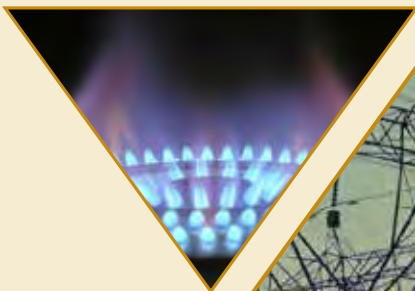


# 2018

# Energy Price Report



energy

Department:  
Energy  
REPUBLIC OF SOUTH AFRICA



# 2018

# ENERGY PRICE REPORT

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## FOREWORD

It gives me a great pleasure to introduce the 2018 edition of the Energy Price Report for South Africa. The Energy Price Report is based on the information collated from government departments, state-owned-entities, oil and gas industries. This publication covers a broad overview and analysis of the South African energy prices and aims to keep stakeholders informed about energy prices and key issues affecting the energy industry.

This edition presents energy prices data in a format which provides an overall picture of monthly and annual trends for common energy carriers used in South Africa. In order to clearly present and analyse the energy pricing trends, this report is divided into four main focus areas: Petroleum; Natural Gas, Coal; and Electricity.

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 express my appreciation to all the energy data providers who have helped us to accomplish what is set out in this report.

This report only covers energy price data and analysis for 2017 as historical information will always be available in our previous editions respectively.

The Department of Energy is working hard to reduce delays in the publishing of the Energy Price Report and hopes that the publication will become a standard work of reference among energy analysts in South Africa and abroad. Comments and inputs are welcome and could be addressed to [publications@energy.gov.za](mailto:publications@energy.gov.za).

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**Mr Thabane Zulu**

Director General: Energy

Date:



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## ABBREVIATIONS AND ACRONYMS

<b>BFP</b>	Basic Fuel Price
<b>DSML</b>	Demand-Side Management Levy
<b>DoE</b>	Department of Energy
<b>IP</b>	Illuminating Paraffin
<b>IPP</b>	Independent Power Producer
<b>LPG</b>	Liquefied Petroleum Gas
<b>LRP</b>	Lead Replacement Petrol
<b>MRGP</b>	Maximum Refinery Gate Price
<b>MRP</b>	Maximum Retail Price
<b>MYPD</b>	Multi Year Price Determination
<b>OPEC</b>	Organization of the Petroleum Exporting Countries
<b>NERSA</b>	National Energy Regulator of South Africa
<b>RAF</b>	Road Accident Fund
<b>SADC</b>	Southern African Development Community
<b>SARB</b>	South African Reserve Bank
<b>ULP</b>	Unleaded Petrol
<b>US Dollar per barrel</b>	USD/bbl



# 1. INTRODUCTION

Energy drives economic growth and social development around the world, therefore access to energy is a prerequisite for economic and social development. The energy sector is large and made up of the complex and inter-related network of companies that are directly and indirectly involved in the production and distribution of energy needed to power the economy and facilitate the means of production and transportation.

This report covers consecutive monthly prices as well as trend analysis of various energy carriers for the year 2017. In South Africa, electricity prices are reviewed once a year while petroleum products prices are changed once a month due to fluctuations in international oil prices (quoted in US dollars) and the Rand/US Dollar exchange rate.

## **The report consists of the following sections:**

- Section 2 covers prices of crude oil, and all major petroleum products (petrol, diesel, illuminating paraffin and liquid petroleum gas).
- Section 3 covers natural gas prices.
- Section 4 covers the prices of locally consumed and exported coal.
- Section 5 presents the national Eskom electricity prices. This does not include the prices of electricity sold by individual/various municipalities to end customers.

Each section gives a brief introduction followed by a table of prices and graphs depicting the price movements over time. Where possible, a brief analysis of possible reasons for price fluctuations is provided.

The purpose of this Report is to provide an overview of the latest energy pricing trends and analysis for the major energy carriers in South Africa i.e. coal, natural gas and crude oil. Energy prices are significant indicators in the cost of providing services such as transport or electricity.





## 2. PETROLEUM

This section covers the monthly international crude oil prices as well as the breakdown of petroleum products prices sold nationally for the year 2017. The main focus of the analysis in this section is on the price movements as well as related global and national events that led to those movements.

### 2.1 Crude Oil

Crude oil is one of the most actively traded commodities in the world. Petroleum still remains the primary energy source for transportation and manufacturing industries. For this reason, oil price movements may impose significant influence on economic situation in different countries. Oil prices are changing due to the interaction between supply and demand forces on the international commodity markets.<sup>1</sup>

Oil is a commodity, and as such, it tends to see larger fluctuations in price than more stable investments such as stocks and bonds. OPEC, or the Organization of Petroleum Exporting Countries, is the main influencer of fluctuations in oil prices. OPEC is a consortium made up of 13 countries: Algeria, Angola, Ecuador, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates and Venezuela. OPEC controls 40% of the world's supply of oil. The consortium sets production levels to meet global demand and can influence the price of oil and gas by increasing or decreasing production.

As with any commodity, stock or bond, the laws of demand and supply cause oil prices to change. When supply exceeds demand, prices fall and vice versa. Natural disasters, production costs and political instability are also other factors that can cause oil prices to fluctuate.<sup>2</sup>

Since petroleum products prices are mainly influenced by global oil prices and the exchange rate between the South African Rand and the US Dollar; the narrative in this section will primarily focus on the two and their impact on the petroleum prices on a monthly basis.

The average monthly prices of Brent crude oil and the exchange rate for 2017 are depicted in Table 2.1. The crude oil prices are presented in US Dollar per barrel (USD/bbl) and the exchange in Rand per Dollar.

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1  
2

<http://southafrica.opendataforafrica.org/iaepfb/monthly-crude-oil-prices> (accessed on 2018/02/08)  
<https://www.investopedia.com/> (accessed on 2018/02/08)



**Table 2.1: 2017 Monthly Brent Crude Oil Prices and the Exchange Rate**

Period	Brent Crude Oil	Exchange Rate
January	54.89	13.91
February	55.49	13.84
March	51.97	13.56
April	52.98	13.20
May	50.87	12.94
June	46.89	13.47
July	48.69	13.27
August	51.37	12.90
September	55.16	13.14
October	57.62	13.23
November	62.57	13.13
December	64.21	13.68

Source: <http://southafrica.opendataforafrica.org/iaepfb/monthly-crude-oil-prices> for Brent Crude oil and South African Reserve Bank (SARB) for Exchange Rate

Crude oil prices increased to 54.89 USD/bbl at the beginning of the year due to the fact that OPEC members agreed to cut production by 1.2 million barrels per day from 1 January 2017 during their meeting that was held in Vienna, Austria, on 30 November 2016. Furthermore, Russia and other non-OPEC producers also agreed to cut production by 600 thousand barrels per day.<sup>3</sup> By the end of the first quarter, the crude oil market declined despite indications that OPEC members increasingly favoured extended production cuts but wanted the backing of non-OPEC oil producers.<sup>4</sup>

Towards the end of April, crude oil prices were slowly rebounding with refinery production starting to increase as the Northern Hemisphere summer driving season was approaching, which led to May prices settling at around \$50 USD/bbl. During the same period the Rand weakened against the US Dollar which contributed about 25 cents per litre on the fuel price increases.<sup>5</sup>

By the mid-year of 2017, oil prices declined to 48.69 USD/bbl after data showed an increase in U.S. crude inventories, fuelling concerns that markets remained oversupplied despite efforts by top producers Saudi Arabia and Russia to cut output. Furthermore, OPEC and some non-OPEC producers agreed to extend supply cuts of 1.8 million barrels per day until the end of March 2018 at a meeting in Vienna on 25<sup>th</sup> May 2017. While OPEC's decision was expected, some oil market investors had hoped that the oil producers would agree

