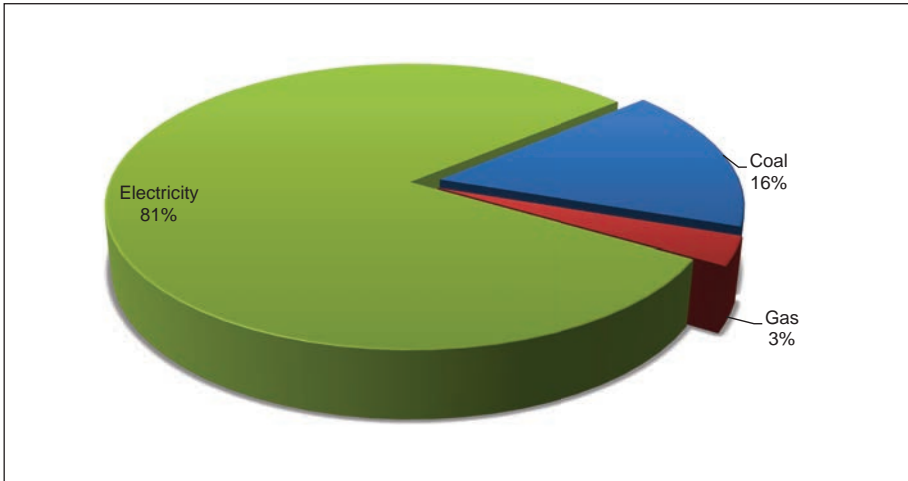
Source: DoE Energy Balances, 2015

#### **2.1.4 Non-Ferrous Metals**

South Africa has rich resources of non-ferrous minerals, some of which are rated amongst the largest in the world. The country was the biggest producer of titanium in 2014 and second biggest producer of zircon minerals in the world and is ranked fourth and second, respectively, in terms of global reserves of these minerals. South Africa is also the producer of copper, cobalt, nickel, lead, zinc and antimony.

The sector consumed roughly 66,301TJ of energy supplied in 2015. The non-ferrous metals electricity consumption amounted to 53,336TJ, which makes up 81% as depicted below. Coal and gas contributed 16% and 3% respectively.

**Figure 2-7: Energy demand in non-ferrous metals, 2015**

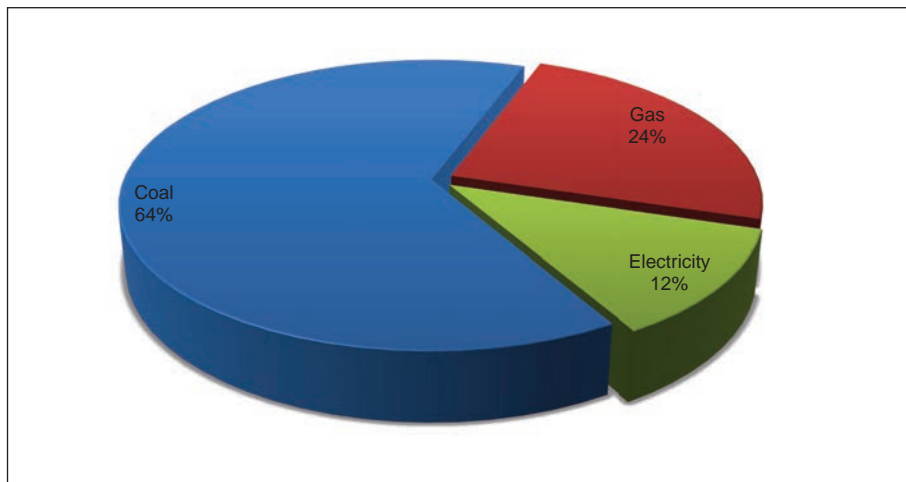


Source: DoE Energy Balances, 2015

### 2.1.5 Non-Metallic Minerals

Sand, limestone, marble, clay and salt are all examples of non-metallic minerals. They are not recyclable because they cannot be reshaped significantly and repurposed, unlike metals that can be melted down and easily reshaped into a new product. The significant energy carrier for the non-metallic minerals sector is provided by coal at 64%, followed by gas contributing 24% while electricity contributed 12%. The total energy consumed by the sector is 64,110TJ.

