MINING

FOR SCHOOLS

MINERALS COUNCIL
SOUTH AFRICA

ECONOMIC GEOGRAPHY: COAL MINING IN SOUTH AFRICA


MINERALS COUNCIL
SOUTH AFRICA

CONTENTS

Coal is the cornerstone of South Africa's energy supply and will continue to play a key role in the country's economy for many years to come

Note: The Minerals Council South Africa was formerly known as the Chamber of Mines of South Africa

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SOUTH AFRICA

SECTION C1

Formed during the Carboniferous Period millions of years ago, coal is used as fuel to generate electricity through combustion and in numerous other industries

Glencore Tweefontein Colliery

WHAT IS COAL?

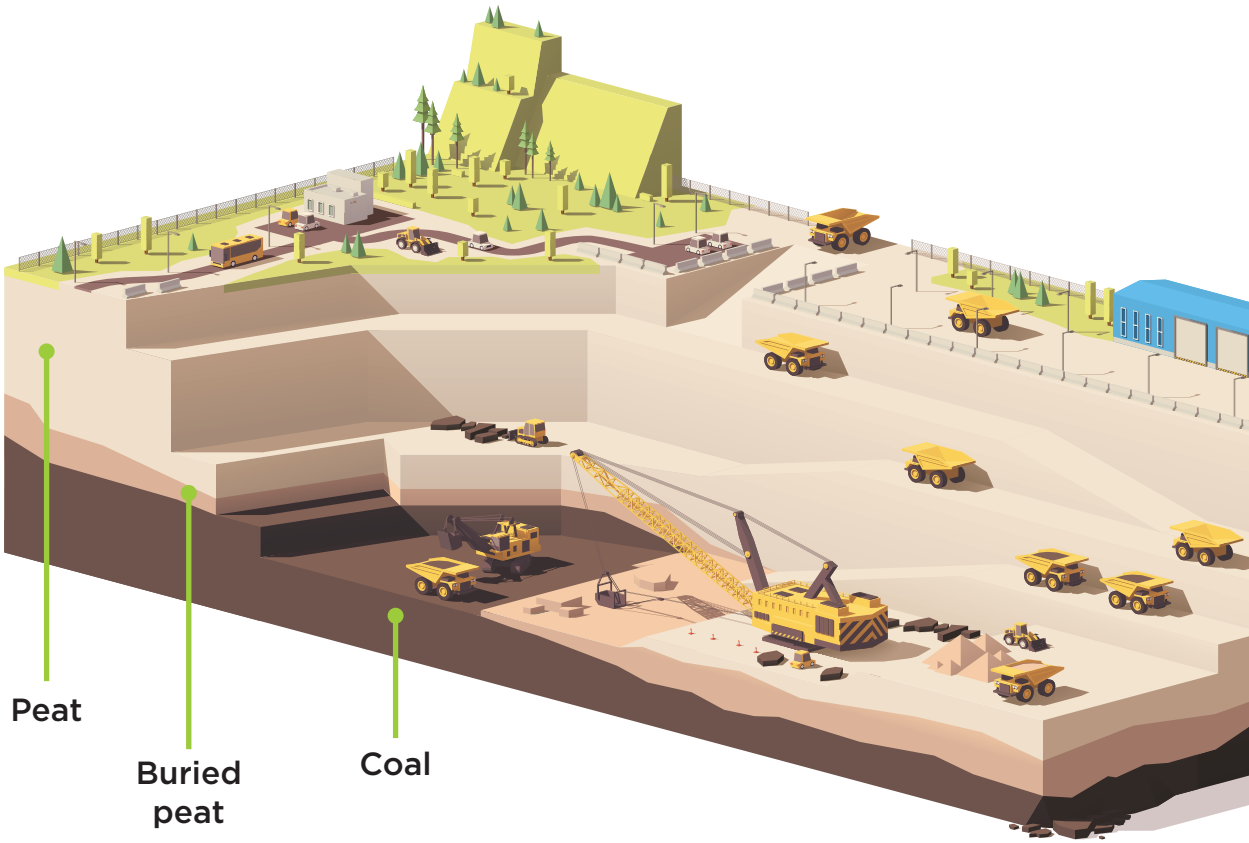
The word coal comes from the Old English *col*, meaning glowing ember.

Coal is a hard black or brownish-black rock formed in rock strata called coal seams. It consists mainly of carbon but also contains hydrogen, sulphur, oxygen and nitrogen.

Coal is formed when dead plant matter decays into peat and over millions of years the heat and pressure of deep burial converts the peat into coal. The harder forms of coal, such as anthracite, are metamorphic rocks, which means they were changed by very high temperature and pressure.

Coal is a fossil fuel and can be burned for energy or heat.

The earliest recognised use of coal by man is from the Shenyang area of China where by 4000 BC Neolithic inhabitants had begun carving ornaments from black lignite. Coal from the Fushun mine in north-eastern China was used to smelt copper as early as 1000 BC.



WHAT MAKES COAL SPECIAL?

1. Coal was formed in ecosystems during the Carboniferous Period millions of years ago
2. Coal seams exist on every continent
3. Coal has been used in South Africa since the Iron Age when charcoal was used to melt iron and copper
4. Since the 19th century, coal has been the largest source of energy for the generation of electricity worldwide
5. Coal supplies about a quarter of the world's primary energy (a primary energy is an energy form found in nature that has not been subjected to any human engineered conversion process)
6. About two-thirds of the coal mined today is burned in power stations to make electricity
7. Some iron and steel making and other industrial processes burn coal
8. Coal can be roasted (heated very hot in a place where there is no oxygen) to produce coke – a fuel used in smelting to reduce metals from their ores
9. Coal is a reliable and affordable source of energy and is the source of some of the most valuable chemicals known to man
10. Coal is the cornerstone of South Africa's energy supply and will continue to play a key role in the country's economy for many years to come – some 81% of the energy produced by Eskom is generated using coal

HCI Coal – Palesa Colliery

TYPES AND CLASSIFICATION OF COAL

As geological processes apply pressure to dead plant material, over time it is transformed into the following:

- Peat – this is not yet coal
- Lignite, or brown coal, the lowest rank of coal, used almost exclusively as fuel for electric power generation. Jet is a compact form of lignite that is sometimes polished and has long been used as an ornamental stone
- Sub-bituminous coal is used as fuel for steam-electric power generation
- Bituminous coal is a dense sedimentary rock, usually black, but sometimes dark brown. It is used primarily as fuel in steam-electric power generation, or heat and power applications in manufacturing and to make coke
- Steam coal was once widely used as a fuel for steam locomotives, where it is sometimes known as 'sea coal'
- Anthracite is the highest rank of coal. It is a harder, glossy black coal used primarily for residential and commercial space heating
- Graphite is no longer coal. It is difficult to ignite and not commonly used as fuel; it is most used in pencils, or powdered for lubrication

Peat

Lignite

Sub-bituminous coal

Bituminous coal

Steam coal

Anthracite

Graphite

Thermal v metallurgical coal: the most important coal classification

Coal classification	Use of coal
Thermal coal *Other name: steam coal*	Burnt to generate electricity via steam
Metallurgical coal *Other name: coking coal*	Burnt at a high temperature to make steel

MC Mining

USES OF COAL

Electricity production

Coal is mainly used as fuel to generate electricity through combustion. Thermal coal is used in power stations to generate electricity.

