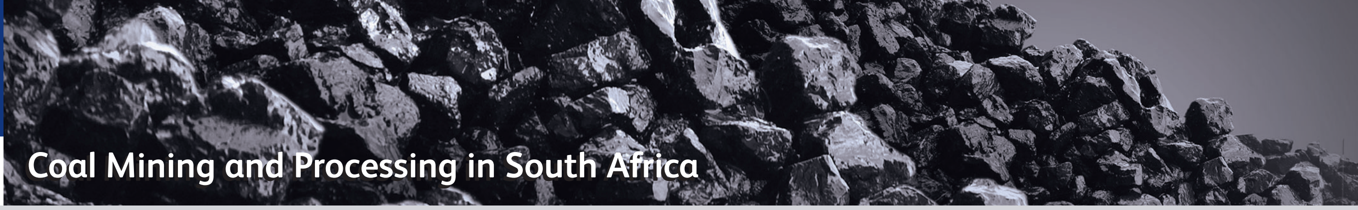


What is Coal?

Coal is the altered remains of prehistoric vegetation that originally accumulated in swamps and peat bogs.

The build-up of silt and other sediments, together with movements in the Earth's crust (known as tectonic movements) buried these swamps and peat bogs, often to great depths. With burial, the plant material was subjected to high temperatures and pressures. This caused physical and chemical changes in the vegetation, transforming it into peat and then into coal.

Peat

Brown coal

Sub-bituminous

Bituminous

Source: Australian Coal Association

Coal formation began during the Carboniferous Period – known as the first coal age – which spanned 360 million to 290 million years ago.

The quality of each coal deposit is determined by temperature and pressure and by the length of time in formation, which is referred to as its 'organic maturity'. Initially the peat is converted into lignite or 'brown coal' – these are coal types with low organic maturity. In comparison to other coals, lignite is quite soft and its colour can range from dark black to various shades of brown.

Over many more millions of years, the continuing effects of temperature and pressure produces further change in the lignite, progressively increasing its organic maturity and transforming it into the range known as 'sub-bituminous' coals.

Further chemical and physical changes occur until these coals became harder and blacker, forming the 'bituminous' or 'hard coals'. Under the right conditions, the progressive increase in the organic maturity can continue, finally forming anthracite.

Definition

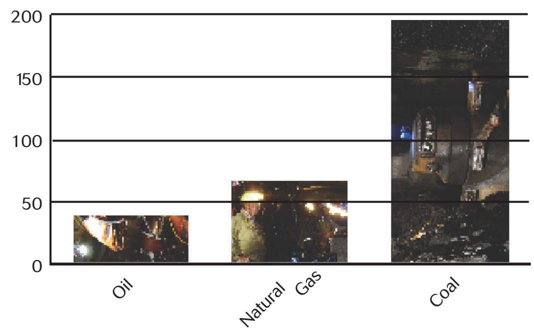
Coal is a fossil fuel. It is a combustible, sedimentary, organic rock, which is composed mainly of carbon, hydrogen and oxygen. It is formed from vegetation, that has been consolidated between other rock strata and altered by the combined effects of pressure and heat over millions of years to form coal seams.

Types of Coal

The degree of change undergone by a coal as it matures from peat to anthracite – known as coalification – has an important bearing on its physical and chemical properties and is referred to as the 'rank' of the coal.

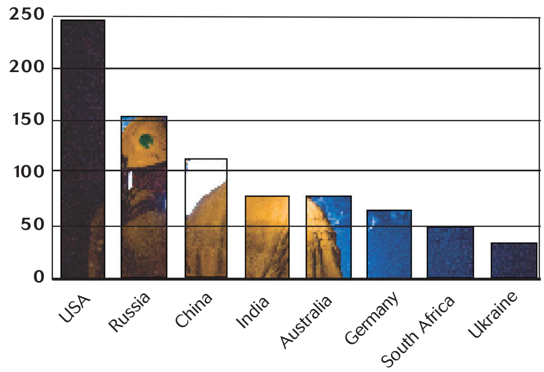
Reserves-to-production Ratios. 2003 (years)

Source: BP 2004



Countries with the Largest Reserves of Coal, 2003 (billion tonnes)

Source: BP 2004



Low-rank coals, such as lignite and sub-bituminous coals are typically softer, friable materials with a dull, earthy appearance. They are characterised by high moisture levels and low carbon content, and therefore a low energy content.

Higher rank coals are generally harder and stronger and often have a black, vitreous lustre. They contain more carbon, have lower moisture content and produce more energy. Anthracite is at the top of the rank scale and has a correspondingly higher carbon and energy content and a lower level of moisture.

Where is Coal Found?

It has been estimated that there are over 984 billion tonnes of proven coal reserves worldwide (see Definitions on the following page). This means that there is enough coal to last us over 190 years (see figure 1). Coal is located worldwide – it can be found on every continent in over 70 countries, with the biggest reserves in the USA, Russia, China and India.

While it is estimated that there is enough coal to last us 190 years, this could extend still further through a number of developments, including:

- the discovery of new reserves through ongoing and improved exploration activities.
- advances in mining techniques, which will allow previously inaccessible reserves to be reached.

All fossil fuels will eventually run out and it is essential that we use them as efficiently as possible. Significant improvements continue to be made in how efficiently coal is used so that more energy can be generated from each tonne of coal produced.

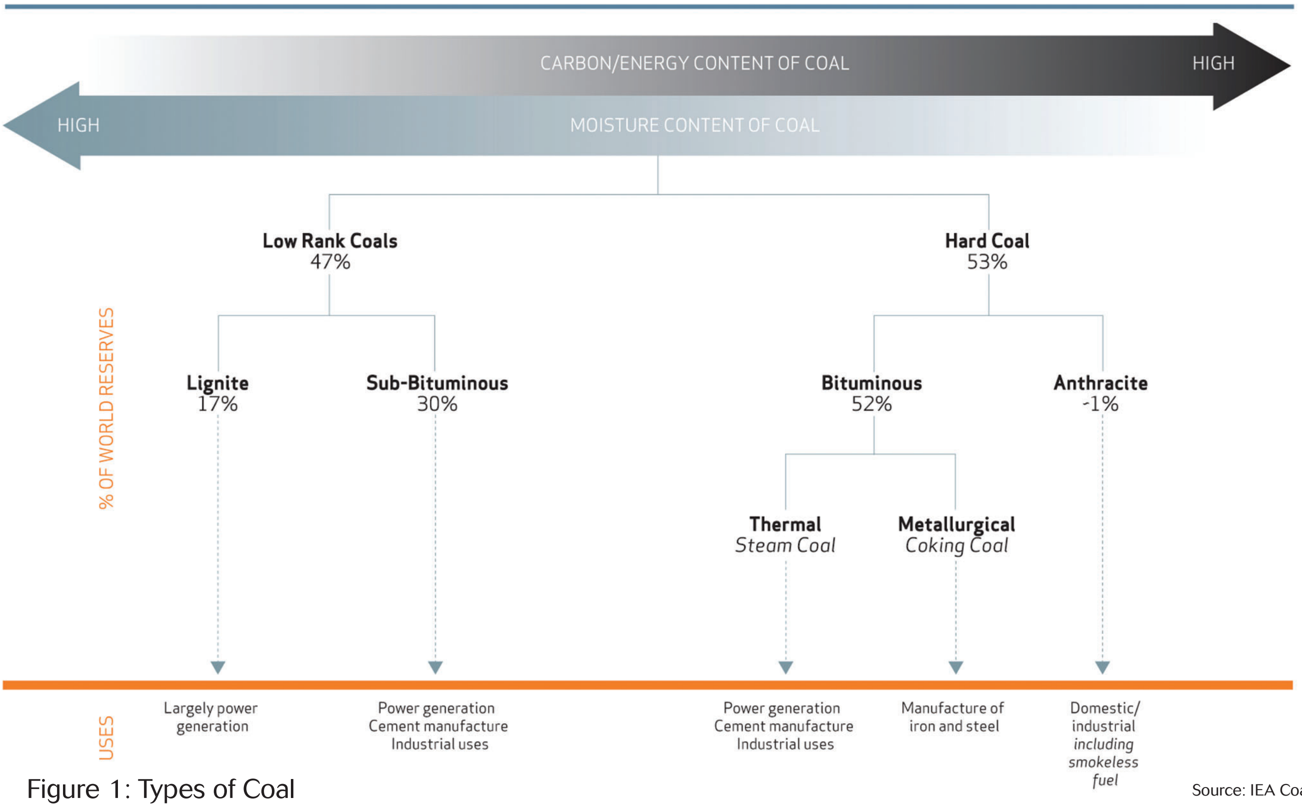


Figure 1: Types of Coal

Source: IEA Coal Information, 2004

Source: IEA Coal Information 2004

Definitions

Resource

The amount of coal that may be present in a deposit or coalfield. This does not take into account the feasibility of mining the coal economically. Not all resources are recoverable using current technology.

Reserves

Reserves can be defined in terms of proved (or measured) reserves and probable (or indicated) reserves.
Probable reserves have been estimated with a lower degree of confidence than proved reserves.

Proved reserves

Proved reserves are not only considered to be recoverable but can also be recovered economically. This means they take into account what current mining technology can achieve and the economics of recovery. Proved reserves will therefore change according to the price of coal; if the price of coal is low, proved reserves will decrease.

Lignite

Bituminous Coal

Anthracite

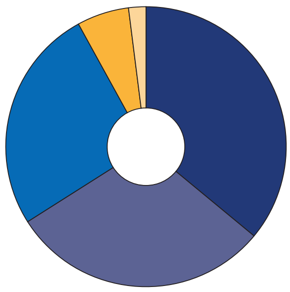
Finding Coal

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. This allows an accurate picture of the area to be developed.

The area will only ever become a mine if it is large enough and of sufficient quality that the coal can be economically recovered. Once this has been confirmed, mining operations begin.

This material was obtained from the World Coal Institute.
Learners - if you use any part of it you need to write it in your own words and include the following in your reference list: World Coal Institute. 2005. The Coal Resource: A Comprehensive Overview of Coal. [Online]. Available: http://www.worldcoal.org/assets_cm/files/PDF/thecoalresource.pdf [28 October 2008]

Coal Reserves Showing Regional Shares (at end of 2003)

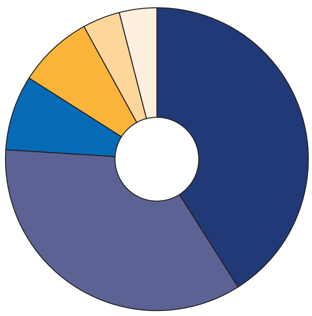


Europe and Eurasia	36%
Asia Pacific	30%
North America	26%
Africa	6%
South and Central America	2%

Middle East coal reserves less than 1% of total reserves

Source: BP 2004

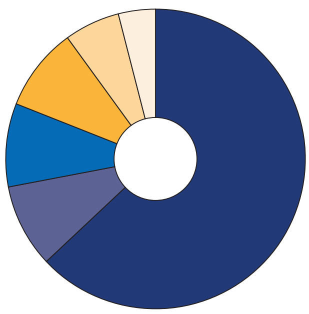
Gas Reserves Showing Regional Shares (at end of 2003)



Middle East	41%
Europe and Eurasia	35%
Asia Pacific	8%
Africa	8%
North America	4%
South and Central America	4%

Source: BP 2004

Oil Reserves Showing Regional Shares (at end of 2003)



Middle East	63%
Africa	9%
South and Central America	9%
Europe and Eurasia	9%
North America	6%
Asia Pacific	4%

Source: BP 2004

Obtaining and Using Coal

Source: http://www.aust-star.com/site/default.asp?od=9

For centuries coal was man's main source of heat and of energy.

In the industrial age, coal suffered a major decline when the oil industry displaced it and the world opted for liquid fuel.

Gaseous fuels, initially the by-product of oil, also grew in importance. Oil became the substitute for coal and defeated coal in most of its traditional markets. Oil not only dominated the world's transport scene, it came to have widespread use in domestic and industrial heating and for power generation. In short, in many countries, oil became the prime source of energy.

That situation still prevails. On a global scale, oil and gas are still the most widely used fuels. However, since the oil price explosions in the 1970s, coal has been restored as the dominant fuel for power stations and cement works. Coal has steadily come back into favour.

Geology

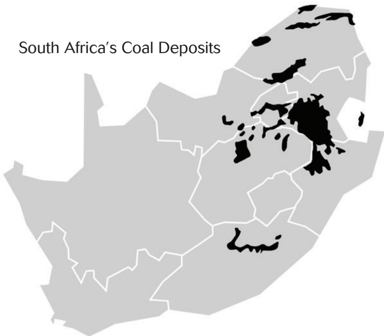
Coal is formed when peat (the residue of decomposed vegetation) is subjected to high pressure and temperature over a long time period. Generally, the greater the pressure and temperature, the higher the coal rank or maturity: from peat to lignite to bituminous to anthracite.

Coal reserves in South Africa are found in sediments of Permian age, which overlie a large area of the country. They generally occur as fairly thick, flat, shallow-lying coal seams. The Witbank area of Mpumalanga contains extensive coal reserves and is the country's most productive coalfield. Five major coal seams occur at intervals within a sedimentary sequence deposited during a 35-million year geological time period.

Occurrence and Production

The coalfields in the country are spread over an area of 700 kilometres from north to south and 500 kilometres from east to west. Generally the rank or carbon content of the coals increases eastwards while the number of seams and their thickness decrease. Thus, Mpumalanga and Northern Province coals are usually classified as bituminous, occurring in seams up to several metres thick, while KwaZulu-Natal coals are often anthracitic and are found in relatively thin seams. The recoverable coal reserves in South Africa amount to about 55 billion tonnes, equivalent to nearly 11% of the world's total (this figure excludes low-grade, high-ash content coal which could add as much as 25% to the country's total reserves). Most of South Africa's coal is of a bituminous thermal grade; only 2% is anthracite, and 1,6% coal of metallurgical quality. At current production levels, coal reserves are estimated to last for 200 years.

