SOUTH AFRICAN COAL SECTOR REPORT

DIRECTORATE: ENERGY DATA COLLECTION, MANAGEMENT AND ANALYSIS

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Department:
Energy
REPUBLIC OF SOUTH AFRICA

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Published by:

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ISBN:

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FOREWORD

It gives me great pleasure to introduce the report: South African Coal Sector. This report is based on information collated from government departments, coal industry and research papers. This publication covers a broad overview and analysis of the South African coal industry and aims to keep stakeholders informed about developments as well as key issues affecting the industry.

This publication presents the industry in a format which provides an overview of South Africa's coal market, the value chain and the different uses of coal. It also presents and analyses the supply and consumption trends, which are further categorized into market sectors.

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.

Mr Thabane Zulu

Director General

Department of Energy

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NOMENCLATURE

CCS	Carbon Capture and Storage
CTL	Coal-to-Liquids
CV	Calorific Value
DMR	Department of Mineral Resources
DoE	Department of Energy
GHG	Greenhouse gas
GTL	Gas-to-Liquids
IPPs	Independent Power Producers
IRP	Integrated Resource Plan
MPRDA	Mineral and Petroleum Resources Development Act
NEMA	National Environmental Management Act
NWA	National Water Act
RBCT	Richards Bay Coal Terminal
ROM	Run-of-Mine
SACCCS	South African Centre for Carbon Capture and Storage
US$/tonne	US dollar per tonne
kt	kilo ton
MJ/kg	Megajoule per kilogram
MJ/MWh	Megajoule per Megawatt hour

1. INTRODUCTION

Coal is a combustible sedimentary rock formed from vegetation that has been consolidated between other rock strata and altered by the combined effects of pressure and heat over millions of years. Coal is composed primarily of carbon, and also contains varying amounts of other components, like hydrogen, oxygen, sulphur and other impurities. Main parameters used to define coal are calorific value, ash, moisture and sulphur.

According to the energy balance compiled by the DoE, coal constitutes approximately 72% of total primary energy supply in South Africa, and is mostly used for power generation. In addition, coal is used to produce virtually all non-recycled iron. Coal is abundant, affordable, easy to transport, store and use, plus free of geopolitical tensions; all these attributes make it very popular.

South Africa contributes about 3.5% of the world's coal resources. The country's production is around 3.3% of the world's annual total and exports approximately 6% of global exports. Coal is the major primary energy source for South Africa. More than 90% of the country's electricity and approximately 30% of the liquid fuel are produced from coal (DoE, 2016). Coal also plays a significant role in supply to the South African chemicals industry and is an essential component of its steelmaking industry. Despite the country's attempts at diversifying energy, coal is expected to play a major role in the foreseeable future and it is the leading mining commodity revenue generator in South Africa.

2. OVERVIEW OF THE COAL INDUSTRY

The coal industry's value chain is segmented. The value chain includes resources and reserves, exploration, mining, coal preparation, transportation, coal exports, electricity, Coal-to-Liquid, metallurgical use, industrial use and residential use.

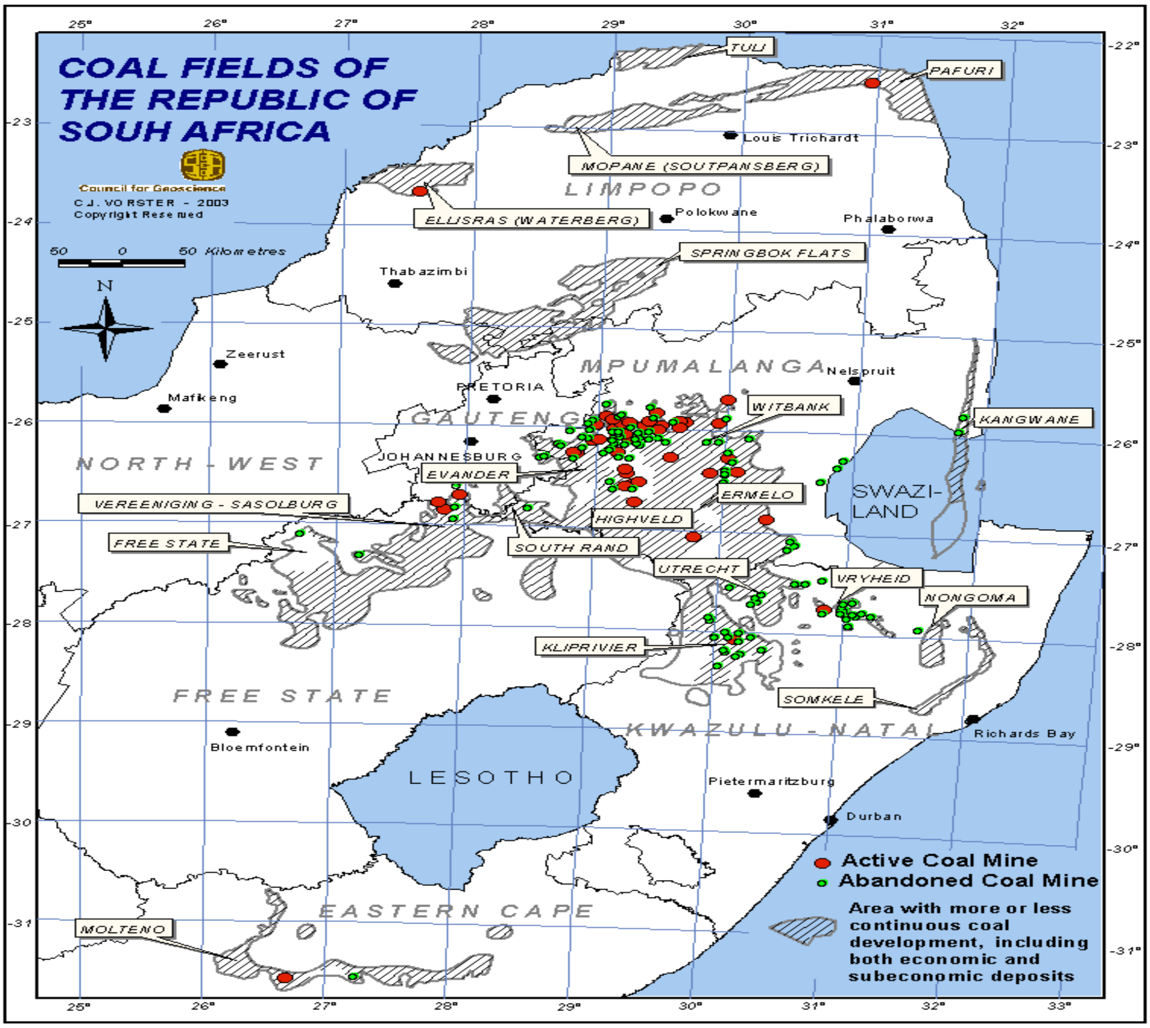
2.1 Occurrence

Coal in the ground is classified as a coal resource and only once an applicable study has been completed to determine economic viability and based on a mine plan, can the coal be classified as a coal reserve.

South Africa's coal resources are contained in the Ecca deposits, a stratum of the Karoo Supergroup. There are 19 coalfields in the country and they are largely located in the north-eastern quarter of the country, i.e. Mpumalanga, Limpopo and extend to KwaZulu-Natal and the Free State. The coalfields where production occurs include Ermelo, Highveld, Kangwane, Kliprivier, Nongoma, Soutpansberg, Utrecht, Vereeniging-Sasolburg, Vryheid, Waterberg (Ellisras) and Witbank (Figure 1). The majority of coal comes from the Witbank and Highveld coalfields, which together account for about 75% of South Africa's production. However, these sources will be exhausted in the next century (DMR, 2016).