Steel production

The steel industry is the second largest user of coal. Coal and iron are essential raw materials used in the production of steel, which is one the most useful metals products known to man.

Coking coal is used as a fuel to melt iron in furnaces to produce cast iron which in turn is further refined to produce steel. Coking coal is a solid carbonaceous residue derived from low-ash, low-sulphur bituminous coal.

Cement

Coal is used as an energy source in the cement industry given that the production of cement is extremely energy-intensive. By-products generated from burning coal are also used in concrete production.

Paper and aluminium industries

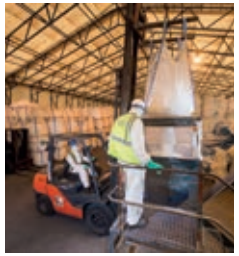
Both of these industries are energy-intensive. Given that coal is currently the most cost-effective source of energy, it is an essential input.

Chemical and pharmaceutical industries

Many chemical products are manufactured from the by-products of coal. Refined coal tar is used to make chemicals such as creosote oil, naphthalene, phenol and benzene.

Coal gas and coal liquid as transportation fuel

Coal can be converted into gas and liquid which can be used to fuel cars, motorcycles and ships.



Plant fertiliser

Coal can be turned into ammonia fertiliser by breaking it into carbon monoxide and hydrogen gas. The hydrogen mixes with nitrogen to make ammonia.

Glencore – Impunzi Colliery

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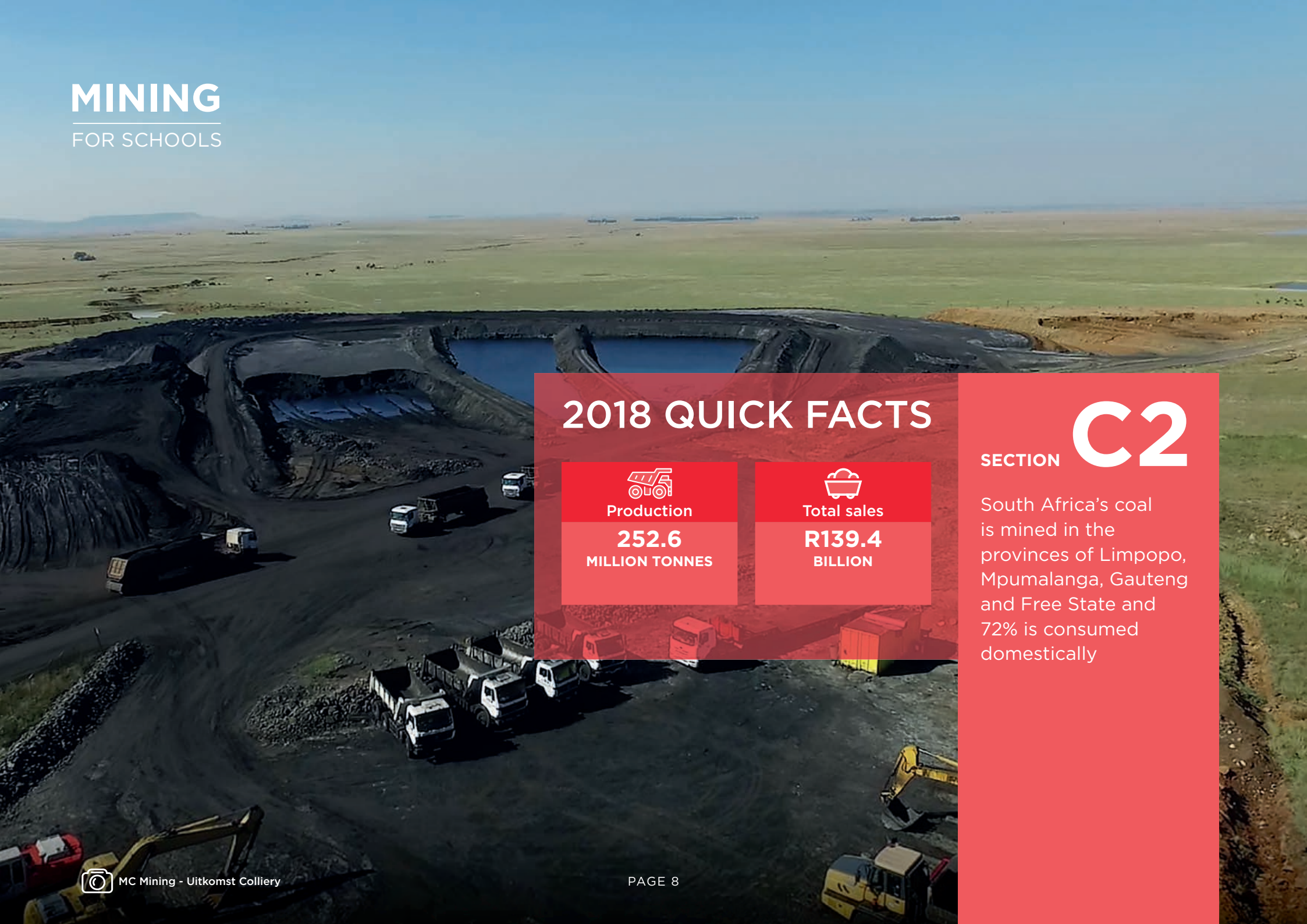


2018 QUICK FACTS

Production

252.6
MILLION TONNES

Total sales

R139.4
BILLION

SECTION C2

South Africa's coal is mined in the provinces of Limpopo, Mpumalanga, Gauteng and Free State and 72% is consumed domestically

MC Mining - Uitkomst Colliery

THE GEOLOGY OF COAL

At various times in the geologic past, the Earth had dense forests in low-lying wetland areas. Due to natural processes such as flooding, these forests were buried underneath soil.

As more and more soil deposited over them, they were compressed. The temperature also rose as they sank deeper and deeper. As this process continued, the plant matter was protected from breakdown, usually by mud or acidic water. This trapped the carbon in immense peat bogs that were eventually covered and deeply buried by sediments.

Under high pressure and high temperature, dead vegetation was slowly converted to coal. This coalification starts with dead plant matter decaying into peat. Then, over millions of years, the heat and pressure of deep burial causes the loss of water, methane and carbon dioxide and an increase in the proportion of carbon. In this way, first lignite (also called 'brown coal'), then sub-bituminous coal, bituminous coal, and lastly anthracite (also called 'hard' or 'black' coal) may be formed.

The wide, shallow seas of the Carboniferous Period provided ideal conditions for coal formation, although coal was formed in most geological periods. Coal is known from Precambrian strata, which predate land plants – this coal is presumed to have originated from algae.

South Africa's coal resources are contained in the Ecca deposits, a stratum of the Karoo Supergroup, and date from the Permian period between 280 and 250 million years ago. In general terms, they are largely located in the north-eastern quarter of the country. The coal measures are generally shallow, largely unfaulted and lightly inclined, making their exploitation suitable for opencast and mechanised mining.