South Africa is the third-biggest coal producer in the world. South African collieries range in size from small operations with output limited to a few thousand



tonnes of coal per year to Secunda, the world's largest underground coal mining complex, which has an annual production of about 35 million tonnes. Almost 90% of the country's saleable coal is mined in Mpumalanga.

From the beginning of 2000, the domestic coal industry consistently increased production, albeit very slowly. The local industry is in the throes of consolidation. Anglo Coal increased its stake in Colombian Carbones del Cerrejon, and Lonmin sold its Duiker operations to Glencore. In addition, three of the largest locally-based companies, BHP Billiton, Anglo Coal and Glencore have acquired 50% of a large coal block in Colombia.

Mining Methods

Around 40% of coal comes from opencast operations, some of which have recovery rates approaching 90%. Coal lying less than 70 metres below the surface is extracted from a progressive series of long, narrow, parallel trenches. Overburden rock and soil lying above the coal seams is blasted and scraped out of the currently mined trench and tipped into the mined out void of the previous trench. Walking draglines, with large scraper buckets slung beneath long crane-type boom arms, carry out the stripping operation. The exposed underlying coal seams are drilled, blasted loose and hauled out of the pit by heavy-duty trucks. When the coal from all viable seams has been removed and the spoil of the next parallel trench has been deposited in the void, the rehabilitation process begins. The overburden is flattened, the previously stored topsoil is spread over it and the area is seeded with a mixture of grasses to return the landscape to its ecological balance.

Three different mining methods are used in underground mines:

Bord and Pillar Mining Method: The most common technique, accounting for just under half of total production, is the 'bord and pillar' method. Bord and pillar mining 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, and a chequer-board pattern of mined-out 'rooms'. This method currently permits around 65% of the available coal to be extracted. However, the adoption by several collieries of the 'squat-pillar' method developed by the now defunct Chamber of Mines Research Organisation (COMRO), and approved by the Government Mining Engineer, will increase extraction rates, especially at depth, through the employment in bord-and-pillar mining of smaller pillars than were previously thought necessary.

When the overlying strata impose no restrictions, 'total-extraction' mining can take place. However, in reality somewhat less than 90% is recovered on average.

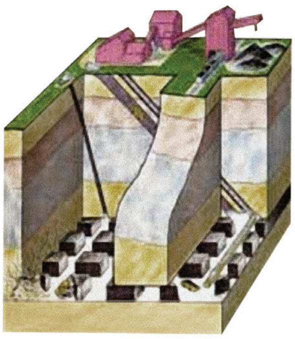
There are two major underground total extraction systems employed in South Africa. In **rib-pillar extraction,** a continuous miner machine cuts a roadway up to 1,5 kilometres in length through the coal and five metres in from the edge of the area to be mined. This leaves a five meter-wide band of coal in the form of a long, isolated rib pillar along one side of the tunnel.

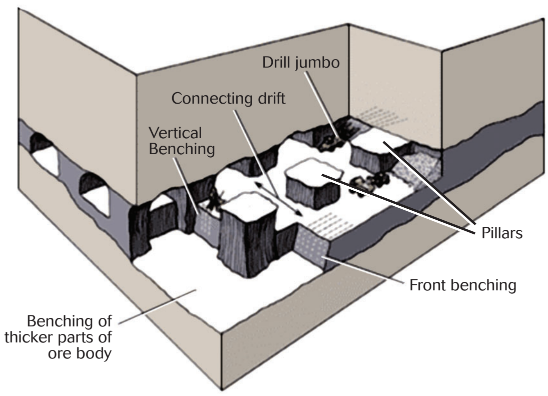
With the aid of timber or hydraulic props to hold up the now unstable roof, the continuous miner cuts away the rib pillar in a series of curved cutting sweeps. The machine repeats the cycle by mining into the remaining coal area, again cutting a tunnel and leaving a rib pillar.

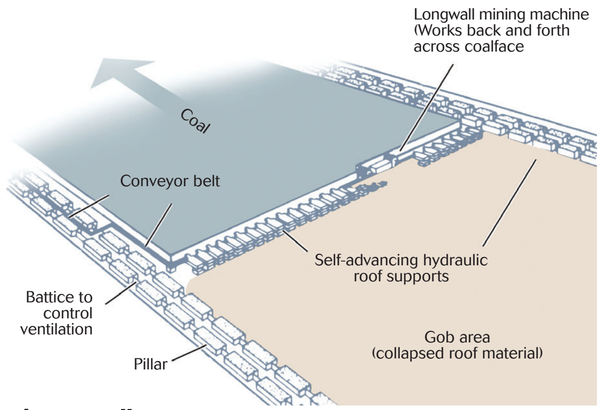
The other total extraction method employed is **longwall mining.** Longwalls are usually several hundred metres long and essentially consist of a corridor in which one wall and the roof are formed by steel supports capable of resisting hundreds of tonnes of pressure from the subsiding mine roof above. 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 longwall 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.

The Bord and Pillar Mining Method

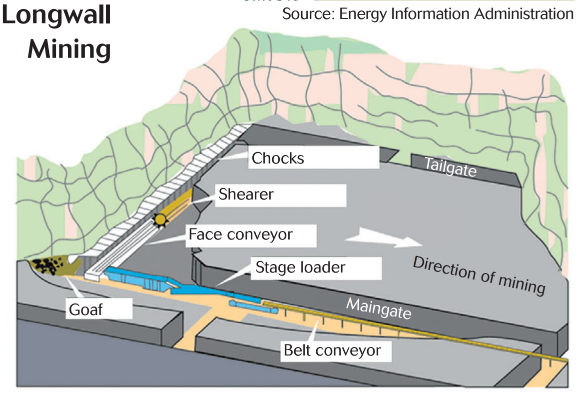






Source: Energy Information Administration

Longwall Mining



http://www.capcoal.com.au/mining.htm

Domestic Uses

Coal is South Africa's primary energy source and has been a major stimulus to economic growth and a significant factor in the country's industrialisation. It provides 88% of commercial energy needs and plays a vital role in meeting liquid-fuel requirements. The South African coal mining industry is fortunate to be supported by a large domestic market as well as having a strong international position. Domestic sales are dominated by electricity generation (53%), synfuels and petrochemicals (33%), with metallurgical and other users accounting for the remaining 12%.

About 40% of all bituminous coal produced in South Africa is used in the generation of electricity, making this industry the largest single user of coal in the country.

With power generation demand likely to go on rising, there is the inevitable question of how long South Africa's coal reserves will last. Assuming growth rates of between 3% and 5%, the coal used by 2030, when estimates suggest electricity demand is likely to peak at 75000 megawatts, together with coal dedicated to future use by power stations either operating or under construction in 40 years' time, amounts to a staggering 30 billion tonnes, about half of the country's reserves. By that time today's power stations will have reached the end of their useful lives and consumed most of the coal reserves of the dedicated collieries.

Inevitably, alternative methods of generating electricity will need to be phased in alongside South Africa's coal-fired programme. More nuclear power stations are likely to come on stream in the early years of the 21st century and by the year 2030, fast-breeder reactors will probably take up the base-load of electricity production. In the meantime, Eskom has demonstrated with its Lethabo power station, which at times uses coal with an ash content as high as 40%, that low grade coal can be used in power generation, so adding up to 25% to the total of the Republic's proven coal reserves.

The second most important coal user in the home market is Sasol – the only successful commercial oil-from-coal plant in the world. Sasol uses the Fischer-Tropsch indirect liquefaction method, which has the added benefit of being able to process high-ash content coal – to convert coal into petrol and diesel fuels, and provides raw materials for the petrochemical industries and other important by-products such as fertilizer.

Other significant domestic users are Iscor's metallurgical plants. The steel industry requires coking coal to be prepared in coke ovens to provide metallurgical coke capable of reducing and melting iron ore to liquid iron in blast furnaces, the cement industry and large municipalities.

In the last few years, off take by Eskom, the railways and the mining industry has shrunk, while demand from Sasol and the metallurgical sector is flat. Any capacity for local consumption added to the South African coal mining industry in the foreseeable future, therefore, is likely to be replacement, rather than additional capacity.

This material was obtained from the Chamber of Mines of South Africa website www.bullion.org.za. Learners – if you use any part of it you need to write it in your own words and include the following in your reference list: Chamber of Mines of South Africa. 2008. Coal mining in South Africa. [Online]. Available: http://www.bullion.org.za/ [28 October 2008]

Coal and the Environment

Anglo Establishes Improvement Group

Anglo Coal South Africa has established a Rehabilitation Improvement working group to investigate ways of improving land rehabilitation and minimising the environmental liabilities posed by the closure of operations as they reach the end of their lives.

According to Richard Garner, Anglo Coal South Africa's manager of environmental services, Ben Magara and his executive team, which identified rehabilitation as one of the division's key headline risk areas, initiated the group.

'The group will examine all aspects of the rehabilitation process, from the front end to the back end, and identify good practices currently employed across both Anglo Coal South Africa and elsewhere in the Anglo American Group,' he says.

The core aims of the project include cost savings, bringing about improved efficiency in the rehabilitation process, and the creation of an enhanced end product.

Headed by Isibonelo Colliery general manager Clive Ritchie, the Rehabilitation Improvement Group (RIG) not only comprises a team of environmentalists and experts on mine closure and rehabilitation, it draws expertise from a broad range of fields, including mining, mine planning, finance and surveying.

Richard explains that it is especially important that mine planners are involved in the initiative, as the planning of new mines has a direct bearing on the success of rehabilitation.

'If the mining layout and planning does not take into account rehabilitation before mining occurs, the additional work needed to address the discrepancies in legal closure commitments and the post-mining landscape are enormous and costly,' he explains.

In the coming months, the RIG will visit all of Anglo Coal South Africa's collieries, not only to identify successful rehabilitation methods, but also to pinpoint problem areas. Once it has completed this tour, it will visit other Anglo American operations, both in South Africa and beyond its borders as focus areas are identified.

The final result, Richard explains, will be to close the gaps that currently exist at local operations, and to develop an 'Anglo Coal Way for Rehabilitation'.

Stemming from its findings, the group will develop a set of guidelines and workshops for colliery level management. It will also focus on the development of a strategy to communicate the group's activities and findings, and will later measure the implementation of best rehabilitation practices within the division.

This material was published by Anglo American on 29 May 2007. Learners – if you use any part of it you need to write it in your own words and include the following in your reference list: Anglo American. 29 May 2007 Anglo Coal South Africa launches Rehabilitation Improvement Group. Anglo American: South Africa.

Mining environmentally sensitive areas

Plans to mine for coal in the catchment areas of major rivers present a serious threat to South Africa's fresh water resources.

Acid pollution caused by coal mining has already destroyed the Wilge River that flows through the Ezemvelo Reserve near Bronkhorstpruit, Mpumalanga, and has caused mass deaths of fish and crocodiles at the Olifants River inlet to Loskop Dam, between Middelburg and Groblersdal.

Now proposals are on the table to mine in an area north-west of Ermelo, where the Vaal River originates. Professor Terence McCarthy of the school of geosciences at the University of the Witwatersrand has written to the mining company's consultants, warning that if the project goes ahead, it is likely that within a decade the water quality in the upper Vaal will deteriorate to the point where it will no longer be fit for human consumption. The Grootdraai Dam would then no longer be able to supply water for the Gauteng region. 'I believe that it is in the national interest that the project should not proceed,' McCarthy says.

He explains in his letter that the proposed mining area encompasses a large portion of the headwaters of the Vaal River, and it is almost certain that the proposed mining will result in serious pollution of this river system.

'We know from past experience on the Olifants River in the Witbank area, that serious pollution of the river is unavoidable. 'In that case, the miners have managed to use the Witbank dams in conjunction with a controlled release policy to contain the pollution for the moment. This control is only temporary, however, and will be lost when the mines close.'

'On the tributaries of the Wilge River such control is not possible, and serious pollution has resulted. The salt load in Loskop Dam is steadily rising, with serious ecological consequences,' writes McCarthy.

Similar concerns have been expressed about prospective mining on the Drakensberg escarpment near Wakkerstroom in an area that contains the headstreams of four major rivers - the Vaal going west, and the Usuthu, Pongola and Tugela flowing to the Indian Ocean.

Fears have been expressed that the mining would affect the groundwater table and pollute the rivers.

Koos Pretorius, chairman of the Escarpment Environment Protection Group, which has been established to fight ecologically destructive mining further north along the escarpment, told the meeting that there were 114 applications for mining in the region.

Noting the calamity this spells for the rivers and, ultimately, for the northern provinces' water supplies, Angus Burns, the co-ordinator of the Enkangala Grassland Project, a conservation group in the region, said: 'There is more coal in less-sensitive areas outside the escarpment region than we'll ever be able to exploit. Why then mine for it in ecologically precious areas that contain no more than 15% of our coal deposits?'

Acid mine drainage results from the exposure of coal and broken rock. Mines treat the water with lime to reduce the acidity. It is kept in reservoirs and released in a controlled manner into rivers when their levels are sufficient to dilute the remaining acidity.

The threat to fresh water supplies from mining is in addition to growing alarm at the leakage of sewage into rivers and underground water systems.

Concern about the water situation was echoed this week by Dr Morne du Plessis, the chief executive of the Worldwide Fund for Nature (WWF) in South Africa.

He said more than 98% of our freshwater supply was already accounted for, and that at current rates of supply and consumption, we'd run out of fresh water by 2025.

'Government, civil society and the private sector must work together to build a future in which healthy aquatic ecosystems underpin the sustainable development of South Africa and enhance the quality of life of all its people.'

Lindiwe Hendricks, the minister of water affairs and forestry, has responded to reports about acid mine drainage, saying the mines were co-operating with the government.

This material was adapted from an article that was published by The Sunday Independent on 16 June 2008. Learners - if you use any part of it you need to write it in your own words and include the following in your reference list: The Sunday Independent. 16 June 2008. Coal Mining Exploration Plan and Environment Protection in South Africa. [Online] Available: http://paguntaka.org/2008/06/16/coal-mining-exploration-plan-and-evironment-protection-in-south-africa/

Methane Blast Kills Miner

20 March 2008

Witbank – A miner was killed and four others seriously injured by an explosion at Matla coal mine outside Witbank, said the National Union of Mineworkers on Thursday.