Alternatively, the Waterberg coalfield in the Limpopo province contains vast resources of coal and is the next area that will supply South Africa with energy well into the future. Although the Waterberg is very small in area compared to the likes of the Witbank and Highveld coalfields it has a total seam thickness of about 110m which makes the reserves of the Waterberg to be large (Chabedi & Zvarivadza, 2016).

Figure 1: South Africa's coal fields



Source: Council of Geoscience

Generally, the rank or carbon content of the coal increases eastwards while the number and thickness of reserves decreases. Consequently, coal from Mpumalanga and Limpopo is usually classified as bituminous, occurring in seams up to several metres thick, while KwaZulu-Natal coal is often anthracitic and are found in relatively thin seams. The recoverable coal reserves in South Africa amount to some 66.7 billion tons, equivalent to about 7% of the world's total (DMR, 2016).

2.2 Exploration

Due to its abundance, there exists a large area likely to hold significant coal resources. Coal reserves are discovered through exploration activities. The process usually involves creating a geological map of the area, then carrying out geochemical and geophysical surveys, followed by exploration drilling. It is necessary to prospect at much smaller scales before selecting sites for establishing mining operations, so as to provide confidence that production will be of suitable quality and economically viable.

South Africa's coal green fields are mostly located in the Waterberg basin, which is reported to be the future of coal mining in the country. Some of the exploration projects recently conducted in this region includes the Waterberg Coal Joint project conducted by Sekoko Resources. This project is based on the Coal Zone and the exploration program estimated 5Bt of resources.

Nozala Coal is a joint venture between Nozala and the NAB Mining Group. Nozala Coal currently has two prospecting rights, one in the Witbank coalfield and the other in the Waterberg basin. The latter project exploration is still work-in-progress and has a resource of 1.4Bt.

The Waterberg coalfield has only been marginally exploited because of infrastructural constraints such as inadequate road and rail capacity. Other constraints include the distance to the Richards's Bay Coal Terminal and inadequate water availability.

2.3 Mining methods

The most economical method of coal extraction from coal seams depends on the depth and quality of the seams, as well as the geology and environmental factors. Surface (opencast) mining and deep underground mining are the two basic methods of mining used in South Africa. Approximately 51% of South African coal mining is done underground and about 49% is produced by open-cast techniques.

There are three different mining methods that are commonly used in underground mines in South Africa. The most common technique is the 'bord and pillar' method, which accounts for just under half of total coal production (SACRM, 2011). This method is ideal for relatively shallow deposits where overlying rock pressure is low. Seams are mined leaving in situ coal pillars, which are big enough to support the roof indefinitely. This method currently permits around 65% of the available coal to be extracted.

When the overlying strata impose no restrictions, ‘total extraction’ can take place underground. However, still less than 90% is recovered on average. There are two major underground systems employed in South Africa in such a case. In rib-pillar extraction, a continuous miner machine cuts a roadway up to 1.5 kilometres in length through the coal and 5 metres in from the edge of the area to be mined. This leaves a 5 meter-wide band of coal in the form of a long, isolated rib pillar along one side of the tunnel. With the help of timber or hydraulic props to hold up the now unstable roof, the continuous miner cuts away the rib pillar in a series of curved cutting sweeps. The machine repeats the cycle by mining into the remaining coal area, again cutting a tunnel and leaving a rib pillar (Anglo American, 2016).

The other ‘total extraction’ method employed is long wall mining. Long walls are usually several hundred metres long and essentially consist of a corridor in which one wall and the roof are formed by steel supports capable of resisting hundreds of tonnes of pressure from the subsiding mine roof above. The second side of the corridor is formed of coal and is the actual face from which coal is cut. A mechanical coal cutter, bearing two large revolving shearing drums with steel picks, runs the whole length of the coalface on rafts. This cuts into the coal and widens the corridor during each sweep, thus advancing the coalface. The hewn coal falls on to a conveyor and is drawn out of the long wall face. Hydraulic rams linked to the line of props push the conveyor and coal cutter forward into the newly mined out space in the face. In turn, each hydraulic support is then released from its position and hauls itself forward after the advancing face, reinstalling its steel canopy against the recently exposed area of face roof (Anglo American, 2016).

Opencast operations have high recovery rates, with some operations approaching 90% recovery. This method is employed where coal is lying less than 70 metres below the surface. Overburden rock and soil lying above the coal seams is blasted and scraped out by walking draglines, with large scraper buckets slung beneath long crane-type boom arms. The exposed underlying coal seams are drilled, blasted loose and hauled out of the pit by heavy-duty trucks. The coal is then transported to either the coal preparation plant or directly to where it will be used.

2.4 Coal preparation

Coal straight from the ground is known as run-of-mine (ROM) coal. The ROM often contains unwanted impurities such as rock and dirt and comes in a mixture of different sized fragments. However, coal users need coal of a consistent quality. Coal preparation, also known as coal beneficiation or coal washing, refers to the treatment of ROM coal to ensure a consistent quality and to enhance its suitability for particular end-uses (Anglo American, 2016).

The treatment depends on the properties of the coal and its intended use. It may require only simple crushing or it may need to go through a complex treatment process to reduce impurities. To remove impurities, the raw ROM coal is crushed and then separated into various size fractions. Larger material is usually treated using dense medium separation. In this process, the coal is separated from other impurities by being floated in a tank containing a liquid of specific gravity, usually a suspension of finely ground magnetite. As coal is lighter, it floats and can be separated out, while heavier rock and other impurities sink and are removed as waste (Anglo American, 2016).

The smaller size fractions are treated in a number of ways, usually based on differences in mass, such as in centrifuges. A centrifuge is a machine which turns a container around very quickly, causing solids and liquids inside it to separate. Alternative methods use the different surface properties of coal and waste. In 'froth flotation', coal particles are removed in a froth produced by blowing air into a water bath containing chemical reagents. The bubbles attract the coal but not the waste and are skimmed off to recover the coal fines. Recent technological developments have helped increase the recovery of ultra-fine coal material (Anglo American, 2016).

2.5 Coal transportation

The coal transportation modes are dictated by the type of users and location (i.e. distance to be travelled). Coal is generally transported by conveyor belt or truck over short distances. Rail transport is predominantly used for export coal to the terminal from where it is shipped by sea to the export markets.

2.5.1 Conveyor belts

In the South African coal mining industry, conveyor belts are used to transport coal to a number of power stations in the Mpumalanga area as a number of them are built next to the coal mines. The coal-fired power plants are designed with a coal mine next to them for the ease of supplying coal in a system called a 'tied-colliery' contract. These are long-term contracts meant to ensure coal supply security to the power stations. However, road transport is used to supplement coal supply to the power stations which are already being supplied via conveyor belts as the respective mines reserves are presently unable to meet the power stations' demand as a result of depletion.

2.5.2 Road transport

Eskom transports coal in Mpumalanga over a road network of about 3 200 km using a fleet of more than 2 000 trucks. The average distance travelled by these coal transportation trucks is 600 000 km/day and about 124kt of coal is moved on South Africa's roads each day through a network of 30 to 40 haulage routes. Eskom has 58 transport contracts in place with logistics companies to transport coal from mines to its power stations (Eskom, 2016).

The increased use of road transportation to the power stations in Mpumalanga is detrimental to the environment. This inevitable situation is due to the coal mines in the area experiencing depletion and unable to meet the capacity of the designated power stations. The situation will only improve when new coal mines are established at Waterberg coalfields in Limpopo Province and this will take time as the infrastructure in that area has to be developed first.

2.5.3 Rail Transport (Transnet/TFR)

The South African rail network is operated by the state corporation TRANSNET through one of its business units Transnet Freight Rail (TFR). The TFR uses the national rail network comprising 22 000km for freight transportation of which 1 500km comprises heavy haul lines for export coal and iron ore. Starting at Mpumalanga's 44 coal-rich mines, the 580km line descends from the Highveld through rural KwaZulu-Natal and terminates at Richards Bay. The double line is bi-directionally signalled and fully electrified. Two 100 wagon trains are coupled to form one 200-wagon train at Ermelo. These trains stretch 2.5km and are loaded to 20 800 gross tons (TFR, 2016).