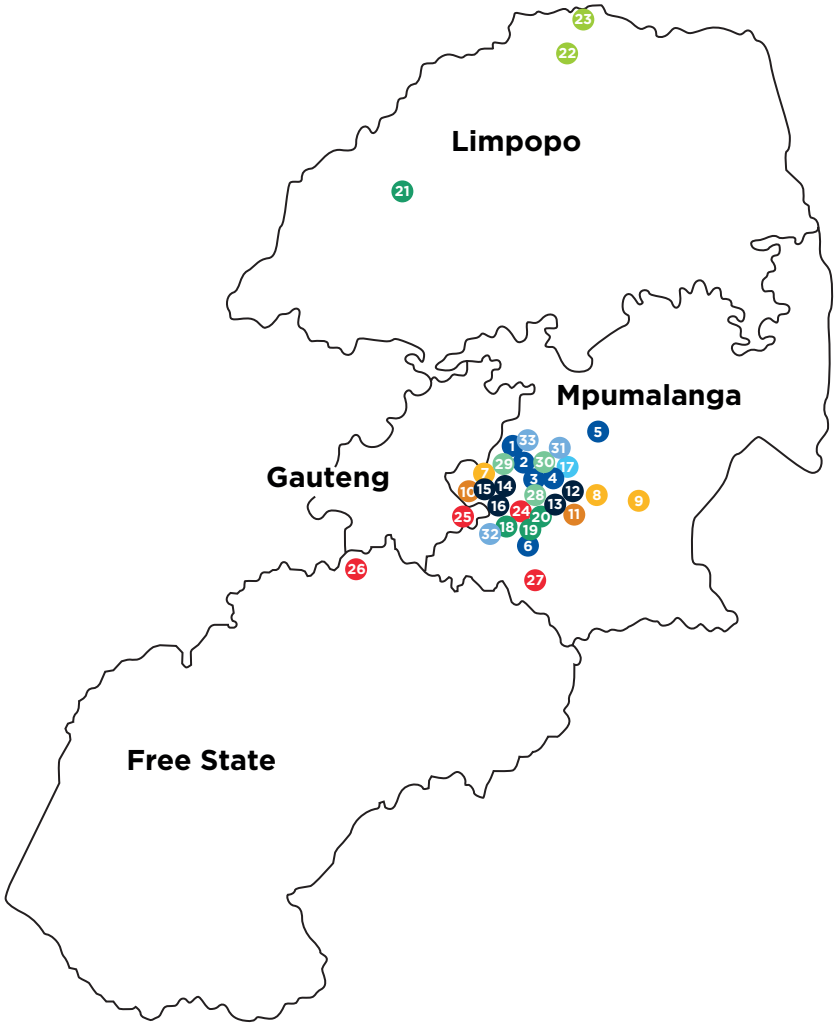
The largest reserves of coal are found in Europe (30%), North America (28%), East Asia (13%), South East Asia (12%) and South and Central Asia (11%). By comparison, Africa's resources, almost exclusively in South Africa, are estimated at a mere 3.5%.

Under high pressure and high temperature, dead vegetation was slowly converted to coal

WHERE COAL IS MINED IN SOUTH AFRICA

Legend

- Anglo American
- South32
- Universal Coal
- Glencore
- Sasol
- Exxaro
- MCMining
- Seriti
- Canyon Coal
- Wescoal



1 Landau
2 Greenside
3 Kleinkopie
4 Goedehoop
5 Mafube
6 Isibonelo
7 Khutala
8 Klipspruit
9 Wolvekrans
10 Kangala
11 North Block Complex
12 Umcebo
13 Izimbiwa
14 Impunzi
15 Tweefontein
16 Goedgevonden
17 Twistdraai
18 Leeuwpan
19 Matla
20 Exxaro Coal Central
21 Grootgeluk
22 Makhado
23 Vele
24 Kriel
25 New Largo
26 New Vaal Colliery
27 New Denmark
28 Hakhano
29 Phalanndwa
30 Singani
31 Elandspruit
32 Khanyisa
33 Vanggatfontein

SOUTH AFRICAN COAL MINING TODAY

In 2018, South Africa produced 252.6 million tonnes (Mt) of coal. Sales of coal were valued at R139.4 billion.

The country's coal mining industry employs over 86,900 people, who earn some R24.7 billion. Some 70% of the coal mined in South Africa is consumed domestically, with some 81% of electricity being generated from coal.

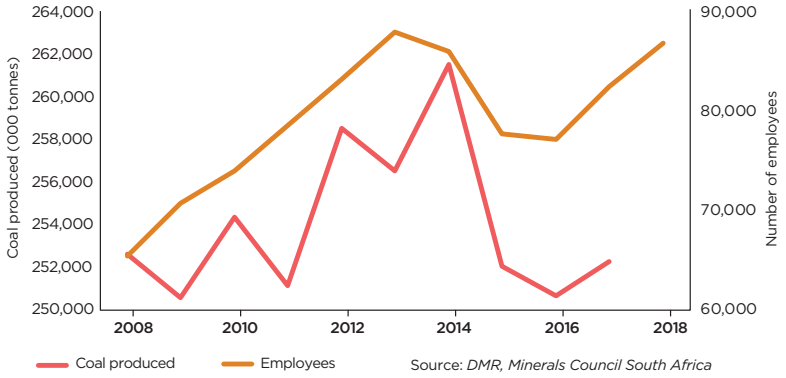
At current rates of production, South Africa has reserves sufficient to satisfy its needs for more than a century. With shallow and high-quality resources in the Witbank (or Emalahleni) coal field being depleted, mining companies are required to find alternative and more cost-effective methods to extract the deeper, low quality coal seams of the basin. In addition, emphasis is being placed on exploring and developing the Waterberg coal field as well as others in Limpopo province.

South African coal has a comparatively medium ash content, which can be reduced by washing before sale. Higher grades of coal are delivered to export markets with the lower-grade product burned by Eskom's specially-designed power station boiler hearths.

MAJOR SOUTH AFRICAN COAL MINING COMPANIES

AngloAmerican COAL
exxaro POWERING POSSIBILITY
GLENCORE
ledjadja coal part of resgen
MCMining LIMITED
resgen
sasol reaching new frontiers
SERITI
SOUTH32
Universal Coal
WESCOAL
canyoncoal

Coal production and employment: 2008 - 2018



Source: *DMR, Minerals Council South Africa*

2018 QUICK FACTS

Percentage exported (by value)	Royalties paid
49%	R1.6 BILLION

SECTION **C3**

The life cycle of coal mining begins with exploration and ends with the fossil fuel being transported locally and overseas

Universal Coal – Kangala Colliery

THE COAL MINING LIFE CYCLE

EXPLORATION

Coal exploration includes gathering data, which allows for decisions to be made on the desirability of further exploration, the technical feasibility of mining, and economic feasibility – including the size of the mine and the quality of the coal.

Geologic mapping, aerial photography and photogrammetry are all used in exploration. Drilling is the most reliable and cost-effective method of gathering information about a coal deposit and the mining conditions. It provides physical samples of the coal and overlying strata for chemical and physical analysis. Geophysical exploration measures the seismic, electric, magnetic, radiometric and gravitational properties of materials in order to detect the structural features that define the coal deposits.

MINE DEVELOPMENT

Coal can be extracted from the earth either by surface mining or underground mining.

In **open-pit coal mining**, a pit is dug in an area and this pit becomes the open-pit mine, sometimes called a quarry. Open-pit mines can expand to huge dimensions, until the coal deposit has been mined or the cost of transporting becomes too great.

In **underground coal mining**, access to the coal seam is gained by suitable openings from the surface, and a network of roadways driven in the seam then makes possible the installation of facilities for human and material transport, ventilation, water handling and drainage, and power.

OPEN-PIT MINING

Some 53% of South Africa's coal is produced from surface mining, via open-cast or open-pit mines. This is because the coal is less than 60 metres below the surface.