**Figure 2-8: Energy demand in non-metallic minerals, 2015**



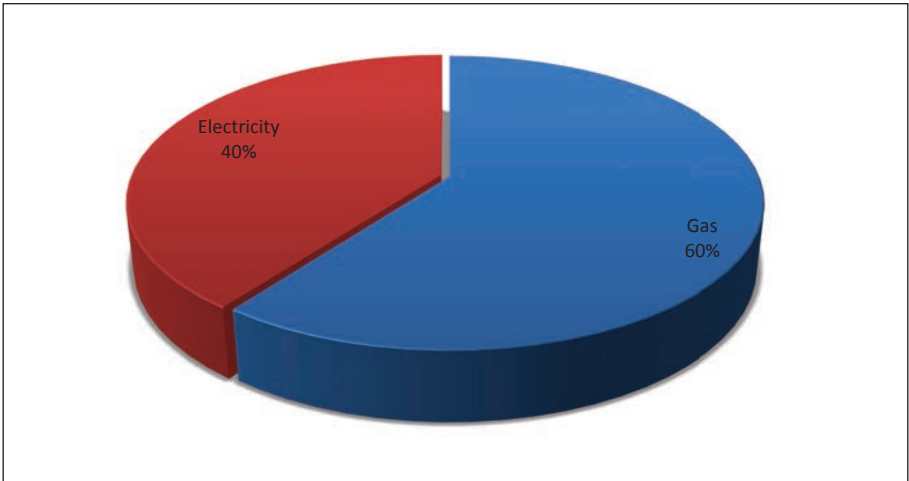
Source: DoE Energy Balances, 2015

### 2.1.6 Food and Tobacco

The food industry in South Africa is partly a reflection of the country's major agricultural activities. Of the world's main food crops, it's only rice that is not significant, with most of South Africa's rice requirements being imported from the Far East and the USA. For the rest, South Africa is at least self-sufficient, and in certain cases, e.g. maize, is sometimes a net exporter except in times of excessive drought or floods.

The tobacco industry has 176 commercial tobacco farmers and 155 small-scale tobacco farmers with a market value of R29 billion in 2016 and contributing over R16 billion in excise and VAT revenue to government during the 2016/17 tax year. The major tobacco growing areas in South Africa are: The Limpopo Province: Ellisras, Mokopane, Naboomspruit, Sterkrivier, Vaalwater; the NorthWest Province: Brits, Groot Marico, Rustenburg; Mpumalanga: The Lowveld and the Loskop areas; Eastern Cape: Gamtoos Valley and the Western Cape: Oudtshoorn. The total energy consumption by the sector in 2015 was 6,765TJ with electricity and gas contributing 40% and 60% of that amount respectively, as depicted in the figure below.

**Figure 2-9: Energy demand in food and tobacco, 2015**



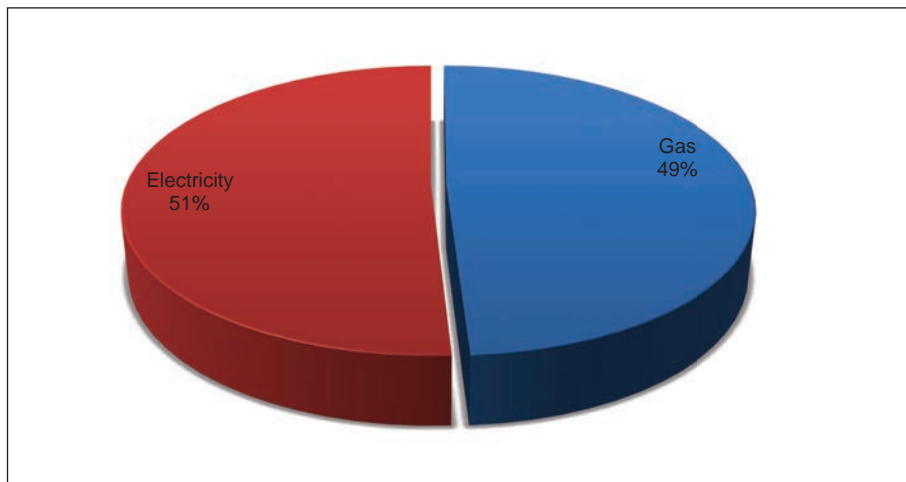
Source: DoE Energy Balances, 2015

### 2.1.7 Pulp and Paper

Packaging, tissue and chemical cellulose are growth sectors for South Africa. They are showing the work, energy and refocus of an industry that was under pressure but which is emerging with increased global competitiveness in its chosen grades (PAMSA, 2016). The consumption of printing and writing grades is up, however on a per person analysis, they reflect a decline. Packaging grades continue to grow while tissue is fairly static in consumption terms.

The pulp and paper industry utilised 51% of electricity as its energy source and 49% of gas, consuming 10,174TJ in total. This reflects the industry's shift from complete reliance on electricity for production. Energy demand in this sector excludes own generation from biomass, which is currently not reported.