3 Information was sourced from DoE January 2017 Media statement on adjustment of fuel prices

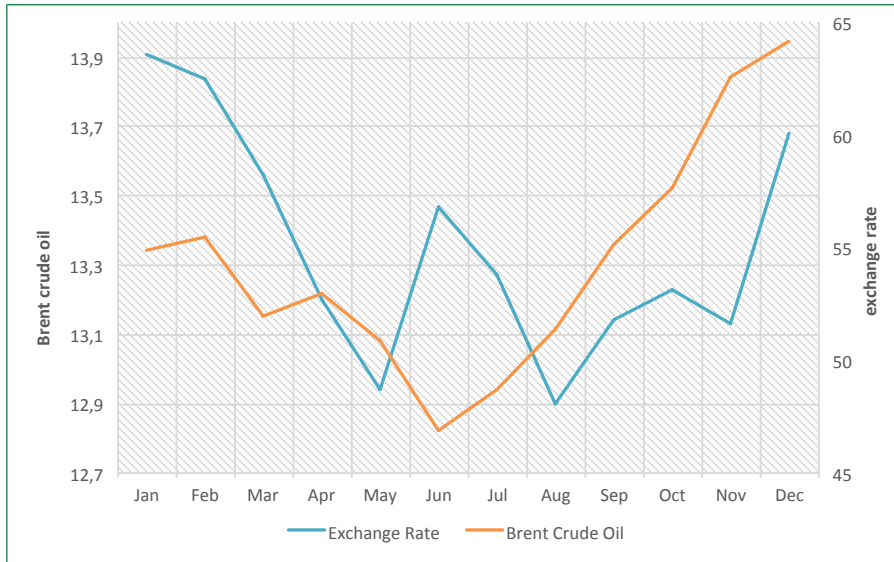
4 <http://southafrica.opendataforafrica.org/iaepfb/monthly-crude-oil-prices> (accessed on 2018/02/08)

5 Information was sourced from DoE May 2017 Media statement on adjustment of fuel prices



to longer or deeper cuts to drain a global glut of crude supplies. The prices of petroleum products in the international markets decreased in line with lower crude oil prices though the Rand strengthened against the US Dollar during the same period.<sup>6</sup>

**Figure 2.1: 2017 Monthly Brent Crude Oil Prices and the Exchange Rate**



Source: <http://southafrica.opendataforafrica.org/iaeapfb/monthly-crude-oil-prices> for Brent Crude oil and South African Reserve Bank (SARB) for Exchange Rate

The oil prices increased since the beginning of September 2017, mainly due to, (a) Improved compliance on production freeze by OPEC countries, (b) Evidence that US drilling activity and production is not rising as was expected, and (c) Evidence that stocks of crude oil in the US are falling faster than anticipated.<sup>7</sup> The oil price increases continued relentlessly until December where they peaked at 64 USD/bbl.

<sup>6</sup> Information was sourced from DoE June 2017 Media statement on adjustment of fuel prices  
<sup>7</sup> Information was sourced from DoE October 2017 Media statement on adjustment of fuel prices



## 2.2 Petroleum Products

South Africa's fuel prices are adjusted on a monthly basis, informed by international and local factors. International factors include the fact that South Africa imports both crude oil and finished products at a price set at the international level, including shipping costs. Locally factors includes the exchange rate of the Rand against the US dollar as well as fuel levies and the Road Accident Fund (RAF) levy that are determined and adjusted annually by the Minister of Finance.

Petrol 95 Octane Unleaded, Petrol 93 Unleaded, Petrol 95 LRP, Petrol 93 LRP, Diesel 0.05% Sulphur, Diesel 0.005% Sulphur and Illuminating Paraffin are the products covered by the calculation of the Basic Fuel Price (BFP). The BFP is based on an import parity principle. In other words, it is the cost that a South African importer of petrol incurs to buy the petrol from an international refinery, transport the product from that refinery, insure the product against losses at sea and land the product on South African shores. The BFP formula reflects the realistic cost of importing a litre of product from international refineries with products of a similar quality compared to local South African specifications on a sustainable basis.

The tables, graphs and analysis of main petroleum products for 2017 are illustrated and expounded in the subsequent sections.

### 2.2.1 Petrol

By the second month of the year petrol prices soared by 29 cents per litre, due to the increase in the prices of crude oil. The rationale behind crude oil price increases was based on the news that key crude exporters, including Saudi Arabia and Russia, were cutting production to reduce excess supply of crude. Furthermore, the U.S. inventory data showed that the global market was tightening due to lower production by OPEC and other exporters.<sup>8</sup>

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8

Information was sourced from DoE February 2017 Media statement on adjustment of fuel prices



**Table 2.2: 2017 Monthly Petrol ULP 93/95 Prices in Rands per litre**

Period	Petrol (ULP) 93		Petrol (ULP) 95	
	Coast	Gauteng	Coast	Gauteng
<b>January</b>	12.76	13.09	12.85	13.33
<b>February</b>	13.05	13.38	13.14	13.62
<b>March</b>	12.97	13.3	13.06	13.54
<b>April</b>	12.68	13.08	12.81	13.3
<b>May</b>	13.17	13.57	13.3	13.79
<b>June</b>	12.92	13.32	13.05	13.54
<b>July</b>	12.23	12.63	12.37	12.86
<b>August</b>	12.42	12.82	12.56	13.05
<b>September</b>	13.09	13.49	13.23	13.72
<b>October</b>	13.34	13.74	13.52	14.01
<b>November</b>	13.38	13.78	13.56	14.05
<b>December</b>	14.07	14.49	14.27	14.76

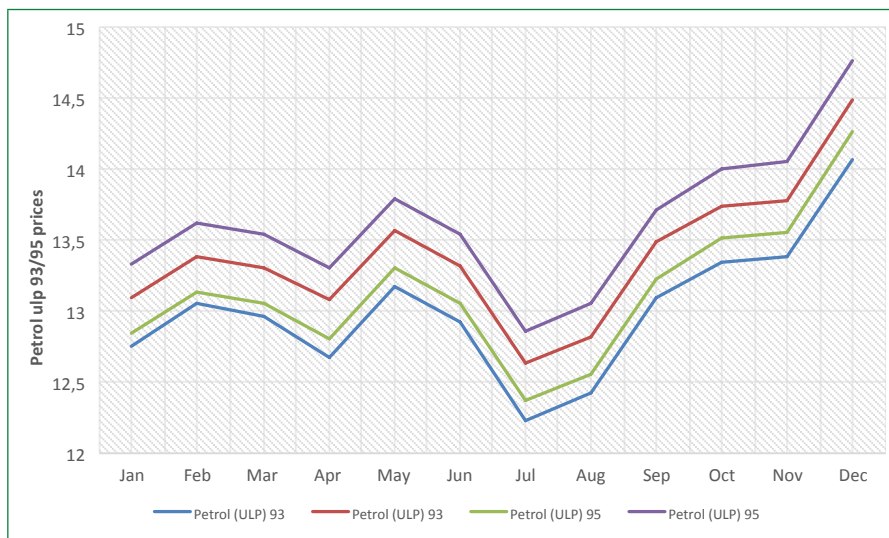
Source: Department of Energy (DoE)

The month of April had traditionally been the difficult one for motorists as a result of the annual increases to the domestic levies and tariffs. However, even though the increase in Road Accident Fund (RAF) and fuel levies were added to the final pump price there was still a decrease of petrol prices in the month. The negative effects of the domestic levies and tariff increases on the final pump price was offset by the plunging in crude oil prices.

The plunging of crude oil prices occurred as overall US commercial stocks increased by 1.3 million barrels, as another sizable 5 million barrel crude stock build more than offset a 3.6 million barrel product inventory draw down putting downward pressure on prices. Libya's oil production reached 700,000 barrels per day, recovering from a drop earlier in the month caused by fighting at two key oil ports which also helped on putting downwards pressure on prices.<sup>9</sup>



**Figure 2.2: 2017 Monthly Petrol ULP 93/95 Prices in Rands per litre**



Source: Department of Energy (DoE)

Motorists were not spared during the festive season with petrol prices increasing by a whopping 71 cents per litre (in December) which recorded the biggest increase of the year. This also became the peak price of petrol for the year with ULP 95 inland and coastal prices rising to R14.76 and R14.27 per litre respectively, this increase was triggered by the crude oil prices hitting a two-year high well above 60 USD/bbl, partly because of the renewed tensions and uncertainties in the Middle East, with and partly due to buoyant global demand expectations and the strong likelihood that OPEC was going to extend its output cuts programme well into the coming year.<sup>10</sup>

The elements that make up the price of unleaded petrol 95 are depicted in Table 2.3 below. The difference between the retail price of ULP 93 and ULP 95 in the inland region of around 15 c/l on average is mainly due to the 10 c/l Demand-Side Management Levy (DSML) charged on ULP 95 as well as quarterly adjustments of octane/grade zone differentials.