Open-pit mines use draglines, as well as truck and shovel operations to extract coal. A dragline excavator uses a dragline to pull a bucket by a wire cable. The operator lowers the bucket down to the coal deposit to be excavated. Next, the operator draws the cable so that the bucket gets dragged along the ground and digs into the deposit. The bucket is then lifted and places the coal it has scooped up where it is needed.

Coal can be extracted from the earth by surface mining or underground mining

Universal Coal – Kangala Colliery

THE COAL MINING LIFE CYCLE CONTINUED

UNDERGROUND MINING

Some 47% of South Africa's coal is produced from bord-and-pillar mining, stoping and longwall mining, types of underground extraction which access coal up to 300 metres under the ground.

Miners travel by lifts down a mine shaft to reach the depths of the mine or enter by means of decline shafts or adits for shallower mines. They operate heavy machinery that extracts the coal and moves it above ground.

In **longwall mining**, continuous longwall miners slice off enormous panels of coal that are about one metre thick, three to four kilometres long, and 250-400 metres wide. The coal is moved by conveyor belt back to the surface. The roof of the mine is maintained by hydraulic supports. As the mine advances, these supports also advance. The area behind the supports collapses.

Stoping is practised when the surrounding rock is strong enough to permit the drilling, blasting, and removal of the coal without caving. In most cases artificial support is also provided.

In **bord-and-pillar mining**, miners carve a 'gallery' out of coal. Columns (pillars) of coal support the ceiling and overburden. The galleries are about nine metres wide, and the support pillars can be 30 metres wide.

A sophisticated machine called a continuous miner extracts the coal or more conventionally, coal can be blasted from the working face.

Underground mining operations leave tailings. Tailings are the residue left over from the process of separating coal from economically unimportant minerals during the coal processing step at plants.

VENTILATION

Underground-mine ventilation provides oxygen to the miners and dilutes, renders harmless, and carries away dangerous accumulations of gases and dust. In some of the gassiest mines, more than six tonnes of air are circulated through the mine for every tonne of coal mined. Air circulation is achieved by creating a pressure difference between the mine workings and the surface through the use of fans. Fresh air is also brought near the production faces, the locations of which may change several times in a shift.

MONITORING AND CONTROL

Advancements in sensor technology and in computer hardware and software capabilities are finding increasing application in underground coal mines, especially in the monitoring and control of ventilation, haulage, and machine condition. Machinery can be remotely operated, and continuous miners have also been equipped with automatic controls. The atmospheric environment is remotely monitored for air velocity, concentrations of various gases, and airborne dust; fans and pumps are also monitored continuously for their operational status and characteristics.

HAULAGE

Coal haulage, the transport of mined coal from working faces to the surface, is a major factor in underground-mine efficiency. It can be considered in three stages: face haulage, which transfers the coal from working faces; intermediate haulage, which transfers the coal onto the main haulage; and the main haulage system, which removes the coal from the mine. Various methods of haulage are used in different situations and stages and may include electric-powered, rubber-tyred vehicles; chain haulage; armoured face conveyors, mine cars driven by electric- or diesel-powered locomotives.

Workers and materials may be carried to and from the working face by scoops, battery- or diesel-powered trucks, tractors, buses or light duty vehicles.

THE COAL MINING LIFE CYCLE CONTINUED

COAL PREPARATION

The coal that comes directly from a mine has impurities in it. Buyers may demand certain specifications depending on the intended use of the coal: utility combustion, carbonisation, liquefaction, or gasification.

A coal preparation or beneficiation plant is a facility that washes coal of impurities such as ash, soil and rock, crushes it into graded and sized chunks (sorting), stockpiles grades, and prepares and loads it for transport to market.

The more of this waste that can be removed from coal, the lower its total ash content, the greater its market value (because its heating value has increased) and the lower its transportation costs.

TRANSPORTING

Once coal has been prepared, higher grades are delivered to export markets while the lower-grade product is purchased by Eskom and burned in specially-designed power station boiler hearths.

Richards Bay Coal Terminal (RBCT) serves as the primary export port for South African coal, and is one of the world's leading coal export terminals. South Africa's national utility, Transnet, provides the railway services linking the coal mines to the port, and the shipping coordination of more than 900 ships per annum.

Opened in 1976 with an original capacity of 12 million tonnes per annum, RBCT has grown into an advanced 24-hour operation with a design capacity of 91 million tonnes per annum.

Positioned at one of the world's deep sea ports, RBCT is able to handle large ships and subsequent large volumes. It has gained a reputation for operating efficiently and reliably. The 276 hectare site currently boasts a quay 2.22 kilometres long with six berths and four ship loaders, with stockyard capacity of 8.2 million tonnes.

REHABILITATION

Reclamation operations include backfilling, regrading the final surface, and revegetating and restoring the land for future use. These actions are carried out at the same time as the mining operation in order to reduce erosion and sediment discharge, slope instability, and water-quality problems.

A primary goal of reclamation is to restore or enhance the land-use capability of disturbed land. Various reclamation programmes aim to restore the ground for farming and livestock, reforestation, recreation, and housing and industrial sites.

MINING
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2018 QUICK FACTS

Employee earnings

R24.7
BILLION

86,919

Direct employees

SECTION C4

Increasingly employees and their families live and work closer to coal mining regions

Seriti - New Denmark Colliery

PEOPLE OF COAL

South Africa's coal mining industry is an important employer in its areas of operation, largely around the Emalahleni coalfields in Mpumalanga province and increasingly on the Waterberg coalfields in Limpopo. The sector employs over 86,900 people, who earn some R24.7 billion.

Employment is created through direct employment by mining companies and indirectly through contractors, and suppliers of goods and services. It is estimated that for every direct job created in the mining industry, a further two to three jobs are created.

The employee profile of the coal mining industry is changing to reflect the people of South Africa. The 2004 Mining Charter provided a framework for the entry, at all levels, of historically disadvantaged South Africans into the industry, including women.

The Department of Mineral Resources (DMR) and coal mining companies encourage women to be active at all levels in the industry. The Mining Charter set a target of 10% for women in core mining jobs and by 2014 overall representation had reached 10.5%. Coal industry members meet, and in some instances, exceed Mining Charter requirements. The coal mining industry strives to ensure that women are attracted to the coal mining industry and that they are retained. Coal mining companies have also implemented career development programmes to develop and fast track women who show promise.

Some coal mining companies have created ownership opportunities to ensure a more equitable distribution of profits. Ownership is implemented through share schemes, employee/community trusts and employee stock ownership plans.

Historically, the coal mining industry drew large numbers of employees from neighbouring countries and rural areas in South Africa but this pattern of migration has changed significantly in recent years. Companies in this sector still draw employees from all over southern Africa, but increasingly employees and their families live and work closer to mining regions.

Glencore – Impunzi Colliery

EMPLOYMENT IN THE COAL MINING INDUSTRY

Coal sector employees tend to be more highly skilled than in other mining sectors, and consequently earn more. This is because mechanisation is far-advanced in the coal sector, both in the large-scale surface and underground coal mines, which tend to be less labour-intensive than deep-level gold and platinum operations.

Employment in the coal sector means more than just a job, but rather a career with opportunities for development. In addition to basic wages, employees are eligible for benefits, such as healthcare, accommodation, training and development.

On-the-job training is an important component of companies' skills development initiatives. Career development and educational support programmes are also offered to employees who are able to further their careers at no cost, and increase their earnings and quality of life in the future. Bursaries, learnerships and apprenticeships are offered to address skills shortages and empower suitable candidates within the company.