Spokesperson Paris Mashego said there had been a methane explosion about noon.

'These workers were supposed to be home for the Easter weekend, but were lured into working through zama-zama,' he said.

Zama-zama was a voluntary shift system allowing mine workers to make extra money on their off days.

Mashego said: 'It is very dangerous to work this shift because employers do not pay much attention to the required safety standards.'

The union believed the mine was under extra production pressure by the Matla power station, which apparently had low coal stocks.

This material was published by News.24 (www.news24.com) on 20 March 2008. Learners – if you use any part of it you need to write it in your own words and include the following in your reference list: www.news24.com. 20 March 2008. Methane blast kills miner. [Online] Available: http://www.news24.com/News24/South_Africa/News/0,,2-7-1442_2292090,00.html

Flying hazard

22 August 2008

The Chamber of Mines of South Africa sent a letter to the South African Civil Aviation Authority on Wednesday warning against aircraft flying at low altitudes over opencast coal mining operations.

This followed a number of reports from its members, particularly those operating in the Middelburg – Emalahleni (Witbank) areas that aircraft regularly fly at low altitudes over their operations.

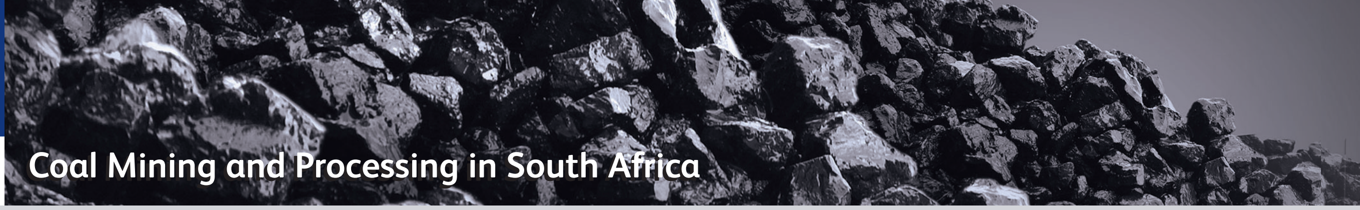
'This is a hazardous practice as these mines conduct blasting on a regular basis as part of their mining operations work involving large quantities of high explosives. While mines take care to limit hazards resulting from blasting work, concussion and airborne debris cannot be eliminated totally. Aircraft flying at low altitudes, therefore, run the risk of flying over mining operations at a time when blasting takes place.

This could lead to accidents, particularly as those responsible for blasting work would not be aware of any approaching aircraft. Concern for the elimination, or minimising of incidents that could lead to harm or loss of life is high on the agenda of the Chamber and its members,' says Dick Kruger of the Chamber.

Kruger adds that as some of these coal mines are operating at high efficiency levels to meet Eskom's demand for coal for electricity generation, the Chamber and its members are working hard to avoid any incidents that could interrupt their operations. 'As it is, most of our members have continued to operate at 90% of electricity supply since January this year. Our commitment to do our part to improve the electricity supply situation in South Africa remains intact so that we can return to 100% supply as soon as possible,' Kruger adds.

Kruger recommends that aircraft flying over opencast mining operations should maintain a minimum altitude of 700 metres above ground level.

This press release was issued by the Chamber of Mines of South Africa on 22 August 2008. Learners – if you use any part of it you need to write it in your own words and include the following in your reference list: Maphalala, J. 22 August 2008. Chamber of Mines warns against aircraft flying at low altitude over opencast coal mines. [Online]. Available: http://www.bullion.org.za/MediaReleases/Downloads/aircraft.htm [28 October 2008]



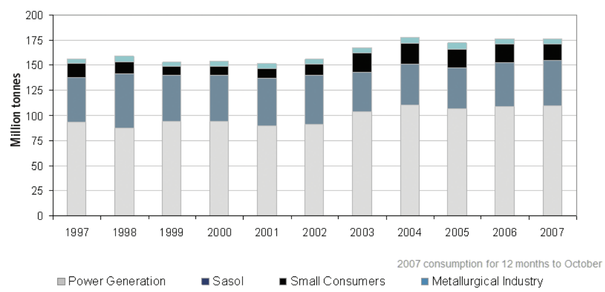
Why Coal?

Coal is abundant, easily extracted from the earth and readily available from countries far removed from the world's political hot spots. Despite what might widely be believed, coal can be a relatively 'clean' energy source. Contrast this with oil, the other important fossil fuel.

A great deal has been written about the likely effects of global warming due to mankind's burning of fossil fuels. Those arguments have considerable merit. However, offset against it is mankind's increasing demand for energy, particularly in developing economies such as those of India, China and South Africa where demand is fast outstripping availability. If the world economy is to continue growing and many millions are to escape the trap of energy poverty, mankind will remain reliant on fossil fuels well beyond the current century.

At present, South Africa produces fractionally less than 95% of its electricity from coal-fired power stations. That is the world's highest proportion, and is unlikely to fall significantly any time soon, not at least until the first new nuclear power stations come on stream. The country has little or no hydroelectricity potential; Eskom cannot delay the construction of new power stations if further 'load shedding' is to be reduced; thermal power stations can be built more quickly than nuclear ones; solar and wind power are expensive and only viable in areas remote from the national power grid; and we cannot risk relying overly on imports of power from countries to the north that are blessed with hydro potential.

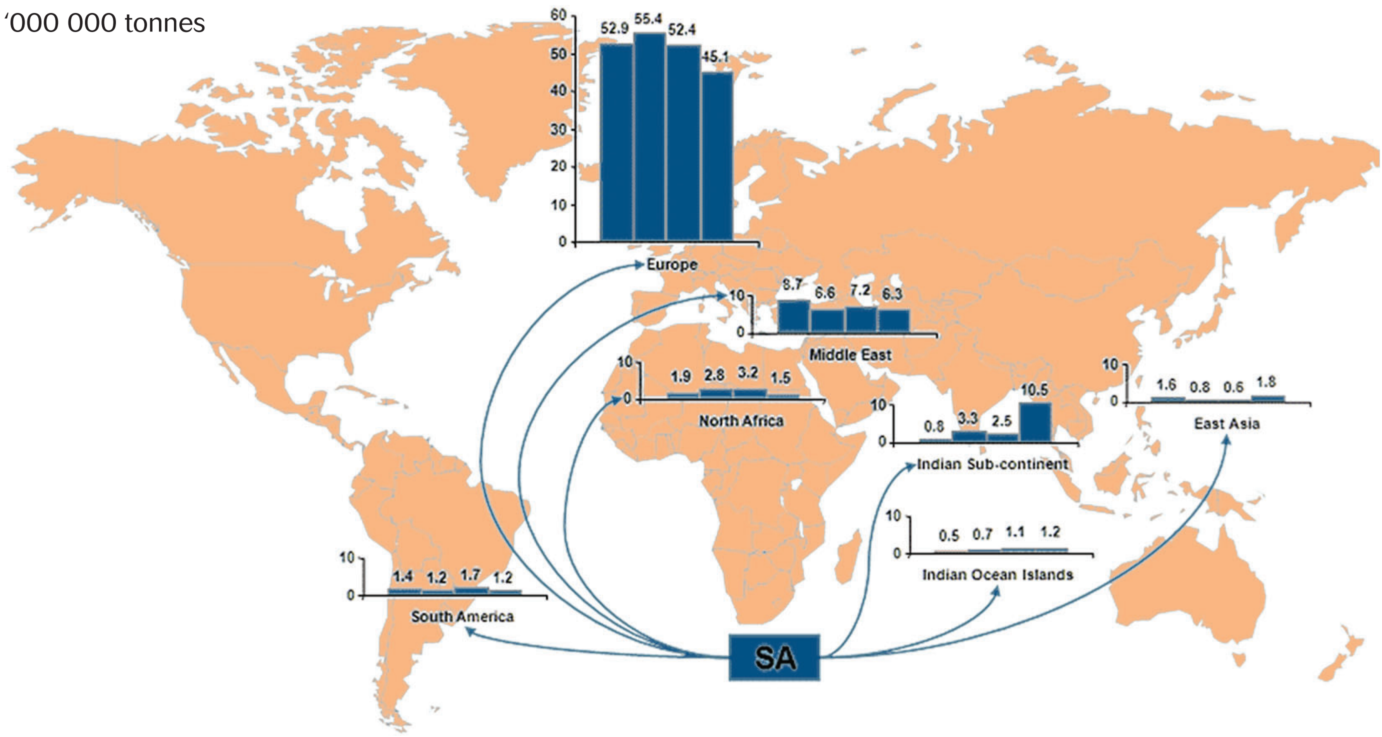
Inland coal consumption



As a country, South Africa will remain essentially self-sufficient for its electricity, which means that coal can look forward to strong growth in domestic demand.

SA coal export markets 2004 – 2007

'000 000 tonnes



Source: Barlow Jonker

Why Coal?

4

Inland Coal Prices

It is well known that South Africa exports its best coals and burns the poorer ones in power stations specifically designed to handle their lower calorific values and their higher ash content. But, strange as it might seem, export demand for those lower-quality coals seems set to increase as India builds new and efficient thermal power stations along its western coastline. This increase in demand for lower grades of coal is coming at a time when an additional 24 million tonnes of combined annual capacity is being added to the Richards Bay and Motola coal terminals. An increase in capacity, which is unlikely to be met by supplies of traditional, export grades of coal.

This means that Eskom may no longer be the only buyer of South African coal that currently falls short of the quality generally demanded by export customers. In the past, coal producers wanting to sell to Eskom have been tied into long-term contracts that, at best, offer steady but unexciting profits. That ostensibly accounts for some 80% of Eskom's consumption. The remaining 20% is bought on the spot market and at spot market prices. As Indian import demand grows and import prices for lower-grade coals start responding to the higher prices of oil and export coal, Eskom could well be faced with paying market-determined export prices for its spot coal purchases.

Domestic South African industrial coal buyers have already experienced this type of competition for the higher grades of coal and are now understood to be paying near export price parity for export-equivalent grade coal being supplied into the inland market. As the world's fifth-largest producer of coal and its fourth-largest exporter, South Africa will continue to play a pivotal role.

In a nutshell, the outlook for coal is bright, which reinforces our positive view of the future of our industry.

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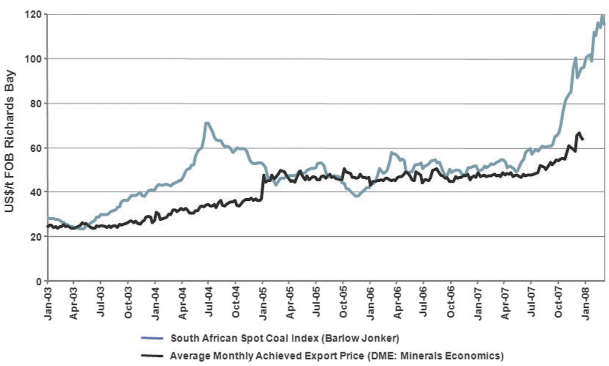
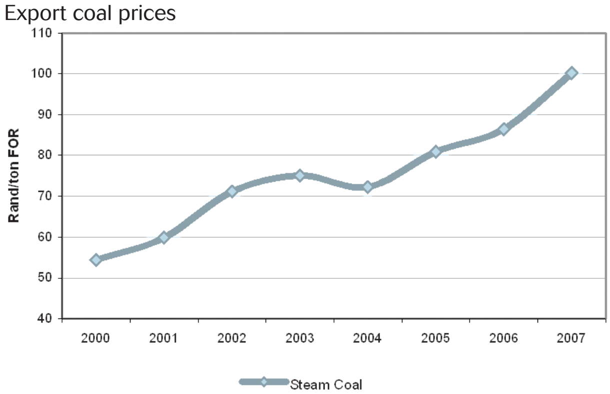
Inland coal consumption



Export coal prices



Coalfields

South Africa is blessed with abundant supplies of readily-extractable coal in widely-separated coal provinces stretching interruptedly from the border with Botswana in the north-west, through the Limpopo and Mpumalanga provinces and into KwaZulu-Natal in the east.

These coal provinces are themselves divided into distinct coalfields in which most of the commercially mineable resources are contained in the Permian-aged Vryheid formations of the Ecca Group.

Most of the country's coal is currently mined in the Highveld, Witbank and Ermelo coalfields located in Mpumalanga province. Geology has determined that the Witbank coalfield is by far the most important source of South Africa's mined coal at present. However, the Waterberg deposits, which extend into Botswana, are widely expected to become the country's principal future coal resource, particularly as this is the region expected to be home to many of the next generation of thermal power stations.

Waterberg Coalfield

Grootgeluk is the only colliery currently operating in the Waterberg field, based on a resource estimated at 12,1 billion tonnes. It produces some 38 million tonnes of run-of-mine material each year of which some 18,8 million tonnes are saleable product and the rest waste. Of Grootgeluk's saleable coal, 14,7 million tonnes are delivered under long-term contract to Eskom each year, 1,7 million tonnes of metallurgical coal are sold domestically on short-term contracts, 1,6 million tonnes of coking coal are delivered on long–term contracts to Mittal's South African steel mills and 1,1 million tonnes of coking and thermal coal are exported.

Highveld Coalfield

Only one of the Highveld coalfield's five coal seams is laterally continuous and economically important. Furthermore, the coal measures tend to be adversely affected by dolerite sills and dykes, that can make mining difficult and that have affected the quality of the coal.

Witbank Coalfield

All five of the major coal seams extend across the coalfield and are relatively un-deformed by geological action. The extensive exploitation of the coalfield – some 55 collieries are currently in operation – has resulted in the area being well-served by efficient coal transportation and other infrastructure. This, in turn, has resulted in seams that are uneconomic elsewhere becoming economic.

Ermelo Coalfield

While the Ermelo coalfield in southeast Mpumalanga is less prolific than its Witbank counterpart, it is attractive as the major junction of the export rail lines linking the inland coalfields to Richards Bay is in the town of Ermelo. In addition, the Majuba power station buys in all of its coal locally while Eskom's previously-mothballed Camden power station will need an annual 6 million tonnes of coal when it is re-commissioned.