10

Information was sourced from DoE December 2017 Media statement on adjustment of fuel prices



**Table 2.3: 2017 Petrol ULP 95 Monthly Levies, Taxes and Margins in cents per litre**

Period	BFP	Custom & Excise duty	Dealers margin	Fuel Levy	Incremental transport recover levy	IP Tracer levy	Petroleum Pipeline levy	RAF levy	Service cost recoveries	Slate levy	Wholesale Margin	Zone differential in Gauteng	DMSL	Equalisation Fund levy	Pump Rounding
Jan-17	591.87	4.00	176.40	285.00	0.00	0.00	0.33	154.00	35.20	0.00	35.60	41.00	10.00	0.00	-0.40
Feb-17	620.87	4.00	176.40	285.00	0.00	0.00	0.33	154.00	35.20	0.00	35.60	41.00	10.00	0.00	-0.40
Mar-17	612.87	4.00	176.40	285.00	0.00	0.00	0.33	154.00	35.20	0.00	35.60	41.00	10.00	0.00	-0.40
Apr-17	548.67	4.00	176.40	315.00	0.00	0.00	0.33	163.00	35.20	0.00	35.60	41.50	10.00	0.00	0.30
May-17	597.67	4.00	176.40	315.00	0.00	0.00	0.33	163.00	35.20	0.00	35.60	41.50	10.00	0.00	0.30
Jun-17	572.67	4.00	176.40	315.00	0.00	0.00	0.33	163.00	35.20	0.00	35.60	41.50	10.00	0.00	0.30
Jul-17	504.67	4.00	176.40	315.00	0.00	0.00	0.33	163.00	35.20	0.00	35.60	41.50	10.00	0.00	0.30
Aug-17	523.67	4.00	176.40	315.00	0.00	0.00	0.33	163.00	35.20	0.00	35.60	41.50	10.00	0.00	0.30
Sep-17	586.07	4.00	181.00	315.00	0.00	0.00	0.33	163.00	35.20	0.00	35.60	41.50	10.00	0.00	0.30
Oct-17	615.07	4.00	181.00	315.00	0.00	0.00	0.33	163.00	35.20	0.00	35.60	41.50	10.00	0.00	0.30
Nov-17	619.07	4.00	181.00	315.00	0.00	0.00	0.33	163.00	35.20	0.00	35.60	41.50	10.00	0.00	0.30
Dec-17	686.17	4.00	187.20	315.00	0.00	0.00	0.33	163.00	34.50	0.00	34.00	41.50	10.00	0.00	0.30

Source: Department of Energy (DoE)

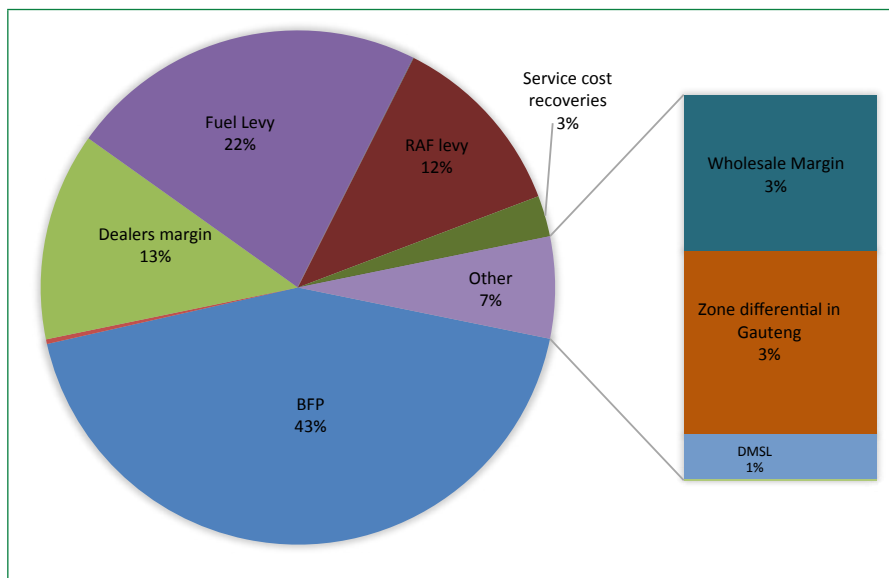
To identify the contribution of each component to the final retail price of petrol, all the components are illustrated in Figure 2.3 with their percentage contributions. During the 2017 budget speech, the Minister of Finance announced adjustments to the taxes levied per litre of fuel to motorists by government at the filling stations which came into effect on the 5th of April. The two levies involved are fuel and RAF levy; which were raised by 30 and 9 cents respectively. Both levies (fuel and RAF levy) contributed 22% and 12% to the final retail price of petrol respectively.

The Basic Fuel Price (BFP) and fuel levy had a larger portion in the final retail price of Petrol ULP 95 in 2017, contributing 43% and 13% respectively

The road transport tariffs in the applicable road transport pricing zones, as well as for transporting fuels by road from pipeline draw-off points to supply depots were determined and effected on the 5th of April 2017 into the price structures of petrol, diesel and Illuminating Paraffin ranging from 0.2 to 8.5 cents per Litre.



**Figure 2.3: 2017 Petrol ULP 95 Monthly Levies, Taxes and Margins**



Source: Department of Energy (DoE)

In line with the application of the Regulatory Accounts System the Minister of Energy has approved a net increase of 3.9 cents per Litre in the annual margin adjustments on petrol and a net increase of 0.7 cents per litre on secondary storage and secondary distribution margins.

### 2.2.2 Diesel

At the beginning of the year 0.05% Sulphur diesel prices for inland and coastal regions were priced at R11.42 and R11.03 per litre respectively. This was succeeded by a prickly 21 cents increase per litre in February due to the weakening of the Rand against the US Dollar and the increase in crude oil prices. By the end of the first quarter diesel prices had insignificantly dropped by a measly 2 cents per litre as the Rand strengthened against the US Dollar from R13.56 to R13.20.





**Table 2.4: 2017 Monthly Diesel Wholesale Prices in Rands per litre**

Period	Diesel 0.05% Sulphur		Diesel 0.005% Sulphur
	Coast	Inland	Inland
<b>January</b>	11.03	11.42	11.44
<b>February</b>	11.24	11.63	11.65
<b>March</b>	11.22	11.61	11.63
<b>April</b>	11.12	11.50	11.53
<b>May</b>	11.42	11.80	11.85
<b>June</b>	11.19	11.57	11.62
<b>July</b>	10.59	10.97	11.02
<b>August</b>	10.88	11.26	11.32
<b>September</b>	11.32	11.70	11.76
<b>October</b>	11.74	12.12	12.18
<b>November</b>	11.97	12.35	12.45
<b>December</b>	12.57	12.96	13.02

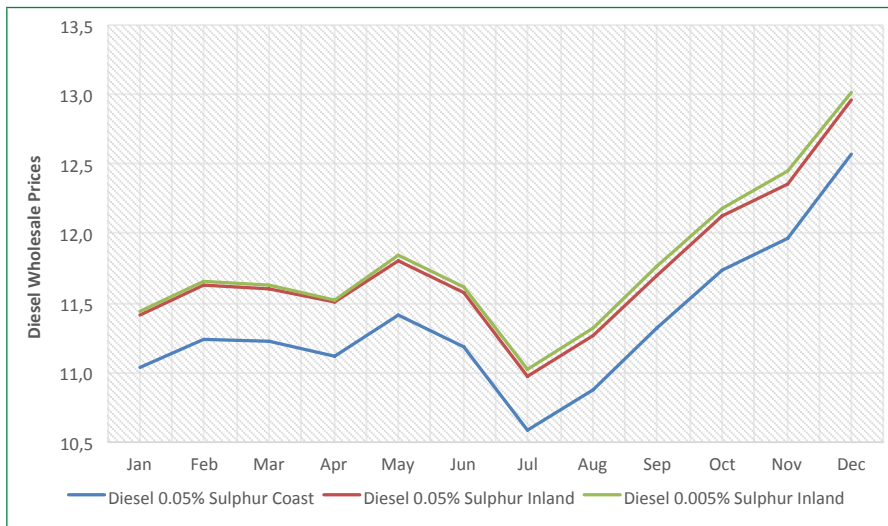
Source: Department of Energy (DoE)