Employment fields within the coal industry are many and include engineering; geology; finance, auditing and accountancy; company secretarial; human resources; medical; environmental science; and safety, among others.

There are several routes available to people wishing to take up a career in coal mining. The Mining Qualifications Authority (MQA) is a Sector Education and Training Authority (SETA) responsible for the administration of skills-development programmes for the mining and minerals sector in South Africa. Mining-related qualifications are offered at the universities of the Witwatersrand, Johannesburg, Pretoria and Free State.

BRIEF HISTORY OF COAL MINING IN SOUTH AFRICA

300 TO 1880

Coal used in South Africa during Iron Age when charcoal was used to melt iron and copper

1864

Commercial coal mining commences in the eastern Cape near Molteno

Early 1870s

The discovery of diamonds in the Kimberley area leads to the expansion of the coal mines in order to meet growing demand for power

Late 1880s

Commercial coal mining in KwaZulu-Natal and on the Witwatersrand commences, following the discovery of gold on the Witwatersrand in 1886

1927

The government creates the Iron and Steel Corporation (Iscor), which becomes the dominant steel producer in the country. Iscor begins construction of the Pretoria steel mill

1939 ONWARDS

Demand for coal grows exponentially as country enters period of industrialisation during and following World War 2

Coal sector is in local private hands – largely those of the old mining houses

1950

South African Synthetic Oil Limited (Sasol) established

1952

South Africa's first power station built in Pretoria West. Major programme of building power stations begins, particularly on coal fields of Witbank and Delmas

1955

Sasol produces its first oil from coal

1960

A total of 435 men die in the Coalbrook colliery disaster

1963

The then Chamber of Mines establishes the Chamber of Mines Research Organisation (COMRO), which goes on to revolutionise safety in mining

1970s

During oil crises, foreign oil companies vie for coal resources and establish new collieries to serve export markets

1976

Richards Bay Coal Terminal (RBCT) established as a partnership between the then leading coal companies with an initial annual capacity of 12Mt

Early 1980s

Sasol's major coal-based synfuels and organic chemicals complex at Secunda is constructed. The Sasol II unit was constructed in 1980 and the Sasol III unit in 1984

1986

Mining industry introduces mandatory life-sustaining refuge chambers and self-contained self-rescuers

1989

Iscor is privatised and listed on the Johannesburg Stock Exchange

1990

COMRO and its research programmes are taken over by the Council for Scientific and Industrial Research (CSIR) when it sets up its mining innovation division

1993

An explosion at Sasol's Middelbult colliery results in the death of 53 workers. An inquest into the explosion finds that coal dust was the primary fuel for the explosion

Leon Commission of Inquiry into Safety and Health in the Mining Industry leads way to new Mine Health and Safety Act (MHSA)

1994

First democratic election in South Africa

Coal company ownership transferred increasingly into the hands of historically disadvantaged South Africans

Fossil Fuel Foundation established

1995

Around one million lower-income households dependent on coal as their primary energy source for cooking, lighting and heating. Since then, electricity supply has been expanded to lower-income households and those in rural areas

1999

Coaltech 2020 Research Programme established

2001

Iscor is unbundled, spinning off its mining interests as Kumba Resources

2002

New Mineral and Petroleum Resources Development Act implemented

Now

Eskom is building two modern thermal power stations, Medupi and Kusile, based on coal reserves in Mpumalanga and Limpopo provinces

2030

South Africa's National Development Plan (NDP) envisages that the proportion of people with access to the electricity grid should have risen to at least 90%, with non-grid options available for the remainder

SECTION C5

The South African coal mining industry believes coal can and should remain part of the energy mix

Seriti – New Vaal Colliery

WHY COAL MINING MATTERS

Coal remains one of South Africa's most abundant and valuable resources. Coal has been instrumental in South Africa's development, not only for the mining sector, but also for the broader industrialisation of the country. The coal mining industry benefits the South African economy and its people in many ways:


Glencore - Goedgevonden Colliery

1. Over 81% of South Africa's electricity requirements and over 30% of liquid fuel demand (coal-to-liquids technology) are derived from coal
2. South Africa ranks amongst the world's top 10 global coal producers, producing around 250 million tonnes annually since 2010. In 2015, coal production represented 3.7% of global output
3. The coal mining industry employed nearly 87,000 people in 2018
4. The industry currently pays its employees some R24.7 billion in salaries and wages per annum
5. Employment is provided for workers from rural communities, which in turn results in the transfer of funds back to these areas
6. It is estimated that for every direct job created in the industry, a further two to three jobs are created down and up-stream, in such sectors as electricity, manufacturing, construction and finance
7. The industry spent R56 billion procuring goods and services in 2018
8. The industry paid some R1.6 billion in royalties in 2018
9. In 2018 the industry produced 252.5 million tonnes of coal and contributed R139.4 billion in sales
10. The industry is a major contributor to transformation through the Mining Charter and to community development through SLPs
11. Coal mining has a role to play in the development of human resources (training) and infrastructure, such as schools, colleges, clinics, roads and housing
12. Coal export earnings have a positive impact on the balance of payments, foreign reserves, monetary policy and on the level of business activity in the country
13. Nearly R14 billion of dividends were paid to shareholders in 2018
14. Coal mining attracts foreign capital to the country, via the JSE or direct investment

FACTORS THAT HINDER AND FAVOUR COAL MINING IN SOUTH AFRICA

FACTORS HINDERING COAL MINING IN SOUTH AFRICA

- **REDUCED DEMAND** Negative views on coal and its environmental impact have resulted in a major decline in its use by the major economies of the world. Because of coal's contribution to greenhouse gas (GHG) emissions, many countries have put in place strict environmental laws which have affected demand for coal. Renewable energy sources (wind, solar, hydroelectric, hydrogen and fuel cells) are beginning to take the place of fossil-based energy sources.
- **POLICY AND REGULATORY FACTORS** The proposed carbon tax will affect all coal users and reduce the competitiveness of South Africa's producers.
- **ACCESS TO CAPITAL** The enacting of environmental laws around the world has seen less and less credit being extended to the construction of coal power plants. The World Bank and the International Monetary Fund do not want to lend funds to utilities and governments that want to build coal power plants. Eskom is one example. Since 2009, net investment in the coal industry has declined at a rate of 10% per year – from R7.3 billion to R3.8 billion in 2017.
- **ELECTRICITY SUPPLY** Developments at Eskom, the South African national electricity supplier, have affected the sustainability and reliability of supply.
- **INADEQUATE INFRASTRUCTURE** The lack of rail and water infrastructure are the main challenges in the development of new coal mines in the Greater Waterberg area and this is currently limiting investment in coal mining in the area. South Africa's water scarcity means there is a lack of water infrastructure such as dams and canals.
- **LAND ACCESS** Mining competes with other sectors such as agriculture and manufacturing for land use.

FACTORS FAVOURING COAL MINING IN SOUTH AFRICA

- Coal is currently the cheapest baseload technology in South Africa (ie the cheapest way to meet the minimum level of demand on an electrical grid over a span of time). South Africa currently has limited alternative solutions for reasonably-priced power other than coal. The industry believes coal can and should remain part of the energy mix.
- Clean coal technologies have been developed which will enable South Africa's move towards a greener future. These technologies include HELE (high efficiency, low emission); beneficiation of discarded coal resources for power generation; underground coal gasification (UCG); and carbon capture storage (CCS). The coal industry believes that this can be done in a way and within a timeframe that can enhance the competitiveness of the South African economy.
- South Africa's coal regions are well known and well explored – knowledge of the area is extensive.
- South Africa has large coal reserves and resources. Companies invest heavily in innovation and skills training to build an even greater understanding of the resource base and how to mine it.
- Coal mining in South Africa is a well-established industry with technical skills.