The Richards Bay Coal Terminal (RBCT) is situated 170km north of Durban on the Indian Ocean coastline. It was opened in 1976 and commenced with an original capacity of 12Mtpa. This capacity grew over the years and reached a capacity of 76Mtpa in 2008. By 2010, capacity had grown into an advanced 24-hour operation with a design of 91Mtpa. Richards Bay Coal Terminal is the largest single coal export terminal in the world, exporting more than 69Mtpa. RBCT is connected to the coal mines via Transnet Freight rail (TFR) running from Mpumalanga coalfields to Richards Bay terminal along the Indian Ocean. The terminal coordinates with the Transnet National Ports Authority (TNPA) for the arrival and departure of more than 900 ships per annum (TRF, 2016).

2.6 Coal export

Globally, coal remains a mainly domestic primary energy source. However, the seaborne coal trade has seen a history of continuous and strong market growth in recent years. About 17% of global coal demand was traded internationally in 2015. The world's coal trade is mostly from steam coal which accounts for approximately 76% of the coal trade and the balance is from coking coal.

Transportation costs account for a large share of the total delivered price of coal, therefore international trade in steam coal is effectively divided into two regional markets, the Atlantic and the Pacific. The Atlantic market is made up of importing countries in Western Europe, notably the UK, Germany and Spain. The Pacific market consists of developing and Organisation for Economic Co-operation and Development (OECD) Asian importers, notably Japan, Korea and Chinese Taipei. The Pacific market currently accounts for about 60% of world steam coal trade.

South Africa was the fifth largest exporter of steam coal in the world in 2015 and due to its geographic location the country can competitively export coal to both the Atlantic and Pacific basins. Almost all hard coal exported from South Africa is steam coal, most of which is exported through the Richards Bay Coal Terminal (RBCT), with some minor volumes shipped through Durban or Maputo in Mozambique. The structure of South African exports has completely changed within the last decade. In recent years, around 60% of South African exports were destined for the Pacific basin, compared to earlier in this century, when more than 80% were destined for the Atlantic basin (DoE, 2016).

Domestic infrastructure constraints have impacted negatively on South Africa's coal exports over the past decade resulting in exports stagnating at around 70Mt. The phase five expansion of Richard's Bay Coal Terminal with a total capacity of 91Mt was completed in April 2010. Although RBCT has 91Mtpa of coal export capacity, the operation has been hindered from achieving maximum export output because of the following reasons:

- limited production of export-grade coal from coal mines
- rail infrastructure constraints associated with lack of optimal operational efficiencies and prolonged wagon or locomotive turnaround times experienced by Transnet Freight Rail in delivering at its 81 Mtpa maximum capacity.

According to RBCT it is projected that there is a potential to expand coal export capacity to 110Mtpa in near future.

2.7 Coal uses

Coal is the major primary energy source for South Africa. More than 90% of the country's electricity, approximately 30% of the liquid fuel, and about 70% of its total energy needs are produced from coal (DoE, 2016). Coal also plays a significant role in supply to the South African chemicals industry and is an essential component in the steelmaking industry, i.e. metallurgical coal.

2.7.1 Electricity Generation

Primarily, electricity is generated using coal. This starts when the coal is pulverised in huge mills into a fine powder before it is blown into huge kettles, called boilers. Due to the heat in the boiler, the coal particles combust and burn to generate heat to turn water into steam. The steam from the boilers is used to turn the blades of a giant fan or propeller, called a turbine. The turbine turns a coil made of copper wire (the rotor) inside a magnet (the stator). Together they make up the generator. The generator produces an electric current, which is sent to the homes and factories of consumers via power lines.

The water is in a closed (primary) circuit and after the energy in the steam is spent in the turbines, it condenses back to water and is re-circulated to the boiler for reheating. Cold water (in a secondary circuit) is used to assist in the condensation process and this is referred to as cooling water. The ash that results from burning the coal falls to the bottom of the boiler and is extracted and removed to an external ash dam while the gaseous emissions exit though a chimney (or flue) and is termed flue gas.

The electricity sector in South Africa is dominated by Eskom, a single, vertically integrated, state-owned utility owning, operating and maintaining the bulk of the generation infrastructure, as well as the national transmission grid. Eskom generates approximately 90% of the electricity used in South Africa and approximately 45% of the electricity used in Africa. In global terms, the utility is among the top seven in generating capacity, among the top nine in terms of sales, and has one of the world's biggest dry-cooled power stations.

Eskom uses over 90Mt of coal per annum and typically burns low quality coal characterised by high ash content and low calorific values. The coal which can be used varies between power stations. The Return-to-Service power stations require higher grade coal (23 MJ/kg), another group require 21-23 MJ/kg and only certain power stations are able to burn the lowest grade (Eskom, 2016).

Below is a table of Eskom's coal-fired power stations and their installed capacity.

Base load stations		Return-to-Service stations	
1. Arnot	2 352 MW	1. Camden	1 510 MW
2. Duvha	3 600 MW	2. Grootvlei	1 200 MW
3. Hendrina	2 000 MW	3. Komati	940 MW
4. Kendal	4 116 MW	Newly built	
5. Kriel	3 000 MW	1. Medupi	4 788 MW
6. Lethabo	3 708 MW	2. Kusile	4 800 MW
7. Majuba	4 110 MW		
8. Matimba	3 990 MW		
9. Matla	3 600 MW		
10. Tutuka	3 654 MW		

Source: Eskom, 2016

2.7.2 Liquid fuel and chemicals production

In South Africa, coal is not only used for electricity generation but also a diverse range of products can be derived from coal. Coal is also used to produce liquid fuels and non-energy coal products such as chemicals.

The conversion of Coal-to-Liquids (CTL), or liquefaction, involves reaction with hydrogen, reduction of the hydrocarbon molecular size and elimination of sulphur, nitrogen and oxygen components found in coal. Two processes are currently used for obtaining liquid fuels from coal by liquefaction. Direct coal liquefaction (DCL) involves high pressure dissolution of coal in solvents at high temperature and pressure. This process is highly efficient, but the resulting mainly aromatic products require significant further processing to achieve the required product quality. Indirect coal liquefaction (ICL) involves gasifying the coal to form synthesis gas (syngas), which is then cleaned to remove sulphur and other impurities. The cleaned gas is then reacted over a catalyst to produce a wide range of products (SACRM, 2013).

Indirect coal liquefaction can follow two routes after coal gasification to form syngas, i.e. Fischer-Tropsch (FT) synthesis or Methanol synthesis. The FT process yields different product ranges depending on the process conditions maintained and catalyst employed. While the high temperature FT (HTFT) process is typically used primarily to produce liquid fuels, other chemicals such as alpha olefins are extracted from the "crude synthetic liquid" phase; the aqueous phase yields alcohols, acetic acid and ketones including acetone, methyl-ethyl-ketone (MEK) and methyl-iso-butyl-ketone (MIBK) upon separation and work up of the aqueous phase from the SAS reactor (SACRM, 2013).

The production of coal-based liquid fuels and chemicals in South Africa is vested in Sasol. Sasol hosts the largest and only commercial Coal-to-Liquids operation globally converting low-grade, sub-bituminous coal and natural gas into liquid fuels and chemicals. The company's CTL process includes four main stages, i.e. gasification of coal to produce syngas, gas purification, FT synthesis and product workup. Sasol produces about 150 000 barrels of synthetic fuel a day and meets about 28% of South Africa's annual fuel needs.

2.7.3 Metallurgical coal

Coking coal is an essential ingredient in iron and steel making. Coal is used in blast furnaces as a reductant and energy source. The use of coal in blast furnaces represents the second largest market for coal globally, after thermal use. This includes both the production of iron for steelmaking, and in the production of ferroalloys. However, South Africa has limited reserves of coking coal, produced from the Limpopo coalfields. Coking coal required by the South African iron and steel industry is largely imported.