During the period under review (i.e June), oil prices reached their lowest point for the year as light sweet crude supplies particularly from the US as well as Libya and Nigeria (unbound by the OPEC cut agreement) continue to rise. Brent crude oil prices declined to a seven-month low and the U.S. crude settled at its cheapest level since September 2016, after increased supply from several key producers overshadowed compliance by OPEC and non-OPEC oil producers with a deal to cut global output. These led to a massive drop of diesel prices by 60 cents per litre in the month of July.<sup>11</sup>

<sup>11</sup> Information was sourced from DoE July 2017 Media statement on adjustment of fuel prices



**Figure 2.4: 2017 Monthly Diesel Wholesale Prices in Rands per litre**



Source: Department of Energy (DoE)

The fourth quarter was characterised by the sustained increases in diesel prices which for the first time traversed the twelve Rand mark in the inland risen to R12.12 per litre. The reasons for the price increases was mainly the result of higher crude oil prices. Though the petrol prices were very strong through August due to impact of Hurricane Harvey, the diesel prices rose faster than the prices of petrol due to the sharp decrease in diesel stocks in the US.<sup>12</sup>

The elements that make up the final price of 0.05% Sulphur Diesel are depicted on Table 2.5. Unlike petrol, certain components that comprise the final petrol price are not applicable to diesel, like the dealers margin, since diesel is regulated up to the wholesale level.



**Table 2.5: 2017 Diesel 0.05% Monthly Levies, Taxes and Margins in cents per litre**

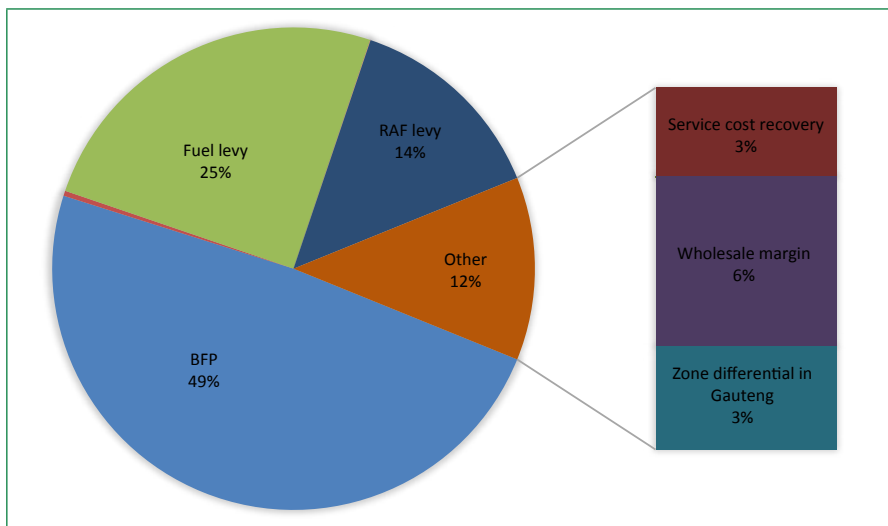
Period	BFP	Custom & Excise duty	Fuel levy	Incremental Inland Transport	IP Tracer levy	Petroleum pipeline levy	RAF levy	Service cost recovery	Slate levy	Wholesale margin	Zone differential in Gauteng
Jan-17	569.63	4.00	270.00	0.00	0.01	0.33	154.00	35.20	0.00	67.66	41.00
Feb-17	590.63	4.00	270.00	0.00	0.01	0.33	154.00	35.20	0.00	67.66	41.00
Mar-17	588.63	4.00	270.00	0.00	0.01	0.33	154.00	35.20	0.00	67.66	41.00
Apr-17	538.63	4.00	300.00	0.00	0.01	0.33	163.00	35.20	0.00	67.66	41.50
May-17	568.63	4.00	300.00	0.00	0.01	0.33	163.00	35.20	0.00	67.66	41.50
Jun-17	545.63	4.00	300.00	0.00	0.01	0.33	163.00	35.20	0.00	67.66	41.50
Jul-17	485.63	4.00	300.00	0.00	0.01	0.33	163.00	35.20	0.00	67.66	41.50
Aug-17	514.63	4.00	300.00	0.00	0.01	0.33	163.00	35.20	0.00	67.66	41.50
Sep-17	558.63	4.00	300.00	0.00	0.01	0.33	163.00	35.20	0.00	67.66	41.50
Oct-17	600.63	4.00	300.00	0.00	0.01	0.33	163.00	35.20	0.00	67.66	41.50
Nov-17	623.63	4.00	300.00	0.00	0.01	0.33	163.00	35.20	0.00	67.66	41.50
Dec-17	684.63	4.00	300.00	0.00	0.01	0.33	163.00	34.50	0.00	67.66	41.50

Source: Department of Energy (DoE)

To identify the contribution of each component to the diesel wholesale price, all the components are shown in Figure 2.5. In 2017, the BFP was the largest contributor to the total wholesale price of diesel with 49%. The second largest contributor to diesel wholesale price was fuel levy contributing 25%, followed by Road Accident Fund (RAF) levy at 14%, wholesale margin and zone differential's contributions amounting to 6% and 3% respectively. The rest of the components contributed a negligible amount towards the final pump price.



**Figure 2.5: 2017 Diesel 0.05% Monthly Levies, Taxes and Margins**



Source: Department of Energy (DoE)

### 2.2.3 Illuminating Paraffin

Paraffin is an alkane hydrocarbon that has a variety of practical uses in industries such as medicine, agriculture and cosmetics. In centuries past, before electricity was invented, paraffin was used in lamps and lanterns as the main source of lighting. Today, paraffin is still used in less developed countries as the main fuel for cooking. Liquid paraffin can be used as a lubricant for machinery. Lubricants can help to extend the life of expensive machinery and equipment by reducing friction, binding and wear. Paraffin can also be used as a coolant for electrical systems, as hydraulic fluid and as a solvent for greases and insecticides. Liquid paraffin also has medicinal properties. It is commonly used to treat dry skin, constipation, and eczema. Paraffin wax is also used as a water-harvesting soil treatment to supply runoff water to dry areas, as an adhesive and as a water-proofing agent.

Paraffin can be extracted from coal, wood and oil shale, but it is primarily obtained from the distillation of petroleum, which was first distilled in 1807 by geologist Abraham Gesner. The cost of producing paraffin was high, however, when new sources of paraffin and cheaper methods of refining were later discovered, it led to lower prices of the fuel. Paraffin, when found in solid form, is called paraffin wax, while the liquid form is referred to as paraffin oil. Liquid paraffin oil is a mineral oil that comes in two forms, either heavy liquid paraffin oil or light liquid paraffin oil. Paraffin is clean burning and maintains a high heat output.<sup>13</sup>

13 <http://birminghamfueloils.co.uk/what-is-paraffin-and-what-are-its-uses/> (accessed on 2018.02.09)



The Single Maximum National Retail Price for Illuminating Paraffin changes on the first Wednesday of each month and is promulgated in the Government Gazette. Paraffin prices still remain the lowest in the country in comparison with other petroleum products.

The Department of Energy started to regulate the maximum retail price for Illuminating Paraffin, excluding the price of any form of packaging since January 2010. However, the prices analysed in this section are wholesale prices and not the Single Maximum National Retail Price.