Utrecht and Klip River Coalfields

Production from the collieries operating in these coalfields in KwaZulu-Natal is comparatively small and has been slowly declining overall. However, the area produces most of the country's anthracite as well as a fair part of its coking coal.

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FREE STATE (2):
New Vaal Colliery
Sigma Colliery

GAUTENG (1):
Leandra Colliery

KWAZULU-NATAL (7):
Durnacol Colliery
Magdalena & Aviemore
Mining Contractors Vryheid
Springlake Colliery
Vaalkrantz Colliery
Welgedachts Exploration
Zululand Antrachite Colliery

LIMPOPO (2):
Grootgeluk Colliery
Tshikondeni Mining Company

MPUMALANGA (61):
Arnot Colliery
Arthur Taylor (ATC)
Arthur Taylor (ATCOM)
Bank 2 Colliery
Bank 5 Colliery
Black Wattle Colliery
Boschmans Colliery
Bosjesspruit Mine
Brandspruit Mine
Delmas Coal
Delmas Colliery -Stuart
Dorstfontein Colliery
Douglas Colliery Services
Droogvallei Colliery
Elandsfontein Colliery
Forzando Coal Mines
Glisa Colliery
Goedehoop Colliery
Goedgevonden Colliery
Golfview Mine
Graspan Colliery
Greenside Colliery
Groenvallei Colliery
Halfgewonen Colliery
Ilanga Coal Mines
Isobonela Colliery
Khutala Mining Services
Kleinkopje Colliery
Klipspruit Colliery
Koornfontein Mines Blinkpan
Kopermyn Colliery
Kriel Colliery
Landau Colliery
Leeuwfontein Colliery
Leeuwpan Colliery
Mashala Resources
Matla Colliery
Middelbult Mine
Middelburg Mine Services
Mimosa Colliery
New Clydesdale Colliery
New Denmark Colliery
Nkomati Anthracite
Optimium Colliery
Paardeplaatz Colliery
Phoenix Colliery
Polmaise Colliery
Rietspruit Colliery
Savmore Colliery
South Witbank Colliery
Spitzkop Colliery
Syferfontein Colliery
Tavistock Colliery
Tselentis Colliery
Twistdraai Colliery
Umlabu Colliery
Waterpan
Witcons
Witkranz Colliery
Witrand Ihlosi
Woestalleen Colliery

This map was published by the Department of Minerals and Energy in February 2007. Learners – if you use it you need to include 'Source: Department of Minerals and Energy' below the map and include the following in your reference list: The Directorate: Mineral Economics. 2007. Operating and developing coal mines in South Africa in 2006. [Online]. Available: http://www.dme.gov.za/pdfs/minerals/D2%202007%20final%20-%20April2007.pdf [28 October 2008]

Exporting Coal

Coal export prices have been increasing in response to rising oil and natural gas prices.

They, in their turn, are being driven by fast-growing demand for energy from China and India, concerns over the political situation in the Middle East and peaking or declining output from long-established fields such as the North Sea.

Whereas countries such as Saudi Arabia can in fairly short order increase their pumping rates to make good shortfalls elsewhere, coal-exporting countries are less flexible. Mine, port and rail capacity cannot be added as quickly as can be comparable oil facilities. This drawback is underscored by the fact that Australia, the world's leading exporter, has been suffering from chronic congestion. Some of its customers, of whom India is one, have been compelled to look elsewhere for the coal needed to fuel newly-built power stations.

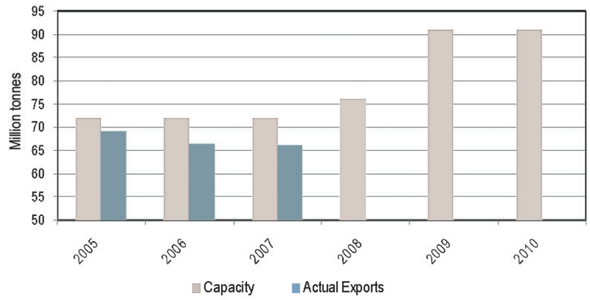
Care must be taken, however, in estimating the patterns of future export demand. China is adding some 40 gigawatts to its generating capacity each year, but that does not necessarily imply a directly corresponding increase in coal usage. Old stations whose percentage thermal efficiencies are generally in the low 20s (in other words only 20% of the energy contained in each tonne of coal is transformed into electrical energy) are being closed and being replaced with new generation stations that are twice as efficient. Half the coal is needed for each megawatt and, as a corollary, carbon emissions are correspondingly lower per unit of power generated.

Though China only became a net importer of coal in January 2007, Beijing has stated its determination not to rely on imports for more than 10% of the country's energy (oil, gas and coal) needs. This, though, must also be seen in the context of China mining ten times as much coal as South Africa and generating just short of four-fifths of its electricity at coal-fired power stations. Whether this degree of self-sufficiency can be maintained is another matter. China is not rushing to build nuclear power stations (as it does not have access to the latest technology), there are limits to the country's ability to exploit its hydro potential and renewable sources such as wind power are not appropriate. In other words, the future lies with coal.

Much the same goes for India. It is building a series of new thermal power stations along its western coastline and is diversifying its coal supply sources following disruptions caused by Australian port congestion. India has been specifically seeking coal with similar specifications – comparatively low calorific value and high ash content – to that supplied by South African coal companies to Eskom.

This opens new export prospects for South African coal companies. But everything depends on expansion of coal-handling capacity at Richards Bay. At present the Richards Bay Coal Terminal (RBCT) has the capacity to handle an annual 72 million tonnes of export coal. And capacity is being increased to 91 million tonnes by 2009. In the past, RBCT has consistently not operated at full capacity, though this has not necessarily been the fault of the terminal's operators. Rail capacity has not always matched demand, wet weather has in some years curtailed mine production and, in recent years, competitive inland prices have led to coal being diverted away from the export market.

RBCT capacity utilisation



In addition to the RBCT expansion, Maputo's coal-handling capacity is being increased from its current 1,1 million tonnes to 6 million tonnes by 2010. That means South Africa's coal miners could export an additional 24 million tonnes by 2010. Unless export and inland prices fall into line, the increased export capacity could reduce the amounts available to a local market in which domestic demand is rising.

There has, then, been a structural shift in the local market. Coal companies that formerly did not have RBCT export allocations and that needed to rely on the residual domestic market, could not benefit from rising export prices. Now, however, domestic prices are becoming strongly aligned to those for export coal and the outlook is positive for coal exporters and those without allocations alike.

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Coal and the Environment

There is incontrovertible evidence that carbon emissions are having a significant effect on the environment. These emissions are in part due to the burning of fossil fuels by the world's electrical power generators and the transport sector.

That said, the dilemma is that people in the economically-developed countries are not willing to cut the standards of living to which they have grown accustomed. While the message of global warming is well understood, almost all developed countries have turned their back on 'clean' alternatives such as nuclear power generation. We cannot do without our cars, and the capacity to produce electricity from renewable resources such as wind or solar is limited. Conservation is part of the solution. But the inescapable fact is that coal will become an increasingly important part of the developed world's energy mix.

On the other side of the economic divide, people in many developing countries are motivated to seek the equivalent material benefits enjoyed by those in developed countries. A quarter of the world's people do not have access to electricity. Calls by developed countries on developing nations to curb their hunger for motor vehicles and easily accessible energy fall on deaf ears. Why, the poor countries ask, should we accept anything less than the rich? Slowing, never mind halting or reversing, the growth in demand for energy will prove incredibly difficult.

Furthermore, virtually every one of the world's nations is seeking as high a degree of energy autonomy as possible. Countries may not have oil or gas, but many have domestic coal resources.

Can the conflicting demands of increasing demand for energy and the effect on the environment of burning fossil fuels be settled? The answer is yes - part of that answer lies with coal.

The technology already exists for reducing the amount of carbon dioxide emitted when coal is burned in power stations. Top of the list comes the introduction of existing technology that makes the generation process more efficient. As an example, China is already replacing small, older power stations that only convert some 20% of the energy in a tonne of coal into electrical energy with state-of-the-art power stations that can convert 40%. This results in a halving of the amount of coal needed to generate each megawatt of electricity and a direct halving of carbon dioxide emissions for each megawatt.

Just around the corner is carbon capture and sequestration (CCS), a technology that might appear to come directly from the realms of science fiction but that is already something of a reality. Essentially the process is to capture carbon dioxide from the atmosphere (or, at least, directly from power station and factory chimneys) and sequestrate it by pumping it into deep underground geological formations. Statoil, the Norwegian oil company, is already using the process on a small scale with carbon dioxide being pumped into oil-bearing rocks (old oil wells) under the North Sea. The process has a double advantage in that the carbon dioxide under pressure forces out residual oil and natural gas that might not otherwise be extracted from the undersea oil wells.

CCS has a cost, but once a global pricing system for carbon and marketable carbon credits are in place, cost should not be a barrier.

Other environmentally-unfriendly by-products from the burning of fossil fuels can be removed. Scrubbers on factory or power station smokestacks can remove fly ash; fluidized bed combustion removes pollutants from coal as it is being burned and coal gasification converts coal into gas that is cleaner to burn than coal itself.

On a smaller scale, mining itself can affect the local environment. But, managed correctly, the longer-term effects can be minimised. Most countries insist that all mining land be reclaimed – that the waste rock removed to gain access to coal either be returned to the place from which it was taken or else stored in a way that neither creates an eyesore nor permanently damages the local environment. The effect on ground water and other water sources also needs to be carefully monitored and controlled.

Coal Facts

Coal provides 25% of global primary energy needs and generates 40% of the world's electricity

Total Global Hard Coal Production

*Note: Mt is an abbreviation for megatonne

2006e	5 370 Mt	An 8,8 % increase over the previous year &
2005	4 934 Mt	92% growth over the past 25 years.
1996	3 734 Mt	

Total Global Brown Coal/Lignite Production

2006e	914 Mt	2005	906 Mt

Brown coal production increased by 0,9% in 2006. Germany remains the world's largest brown coal producer, despite production falling in 2006. Brown coal production increased in Turkey, Russia and Romania.

Reserves

Coal reserves are available in almost every country worldwide, with recoverable reserves in around 70 countries. At current production levels, proven coal reserves are estimated to last 147 years. In contrast, proven oil and gas reserves are equivalent to around 41 and 63 years respectively at current production levels. Over 68% of oil and 67% of gas reserves are concentrated in the Middle East and Russia.

Top Ten Hard Coal Producers (2006e)

PR China	2 482 Mt	Russia	233Mt
USA	990 Mt	Indonesia	169Mt
India	427 Mt	Poland	95Mt
Australia	309 Mt	Kazakhstan	92Mt
South Africa	244 Mt	Colombia	64Mt

Global Hard Coal Consumption

	1986	**1996**	**2006e**
World	3 232 Mt	3 773 Mt	5 339 Mt

Selected Regional Aggregate Estimates

Europe	17%	11%	7%
Former Soviet Union	17%	8%	6%
North America	21%	23%	18%
Asia-Pacific	39%	53%	65%

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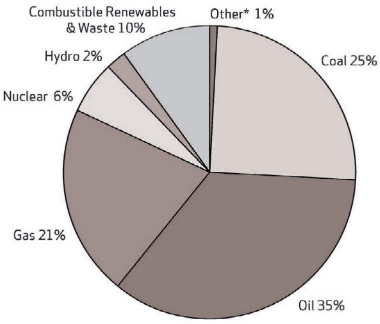
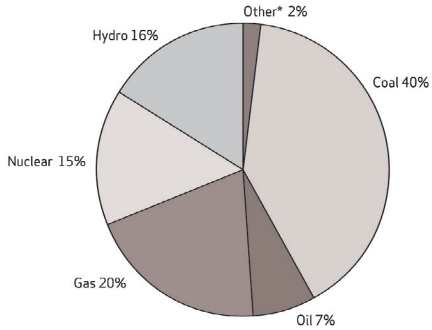
Total World Primary Energy Consumption (% by fuel – 2005)



* Other includes geothermal, solar, wind, heat etc.

Total World Electricity Generation (% by fuel – 2005)



*Other includes geothermal, solar, wind, combustible renewables & waste

Coal in Electricity Generation

Coal is the major fuel used for generating electricity worldwide – countries heavily dependent on coal for electricity include (2006e):

Poland	93%	Israel	71%*	Czech Rep	59%
South Africa	93%*	Kazakhstan	70%*	Greece	58%
Australia	80%	India	69%*	USA	50%
PR China	78%	Morocco	69%*	Germany	47%

* only 2005 figures available for these countries

Coal & Steel

Approximately 13% (around 717 Mt) of total hard coal production is currently used by the steel industry and almost 70% of total global steel production is dependent on coal.

International Hard Coal Trade (Source: IEA – www.iea.org)

	Steam	Coking	Total Trade
1996	318 Mt	196 Mt	513 Mt
2000	421 Mt	188 Mt	609 Mt
2006	593 Mt	222 Mt	815 Mt

Development of Seaborne Trade (Source: SSY – www.ssyonline.com)

	Steam Coal		Coking Coal	
	Atlantic	Pacific	Atlantic	Pacific
1986	74 Mt	59 Mt	61 Mt	81 Mt
1996	125 Mt	139 Mt	70 Mt	103 Mt
2006	240 Mt	330 Mt	72 Mt	129 Mt

Since 1986, seaborne steam coal trade has increased on average by about 7,5% p.a. and seaborne coking coal trade by 1,8% p.a.