South Africa was ranked the 23rd largest crude steel producing country in the world in 2015 and produces approximately 45% of total crude steel production of the African continent, according to Worldsteel Association. The country is also a significant exporter of ferroalloys including ferromanganese, ferrochrome and ferrovanadium.

In South Africa, 80% of iron is produced in blast furnaces, 6% in electric furnaces and 14% in "other" processes (e.g. COREX), (SAISI, 2016). The Southern African coke industry produces two types of coke, being market coke which is used by the ferroalloy industry, and metallurgical coke for steel plants.

There are four main users of coal for iron and steel production in South Africa. Two of these operations use coal to make coke for production, these being the ArcelorMittal operations in Newcastle and Vanderbijlpark. The ArcelorMittal operation at Saldanha uses the Corex® process, which uses coal directly without conversion to coke. Finally, the Evraz Highveld Steel and Vanadium operation in Witbank uses coal in a process for production of iron and steel from magnetite.

2.7.4 Other uses

Other uses of coal include industrial and commercial use as an important fuel source to generate steam to provide heat and power. The industrial sector includes pulp and paper manufacturers, food and tobacco (particularly sugar refining and breweries), cement manufacturers, brick and refractory manufacturers, textile manufacture as well as mining.

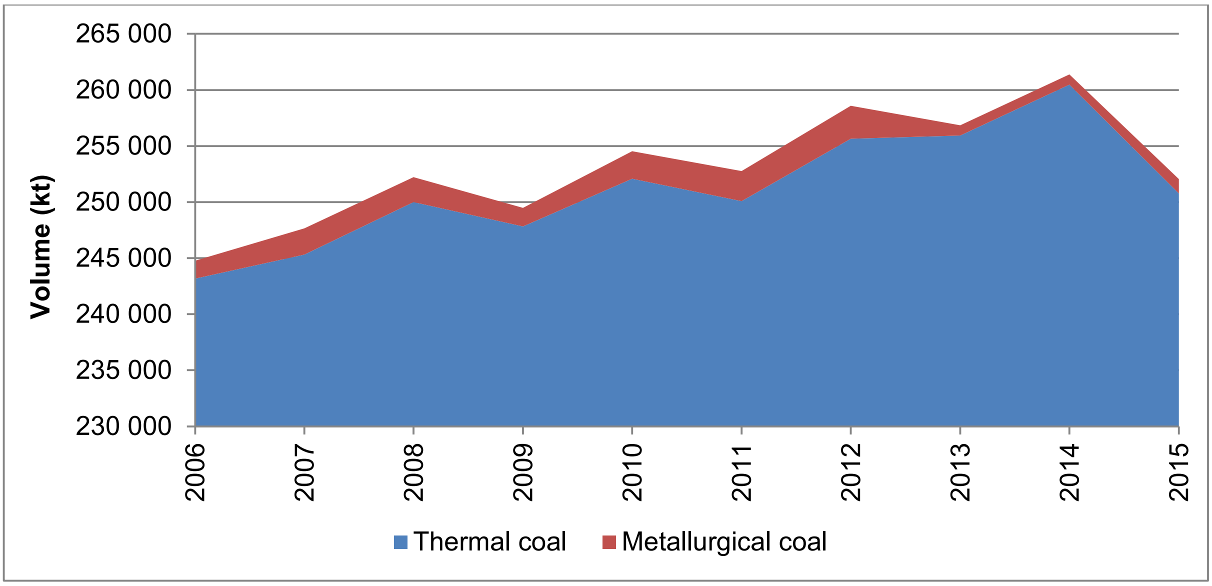
Many households across South Africa use coal as a preferred energy source. Coal is a relatively cheap fuel, which is attractive to informal households that rely on inconsistent levels of income, particularly those that are situated inland near coal mines.

3. COAL SUPPLY IN SOUTH AFRICA

3.1 Coal production

South Africa's supply of coal includes production and trade. The country's coal production has remained stagnant at levels around 250Mt a year, only posting small incremental changes. Production was almost entirely made up of steam coal while the production of metallurgical coal declined at an average rate of 7% per annum from 2006 to 2015 (Fig. 2).

Figure 2: Production of coal, 2006-2015



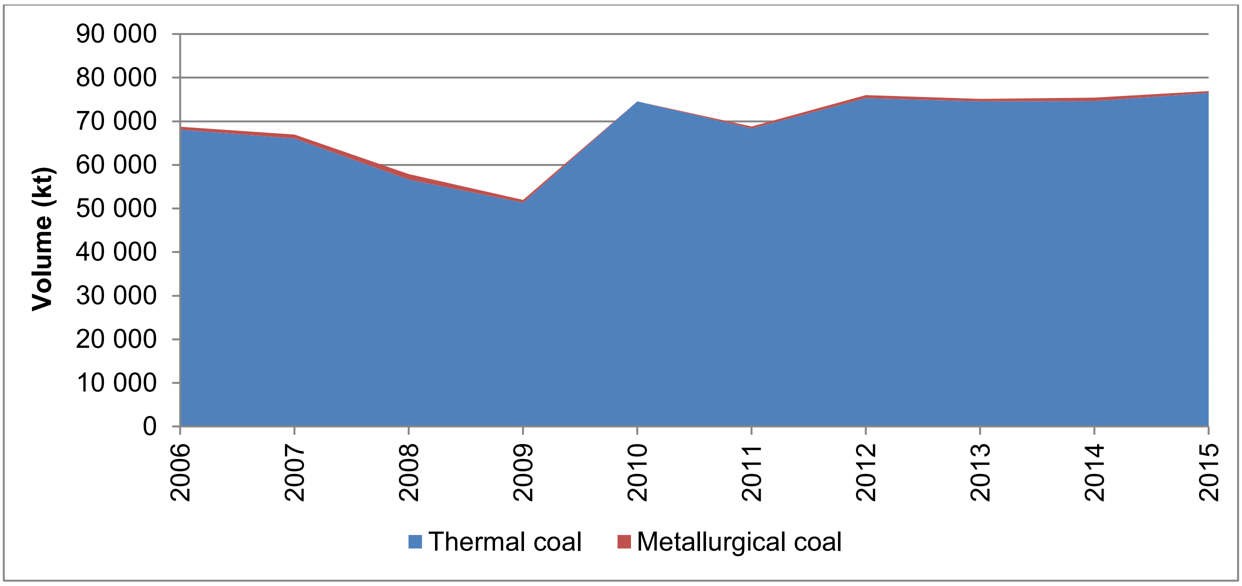
Source: DoE

South Africa's coal production is dominated by five mining companies: Anglo American Thermal Coal, Exxaro Resources, Sasol Mining, BHP Billiton Energy Coal South Africa (Becsa) and Glencore. These companies, together account for over 80% of the country's yearly saleable coal production while the balance is made up by many small and medium-sized producers.

3.2 Coal exports

Coal exports grew by an average rate of 2.6% per annum from 68.7Mt in 2006 to 76.9Mt in 2015. Exports declined between 2006 and 2009 due to a decline in exports to the European market following the global financial crisis. In 2010, exports recovered by 45% on the back of an increase in demand from the Asian markets and the recovery of the European economy. However, due to infrastructure bottlenecks, export volumes have on average stagnated at around 75 Mt since 2012 (Fig. 3).