At the beginning of the year the inland and coastal prices were priced at R7.42 and R6.87 per litre respectively, as shown in Table 2.6 below. By the end of the third quarter in March, prices dropped by a mere 8 cents per litre to R7.50 in the inland. Although crude oil prices increased in March, the strengthening of the Rand led to a net decrease. Crude oil prices increased due to:

- a. The strained relationship between Tehran and the United States that raised concerns that US sanctions could be tightened further to impact Iranian oil exports, which were only allowed to return to normal last year, and
- b. The fact that OPEC members have reportedly achieved a high level of compliance with the production cuts announced in November last year.<sup>14</sup>

**Table 2.6: 2017 Monthly Illuminating Paraffin Prices in Rands per litre**

Period	Illuminating Paraffin	
	Coast	Gauteng
January	7.42	6.87
February	7.59	7.04
March	7.51	6.96
April	7.02	6.44
May	7.36	6.78
June	7.14	6.56
July	6.57	5.99
August	6.83	6.25
September	7.32	6.74
October	7.71	7.13
November	7.92	7.34
December	8.65	8.07

Source: Department of Energy (DoE)

<sup>14</sup> Information was sourced from DoE March 2017 Media statement on adjustment of fuel prices



The coastal prices in August rose by 26 cents per litre to R6.83 per litre, this was partially triggered by the Rand depreciating against the US Dollar which led to the higher contribution to the Basic Fuel Price on IP by 10.88 cents per litre. The other contributor to the increase in August Illuminating Paraffin prices was the rise in crude oil prices, partly due to drawdowns of global inventories including in the closely watched US market. The market was anticipating a return to balance at some point in the year and there were signs that it was happening. The expectations were that the rising crude oil prices will hit a ceiling as higher prices may have tempted OPEC members to start producing above the output cuts agreed in late 2016 and reconfirmed in June this year.<sup>15</sup>

**Figure 2.6: 2017 Monthly Illuminating Paraffin Prices in Rands per litre**



Source: Department of Energy (DoE)

By the midst of the fourth quarter local paraffin prices increased by 21 cents per litre, even though the average prices of petroleum products on the international markets decreased<sup>16</sup>. The increase was the result of the weakening of the Rand against the US Dollar from R13.14 to R13.23.

<sup>15</sup> Information was sourced from DoE August 2017 Media statement on adjustment of fuel prices  
<sup>16</sup> Information was sourced from DoE November 2017 Media statement on adjustment of fuel prices



## 2.2.4 Liquid Petroleum Gas (LPG)

The production and supply of LPG involves many players in the value chain, including the refineries/producers, wholesalers, distributors, dealers, retailers and end-users. Refineries or producers are typically involved at all levels of the supply value chain, from the acquisition of crude oil up to the cylinder or bottle retailing level. Some major wholesalers or distributors also participate in the downstream transportation, bottling, storage and distribution of LPG. Retailers or dealers may also be involved in filling LPG cylinders to sell to small industrial/commercial or household end-users.

In South Africa, LPG is produced primarily as a derivative of the crude oil refining process. The manufacturers of liquid fuels involved at this level of the value chain include international oil firms, local firms Sasol and the state-owned PetroSA. There are six refineries located around South Africa, of which five produce LPG. These five refineries account for producing over 80% of LPG consumed in South Africa annually, while the remainder is imported to compensate for the shortfall.

LPG produced in South Africa is made available to third parties, with a portion of the LPG manufactured being consumed internally by some producers. The balance of LPG produced (excluding the LPG consumed internally) is made available to the South African market, either through sales to shareholders or directly to customers.

When local supply is unable to meet demand, it is generally supplemented through imported product – especially during the peak demand season and when there are planned or unplanned maintenance shutdowns at refineries.

The wholesale level of the value chain comprises those players that channel the LPG from producers or refineries towards end-users. Wholesalers procure and/or import LPG, after which they direct it in either bulk or cylinder form to end-users.

Distributors/Resellers comprise market participants selling LPG to an end-user. In an effort to reach the vast network of customers to be serviced, wholesalers appoint distributors to act as their agents.

Some retailers procure LPG in bulk to fill cylinders. Most offer LPG as part of a much broader product offering and rely on the large wholesalers for equipment, cylinders and logistical support. This level of the value chain is thought to act as a key channel to household end-users. Given the diverse range of retailers, they can be categorised according to type of outlet, namely filling stations, and hardware and camping shops.



End-users can broadly be classified as industrial/commercial users or domestic users. LPG is supplied to these end-users in either bulk or cylinder form, depending on the customer's requirements. Industrial/Commercial users of LPG in South Africa account for approximately 85% of consumption, while domestic users consume the remaining 15%.<sup>17</sup>

The maximum retail price can be defined as “the price of LPG as per prescripts of the Regulation in respect of the Refinery Gate Price of Liquefied Petroleum Gas, Regulation No. 1029 of 31 July 2002 or its successors”. Table 2.7 and Figure 2.7 depicts only the regulated maximum retail gate prices for LPG and as such the narrative in this section is based only on the regulated maximum retail gate prices for LPG. The Petroleum Products Act stipulates that any person selling LPG from any outlet to a customer is required to do so at a price that is equal to or less than the Maximum Retail Prices (MRP) of LPG.

**Table 2.7: 2017 Monthly Regulated Maximum Retail Prices for Liquefied Petroleum Gas in cents per kilogram**

Period	Regulated Maximum Retail Prices	
	Inland	Coastal
January	2207	2019
February	2228	2040
March	2226	2038
April	2125	1937
May	2221	2032
June	2144	1955
July	2053	1864
August	2092	1904
September	2178	1990
October	2217	2028
November	2234	2045
December	2438	2236

Source: Department of Energy (DoE)

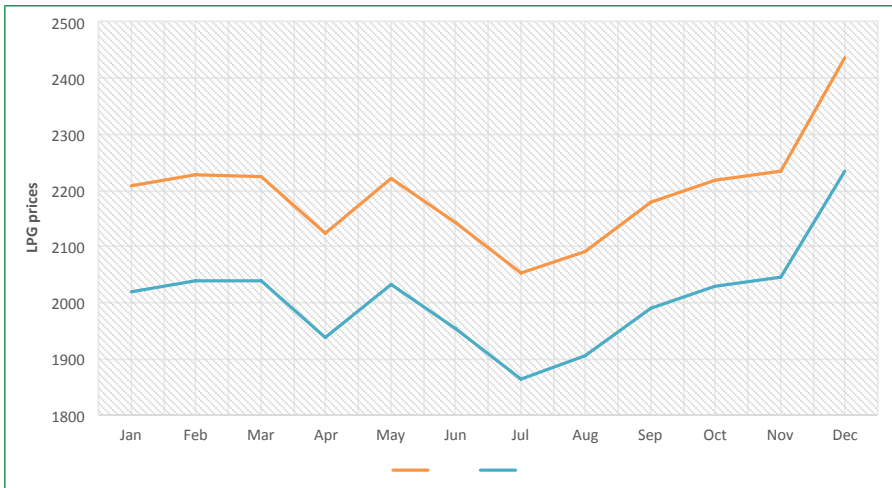
<sup>17</sup> <http://www.compcom.co.za/wp-content/uploads/2017/04/Chapter-4-Dynamics-of-the-LPG-market-in-South-Africa.pdf> (accessed on 2018/02/12)





Like other petroleum products, LPG is not immune from international and local factors affecting petroleum prices. Having begun the year at R22.07 per kilogram in the inland by the recorded increase of R1.06 per kilogram. The price trends for LPG in 2017 continued to fluctuate according to changes in crude oil prices and the exchange rate. By the month of September, LPG prices increased by 86.00 cents per kilogram owing to (a) the increase in the crude oil prices and the weaker Rand; (b) Massive floods caused by the storm which forced several refineries to close along the U.S. Gulf Coast; and (c) Harvey, the most powerful hurricane to hit Texas in more than 50 years, caused large-scale flooding and forced closure of Houston port and several refineries.<sup>18</sup>

**Figure 2.7: 2017 Monthly Regulated Maximum Retail Prices for Liquefied Petroleum Gas in cents per kilogram**



Source: Department of Energy (DoE)

The year ended with a high of R24.38 and R22.36 per kilogram inland and coastal respectively, as shown in figure 2.17 above, which was the highest for the year.

Two levels of the LPG value chain are subject to price regulation. The first is the refinery level, where LPG is sold from the refinery gate by producers at a regulated maximum price determined by the DoE. The second level of the value chain subject to price regulation is the retail level, where the DoE also regulates the price of LPG sold through cylinders.

18 Information was sourced from DoE September 2017 Media statement on adjustment of fuel prices.



### 3. NATURAL GAS

Natural gas is playing a larger role in the energy industry. Once thought of as a by-product of oil production, natural gas is now used in a variety of ways, from residential uses to industrial, to electricity generation. Natural gas cars are now a reality, with around 12.7 million natural gas vehicles worldwide as of 2010.