Top Coal Exporters (2006e)

	Total of which	Steam	Coking
Australia	231 Mt	111 Mt	121 Mt
Indonesia	129 Mt	104 Mt	25 Mt
Russia	92 Mt	82 Mt	10 Mt
South Africa	69 Mt	68 Mt	1 Mt
PR China	63 Mt	59 Mt	4 Mt
Colombia	60 Mt	60 Mt	-
USA	45 Mt	20 Mt	25 Mt

Top Coal Importers (2006e)

	Total of which	Steam	Coking
Japan	178 Mt	105 Mt	73 Mt
Korea	80 Mt	60 Mt	20 Mt
Chinese Taipei	64 Mt	58 Mt	6 Mt
UK	51 Mt	44 Mt	7 Mt
Germany	41 Mt	33 Mt	9 Mt
India	41 Mt	22 Mt	19 Mt
PR China	38 Mt	29 Mt	9 Mt

Other major importers of coking coal include: India (19 Mt), Brazil (13 Mt) & PR China (9 Mt)

This material was obtained from the World Coal Institute (www.worldcoal.org). Learners– if you use any part of it you need to write it in your own words and includ the following in your reference list: World Coal Institute. October 2007. Coal Facts 2007 Edition. [Online]. Available: http://www.worldcoal.org/assets_cm/files/PDF/fact_card07.pdf [21 November 2008]

How is Coal Mined?

As was the case fifty years ago, most coal is produced from two major types of mines – underground and surface. As a consequence of technological advances, the methods for recovering coal from the Earth have undergone drastic changes in the past 25 years.

Fifty years ago, when most coal mining was done manually, underground mines accounted for 96 % of the coal produced each year. Today, almost 60 percent is produced from surface mines. Most underground mines in the United States are located east of the Mississippi River, although there are some in the west, particularly in Utah and Colorado.

More than two-thirds of the coal produced underground is extracted by continuous mining machines in the room and pillar (or bord and pillar) method. The continuous mining machine contains tungsten bits on a revolving cylinder. The continuous miner breaks the coal from the face and then conveys it to a waiting shuttle car which transports it to the conveyor belt to be moved to the surface. No blasting is needed. After advancing a specified distance, the continuous miner is backed out and roof bolts are put in place. The process is repeated until the coal seam is mined.

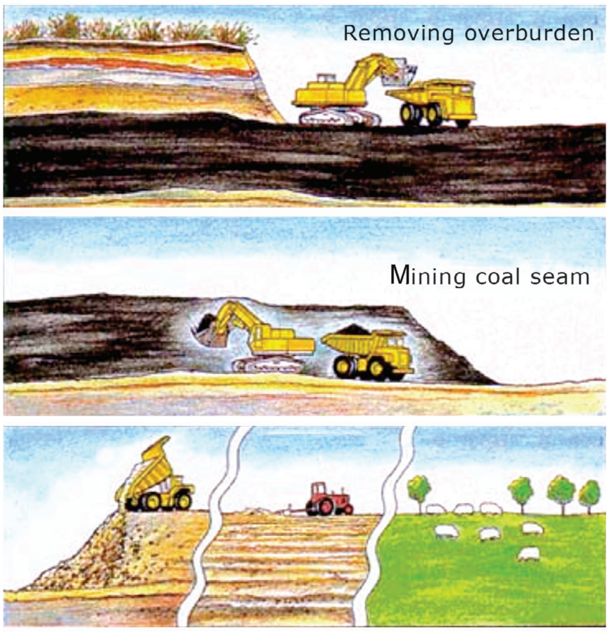
Another method, called longwall mining, accounts for about 20% of production. This method involves pulling a cutting machine across a 400 to 600 foot long face (longwall) of the coal seam. This machine has a revolving cylinder with tungsten bits that shear off the coal. The coal falls into a conveyor system which carries it out of the mine. The roof is supported by large steel supports, attached to the longwall machine. As the machine moves forward, the roof supports are advanced. The roof behind the supports is allowed to fall. Nearly 80% of the coal can be removed using this method. The remaining 11 percent of underground production is produced by conventional mining, which uses explosives to break up the coal for removal.

Half of the mineable surface coal in the United States is located in the West, but significant amounts are also present in Appalachia and the Midwest. Surface mining is used when the coal seam is located relatively close to the surface, making underground mining impractical.

Before a company can surface mine, it must gather information about the site regarding growing conditions, climate, soil composition, vegetation, wildlife, etc. With this information, the company then applies to the state or federal government for a permit to mine. The company must post a bond for each acre of land it mines to assure that it will be properly reclaimed.

Most surface mines follow the same basic steps to produce coal. First, bulldozers clear and level the mining area.The topsoil is removed and stored for later use in the reclamation process. Many small holes are drilled through the overburden (dirt and rock

Opencast Mining



Replacing overburden | Tilling soil | Pasture restored and trees planted

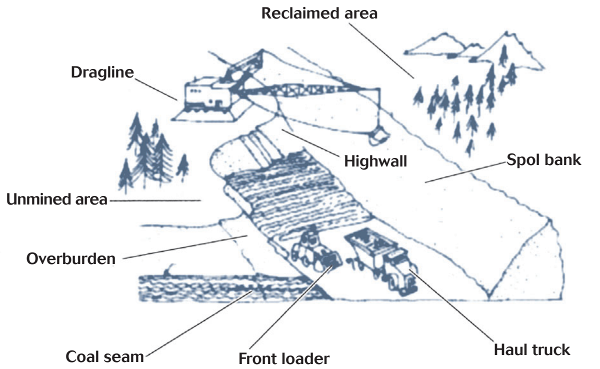
http://www.minerals.co.nz/html/main_topics/resources_for_schools/coal/coal_index.html above the coal seam) to the coal seam. Each is loaded with explosives, which are discharged, shattering the rock in the overburden. Giant power shovels or draglines clear away the overburden until the coal is exposed. Smaller shovels then scoop up the coal and load it onto trucks, which carry the coal to the preparation plant.

Once the coal is removed, the land is returned to the desired contour and the topsoil is replaced. Native vegetation and/or trees are planted. Coal companies operating surface mines must comply with strict requirements and regulations of the Federal Surface Mining Control and Reclamation Act. A crucial part of the surface mining process is restoring a mined site to acceptable ecological conditions, which means it must be made as productive as it was prior to mining. There are farms, parks, wilderness and recreation areas on what were once surface mines.

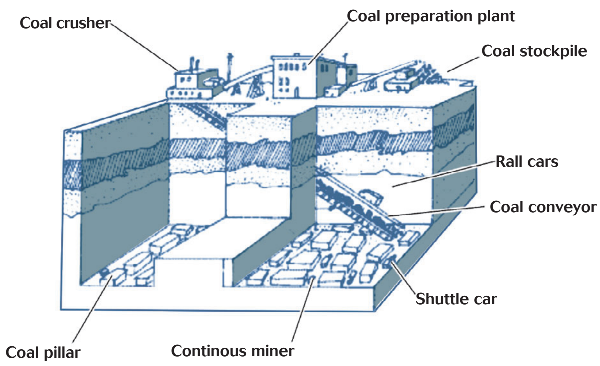
The major stigma associated with the coal industry today is the abandoned or 'orphan' mines of the early coal mining years. These orphan mines are systematically being reclaimed under the Surface Mining Act. Coal producers are taxed at the rate of 35c a tonne for surface mined coal, 10c a tonne for lignite mined coal, and 15c a tonne for underground mined coal. The tax is paid to the government and is used to reclaim the orphaned mines.

This material was provided by the National Energy Foundation and found on the Kentucky Coal Education website. Learners – If you use any part of it you need to write it in your own words and include the following in your reference list: Kentucky Coal Education. 2008. How is coal mined? [Online]. Available: http://www.coaleducation.org/lessons/twe/mcoal.htm [28 October 2008]

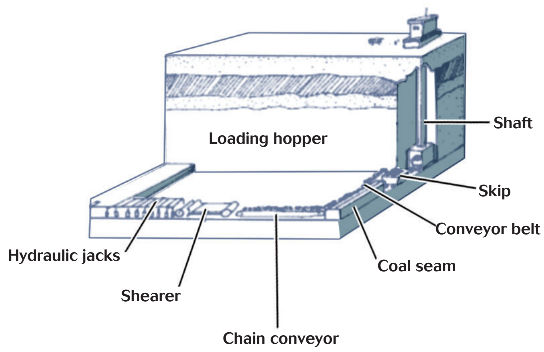
Surface Mine



Room and Pillar Method



Longwall Mining



Anglo Coal – Our Product

Coal is a compact black or dark brown carbonaceous rock consisting of layers of partially decomposed plant and vegetable matter.

South African coal was formed 250 to 300 million years ago, when the country was still attached to the super-continent known as Gondwanaland. The super-continent, which comprised Africa, South America, India, Australia and Antarctica, later fragmented into the continents that we know today.

Coal formation in the southern hemisphere was preceded by an ice age. With the melting and retreat of this ice, swamps formed in valleys allowing the establishment of thick vegetation (trees, ferns, grasses and mosses).

Most of these plants had shallow, poorly-developed root systems and were therefore easily toppled. The dead plants accumulated over millions of years and underwent a slow decay process forming a soft spongy material called peat.

Over time, the peat was buried under sediment washed down by the rivers and rain. This cover of silt and mud protected the material from erosion and allowed it to gradually transform over millions of years into coal as we know it today. The amount of change brought about by time, pressure and heat determines the carbon content (and burn character) of the coal and therefore its 'rank'.

The sediment eventually displaced the swamp waters, creating conditions that were once again favourable for plant growth, and the cycle was repeated several times. The net result was a package of several coal layers, called seams, sandwiched between the layers of rock. Sometimes movements in the Earth caused the coal seams to tilt, with one side of the coal being buried deep into the earth and the other being left close to the surface along hillsides and in river beds.

Coal is known as a fossil fuel because its energy was captured in prehistoric times.

What is Coal Used For?

There are two major types of coal – coking coal and thermal coal.

Coking coal is used to make coke, an ingredient in steel production, while thermal coal is used to provide heat energy. Its main use is in power stations where coal heats water to produce steam. This steam then powers turbines which produce electricity.

The coal consuming industry has diversified, with coal providing the primary energy needs for electricity generation, petro-chemicals and steel production, as well as a host of other industries, from brick-making to cement and lime calcining.

Presently (1999), about 77% of our country's primary energy needs are provided by coal, and this is unlikely to change significantly in the next decade due to the relative lack of suitable alternatives to coal as an energy source.

South Africa produces an average of 224 million tonnes of marketable coal annually, making it the fifth-largest coal-producing country in the world. Twenty-five percent of our production is exported internationally, making South Africa the third-largest coal exporting country.

The remainder of South Africa's coal production feeds the various local industries: 53% is used for electricity generation, 33% for petrochemical industries (Sasol), 12% for metallurgical industries (Iscor) and 2% for domestic heating and cooking.

South Africa's coal reserves are estimated at 53 billion tonnes and with our present production rate there should be almost 200 years of coal supply left.

This material was issued by Anglo American on 23 July 1999. Learners – If you use any part of it you need to write it in your own words and include the following in your reference list: Anglo American. 23 July 1999. Anglo Coal – Our product. Anglo American: South Africa.

Mining Methods

Coal is mined by two methods – surface or 'opencast' mining and underground or 'deep' mining.

The choice of mining method is largely determined by the geology of the coal deposit. Underground mining currently accounts for about 60% of world coal production, although in several important coal-producing countries surface mining is more common. Surface mining accounts for around 80% of production in Australia, while in the USA it is used for about 67% of production.

Underground Mining

There are two main methods of underground mining: room-and-pillar and longwall mining.

- Room and pillar mining. Coal deposits are mined by cutting a network of 'rooms' into the coal seam and leaving behind 'pillars' of coal to support the roof of the mine. These pillars can be up to 40% of the total coal in the seam – although this coal can sometimes be recovered at a later stage. This can be achieved in what is known as 'retreat mining', where coal is mined from the pillars as workers retreat. The roof is then allowed to collapse and the mine is abandoned.
- Longwall mining. This involves the full extraction of coal from a section of the seam or 'face' using mechanical shearers. A longwall face requires careful planning to ensure favourable geology exists throughout the section before development work begins. The coal 'face' can vary in length from100–350 m. Selfadvancing, hydraulically-powered supports temporarily hold up the roof while coal is extracted. When coal has been extracted from the area, the roof is allowed to collapse. Over 75% of the coal in the deposit can be extracted from panels of coal that can extend 3 km through the coal seam.

Longwall mining involves the full extraction of coal from a section of the seam using mechanical shearers. Source: Joy Mining Machinery.

Definition
Overburden is the layer of soil and rocks (strata) between the coal seams and the surface.

The main advantage of room and pillar mining over longwall mining is that it allows coal production to start much more quickly, using mobile machinery that costs under US$5 million (longwall mining machinery can cost US$50 million).

The choice of mining technique is site-specific, but always based on economic considerations; differences even within a single mine can lead to both methods being used.

Surface Mining

Surface mining – also known as opencast or opencut mining – is only economic when the coal seam is near the surface. This method recovers a higher proportion of the coal deposit than underground mining as all coal seams are exploited – 90% or more of the coal can be recovered. Large opencast mines can cover an area of many square kilometres and use very large pieces of equipment, including: draglines, which remove the overburden; power shovels; large trucks, which transport overburden and coal; bucket wheel excavators; and conveyors.

The overburden of soil and rock is first broken up by explosives; it is then removed by draglines or by shovel and truck. Once the coal seam is exposed, it is drilled, fractured and systematically mined in strips. The coal is then loaded on to large trucks or conveyors for transport to either the coal preparation plant or direct to where it will be used.

Coal Preparation

Coal straight from the ground, known as runof-mine (ROM) coal, 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.

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 run-of-mine 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 the coal is lighter, it floats and can be separated off, while heavier rock and other impurities sink and are removed as waste.

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.

Definition
DWT – Deadweight Tonnes which refers to the deadweight capacity of a ship, including its cargo, bunker fuel, fresh water, stores etc.