Figure 3: Coal exports, 2006-2015

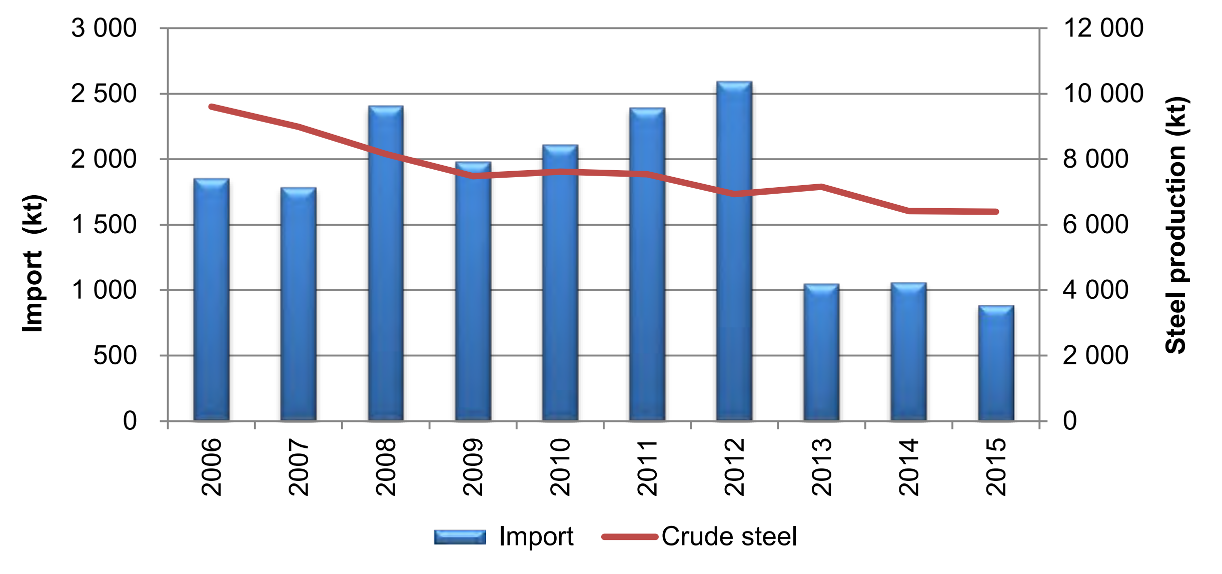


Source: DoE

3.3 Coal imports

South Africa's coal imports, which is mainly coking coal, is depended on the country's iron and steel industry. On the other hand, the iron and steel production is depended on the country's economic performance. Consequently, imports of coal followed a similar trend as the country's steel production, with imports peaking in 2008 before dropping by 17.8% in 2009 due to the economic crisis. Coal imports remained at low levels until reaching just over 1 Mt in 2013 and declined by 16% in 2015 on the back of declining steel production (Fig. 4).

Figure 4: Coal imports, 2006 - 2015

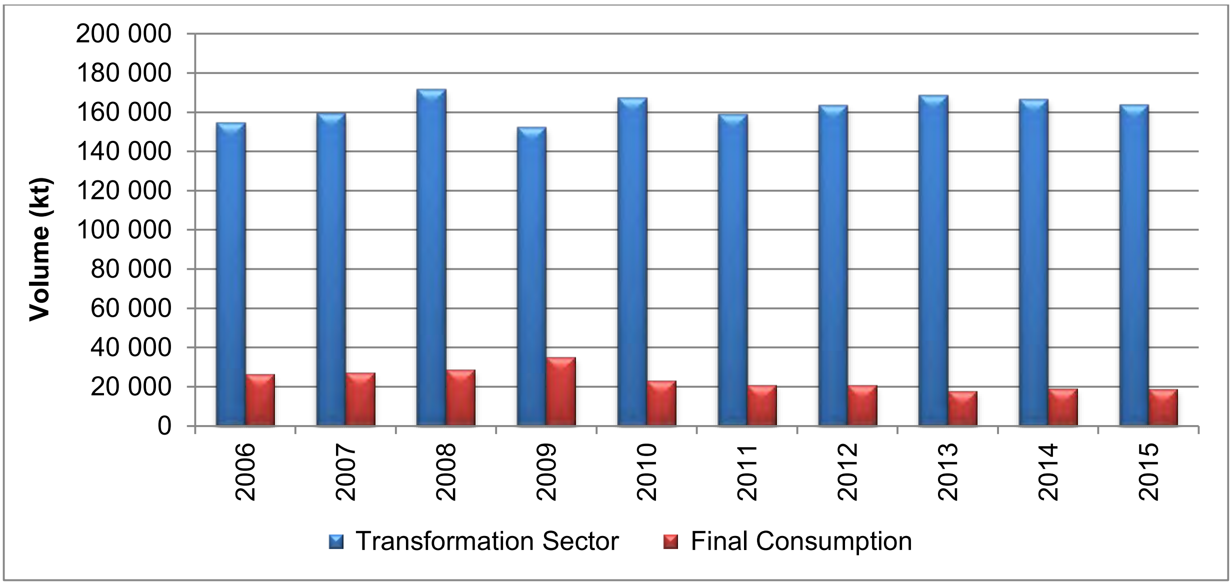


Source: DoE

4. COAL DEMAND IN SOUTH AFRICA

The consumption of coal occurs in several sectors including the transformation, energy, transport and various other sectors. The transformation sector consumes the majority of the coal produced while final consumption in other sectors has declined by an average rate of 6% per annum (Fig. 5).

Figure 5: Coal consumption, 2006 - 2015

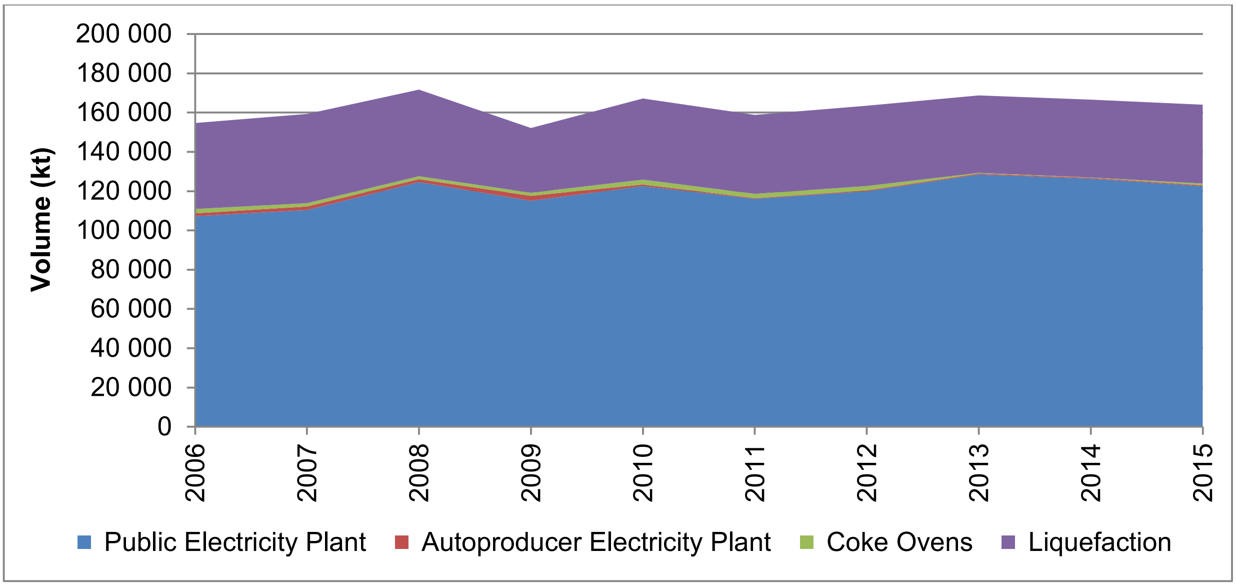


Source: DoE

4.1 Transformation sector

The transformation sector includes plants in which coal is used to derive energy products. These energy plants include public and auto-producer electricity plants, coke ovens and liquefaction plants. In South Africa, coal transformation occurs mainly in the electricity generating plant, which grew from 69% in 2006 to 75% in 2015 of the total coal transformed. This was followed by the use of coal in liquefaction plant which was stagnant during the 10 year period. The balance was consumed in auto-producer electricity plants and coke ovens (Fig. 6).