Nationally, the single largest factor affecting demand for natural gas is temperature. During winter, natural gas is used for heating while during summer, it is often used to power air conditioners. The demand and price of natural gas thus fluctuates whether it is summer or winter. During winter, demand is at its peak and so prices adjust accordingly.

Natural gas is most commonly transported via pipelines. This is primarily due to natural gas having a relatively low amount of energy per volume and the additional cost that containers would add.

The three largest users of natural gas are industrial, domestic and power generation. Of the three, the use of natural gas for power generation has risen the quickest.

#### **Industrial**

Industrial users often use natural gas as a source of heat. It ignites quickly and turning off a natural gas furnace doesn't waste any fuel. Stopping the fuel source can easily put out a natural gas furnace. In comparison, a coal furnace will continue to burn until the coal is depleted. This makes it far more expensive if the coal furnace has to be started more than once.

#### **Domestic**

The largest residential use of natural gas is home heating, especially in the winter. Other uses include boilers, furnaces, water heaters and outdoor barbeque grills. It can burn up to 1093°C from a simple stovetop, making it a powerful domestic cooking fuel.

#### **Power Generation**

Power plants are the fastest growing users of natural gas, since natural gas powered plants are more environmentally friendly than coal or oil based plants. Some natural gas power plants operate year round, while others are more seasonal.<sup>19</sup>



Table 3.1 below presents the South African historical natural gas prices supplied by Sasol Gas for 2017. The tariffs are grouped into six customer categories of average annual consumption measured in Rand per GigaJoule.

**Table 3.1: 2017 Monthly Natural Gas Prices in Rand per GigaJoule**

Period	Maximum price	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
		33 GJ	333 GJ	3 333 GJ	33 333 GJ	333 333 GJ	1 054 093 GJ
January	138.08	85.30	85.29	76.98	51.32	46.18	41.05
February	138.08	85.30	85.29	76.98	51.32	46.18	41.05
March	138.08	85.30	85.29	76.98	51.32	46.18	41.05
April	141.45	87.41	87.40	78.86	52.57	47.31	42.05
May	141.45	87.41	87.40	78.86	52.57	47.31	42.05
June	141.45	87.41	87.40	78.86	52.57	47.31	42.05
July	143.18	88.49	88.48	79.82	53.21	47.89	42.56
August	143.18	88.49	88.48	79.82	53.21	47.89	42.56
September	143.18	88.49	88.48	79.82	53.21	47.89	42.56
October	142.14	87.84	87.83	79.24	52.82	47.54	42.25
November	142.14	87.84	87.83	79.24	52.82	47.54	42.25
December	142.14	87.84	87.83	79.24	52.82	47.54	42.25

Source: SASOL

#### Explanatory Notes:

1. According to the Regulatory Agreement, in terms of Section 36 of the Gas Bill, Sasol Gas has to comply to the Market Value Pricing principle which are defined as follows:
  - a. The cost of the alternative fuel delivered to the customer's premises or anticipated place of use (in the case of Greenfields customers) plus;
  - b. The difference between all the operating costs of the customer's use of the alternative fuel and all the operating costs of using natural gas; plus
  - c. The difference between the Net Present Value (NPV) of the capital costs of the customer's continued use of the alternative fuel and the NPV of the capital costs involved in switching to natural gas, as would be reflected in the customer's accounts.

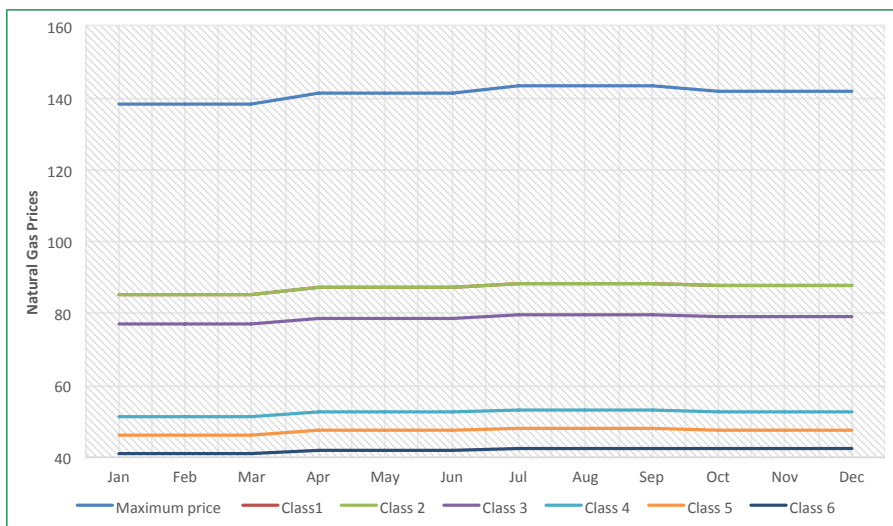


2. Gas prices are negotiated with customers individually. The prices above are indicative of pipeline gas sold by Sasol Gas and are exclusive of VAT.
3. Since April 2014, the above-mentioned indicative gas prices are subject to monthly adjustment in accordance with the applicable adjustment formula. The maximum Gas Energy Prices (“GE”) are determined in accordance with the Methodology to Approve Maximum Prices of Piped-Gas in South Africa promulgated by NERSA in October 2011 (the “Methodology”). In terms of the said Methodology, the maximum energy prices are referenced to price indicators of certain energy sources.

The legal basis for the National Energy Regulator of South Africa (NERSA) to regulate prices of piped-gas is derived from the National Energy Regulator Act, 2004 (Act No. 40 of 2004), read with the Gas Act, 2001 (Act No. 48 of 2001) (‘the Gas Act’). In terms of section 4(g) of the Gas Act, the Energy Regulator must, as appropriate, in accordance with this Act, regulate prices in terms of Section 21(1)(p) in the prescribed manner.

Therefore, for NERSA to approve maximum prices of piped-gas, it must be of the view that there exist market conditions or market features indicating inadequate competition in line with the provisions of Chapters 2 and 3 of the Competition Act.

**Figure 3.1: 2017 Monthly Natural Gas Prices in Rand per GigaJoule**



Source: SASOL



Figure 3.1 shows the prices of piped natural gas sold by Sasol to various customers. Sasol Gas maximum price application is made in terms of the Energy Price Indicators Approach. In terms of this approach, the maximum price for gas is referenced to price indicators of certain relevant energy sources (i.e. coal, electricity, heavy fuel oil, LPG and diesel). On 23 November 2017, NERSA decided to approve the multi-year trading margin applied for by Sasol Gas for the periods 1 July 2017 to 30 June 2018 and 1 July 2018 to 30 June 2019, in so far as it relates to the trading margin applicable to end user customers as follows:

FY 18	FY 19
R5.99/GJ	R7.66/GJ

The National Energy Regulator does not have the mandate to set gas prices, but approves maximum prices, from which discounts are allowed and should be applied in compliance with section 22 of the Gas Act. In approving the maximum prices of gas NERSA:

- will not set actual prices, but will review applications for maximum piped-gas prices prepared by licensees or applicants;
- may request licensees or applicants to amend maximum prices; and
- may approve or decide not to approve maximum gas prices.

The National Energy Regulator only approves a price ceiling, implying that the actual prices charged to customers should not exceed the maximum price. Actual prices are determined based on contractual negotiations between a licensee and its customers, and the negotiated price should comply with section 22 of the Gas Act.<sup>20</sup>

20

The above narrative was derived from <http://www.nersa.org.za/> (accessed on 2018/02/21)



## 4. COAL

Internationally, coal is the most widely used primary fuel, accounting for about 36% of the total fuel consumption of the world's electricity production. About 77% 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 28% 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.