Longwall Mining

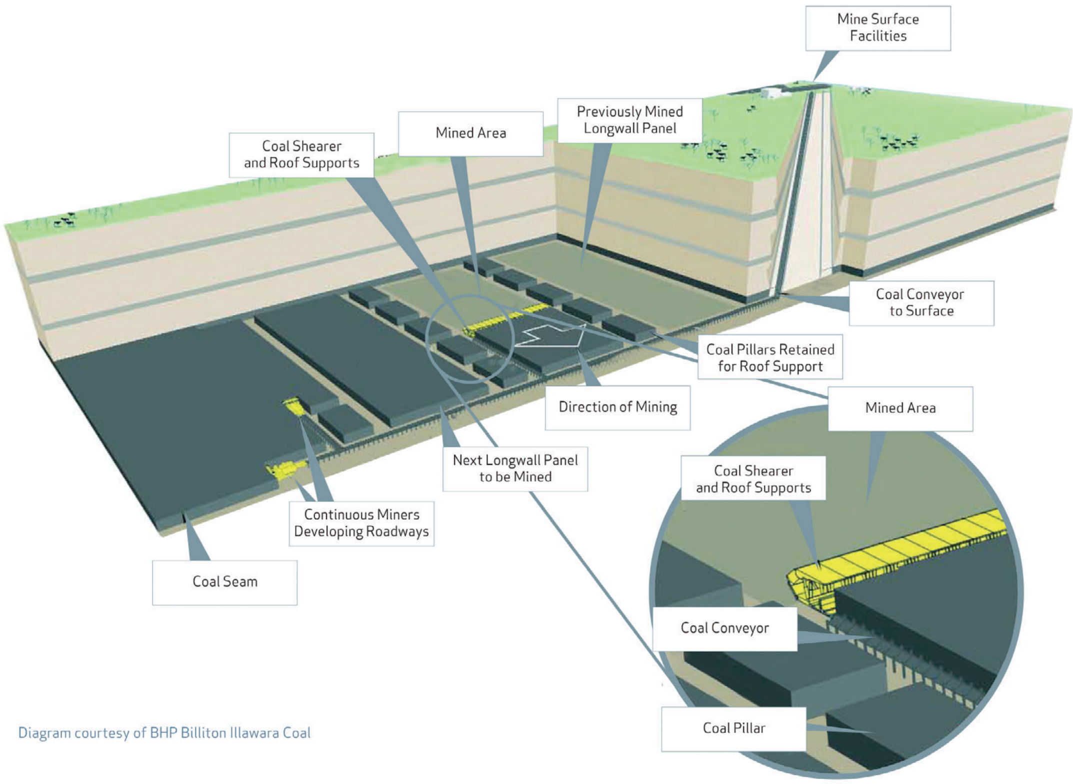
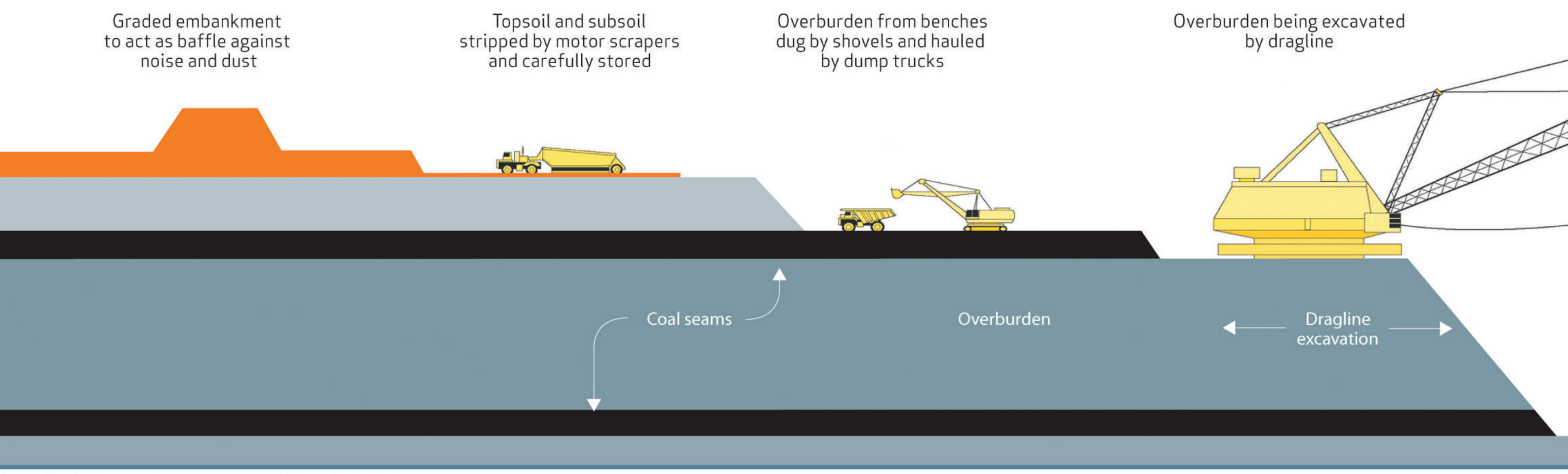


Diagram courtesy of BHP Billiton Illawara Coal

Coal Transportation

The way that coal is transported to where it will be used depends on the distance to be covered. Coal is generally transported by conveyor or truck over short distances. Trains and barges are used for longer distances within domestic markets, or alternatively coal can be mixed with water to form a coal slurry and transported through a pipeline. Ships are commonly used for international transportation, in sizes ranging from Handymax (40–60,000 DWT), Panamax (about 60–80,000 DWT) to large Capesize vessels (about 80 000+ DWT). Around 700 million tonnes (Mt) of coal was traded internationally in 2003 and around 90% of this was seaborne trade. Coal transportation can be very expensive – in some instances it accounts for up to 70% of the delivered cost of coal. Measures are taken at every stage of coal transportation and storage to minimise environmental impacts (see Coal Sheets 9 and 10 for more information on coal and the environment).



Surface Coal Mining Operations and Mine Rehabilitation

Safety at Coal Mines

The coal industry takes the issue of safety very seriously. Coal mining deep underground involves a higher safety risk than coal mined in opencast pits. However, modern coal mines have rigorous safety procedures, health and safety standards and worker education and training, which have led to significant improvements in safety levels in both underground and opencast mining (see figure 1).

There are still problems within the industry. The majority of coal mine accidents and fatalities occur in China. Most accidents are in small-scale town and village mines, often illegally operated, where mining techniques are labour intensive and use very basic equipment. The Chinese government is taking steps to improve safety levels, including the forced closure of small-scale mines and those that fail to meet safety standards.

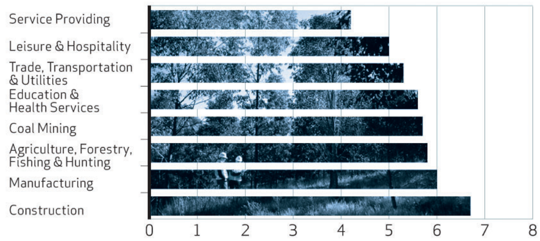


Figure 1: Injury rates in selected US Industries, 2003 (per 100 full-time employees)

Source: Bureau of Labour Statistics, US Department of Labour

Coal Mining and the Community

Froth flotation cells at Goedehoop Colliery are used for fine coal beneficiation.

Source: Anglo Coal

Coal mining generally takes place in rural areas where mining and the associated industries are usually one of, if not, the largest employers in the area. It is estimated that coal employs over 7 million people worldwide, 90% of whom are in developing countries.

Not only does coal mining directly employ millions worldwide, it generates income and employment in other regional industries that are dependent on coal mining. These industries provide goods and services into coal mining, such as fuel, electricity and equipment, or are dependent on expenditure from employees of coal mines.

Large-scale coal mines provide a significant source of local income in the form of wages, community programmes and inputs into production in the local economy.

However, mining and energy extraction can sometimes lead to land use conflicts and difficulties in relationships with neighbours and local communities. Many conflicts over land use can be resolved by highlighting that mining is only a temporary land use. Mine rehabilitation means that the land can be used once again for other purposes after mine closure.

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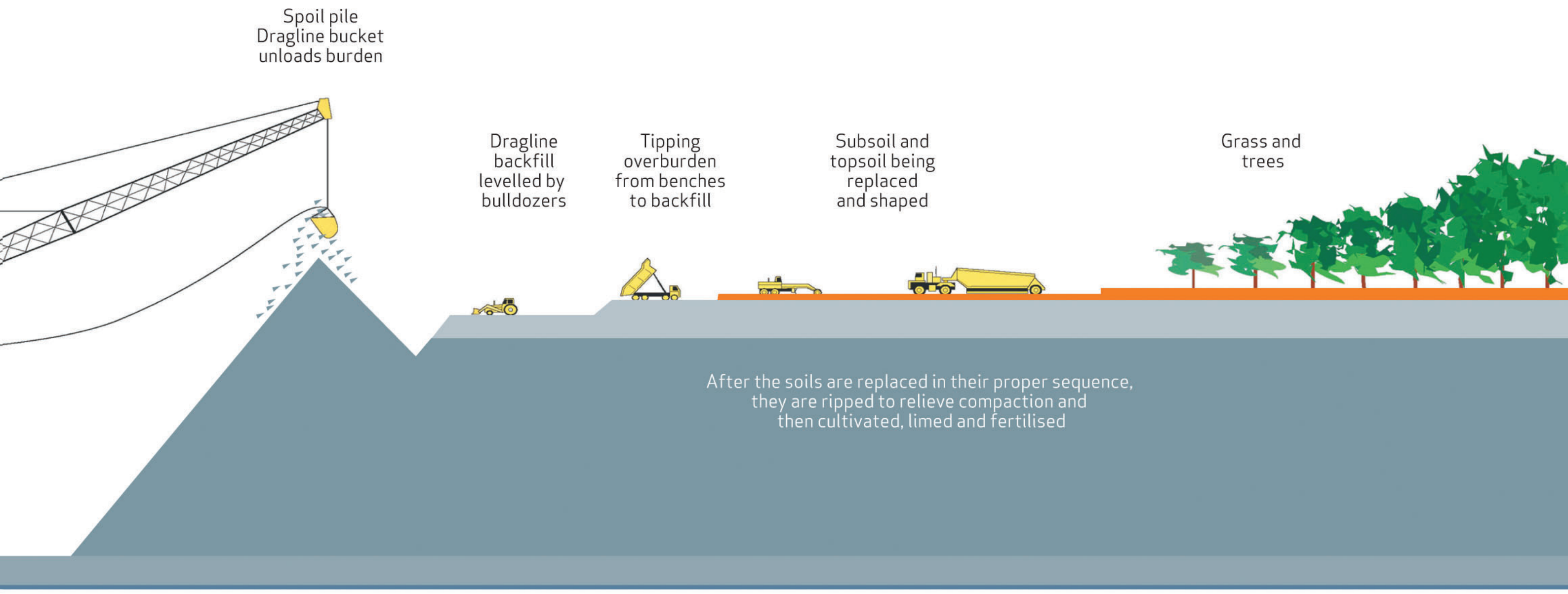


The Global Coal Market

Coal is a global industry, with coal mined commercially in over 50 countries and coal used in over 70.

The world currently consumes over 4 050 million tonnes of coal. Coal is used by a variety of sectors – including power generation, iron and steel production, cement manufacturing and as a liquid fuel. The majority of coal is either utilized in power generation – steam coal or lignite – or iron and steel production – coking coal.

Major Coal Importers, 2003 (Million tonnes)			
Japan	162	Republic of Korea	72
Chinese Taipei	54	Germany	35
UK	32	Russia	24
India	24	USA	23
Netherlands	22	Spain	22

Source: IEA Coal Information 2004

Coal Production

Over 4 030 million tonnes of coal is currently produced – a 38% increase over the past 20 years. Coal production has grown fastest in Asia, while Europe has actually seen a decline in production.

The largest coal-producing countries are not confined to one region – the top five producers are China, the USA, India, Australia and South Africa. Much of global coal production is used in the country in which it was produced, only around 18% of hard coal production is destined for the international coal market.

Global coal production is expected to reach 7 billion tonnes in 2030 – with China accounting for around half the increase over this period. Steam coal production is projected to have reached around 5,2 billion tonnes; coking coal 624 million tonnes; and brown coal 1,2 billion tonnes.

Coal Consumption

Coal plays a vital role in power generation and this role is set to continue. Coal currently fuels 39% of the world's electricity and this proportion is expected to remain at similar levels over the next 30 years.

Consumption of steam coal is projected to grow by 1,5% per year over the period 2002–2030. Lignite, also used in power generation, will grow by 1% per year. Demand for coking coal in iron and steel production is set to increase by 0,9% per year over this period.

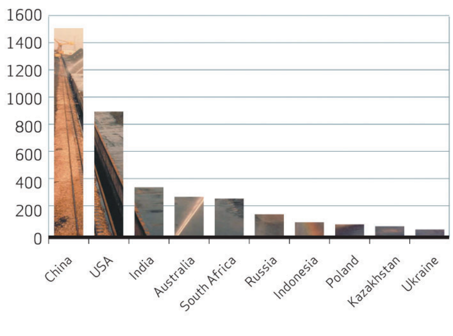
The biggest market for coal is Asia, which currently accounts for 54% of global coal consumption – although China is responsible for a significant proportion of this. Many countries do not have natural energy resources sufficient to cover their energy needs, and therefore need to import energy to help meet their requirements. Japan, Chinese Taipei and Korea, for example, import significant quantities of steam coal for electricity generation and coking coal for steel production.

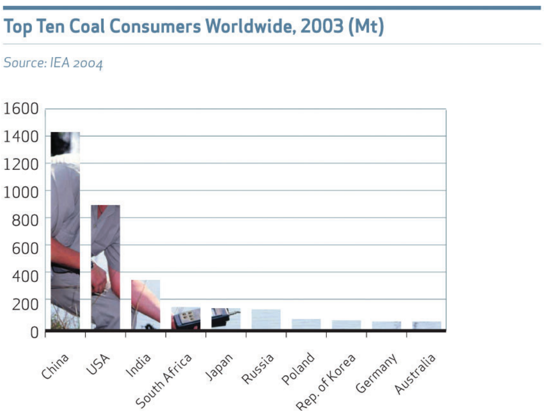
It is not just a lack of indigenous coal supplies that prompts countries to import coal but also the importance of obtaining specific types of coal. Major coal producers such as China, the USA and India, for example, also import quantities of coal for quality and logistical reasons.