SAFETY AND HEALTH


Glencore - Teenfontein Colliery

SAFETY

Background

South Africa's coal deposits are relatively shallow with thick seams compared to coal deposits in other countries, making it suitable for fairly shallow underground and opencast mining operations.

The South African coal mining industry is technologically advanced and less labour intensive than other sectors of the mining industry. Central to the coal mining industry's approach to improving safety is the removal of miners from working-face dangers and potential health hazards.

The industry is guided by extensive health and safety legislation and regulations. Government monitors and enforces compliance to health and safety measures at mines and audits and inspections are conducted to ensure compliance.

Rigorous safety procedures, health and safety standards and employee education and training programmes have resulted in significant improvements in safety performance in both underground and opencast coal mining.

The most significant safety issues are:

Falls of ground

Mining activities impose abnormal stress on the surrounding rock. The term 'fall of ground' describes accidents that relate to unexpected movement of the rock mass and the uncontrolled release of debris and rock, as a result of gravity and/or pressure and strain burst.

Improvements in rock engineering techniques, seismic monitoring and improved roof support using bolting and netting have minimised risk and significantly reduced the incidence of falls of ground in working areas.

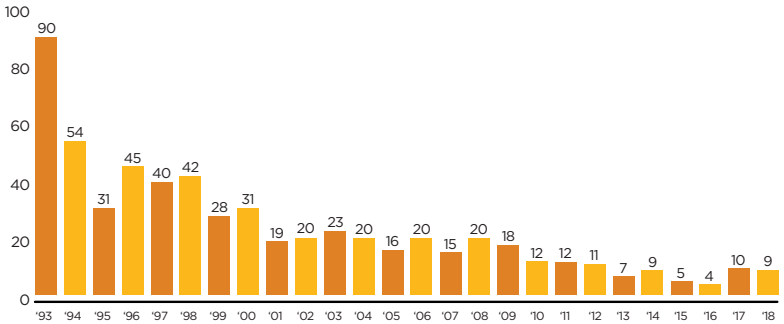
Explosions as a result of methane or particulates

Methane gas is inherently present in the coal seam and surrounding rock, and presents a risk of uncontrolled ignition. The presence of dust particulates add to the risk of explosion. Techniques have been developed to monitor and manage the presence of methane. For example, large fans ensure dilution of methane, while dust prevention measures limit the levels of coal dust particulates in the air. In extreme situations, methane inhalation may result in asphyxiation. Underground methane levels are monitored continuously using methanometers which detect tiny parts per million of methane, and immediately transmit methane concentration readings, providing warnings to mineworkers and management to take the necessary action.

Safety performance

South African coal mines continue to be among the safest mines in the world. The number of fatalities in the South African coal industry decreased by 89% from 1933 to 2016, while the number of serious injuries decreased by 31% over the same time period. Regrettably, in 2017, the industry saw a regression in terms of safety performance, with 10 fatalities reported. Since 2017, the mining industry as a whole has redoubled its efforts to achieve its goal of zero harm.

Number of fatalities in South African coal industry (1993 - 2018)



SAFETY AND HEALTH CONTINUED

Safety and technology

Following the Kinross gold mine disaster in 1986, the mining industry introduced mandatory life sustaining refuge chambers and self-contained self-rescuers.

Through technological advancements such as these, coal mining has seen an increase in safety standards for employees. Improved pillar and roof support infrastructure has mitigated against falls of ground fatalities and injuries. Mine planners are able to efficiently map mines, monitor coal seams, and locate potential problems before they pose a danger to mine workers.

There have been vast improvements in communication devices that are able to stay active during power outages, fan stoppages or gas accumulations. It is vital that workers are able to communicate with each other at all times especially during life-threatening situations.


Universal Coal

HEALTH

The South African coal mining industry is concerned about the overall health and well-being of employees, in and outside the workplace. The industry provides access to health care and promotes healthy living.

Occupational health programmes help prevent and mitigate occupational health risks. Exposure to health risks is analysed, monitored and managed, and preventative measures are taken. Employee communication about risk and prevention is vital. Rehabilitation and return-to-work programmes are also provided.

The industry promotes a healthy workforce through health and wellness programmes. Wellness programmes aim to reduce health risks, provide access to health care, and educate, inform and empower employees to take responsibility for their own wellbeing. Focus is on reducing lifestyle diseases (such as hypertension, diabetes and cholesterol levels), managing the risks of human immunodeficiency virus (HIV) infection, and effectively managing mental health conditions.

Occupational health issues

The primary occupational health concerns associated with coal mining in South Africa are dust-induced occupational lung diseases and noise-induced hearing loss (NIHL).

Dust-induced occupational lung diseases

Dust exposure in coal mines is a risk factor for occupational lung diseases such as coal workers' pneumoconiosis, also known as black lung; chronic obstructive airways disease; and lung function deficiency.

Employee exposure varies considerably as some employees are continuously exposed while others are exposed for short periods of time. Measuring is key to understanding exposure and to designing effective dust control. Dust sampling in the South African coal industry has been a legal requirement for several decades. Daily dust-suppression inspections take place at operations and reports are made to the DMR on dust levels.

Dust suppression systems are critical to preventing the exposure of employees to unacceptable levels of dust. Coal mining companies have been using dust-suppression since the 1960s and have been at the forefront of developing new dust-suppression equipment and techniques in South Africa. Equipment such as continuous miners are remotely-controlled and contain dust-suppression technology, such as high-pressure water-spray systems and scrubbers.

Coal mining employees are equipped with personal protection equipment (PPE).

Operations are continuously ventilated, which contributes to a healthier working environment as large quantities of clean air enter the mine areas underground and dilute the dust concentration.

At an occupational health and safety summit in November 2016, mining industry stakeholders agreed that, by December 2024, 95% of all exposure measurement results of coal dust respirable particulate must be below the level of 1.5mg/m^3 (<5% silica).

Noise induced hearing loss

NIHL has been recognised as a major occupational health risk in the South African coal mining industry. Prolonged exposure to hazardous noise more than 85dBA causes loss of hearing, which occurs gradually.

Throughout the industry, emphasis is placed on noise suppression (that is silencing at the source) and hearing conservation.

SAFETY AND HEALTH CONTINUED


Glencore - Teenfontein Colliery

An important part of hearing conservation is noise monitoring to prevent exposure, provision of PPE, and regular hearing tests.

Occupational health and safety targets were set by the Mine Health and Safety Council in 2014 with the aim of eliminating NIHL.

Public health issues

Public health issues affect the health and wellbeing of our employees outside of the workplace but also have the potential to impact safety and health in the workplace.

Pulmonary tuberculosis (TB)

TB has a high social and economic cost, both for the individuals concerned and for the whole industry. It is a serious infection and is the leading cause of death for people living with HIV.

The coal mining industry's wellness programmes educate employees about TB and provide support for the management of the disease.

HIV/AIDS

The prevention, management and treatment of HIV/AIDS plays a critical role in the well-being of employees and communities – and is also key to sound economic and social development. The South African coal mining industry works together with government to address this issue.