As a result of new entrants, operating collieries increased to 64 during 2004. Of these, a relatively small number of large-scale producers supply coal primarily to electricity and synthetic fuel producers. About 51% of South African coal mining is done underground and about 49% is produced by open-cast methods. The coal mining industry is highly concentrated, with five companies accounting for 85% saleable coal production. 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 beneficiation of coal, particularly for export, results in more than 65 Mt of coal discards being produced every year. About 21% of the run-of-mine coal produced is exported, and 21% is used locally (excluding power-station coal). The rest is not saleable and is discarded. The remainder of South Africa's coal production feeds the various local industries: • 62% is used for electricity generation • 23% for petrochemical industries (Sasol) • 8% for general industry • 4% for the metallurgical industry (Mittal) • 4% is purchased by merchants and sold locally or exported.

The key role played by South Africa's coal reserves in the economy is illustrated by the fact that Eskom ranks first in the world as a steam coal user and seventh as an electricity generator. Sasol is the largest coal-to-chemicals producer. By international standards, South Africa's coal deposits are relatively shallow with thick seams, which make them easier and, usually, cheaper to mine.<sup>21</sup>

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21 The narrative is based on the RSA yearbook 2016/17



The following section provides the prices of thermal coal sold locally and exported.

## 4.1 Local and export coal prices

Table 4.1 below shows the average local and export prices of anthracite and bituminous coal from 2008 to 2017.

**Table 4.1: Annual average local and export coal prices in Rand per ton**

Period	Coal Bituminous		Coal Anthracite	
	Average Price Exports (FOB)	Average Price Local Sales (FOR)	Average Price Exports (FOB)	Average Price Local Sales (FOR)
Jan-08	735.64	150.68	602.11	604.24
Jan-09	517.91	171.63	889.64	690.36
Jan-10	549.33	180.50	776.83	781.75
Jan-11	727.85	196.02	864.65	898.90
Jan-12	682.00	222.00	961.00	957.00
Jan-13	692.00	263.00	889.00	922.00
Jan-14	677.50	292.42	738.17	983.92
Jan-15	614.98	308.58	777.25	1028.00
Jan-16	733.58	332.75	702.17	1021.83
Jan-17	871.75	374.00	825.83	1086.33

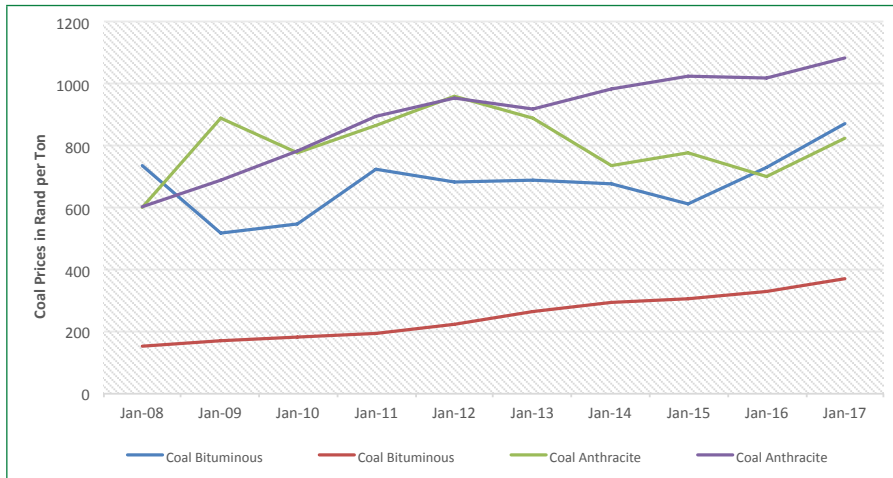
Source: Department of Mineral Resources (DMR)

### Explanatory Notes:

1. FOB: Free On Board.
2. FOR: Free On Road.
3. The prices are exclusive of VAT



**Figure 4.1: Annual Average Local (FOR) and Exports Prices (FOB) in Rand per ton**



Eskom and local customers are competing with global importers, which is likely to keep export prices high. A decade ago South Africa sent the bulk of its coal exports to Europe, but currently the market has shifted towards Asia, particularly India and Pakistan. India is the main importer of South African coal and has pushed up the demand for coal in the recent years. South African coal has a significant freight advantage over similar grades of coal from Australia, and from more distant suppliers such as the United States and Colombia.

South Africa's main export harbour at Richards Bay shipped out a record 76.47 million tonnes in 2017, of last year's shipments, 81.6 percent went to Asia with India being the largest buyer, followed by Pakistan, and just 10.1 percent went to Europe.<sup>22</sup>

Prices increased for both coal bituminous and anthracite locally and exports in 2017. Coal anthracite prices have consistently been higher compared to bituminous over the period depicted on figure 4.1 above. Local coal anthracite prices were at an all time high at R1086,33 per ton for the ten year period as indicated above.

22 <https://uk.reuters.com/article/column-russell-coal-safrica/column-south-african-coal-loses-europe-but-gains-south-asia-russell-idUKL4N1PS2W7> (accessed 14/09/2018)





## 5. ELECTRICITY

Eskom is South Africa's primary electricity supplier, generating approximately 90% of the electricity used in South Africa, and about 40% of the electricity used in Africa. The electricity industry is regulated by NERSA in terms of the Electricity Regulation Act, 2006 and the National Energy Regulatory Act, 2004. NERSA not only provides licences, regulatory rules, guidelines and codes, but also determines Eskom's revenue requirement based on the requirements of the Electricity Pricing Policy.

The electricity generated by Eskom, together with imports and that produced by IPPs, is supplied in bulk to distributors, both metros and municipalities, as well as distributed to industrial, commercial, residential and other customers in our licensed areas of supply. Eskom also supplies a number of international customers, including electricity utilities, in the SADC region.

Eskom generated 221 936GWh of energy from the following primary energy sources:

- Coal-fired stations -202 106
- Nuclear power -14 193
- Pumped storage stations -4 479
- Hydro stations -709
- Wind -331
- Open-cycle gas turbines (OCGTs) -118

Eskom operates 30 power stations with a total capacity of 45 561MW, of which 37 868MW and 1 860MW is derived from coal fired and nuclear power base load stations. The remaining capacity is derived from Sere Wind Farm, pumped storage, hydro and gas fired stations.

Electricity demand is expected to double over the next 20 years as government implements its Programme of Action, including the Infrastructure Development Programme, to put the country's economy onto a higher growth path. To this end, more than R340 billion will be spent on Eskom's New Build Programme. This will bring on line a further 11 641 MW of new capacity in the short term, adding to Eskom's existing 40 000 MW of capacity. The DoE has procured private peaker stations to the capacity of nearly 1 000 MW that can be used when there is a larger demand than what the Eskom generators can produce. The



Avon plant in Eastern Cape was completed in September 2015 and can produce 330 MW. The Dedisa plant in KwaZulu-Natal was expected to produce 630 MW. Total projects costs were R8 billion, while 210 permanent jobs and 6 190 temporary jobs were created at both plants. In total, Eskom sold 212 190GWh of electricity to 6 258 616 customers.<sup>23</sup>

Eskom generates its revenue from different electricity users. Table 5.1 shows various types of electricity users from 2008/09 to 2017/18. The electricity usage includes electricity used for domestic and street lighting, commercial, industrial, international, mining and farming.

**Table 5.1: Annual Average Eskom Prices by Customer Category in cents per kilowatt hour (2008/09 to 2017/18)**

Year	Bulk	Domestic and Street lighting	Commercial	Industrial	Mining	Rural / Farming	Traction/ Rail	International	Average for all categories
2008/2009	23.29	53.43	31.61	21.69	23.12	45.78	29.78	18.45	24.97
2009/2010	30.84	63.98	40.97	27.03	30.25	58.96	38.23	22.47	32.00
2010/2011	39.53	66.45	52.63	34.34	39.78	72.72	48.55	31.04	40.31
2011/2012	49.96	79.52	65.92	42.13	50.11	89.22	58.23	37.53	50.27
2012/2013	54.59	87.05	73.24	45.56	55.74	99.75	68.66	42.72	55.50
2013/2014	60.67	92.41	82.67	51.79	64.66	108.75	77.34	47.56	62.22
2014/2015	65.92	98.06	89.16	56.81	69.52	115.66	83.63	52.55	67.68
2015/2016	74.11	108.11	100.07	62.64	78.01	128.19	96.60	59.82	75.98
2016/2017	81.38	118.60	109.09	67.71	84.80	141.70	104.95	70.77	83.32
2017/2018	82.94	118.56	111.25	70.02	86.91	142.78	100.10	62.42	84.65