Coal will continue to play a key role in the world's energy mix, with demand in certain regions set to

Top Ten Coal-Producing Countries Worldwide, 2003 (Mt)

Source: IEA 2004





grow rapidly. Growth in both the steam and coking coal markets will be strongest in developing Asian countries, where demand for electricity and the need for steel in construction, car production, and demands for household appliances will increase as incomes rise.

Coal Trade

Coal is traded all over the world, with coal shipped huge distances by sea to reach markets.

Over the last twenty years, seaborne trade in steam coal has increased on average by about 8% each year, while seaborne coking coal trade has increased by 2% a year. Overall international trade in coal reached 718 million tonnes in 2003; while this is a significant amount of coal it still only accounts for about 18% of total coal consumed.

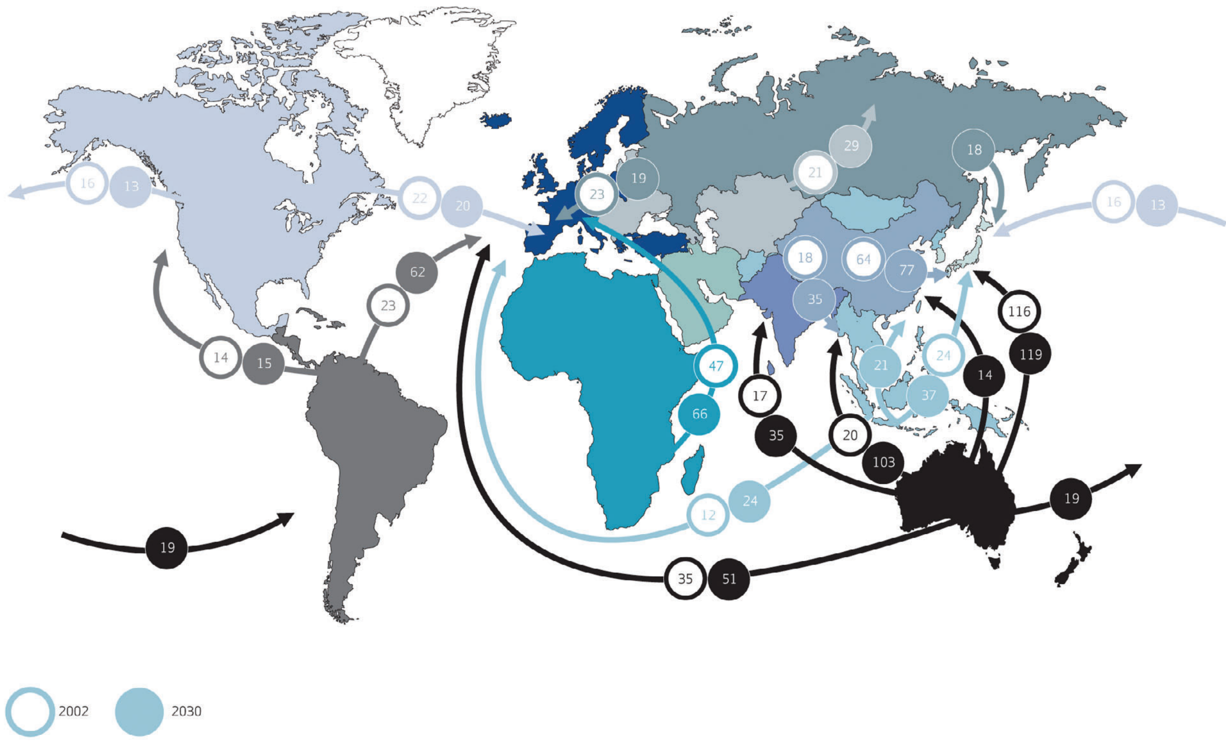
Transportation costs account for a large share of the total delivered price of coal, therefore international trade in steam coal is effectively divided into two regional markets – the Atlantic and the Pacific. The Atlantic market is made up of importing countries in western Europe, notably the UK, Germany and Spain. The Pacific market consists of developing and OECD Asian importers, notably Japan, Korea and Chinese Taipei. The Pacific market currently accounts for about 60% of world steam coal trade. Markets tend to overlap when coal prices are high and supplies plentiful. South Africa is a natural point of convergence between the two markets.

Australia is the world's largest coal exporter; exporting over 207 million tonnes of hard coal in 2003, out of its total production of 274 million tonnes.

> **Definition**
> OECD is the Organisation for Economic Cooperation and Development. It is a group of 30 member countries who are committed to democratic government and the market economy.

Coal is one of Australia's most valuable export commodities. Although almost three-quarters of Australia's exports go to the Asian market, Australian coals are used all over the world, including Europe, the Americas and Africa. International coking coal trade is limited. Australia is also the largest supplier of coking coal, accounting for 51% of world exports. The USA and Canada are significant exporters and China is emerging as an important supplier. Coking coal is more expensive than steam coal, which means that Australia is able to afford the high freight rates involved in exporting coking coal worldwide.

Major Inter-Regional Coal Trade Flows, 2002-2030 (Mt)



Source: IEA 2004

Energy Security

Minimising the risk of disruptions to our energy supplies is ever more important – whether they are caused by accident, political intervention, terrorism or industrial disputes. Coal has an important role to play at a time when we are increasingly concerned with issues relating to energy security.

The global coal market is large and diverse, with many different producers and consumers from every continent. Coal supplies do not come from one specific area, which would make consumers dependent on the security of supplies and stability of only one region. They are spread out worldwide and coal is traded internationally.

Many countries rely on domestic supplies of coal for their energy needs – such as China, the USA, India, Australia and South Africa. Others import coal from a variety of countries: in 2003 the UK, for example, imported coal from Australia, Colombia, Poland, Russia, South Africa and the USA, as well as smaller amounts from a number of other countries and its own domestic supplies.

Coal therefore has an important role to play in maintaining the security of the global energy mix.

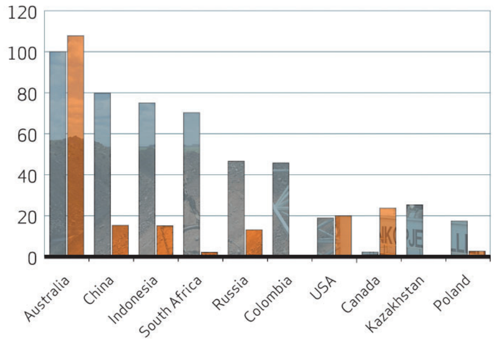
- Coal reserves are very large and will be available for the foreseeable future without raising geopolitical or safety issues.
- Coal is readily available from a wide variety of sources in a well-supplied worldwide market.
- Coal can be easily stored at power stations and stocks can be drawn on in emergencies.
- Coal-based power is not dependent on the weather and can be used as a backup for wind and hydropower.
- Coal does not need high pressure pipelines or dedicated supply routes.
- Coal supply routes do not need to be protected at enormous expense.

Major Coal Exporters, 2003 (Mt)

Steam

Coking

Source: IEA 2004



These features help to facilitate efficient and competitive energy markets and help to stabilise energy prices through inter-fuel competition and logistical reasons.

Coal will continue to play a key role in the world's energy mix, with demand in certain regions set to grow rapidly. Growth in both the steam and coking coal markets will be strongest in developing Asian countries, where demand for electricity and the need for steel in construction, car production, and demands for household appliances will increase as incomes rise.

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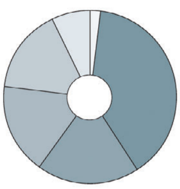
Total World Electricity Generation (% by Fuel, 2002)

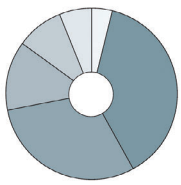


Coal	39%
Gas	19%
Nuclear	17%
Hydro	16%
Oil	7%
Other*	2%

** Other includes solar, wind, combustible renewables, geothermal and waste*

Source: IEA 2004

Total World Electricity Generation (% by Fuel, projected for 2030)



Coal	38%
Gas	30%
Hydro	13%
Nuclear	9%
Other*	6%
Oil	4%

** Other includes solar, wind, combustible renewables, geothermal and waste*

Source: IEA 2004

Coal and the Environment

Our consumption of energy can have a significant impact on the environment. Minimising the negative impacts of human activities on the natural environment – including energy use – is a key global priority.

However, it is important to balance concerns for the environment alongside the priorities of economic and social development. 'Sustainable development' encapsulates all three areas and has been defined as: 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.

While coal makes an important contribution to economic and social development worldwide, its environmental impact has been a challenge.

Coal Mining and the Environment

Coal mining – particularly surface mining – requires large areas of land to be temporarily disturbed. This raises a number of environmental challenges, including soil erosion, dust, noise and water pollution, and impacts on local biodiversity. Steps are taken in modern mining operations to minimize these impacts. Good planning and environmental management minimises the impact of mining on the environment and helps to preserve biodiversity.

Land Disturbance

In best practice, studies of the immediate environment are carried out several years before a coal mine opens in order to define the existing conditions and to identify sensitivities and potential problems. The studies look at the impact of mining on surface and groundwater, soils, local land use and native vegetation and wildlife populations. Computer simulations can be undertaken to model impacts on the local environment. The findings are then reviewed as part of the process leading to the award of a mining permit by the relevant government authorities.

Mine Subsidence

A problem that can be associated with underground coal mining is subsidence, whereby the ground level lowers as a result of coal having been mined beneath. Any land use activity that could place public or private property or valuable landscapes at risk is clearly a concern.

A thorough understanding of subsistence patterns in a particular region allows the effects of underground mining on the surface to be quantified. This ensures the safe, maximum recovery of a coal resource, while providing protection to other land uses.

Water Pollution

Acid mine drainage (AMD) is metal-rich water formed from the chemical reaction between water and rocks containing sulfur-bearing minerals. The runoff formed is usually acidic and frequently comes from areas where ore- or coal-mining activities have exposed rocks containing pyrite, a sulfur-bearing mineral. However, metal-rich drainage can also occur in mineralised areas that have not been mined.

AMD is formed when the pyrite reacts with air and water to form sulfuric acid and dissolved iron. This acid run-off dissolves heavy metals such as copper, lead and mercury into ground and surface water.

There are mine management methods that can minimise the problem of AMD, and effective mine design can keep water away from acid generating materials and help prevent AMD occurring. AMD can be treated actively or passively. Active treatment involves installing a water treatment plant, where the AMD is first dosed with lime to neutralise the acid and then passed through settling tanks to remove the sediment and particulate metals. Passive treatment aims to develop a self-operating system that can treat the effluent without constant human intervention.

Dust and Noise Pollution

During mining operations, the impact of air and noise pollution on workers and local communities can be minimised by modern mine planning techniques and specialised equipment. Dust at mining operations can be caused by trucks being driven on unsealed roads, coal crushing operations, drilling operations and wind blowing over areas disturbed by mining.

Dust levels can be controlled by spraying water on roads, stockpiles and conveyors. Other steps can also be taken, including fitting drills with dust collection systems and purchasing additional land surrounding the mine to act as a buffer zone between the mine and its neighbours. Trees planted in these buffer zones can also minimise the visual impact of mining operations on local communities. Noise can be controlled through the careful selection of equipment and insulation and sound enclosures around machinery. In best practice, each site has noise and vibration monitoring equipment installed, so that noise levels can be measured to ensure the mine is within specified limits.

The Moura mine was the first operation in Australia to establish a commercial coal mine methane business alongside its coal- mining operations. The project has the potential to make overall GHG emissions savings equivalent to 2,8 million tonnes of CO_2 per annum.
Source: Anglo Coal Australia.

Rehabilitation

Coal mining is only a temporary use of land, so it is vital that rehabilitation of land takes place once mining operations have ceased. In best practice, a detailed rehabilitation or reclamation plan is designed and approved for each coal mine, covering the period from the start of operations until well after mining has finished. Land reclamation is an integral part of modern mining operations around the world and the cost of rehabilitating the land once mining has ceased is factored into the mine's operating costs. Mine reclamation activities are undertaken gradually – with the shaping and contouring of spoil piles, replacement of topsoil, seeding with grasses and planting of trees taking place on the mined-out areas. Care is taken to relocate streams, wildlife, and other valuable resources.

Reclaimed land can have many uses, including agriculture, forestry, wildlife habitation and recreation.

Using Methane from Coal Mines

Methane (CH_4) is a gas formed as part of the process of coal formation. It is released from the coal seam and the surrounding disturbed strata during mining operations.

Methane is a potent greenhouse gas – it is estimated to account for 18% of the overall global warming effect arising from human activities (CO_2 is estimated to contribute 50%). While coal is not the only source of methane emissions – production of rice in wet paddy fields and other agricultural activities are major emitters – methane from coal seams can be utilised rather than released to the atmosphere with a significant environmental benefit.

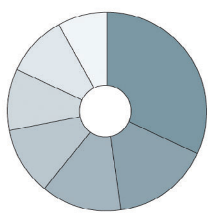
Coal mine methane (CMM) is methane released from coal seams during coal mining. Coalbed methane CBM) is methane trapped within coal seams that have not, or will not, be mined.

Methane is highly explosive and has to be drained during mining operations to keep working conditions safe. At active underground mines, large-scale ventilation systems move massive quantities of air through the mine, keeping the mine safe but also releasing methane into the atmosphere at very low concentrations. Some active and abandoned mines produce methane from degasification systems, also known as gas drainage systems, which use wells to recover methane.

As well as improving safety at coal mines, the use of CMM improves the environmental performance of a coal mining operation and can have a commercial benefit. Coal mine methane has a variety of uses, including on-site or off-site electricity production, use in industrial processes and fuel for cofiring boilers.

Coalbed methane can be extracted by drilling into and mechanically fracturing unworked coal seams. While the CBM is utilised, the coal itself remains unmined.

Major Sources of Methane Emissions



Livestock	32%
Oil and Natural Gas	16%
Solid Waste	13%
Rice	11%
Waste Water	10%
Other	10%
Coal	8%

Source: US EPA

Coal Use and the Environment

Global consumption of energy raises a number of environmental concerns. For coal, the release of pollutants, such as oxides of sulfur and nitrogen (SO_2 and NO_2), and particulate and trace elements, such as mercury, have been a challenge. Technologies have been developed and deployed to minimise these emissions.