**Figure 2-9: Energy demand in pulp and paper industry, 2015**

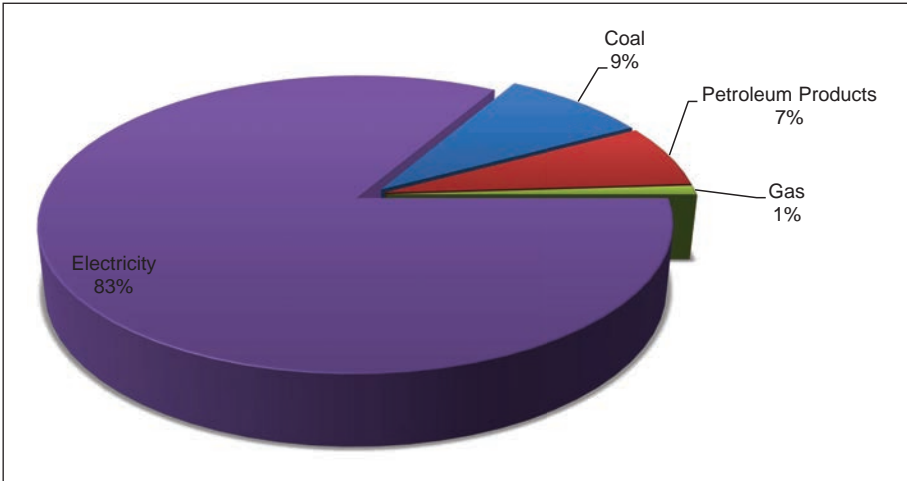


Source: DoE Energy Balances, 2015

## 2.2 Commerce and Public Services Sector

The commercial sector comprises of financial services, information technology, retail, tourism and services industry. Public services sector comprises of government and quasi government institutions which provides goods and services to the public, mainly for free. The total energy utilised by this sector is approximately 124,570TJ. Electricity consumed by this sector sits at 83% while coal's contribution accounted for 9% and petroleum 7% as depicted below. The higher demand for electricity in this sector is perpetuated by the growing retail sector, government's continued participation in the economy and general growth in the tertiary sector.

**Figure 2-10: Energy demand in the commerce and public services sector, 2015**



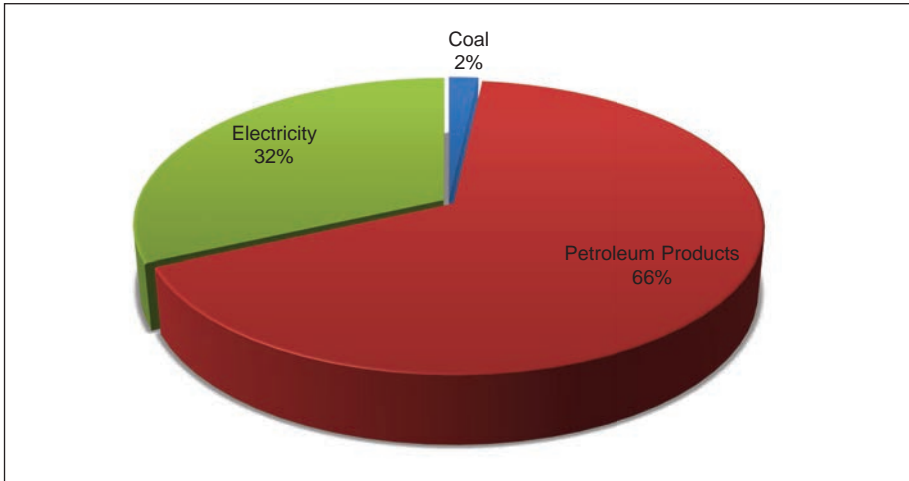
Source: DoE Energy Balances, 2015

## 2.3 Agricultural Sector

South Africa has a dual agricultural economy, with both well-developed commercial farming and more subsistence-based production in the deep rural areas. Agricultural activities range from intensive crop production and mixed farming in winter rainfall and high summer rainfall areas to cattle ranching in the bushveld and sheep farming in the arid regions. Maize is most widely grown, followed by wheat, sugar cane and sunflowers. Citrus and deciduous fruits are exported, as are locally produced wines and flowers. South Africa is not only self-sufficient in virtually all major agricultural products, but is also a net food exporter.

As shown in figure 2-11, the demand for liquid fuels in the agricultural sector was 66% in 2015 with 52,685TJ consumed. This comes mainly as a result of transportation of agricultural raw materials, feeds, intermediary and finished products from farms to various market areas. Electricity accounted for 32% of energy demanded by the sector in 2015 resulting in 25,198TJ in consumption.