Figure 6: Coal consumption in the transformation sector, 2006 - 2015

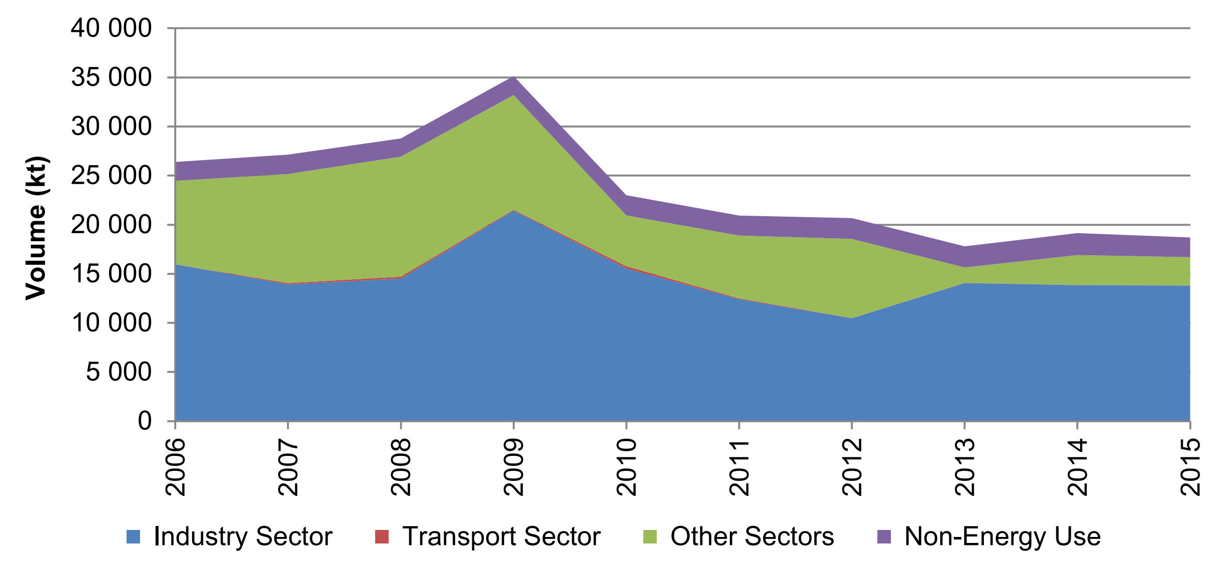


Source: DoE

4.2 Final consumption

Final consumption occurs in the industrial, transport and other sectors as well as in non-energy sectors. The industrial sector constituted the majority of the final consumption, increasing from 60.5% in 2006 to 74% in 2015. Consumption of coal in other sectors has declined over the years at an average rate of 18.2% per annum while consumption for non-energy use was stable during the same period. The transport sector has had the lowest consumption which has also declined between 2006 and 2015 (Fig. 7).

Figure 7: Final consumption in various sectors, 2006 - 2015

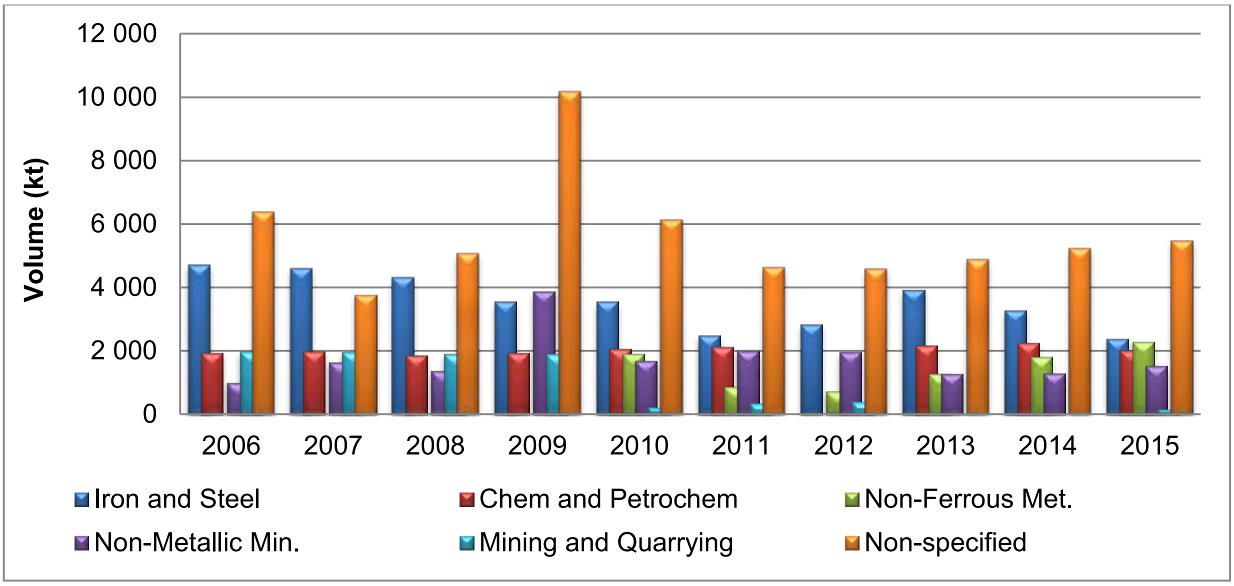


Source: DoE

4.2.1 Coal consumption in the industrial sector

The industrial sector is made up of various sub-sectors. The iron and steel industry is one of such which over the years has experienced a decline in coal consumption from 29.5% in 2006 to 17% in 2015 of the total industrial consumption. This is concomitant to the declining steel production in the country. Coal consumption in the chemical and petrochemical industry has stagnated around 2Mt over the 10 year study period. The consumption of coal in the non-ferrous metals industry was only recorded since 2010 and has since increased while the non-metallic minerals industry consumption was on average just below the 2Mt level. Mining and quarrying coal consumption was stable up to 2009, however this has since declined reaching 153kt in 2015 (Fig. 8).

Figure 8: Coal consumption in the industrial sector

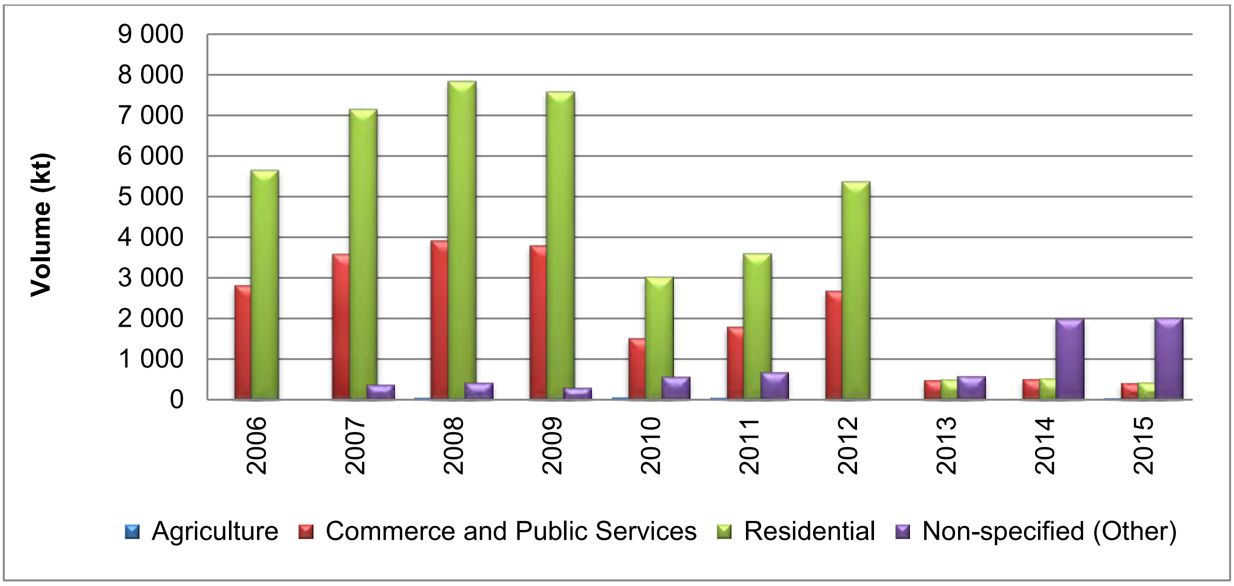


Source: DoE

4.2.2 Coal consumption in other sectors

Other sectors include agriculture, commercial and public services as well as residential. Coal consumption in the agriculture sector was insignificant compared with others. The commercial and public sectors as well as the residential sector followed a similar trend. The sectors peaked in 2008 then declined in 2009 and 2010. This was followed by a recovery in 2011 with a new peak in 2012. However, consumption has since declined reaching 400kt in 2015 for both sectors (Fig. 9).