Source: Eskom

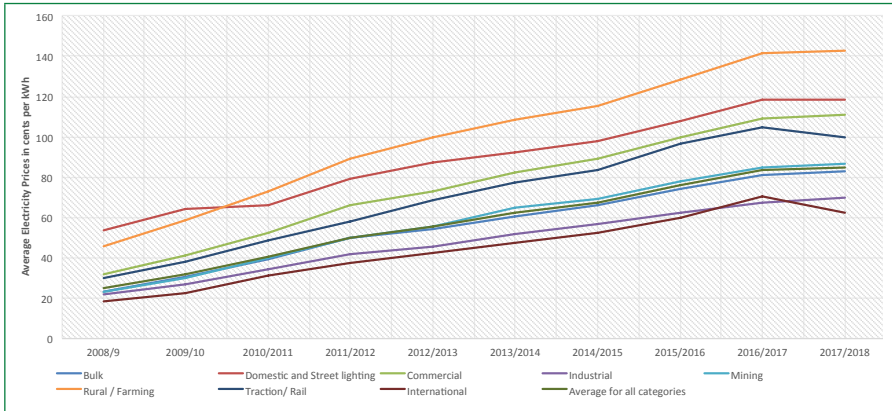
**Explanatory Notes:**

1. The data in this table is from various Eskom Statistical Yearbooks and Annual Reports.
2. The price data in this table is only applicable to Eskom's direct sales to the categories as listed. Sales by local authorities to the Domestic, Commercial and Industry categories are not included in this table.
3. The prices are in c/kWh for each of a number of sales categories.
4. Prices are exclusive of VAT

<sup>23</sup> Information on this section is derived from the Eskom Integrated Report 31 March 2018



**Figure 5.1 Annual Average Eskom Prices by Customer Category in cents per kilowatt hour (2008/09 to 2017/18)**



Source: Eskom

Eskom’s tariffs are adjusted on an annual basis – previously on the 1st of January, but due to the change in Eskom’s financial year price adjustments now take place on the 1st April every year. The average tariff adjustments for the past 10 years are indicated in Table 5.2 below.

**Table 5.2 Eskom’s Average Tariff Adjustment**

Period	Average Price Adjustment (%)	Consumer Price Index (%)
2008/2009	27.5	10.3
2009/2010	31.3	6.16
2010/2011	24.8	5.4
2011/2012	25.8	4.5
2012/2013	16	5.2
2013/2014	8	6
2014/2015	8	6
2015/2016	12.7	5.7
2016/2017	9.4	6.59
2017/2018	2.2	6.6

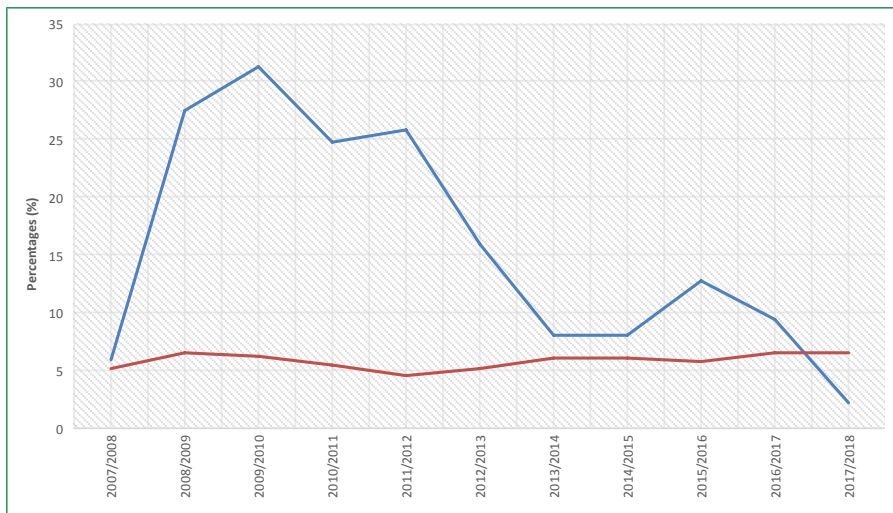
Source: Eskom



## Explanatory Notes:

1. Eskom's average price tariffs were adjusted annually (calendar period: January to December) from 2002 to 2005
2. Eskom's average price tariffs are adjusted at the end of the financial year (end of April) from 2005 to 2015
3. Eskom's average tariff adjustment figures are published on Eskom's website.
4. The adjustments are according to Eskom's financial year end, which is end of the March.

**Figure 5.2: Annual Eskom Average Tariff Adjustment**



Source: Eskom

In terms of Section 4 of the National Energy Regulator Act, 2004 (Act No.40 of 2004), NERSA's mandate is to regulate the electricity industry in terms of the Electricity Regulation Act, 2006 (Act No. 4 of 2006). The Energy Regulator determines Eskom allowed revenue on a multi-year basis. The Energy Regulator implemented the first Multi Year Price Determination (MYPD) for Eskom business activities namely, generation, transmission and distribution from 1 April 2006 to 31 March 2009.



The Multi Year Price Determination (MYPD) incorporates some of the Rate of Return (RoR) and incentive based principles through the introduction of the transmission and distribution service incentive schemes and the energy efficiency demand side management (EEDSM) schemes. The RoR methodology states that the revenue to be earned by Eskom should be equal to the efficient cost to supply electricity plus a fair return on the rate base.

For 2017/18 period, NERSA allowed Eskom to implement a 2.2% tariff increase as part of a previous multi-year increase determination agreement. The increase has provided for R205bn allowable revenue for Eskom in the same period. In 2017, Eskom applied for a total allowable revenue of R219.514bn, which translates to a 19.9% average percentage price increase. However, NERSA approved Eskom's allowable revenue of R190.348bn for the 2018/19 financial year. The approved allowable revenue of R190.348bn which will result in an average percentage price increase of 5.23%.<sup>24</sup>

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<sup>24</sup> The analysis is quoted from the media statement issued by NERSA on Eskom's revenue application decision for 2018/19 financial year date on the 15th of December 2017.



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## APPENDIX B: FUEL PROPERTIES

**Table B.2: Calorific Values of Various Fuels**

Carrier	Calorific Value	Calorific Value Unit	Density
LPG	26.7	MJ/l	0.54
Paraffin Power	37.5	MJ/l	0.81
Gas SASOL	18.0	MJ/m <sup>3</sup>	
Diesel	38.1	MJ/l	0.84
Electricity	3.6	MJ/kWh	
Gas	41.0	MJ/m <sup>3</sup>	
Heavy Fuel Oil	41.6	MJ/l	0.98
Petrol	34.2	MJ/l	0.72
Paraffin Illuminating CSS (StatsSA) Data	37.0	MJ/l	0.79
Aviation Gas	33.9	MJ/l	0.73
Jet Fuel	34.3	MJ/l	0.79
Coal Eskom Average	20.1	MJ/kg	
Coal (General purpose)	24.3	MJ/kg	
Coal (Coking)	30.1	MJ/kg	
Coke	27.9	MJ/kg	
Coke oven gas	17.3	MJ/m <sup>3</sup>	
Blast furnace gas	3.1	MJ/m <sup>3</sup>	
Bagasse (wet)	7.0	MJ/kg	
Bagasse fibre (dry)	14.0	MJ/kg	
Biomass (wood dry typical)	17.0	MJ/kg	
Gas Sasol - methane rich	35.0	MJ/m <sup>3</sup>	



## APPENDIX C: UNIT CONVERSIONS

**Table C.3: Energy Unit Conversion Factors**

Note: toe = ton oil equivalent

From \ To	J	kWh	toe	Btu
1 J	1	$0.278 \times 10^{-6}$	$0.2388 \times 10^{-6}$	$0.948 \times 10^{-3}$
1 kWh	$3.6 \times 10^6$	1	$0.86 \times 10^{-6}$	$3.412 \times 10^3$
1 toe	$42 \times 10^9$	11630	1	$39.68 \times 10^6$
1 Btu	$1.055 \times 10^3$	$0.293 \times 10^{-3}$	$0.252 \times 10^{-9}$	1

**Table C.4: Unit Prefixes**

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	$10^{18}$





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