Industry initiatives include HIV wellness programmes which educate employees about HIV/AIDS and its prevention; testing and counselling; and treatment programmes. The coal mining industry was in the forefront of rolling out antiretroviral therapy (ART) to employees.

Fatigue and substance abuse management

Employee fatigue is a critical safety issue affecting many mines in South Africa. Many accidents point to fatigue as the cause or a contributing factor. Fatigue develops for many reasons including physically demanding work activities and an unhealthy lifestyle, which may include the abuse of alcohol and drugs. The industry has a zero tolerance approach to drug abuse in the interests of all employees' safety.

The industry incorporates fatigue and substance abuse management into its mine safety management systems. Wellness programmes address the subjects of work fatigue and alcohol and drug abuse and emphasise the need for a healthy lifestyle.

ENVIRONMENT


Seriti - Kriel Colliery

The coal mining industry acknowledges that its operations directly and indirectly impact the environment.

Mine management implements environmental management plans and strategies. These plans generally use legal compliance (such as permits and licences) as the minimum requirement. The industry engages with all stakeholders about environmental matters, including government, environmental protection agencies and NGOs.

ENVIRONMENTAL MONITORING

Environmental monitoring and compliance audits are conducted annually, as part of coal mining companies' environmental management systems. These audits are conducted by independent environmental auditors and their reports are submitted to the DMR and the Department of Water and Sanitation (DWS) for review.

Full-time environmental officers monitor compliance with environmental management programmes, authorisations and water use licences.

Coal mining companies require integrated water use licences (IWUL) which regulate the use of water according to the National Water Act. An IWUL is granted or can be suspended at any time by the regulator. Annual monitoring of water use licence conditions is conducted by independent specialists and submitted to the DWS.

WATER

Coal mining can affect groundwater and water table levels and acidity. Spills can contaminate land and waterways. Power stations that burn coal consume large quantities of water, with the potential to affect river flow and impact other land uses.

The coal industry understands that South Africa is a water scarce country and that water is a precious resource. The industry's most important water management principle is to responsibly source and use water, in a way that has minimum negative impact on stakeholders and allows host communities to meet their socio economic needs.

The coal mining industry has a duty to ensure that water is fairly and appropriately distributed among stakeholders and mining operations. Mining companies tend to use potable water only for non-mining activities, such as staff accommodation and offices. Non-potable water, otherwise known as industrial water, is used in mining and processing operations as far as possible.

It is also crucial that coal mines ensure waste water is not discharged into the natural environment and that, wherever possible, water is recycled. Clean runoff can be discharged into surrounding water courses, while other water is treated and can be reused in processes such as dust suppression, irrigation of rehabilitated areas and in coal preparation plants.

POLLUTION

Acid rain is rainfall made acidic by atmospheric pollution to the extent that it causes environmental harm, chiefly to forests and lakes. The main cause is the industrial burning of coal and other fossil fuels, the waste gases from which contain sulphur and nitrogen oxides (SO_x and NO_x) which combine with atmospheric water to form acids.

The coal-burning power stations and large metal working industries of South Africa are concentrated in Mpumalanga province. This area produces most of the country's pollution, producing millions of tonnes of sulphuric and nitric acid a year. Acid rain occurs in this region.

Satellite data produced by a European Space Agency satellite and analysed by Greenpeace between 1 June and 31 August 2018 showed Mpumalanga's nitrogen dioxide (NO_x) emissions to be the highest in the world. According to the World Health

Organisation, the gases aggravate asthma and bronchitis symptoms and are linked to cardiovascular and respiratory disease.

A range of interventions, known as clean coal technologies, are being developed to address atmospheric problems resulting from burning coal. SO_2 can be removed by flue-gas desulfurisation and NO_x by selective catalytic reduction.

Coal particulates cause visible air pollution, illness and premature deaths. Particulates can be removed with electrostatic precipitators. Although perhaps less efficient, wet scrubbers can remove both gases and particulates. Mercury emissions can be reduced up to 95%.

REHABILITATION

The protection and restoration of the land surrounding a mine, including natural habitat, is ongoing throughout the mine's operation, not just at closure. Mines plan for habitat rehabilitation according to their closure plans and in accordance with their environmental management plans and rehabilitation plans.

Indigenous flora and fauna and cultural heritage sites are preserved by mines. Stakeholders' ancestral heritage and ongoing traditions are believed to be sacred and are managed accordingly. Independent specialists assess and monitor biodiversity performance continuously.

Exxaro

COAL MINING AND CLIMATE CHANGE

Coal currently forms the backbone of South Africa's economy as the primary source of energy for electricity generation, and as an essential raw material for steel production. It is also true that the use of coal contributes significantly to carbon emissions which have an impact on climate change.

The most serious and long-term effect of coal use is the release of carbon dioxide, a greenhouse gas that causes climate change and global warming. Coal is the largest contributor to the human-made increase of CO_2 in the atmosphere, some 40% of the total.

In 2016, world carbon dioxide emissions from coal usage stood at 14.5 giga tonnes. In 2013, the head of the UN climate agency advised that most of the world's coal reserves should be left in the ground to avoid catastrophic global warming.

The South African coal mining industry recognises and accepts the science of climate change and that human activities have a negative impact on the earth's climate. The industry also recognises the need to act to ensure that South Africa remains competitive in a carbon-constrained world.

The South African government ratified the Paris Agreement on Climate Change which came into effect on 4 November 2016, demonstrating government's commitment to address the challenges associated with climate change.

We currently derive over 81% of our electricity requirements from coal in this country. Coal remains the cheapest baseload technology. The industry believes that if the South African economy is to remain competitive, and able to meet energy demands, it is critical that the 'least cost option' for electricity generation forms part of the energy mix. Since coal will continue to play an important role in the South African economy, the industry is committed to investing in and using clean coal technologies (see page 28) in order to actively participate in the country's transition to a low carbon economy.

The coal mining industry itself adopts a strategy of energy efficiency at its operations in order to reduce electricity consumption, and therefore reduce impact on climate change.

Anglo American - Greenside Colliery

COAL MINING TECHNOLOGY

TECHNOLOGICAL IMPROVEMENTS

The South African coal mining industry is extensively mechanised. Mine mechanisation helps tackle safety, cost and productivity issues. Machines such as remote-controlled continuous miners are used. A continuous miner is a mining machine that produces a constant flow of ore from the working face of the mine. The machine continuously extracts as it is loading coal with a cutting steel drum and conveyor system.

Modern technology in coal mining increases the safety of workers and enables mine planners to map mines efficiently, monitor orebodies, and track output volumes and productivity more accurately. Dragline operators, for instance, use an in-cab display which provides extensive technological information.

South Africa's coal deposits are relatively shallow with thick seams. This makes it easier and less expensive to mine. Owing to a decline in high-quality reserves in recent years, there has been an increased push by the industry to upgrade technologies and, ultimately, extend the life of major coal deposits.

Some companies have identified the opportunity to use binderless coal briquetting technology. This technology allows coal mines to upgrade discarded thermal coal fines into compacted, transportable and useable briquettes of higher value.

Clean-coal technologies

Coal is currently South Africa's primary energy source and, as a result, the country is one of the world's most emissions intensive economies, emitting about 400 million tonnes of carbon dioxide (CO_2) a year. This represents about 1% of global emissions. The country's synthetic fuels and petrochemicals industry, dominated by Sasol, is also a significant CO_2 emitter.