Figure 9: Coal consumption in other sectors

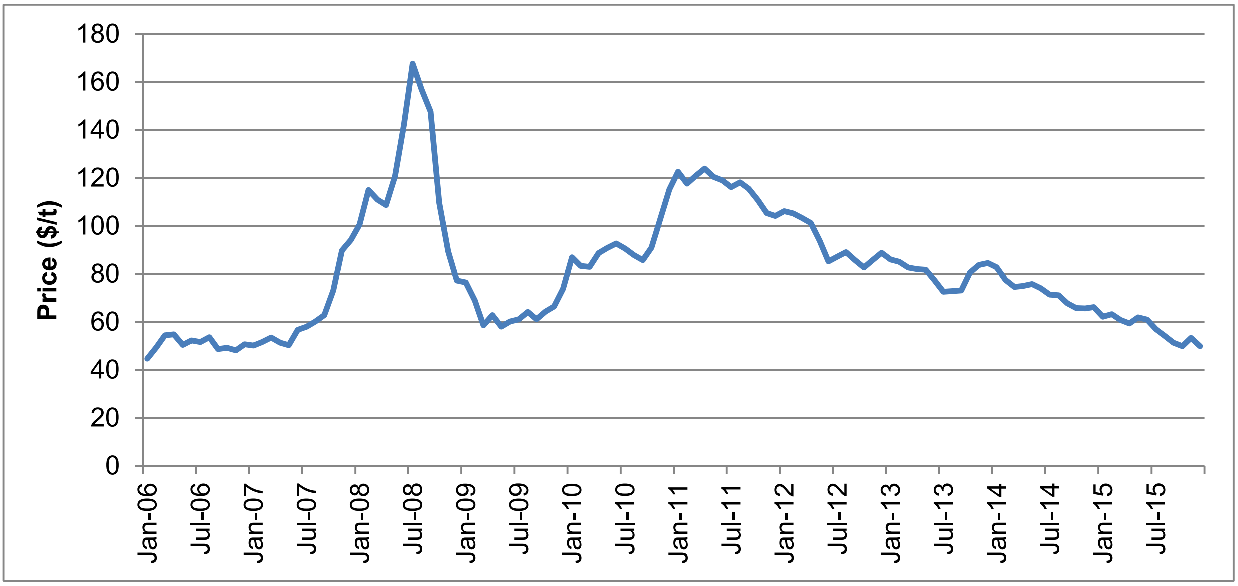


Source: DoE

5. COAL PRICING IN SOUTH AFRICA

South Africa's coal export price grew steadily from the second half of 2007. Prices eventually reached a peak in July 2008 at a record high of R1 279/t, driven by the international markets where the country's coal was in demand. However, by June 2009, the price had dropped to R484/t, as demand weakened due to the financial economic crisis. Prices recovered during the second half of 2009 due to stronger demand from Asia and reached a new peak at the end of the first quarter of 2011. Prices have since declined, reaching R749.22/t at the end of 2015 (Fig. 10).

Figure 10: Coal export price in South Africa: 2006 - 2015



Source: DMR

6. THE IMPACT OF COAL ON THE ENVIRONMENT

South Africa has a sizable coal industry and this has had a considerable impact on the environment across the value chain from mining, beneficiation and utilisation. Environmental impacts from coal extend from land use and transformation, air and water quality to impacts on biodiversity, soils and human health.

6.1 Mining

The primary impacts arise from mining with the two methods, opencast and underground, having different impact. In opencast the potential environmental impacts include land alienation from overburden stockpiles and disposal areas, formation of acid mine drainage, spontaneous combustion, increased erosion and siltation of surface waters as well as contamination of local ground-waters and borehole yields being affected (SACRM, 2011). The effects of underground mining include ground surface disturbance, dust and fumes from mine vehicles and transportation systems and the discharge of contaminated waters. Also mine closure has an impact on the environment including subsidence, slumping and flooding of previously mined areas, underground fires in abandoned coal mines, acid mine drainage, continuing discharge of contaminants to ground and surface waters and land use change. The impact of coal mining on air quality is as a result of the release of methane and the formation of dust (SACRM, 2011).

6.2 Beneficiation

Coal washing gives rise to large waste dumps. The waste dumps have an effect on the environment because they are high-risk areas for spontaneous combustion, and associated emission of harmful gaseous pollutants. The dumps are also potential causes of acid mine drainage, especially when they are located too close to water systems.

6.3 Utilisation

The biggest impact arises from the combustion of coal during power generation. This is followed by the use of coal in the synthetic fuel industry as well as in households. Environmental impact of coal fired power generation includes greenhouse gas emissions, other atmospheric emissions, water consumption and pollution, as well as ash generation. An estimated 476Mt of CO_2 were emitted by South Africa in 2015.

The main greenhouse gas (GHG) emitted from the South African electricity sector is carbon dioxide (CO_2) which is produced when the coal combusts in the presence of air. Eskom reported emitting 223.4Mt of CO_2 in 2015, 4% less than the previous year (Eskom, 2016). Eskom also emitted 2 919t of nitrous oxide (N_2O), a greenhouse gas with a global warming potential of 298 times that of CO_2. Other emissions to air from coal fired power generation include particulates, sulphur dioxide (SO_2) and nitrogen oxide (NO_2) (Eskom, 2016).

The most significant environmental issue for CTL in South Africa is the high level of greenhouse gas emissions associated with the CTL technology. In addition to the GHG emissions, other atmospheric pollutants from the CTL process include particulate matter from ash dumps, sulphurous and nitrogenous gases (SO_x, H_2S and NO_x) as well as volatile organic compounds (VOCs) (SACRM, 2011).

Coal burning appliances used by low income households are characterised by inefficient combustion which leads to high emission rates of particulate matter, volatile hydrocarbons, carbon monoxide and sulphur-containing gases (hydrogen sulphide (H_2S)) and (sulphur dioxide (SO_2)). Also, environmental impacts include those associated with the disposal of ash which is not collected by ash collectors. This ash may be disposed of in local streams or dumped on vacant land, thus resulting in the generation of leachate and subsequent pollution of land and water bodies (SACRM, 2011).

6.4 Mitigations

The South African government through the Department of Environmental Affairs (DEA) has expressed a commitment to reducing CO_2 emissions by 34% by 2020 and 42% by 2025. Subsequently, government through the Department of Energy (DoE), established the South African Centre for Carbon Capture and Storage (SACCCS), as a division of South African National Energy Development Institute (SANEDI), to investigate the feasibility of the carbon capture and storage technology (CCS) in South Africa. CCS technology can contribute towards the reduction of carbon emissions, thus allowing the continued use of coal (Yoro & Sekoai, 2016). The aim of CCS is to capture carbon dioxide emissions at the point of release and transport it to an appropriate site, and then inject it into a deep (greater than 800metres) geological formation (storage). The deep underground storage (CCS) provides a solution for mitigation of at least some of the emissions.