**Figure 2-11: Energy demand in the agriculture sector, 2015**

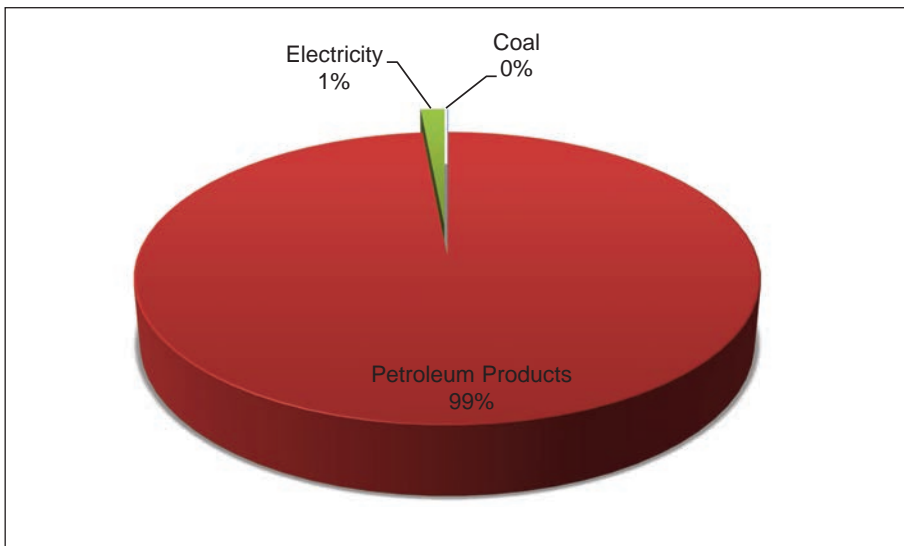


Source: DoE Energy Balances, 2015

## 2.4 Transport Sector

South Africa has a modern and well-developed transport infrastructure. The air and rail networks are the largest on the continent and the roads are in good condition. The country's ports provide a natural stopover for shipping to and from Europe, America, Asia, Australasia and both coasts of Africa. Road transport is by far the biggest consumer of liquid fuels with a total consumption of 742,642TJ in 2015, followed by international civil aviation at 66,426TJ. The transport sector is traditionally liquid fuels intensive. In 2015, petroleum products accounted for 99% of energy demanded by the sector and the sector accounted for 77% of petroleum products consumed in the country.

**Figure 2-12: Energy demand in the transport sector, 2015**

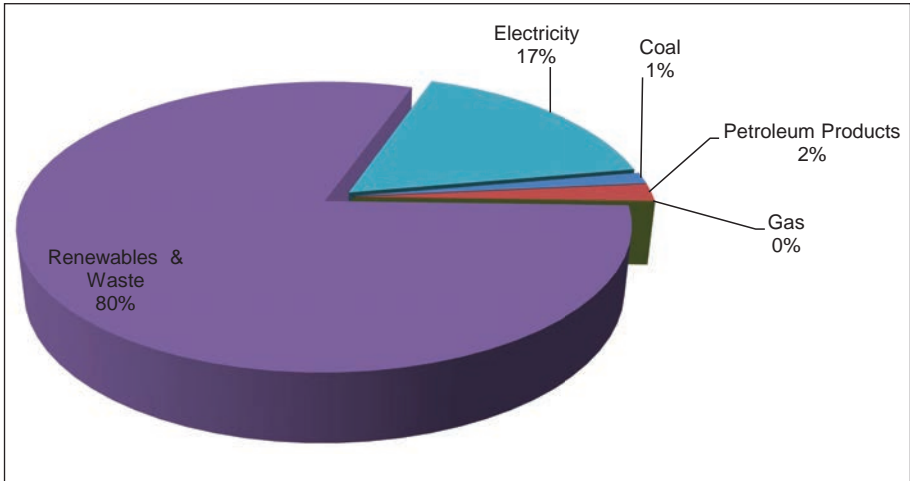


Source: DoE Energy Balances, 2015

## 2.5 Residential Sector

The residential sector consumed 27% of the total energy consumption in 2015. This makes it the second largest energy consumer in the economy. The sector's consumption of electricity amounted to 17% of the total energy consumed in the sector. According to StatsSA (2017), 86% of the households in South Africa have access to electricity. Coal (1%) is primarily used in areas where people have no access to electricity and in areas close to coal mines where coal is obtained cheaply; and is used mainly for cooking and heating purposes. Petroleum products accounted for 2% with a total contribution of 16,856TJ towards the total energy consumed by residents. In total the sector consumed 862,342TJ of energy.

**Figure 2-13: Energy demand in the residential sector, 2015**



Source: DoE Energy Balances, 2015

**NB:** Due to misaligned mappings of the raw data on consumption to the ISIC codes, the Department estimated the residential consumption of coal as one third of sales to merchants and domestic markets. This estimate kept on increasing over the years, which is contrary to the increasing number of residential electricity connections.

It was subsequently found necessary to estimate the actual consumption in this sector using methodologies that take into account the actual residential coal end-use data (from the General Household Survey) carried out by Statistics South Africa (StatsSA). The methodology was based on the average (in Rands) spent each month by sampled household. This average was used to calculate tons of coal consumed by dividing the total expenditure by the average coal price. Inferring these to the total population resulted in the massive drop in coal consumption in residential sector.

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