According to the World Coal Institute, over 90% of greenhouse gas emissions from coal occur during combustion. A range of interventions, known as clean coal technologies, are being developed. In certain instances, these have already been employed in the effort to mitigate the environmental consequences of coal combustion. South Africa's remaining coal reserves are generally of a lower quality, with higher ash content, than the coal that has been mined over the past three decades. Clean-coal technologies have the potential to optimise this coal and the large quantities of discard coal for economic and energy purposes through beneficiation.

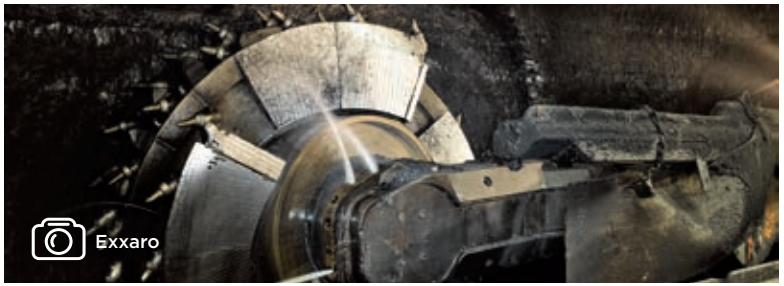
Pulverised coal combustion

Increasing power station efficiency will also result in reduced greenhouse gas emissions. The efficiency of coal-fired power stations can be increased through a technology known as pulverised coal combustion. This involves the combustion of a cloud of finely-ground coal particles. Greater efficiency and lower emissions have also been achieved through increasing operating temperatures and pressures of existing steam cycles.

Carbon capture and storage

Clean-coal technologies, such as post-combustion pollutant capture and carbon capture and storage (CCS), are being developed and employed to mitigate the environmental impact of greenhouse gases and other air pollutants emitted during coal combustion. These technologies include electrostatic precipitators and low NO_x burners for the removal of NO_x, and flue gas desulphurisation for the elimination of SO_x. Further, CCS involves preventing CO_2 produced through combustion from entering the atmosphere and then storing it underground in deep-seated porous rock strata on land or similar strata under the seabed.

The South African National Energy Research Institute has established the Centre for Carbon Capture and Storage, which is working towards having a CCS demonstration plant operational in the country by 2020.



QUOTES ABOUT COAL

Holding on to anger is like grasping a hot coal with the intent of throwing it at someone else; you are the one who gets burned.

Buddha

Perhaps time's definition of coal is the diamond.

Khalil Gibran

Affection is a coal that must be cooled; else, suffered, it will set the heart on fire.

William Shakespeare

Eating coals of fire has always been one of the sensational feats of the Fire Kings, as it is quite generally known that charcoal burns with an extremely intense heat.

Harry Houdini

Coal is a portable climate.

Ralph Waldo Emerson

A diamond is a chunk of coal that did well under pressure.

Henry Kissinger

To shipbrokers, coal was black gold.

Roald Dahl

FUN FACTS ABOUT COAL

- The amount of energy produced by the sun in a two-week period equals the combined stored energy of all the coal, iron, and natural gas reserves known to man
- The ash that is a by-product of coal combustion is used as fillers for things such as tennis rackets, golf balls and linoleum
- The energy we get from coal today comes from the energy that plants absorbed from the sun millions of years ago
- Tinnunculite is a naturally occurring material that only forms when falcon's poop directly into burning coal mines as they fly
- The Romans used to wear coal as jet jewellery, use it in blacksmiths' forges, for heating their soldiers' forts and maintaining a perpetual fire at Minerva's shrine in the city of Bath
- The Titanic's coal stores had been burning for weeks before she set sail, damaging the starboard side of the ship where the iceberg hit. The fire damaged the hull enough to be a large contributing factor in why the iceberg caused such damage
- In some cultures, there is a tradition that children who misbehave will receive only a lump of coal from Santa Claus in their Christmas stockings instead of presents
- It is customary and considered lucky in Scotland and the north of England to give coal as a gift when welcoming in the New Year, representing warmth for the year to come


Exxaro

SECTION **C6**

Fossil fuels are coal, gas or oil – natural fuels formed in the geological past from the remains of living organisms

HCI Coal

TERMS AND DEFINITIONS

Term	Description
Anthracite	Anthracite coal is a form of coal that is almost made entirely of carbon. Anthracite coal is much harder than other forms of coal, and is usually found in areas surrounding mountains or deep valleys.
Carboniferous Period	The Carboniferous Period is famous for its vast swamp forests. These swamps produced the coal from which the term Carboniferous, or "carbon-bearing," is derived. The Carboniferous Period lasted from about 359.2 to 299 million years ago.
Climate change	This term describes changes in the state of the atmosphere over time scales ranging from decades to millions of years. These changes can be caused by processes inside the Earth, forces from outside (e.g. variations in sunlight intensity) or, more recently, human activities.
Coal seam	A coal seam is a dark brown or black banded deposit of coal that is visible within layers of rock, usually thick enough to be profitably mined.
Coking or metallurgical coal	Coking coal is used to create coke, one of the key inputs for the production of steel.
Continuous miner	A continuous miner is a mining machine that produces a constant flow of ore from the working face of the mine. The machine continuously extracts as it is loading coal with a cutting steel drum and conveyor system. Continuous miners are typically used in room and pillar mining operations.
Dragline exacavator	A dragline excavator is a piece of heavy equipment used in civil engineering and surface mining. Draglines fall into two broad categories: those that are based on standard, lifting cranes, and the heavy units which have to be built on-site.
Fossil fuel	Fossil fuels are coal, gas or oil – natural fuels formed in the geological past from the remains of living organisms.
Greenhouse gases and global warming	Greenhouse gases, such as carbon dioxide and chlorofluorocarbons are gases that can trap heat. Overall, greenhouse gases are a good thing, but human activities are adding too much of these gases to the atmosphere. Greenhouse gases act like a blanket, absorbing infrared radiation and preventing it from escaping into outer space. The net effect is the gradual heating of Earth's atmosphere and surface, a process known as global warming.

Term	Description
Haulage	The commercial transport of goods by road or rail. It is also the term used for the transport of mined coal from working faces to the surface.
Iron Age	The African Iron Age is traditionally considered that period in Africa between the second century AD and up to about 1000 AD when iron smelting was practised.
Oil from coal	Coal-to-oil technology dates back to the 1920s, when two German chemists, Franz Fischer and Hans Tropsch, developed a process to convert coal into a gas and then use it to make synthetic fuels. To produce oil, the coal is superheated to more than 1,000°C; steam and oxygen are added; pressure is increased; and the coal is pushed through a series of chemical reactions.
Open pit mining	Open-pit or open-cast mining is a surface mining technique of extracting rock or minerals from the earth by their removal from an open pit.
Peat	Peat is a brown deposit resembling soil, formed by the partial decomposition of vegetable matter in the wet, acidic conditions of bogs and fens, and often cut out and dried for use as fuel and in gardening.
Power station	A power station, also referred to as a power plant or generating plant, is an industrial facility for the generation of electric power.
Tailings	Tailings, also called mine dumps or slimes, are the materials left over after the process of separating the valuable fraction from the uneconomic fraction of an ore.
Thermal or steam coal	Thermal coal is ground to a powder and fired into a boiler to produce heat, which in turn converts water into steam to drive turbines to produce electricity.