Coal will be used more efficiently because of continually improving clean coal technologies. Clean Coal Technology includes advanced Pulverised Fuel (PF) Combustion, Fluidised Bed Combustion and Gasification. Application of new advanced materials to Pulverised Fuel (PF) power plants should enable efficiencies of 55% to be achieved in the future (Eskom, 2016). This results in corresponding reductions in Carbon dioxide (CO_2) emissions as less fuel is used per unit of electricity generated. The advantages of FBC beds are that they produce less mono-nitrogen oxides (NO_x) in the outlet gas due to lower combustion temperatures, and they produce less sulphur oxides (SO_x) when limestone is continuously added to the coal. Integrated Coal Gasification Combined Cycle (IGCC) systems produce less solid waste and lower emissions of SO_x, NO_x and CO_2. Over 99% of the sulphur present in the coal can be recovered for sale as chemically pure sulphur (Eskom, 2016).

National Treasury published the Draft Carbon Tax Bill for public comments in November 2015 with the intention that carbon taxes would be implemented in a phased manner with effect from 1 January 2017 at a marginal rate of R120 per ton CO2-e (Treasury, 2016). The purpose of the 2015 Draft Carbon Tax Bill is to address impacts of climate change and to facilitate a viable and fair transition to a low-carbon economy for South Africa and therefore combat Green House Gas (“GHG”) emissions. In the 2017 Budget Speech, the Minister of Finance stated that a revised Carbon Tax Bill will be published for public consultation and tabled in Parliament by mid-2017.

South Africa is also planning to diversify its energy basket to reduce reliance on coal as stated in the National Development Plan 2030. It needs to explore the potential benefits of developing competitive green industries and jobs, including in the renewable energy and energy efficiency sectors. The country has a huge potential to improve the efficiency with which it uses energy and hence reduce the carbon footprint.

7. SOUTH AFRICA POSITION IN THE INTERNATIONAL COMMUNITY REGARDING THE USE OF COAL AS A TRANSITION TO LOW CARBON ECONOMY

South Africa participates in the United Nation Framework Convention on Climate Change (UNFCCC), with a primary objective focus on mitigation against global warming and climate change. It highlights that fossil fuels combustion inevitably emits greenhouse gases including CO2; South Africa contributes about 450 Mt towards global CO2 emissions, whose mitigation can be achieved through employment of Clean Coal Technologies (CCT).

The Organisation for Economic Cooperation and Development (OECD) countries had adopted a position to discontinue investments in coal-fired power stations, together with the manufacture of machinery and equipment that maintains their operations. The OECD position presents a challenge towards South Africa or Eskom’s access in financing new coal-fired power plants in future unless CCT is employed. This OECD position on coal-fired power generation plants has been effective since January 2017.

The National Development Plan (NDP) provides South Africa’s vision for socio economic growth and advancement, recognising coal as playing a pivotal role in providing primary inputs in energy generation and a vital role that underpins industrialisation. The Department acknowledges that coal remains a backbone of South Africa’s economy through supply of accessible, cheaper and affordable form of energy. Coal mainly contributes 70% towards primary energy consumption, provides above 90% towards electricity generation and almost 30% to total liquid fuels.

South Africa is committed to the management of efficient use of its coal through employment of Clean Coal Technologies like Carbon Capture and Storage (CCS) for stabilisation of CO2; South Africa has made international commitments towards low carbon economy and in mitigation against climate change, and thus new coal fired power plants like Medupi and Kusile utilise supercritical CCT's and are classified as Carbon Capture and Storage ready.

8. POLICY AND REGULATORY FRAMEWORK

The mining sector in South Africa is regulated by a number of laws that guide operations within the sectors. The 1998 White Paper on Minerals and Mining Policy for South Africa remains the policy reference point for the mining sector. The document made clear the government's long term objective of mineral rights vesting in the state.

The National Development Plan (NDP) envisages that by 2030, South Africa will have an energy sector that promotes economic growth and development through adequate investment in energy infrastructure. The sector should provide reliable and efficient energy services at competitive rates, while supporting economic growth and job creation. More specifically, South Africa should have adequate supply security in electricity and in liquid fuels, such that economic activity, transport, and welfare are not disrupted.

The legislation governing the mining sector centres on the Mineral and Petroleum Resources and Development Act (MPRDA) of 2002, with the Amended Mining Charter (2010) and Minerals and Petroleum Royalty Act (2008) having a significant influence. This legislation pertains to all aspects of minerals, and therefore coal exploration, reserves and resources, mining, beneficiation and discards. The Act is comprehensive on environmental management of mining activities, taking a cradle to grave approach.

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. The National Energy Act allows for the strategic stockpiling of minerals but only after thorough consultation with stakeholders.

The use of coal for liquid fuels, metallurgy and industrial heat and power are additionally governed by the National Industrial Policy Framework (2007), and subsequent Industrial Policy Action Plans. The objectives of these policy documents are to diversify the economy beyond traditional commodities and non-tradable services; to intensify industrialisation towards a knowledge economy; to promote labour-intensive industrialisation; to promote broad based industrialisation and to support industrial development in Africa

In 1997 the White Paper on Environmental Management Policy was gazetted, representing a paradigm shift in the approach to environmental management in South Africa. The White

Paper policy was translated into legislation in the form of the National Environmental Management Act (NEMA) of 1998, which provides the legislative framework for environmental management in South Africa. The mining, beneficiation and use of coal have significant air quality implications, and are regulated under the National Environment Management: Air Quality Act (39 of 2004).

9. OUTLOOK

Growth in South African coal production will be driven primarily by domestic power demand as coal is still the cheapest source for electricity generation in the country. The use of coal in producing power will fall over the years, but absolute levels of coal power output are expected to continue to rise until 2026. This is supported by South Africa's 200 years' worth of coal reserves given the current production rate.

South African exports have been hit by Chinese restrictions on imports of coal containing high levels of sulphur and ash. However, demand from India is expected to offset that to some extent after the Indian government raised the coal ash limit for coal imports.

According to Industrial Development Corporation (IDC), thermal coal is not expected to register any significant price increases from current levels over the medium-term, as the increasing shift away from coal-fired power stations is gaining momentum globally. Demand from India is expected to be sustained, but lower Chinese consumption should underpin the flat price outlook. Also, the current low coal prices are likely to hamper any potential growth in short- to medium-term supply (PwC, 2016).

There is a significant improvement to infrastructure expected that will provide a boost to the sector. Transnet's plan to overhaul and expand the railway network will allow for much more efficient transportation of export coal, as well as reducing mining companies' costs. This is part of a Market Demand Strategy (MDS) that is underwritten by a R300 billion rolling Capital Investment Programme over seven years. Since the inception of the Strategy in 2011/12, Transnet has spent more than R80 billion, R31.8 billion of which was spent in 2013/14 in line with the MDS (Transnet, 2016). Most of the expenditure in the past three years concentrated on rail infrastructure maintenance and revitalisation as well as acquisition and refurbishment of rolling stock. This in turn will allow Richards Bay Coal Terminal (RBCT) to operate closer to its full capacity (Transnet, 2016).

10. CONCLUSION

In this report, the coal value chain was outlined from the occurrence of coal in the country including resources and reserves to the different uses of coal. The trend analysis show that coal supply has not changed much over the years mainly due to infrastructure constraints. Coal consumption in the transformation sector has also been stable, however declined in the final consumption by other sectors.

Coal plays an important role in the South African economy, and is the primary energy source for electricity generation. It is also the feedstock for producing a substantial proportion of the country's liquid fuels and provides a considerable source of foreign revenue from exports. Despite an abundant endowment of coal in South Africa, the industry is faced with challenges including supply and infrastructural and its continued use presents other challenges, mainly environmental. The document highlighted some of the steps taken by the South African government in addressing the infrastructure as well as the environmental challenges.

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