A more recent challenge has been that of carbon dioxide emissions (CO_2). The release of CO_2 into the atmosphere from human activities – often referred to as anthropogenic emissions – has been linked to global warming. The combustion of fossil fuels is a major source of anthropogenic emissions worldwide. While the use of oil in the transportation sector is the major source of energy-related CO_2 emissions, coal is also a significant source. As a result, the industry has been researching and developing technological options to meet this new environmental challenge.

Definition
Carbon dioxide is a colourless, odourless, incombustible gas formed during decomposition, combustion and respiration.

Technological Response

Clean coal technologies (CCTs) are a range of technological options which improve the environmental performance of coal. These technologies reduce emissions, reduce waste, and increase the amount of energy gained from each tonne of coal.

Different technologies suit different types of coal and tackle different environmental problems. The choice of technologies can also depend on a country's level of economic development. More expensive, highly advanced technologies may not be suitable in developing countries, for example, where cheaper readily available options can have a larger and more affordable environmental benefit.

Reducing Particulate Emissions

Emissions of particulates, such as ash, have been one of the more visible side-effects of coal combustion in the past. They can impact local visibility, cause dust problems and affect people's respiratory systems. Technologies are available to reduce and, in some cases, almost eliminate particulate emissions.

Coal Cleaning

Coal cleaning, also known as coal beneficiation or coal preparation, increases the heating value and the quality of the coal by lowering levels of sulfur and mineral matter. The ash content of coal can be reduced by over 50%, helping to cut waste from coal combustion. This is particularly important in countries where coal is transported long distances prior to use, since it improves the economics of transportation by removing most of the noncombustible material. Coal cleaning can also improve the efficiency of coal-fired power stations, which leads to a reduction in emissions of carbon dioxide.

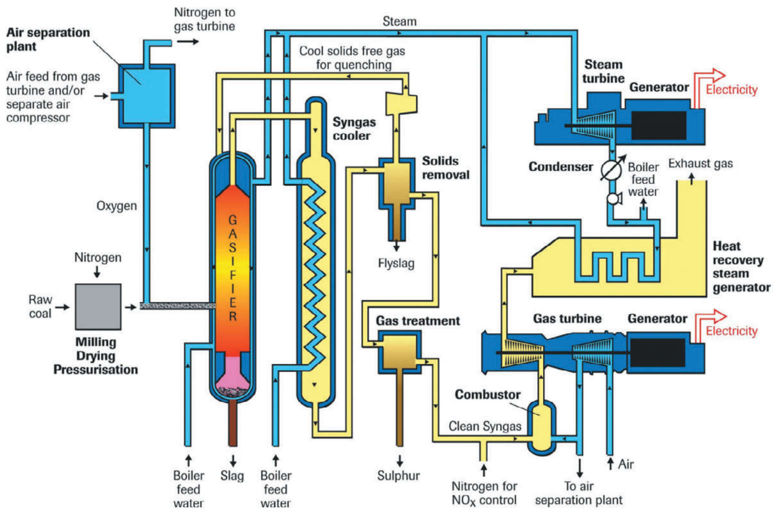
Electrostatic Precipitators and Fabric Filters

Particulates from coal combustion can be controlled by electrostatic precipitators (ESP) and fabric filters. Both can remove over 99,5% of particulate emissions and are widely applied in both developed and developing countries. In electrostatic precipitators, particulate-laden flue gases pass between collecting plates, where an electrical field creates a charge on the particles. This attracts the particles towards the collecting plates, where they accumulate and can be disposed of.

Fabric filters, also known as 'baghouses', are an alternative approach and collect particles from the flue gas on a tightly woven fabric primarily by sieving.

The use of particulate control equipment has a major impact on the environmental performance of coal-fired power stations. At the Lethabo power station

An Integrated Gasification Combined Cycle Unit



in South Africa, electrostatic precipitators remove 99,8% of fly ash, some of which is sold to the cement industry. For Eskom, the plant operator, the use of ESPs has had a major impact on the environmental performance of its power stations. Between 1988 and 2003, it reduced particulate emissions by almost 85% while power generated increased by over 56%.

Preventing Acid Rain

Acid rain came to global attention during the latter part of the last century, when acidification of lakes and tree damage in parts of Europe and North America was discovered.

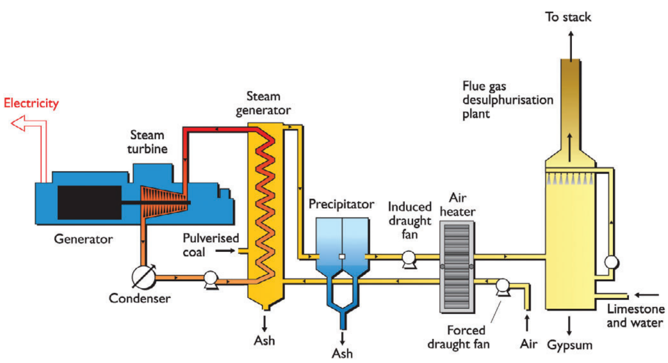
Acid rain was attributed to a number of factors, including acid drainage from deforested areas and emissions from fossil fuel combustion in transportation and power stations.

Oxides of sulphur (SO_2) and nitrogen (NO_2) are emitted to varying degrees during the combustion of fossil fuels. These gases react chemically with water vapour and other substances in the atmosphere to form acids, which are then deposited in rainfall.

Steps have been taken to significantly reduce SO_2 and NO_2 emissions from coal-fired power stations. Certain approaches also have the additional benefit of reducing other emissions, such as mercury.

Sulphur is present in coal as an impurity and reacts with air when coal is burned to form SO_2. In contrast, NO_2 is formed when any fossil fuel is burned. In many circumstances, the use of low sulfur coal is the most economical way to control sulfur dioxide. An alternative approach has been the development of flue gas desulfurisation (FGD) systems for use in coal-fired power stations. FGD systems are sometimes referred to as 'scrubbers' and can remove as much as 99% of SO_2 emissions. In the USA, for example, sulfur emissions from coal-fired power plants decreased by 61% between 1980 and 2000 – even though coal use by utilities increased by 74%. Oxides of nitrogen can contribute to the development of smog as well as acid rain. NO_2 emissions from coal combustion can be reduced by the use of 'low NO_2' burners, improving burner design and applying technologies that treat NO_2 in the exhaust gas stream. Selective catalytic reduction (SCR) and selective noncatalytic reduction (SNCR) technologies can reduce NO_2 emissions by around 80–90% by treating the NO_2 post-combustion. Fluidised bed combustion (FBC) is a high efficiency, advanced technological approach to reducing both NO_2 and SO_2 emissions. FBC is able to achieve reductions of 90% or more. In FBC systems, coal is burned in a bed of heated particles suspended in flowing air. At high air velocities, the bed acts as a fluid resulting in the rapid mixing of the particles. This fluidizing action allows complete coal combustion at relatively low temperatures.

A Flue Gas Desulfurisation System



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Reducing Carbon Dioxide Emissions

A major environmental challenge facing the world today is the risk of 'global warming'.

Naturally-occurring gases in the atmosphere help to regulate the Earth's temperature by trapping other radiation – this is known as the greenhouse effect. Human activities, such as the combustion of fossil fuels, produce additional greenhouse gases (GHG) which accumulate in the atmosphere. Scientists believe that the build-up of these gases is causing an enhanced greenhouse effect, which could cause global warming and climate change.

The major greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride.

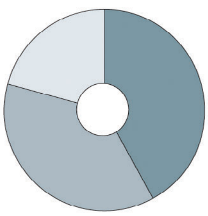
Coal is one of many sources of greenhouse gas emissions generated by human activities and the industry is committed to minimising its emissions.

Greenhouse gases associated with coal include methane, carbon dioxide (CO_2) and nitrous oxide (N_2O). Methane is released from deep coal mining (see Sheet 9). CO_2 and N_2O are released when coal is used in electricity generation or industrial processes, such as steel production and cement manufacture.

Combustion Efficiency

An important step in reducing CO_2 emissions from coal combustion has been improvements in the thermal efficiencies of coal-fired power stations. Thermal efficiency is a measure of the overall fuel conversion efficiency for the electricity generation process. The higher the efficiency levels, the greater the energy being produced from the fuel.

CO_2 Emissions from Fossil Fuels



Oil	41%
Coal	38%
Gas	21%

Source: IEA 2004

The global average thermal efficiency of coalfired power stations is around 30%, with the OECD average at around 38%. In comparison, China has an average thermal efficiency of all its installed coal-fired capacity of some 27% (though newer stations with significantly improved efficiencies are increasingly being installed).

New 'supercritical' technology allows coal-fired power plants to achieve overall thermal efficiencies of 43–45%. These higher levels are possible because supercritical plant operate at higher steam temperatures and pressures than conventional plant. Ultrasupercritical power plants can achieve efficiency levels of up to 50% by operating at even higher temperatures and pressures. More than 400 supercritical plant are operating worldwide, including a number in developing countries.

An alternative approach is to produce a gas from coal – this is achieved in integrated gasification combined cycle (IGCC) systems. In IGCC, coal is not combusted directly but reacted with oxygen and steam to produce a 'syngas' composed mainly of hydrogen and carbon monoxide. This syngas is cleaned of impurities and then burnt in a gas turbine to generate electricity and to produce steam for a steam power cycle.

IGCC systems operate at high efficiencies, typically in the mid-40s but plant designs offering close to 50% efficiencies are available. They also remove 95–99% of NO_2 and SO_2 emissions. Work is being undertaken to make further gains in efficiency levels, with the prospect of net efficiencies of 56% in the future. There are around 160 IGCC plants worldwide.

IGCC systems also offer future potential for hydrogen production linked with carbon capture and storage technologies (described in more detail in the next section).

The Coal-fired Route to CO_2 Reductions			
Up to 5% CO_2 Reductions	**Up to 22% CO_2 Reductions**	**Up to 25% CO_2 Reductions**	**Up to 99% CO_2 Reductions**
Coal Upgrading	Efficiency Improvements of Existing Plant	Advanced Technologies	Zero Emissions
Includes coal washing/drying, briquetting. Widespread use throughout the world.	Conventional coal-fired subcritical generation has improved significantly in its efficiency (38–40%) so reducing emissions. Supercritical and ultrasupercritical plants offer even higher efficiencies (already up to 45%). Improved efficiency subcritical plants operate around the world. Supercritical and ultrasupercritical plants operate successfully in Japan, USA, Europe, Russia and China.	Very high efficiencies and low emissions from innovative technologies such as integrated gasification combined cycle (IGCC), pressurised fluidised bed combustion (PFBC) and, in the future, integrated gasification fuel cells (IGFC). IGCC and PFBC operational in USA, Japan and Europe, IGFC at research and development stage.	Carbon capture and storage. Significant international research and development efforts ongoing. FutureGen project aims to have demonstration plant operational within ten years.
TECHNOLOGICAL INNOVATION			

Carbon Capture and Storage

An important factor in the future use of coal will be the level to which CO_2 emissions can be reduced. Much has been done to achieve this, such as the improvements in efficiency levels. One of the most promising options for the future is carbon capture and storage (CCS).

Carbon capture and storage technologies allow emissions of carbon dioxide to be stripped out of the exhaust stream from coal combustion or gasification and disposed of in such a way that they do not enter the atmosphere. Technologies that allow CO_2 to be captured from emission streams have been used for many years to produce pure CO_2 for use in the food processing and chemicals industry. Petroleum companies often separate CO_2 from natural gas before it is transported to market by pipeline. Some have even started permanently storing CO_2 deep underground in saline aquifers.

While further development is needed to demonstrate the viability of separating out CO_2 from high volume, low CO_2 concentration flue gases from coal-fired power stations, carbon capture is a realistic option for the future.

Once the CO_2 has been captured, it is essential that it can be safely and permanently stored. There are a number of storage options at various stages of development and application.

Carbon dioxide can be injected into the Earth's subsurface, a technique known as geological storage. This technology allows large quantities of CO_2 to be permanently stored and is the most comprehensively

Underground Storage Options for CO_2

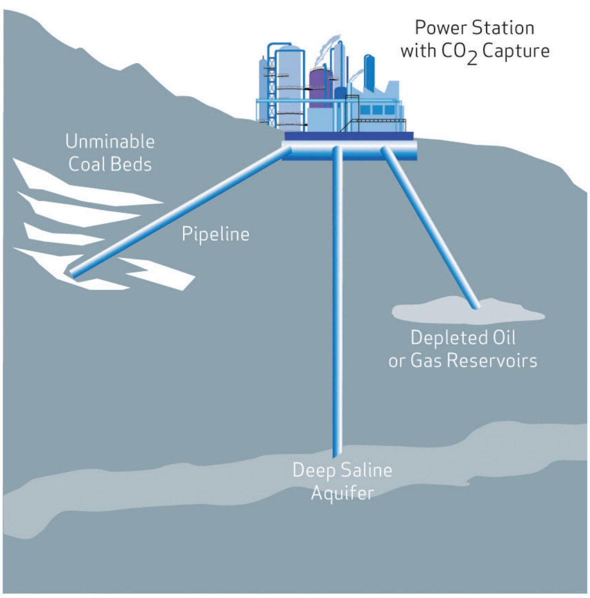


Diagram courtesy of IEA GHG R&D Programme studied storage option. As long as the site is carefully chosen, the CO_2 can be stored for very long periods of time and monitored to ensure there is no leakage.

Depleted oil and gas reservoirs are an important option for geological storage. Latest estimates suggest that depleted oilfields have a total capacity of some 126 gigatonnes* (Gt) of CO_2. Depleted natural gas reservoirs have a considerably larger storage capacity of some 800 Gt of CO_2. Unmineable coal beds are estimated to have a storage capacity of some 150 Gt of CO_2.

Large amounts of CO_2 can also be stored in deep saline water-saturated reservoir rocks, allowing countries to store their CO_2 emissions for many hundreds of years. Firm estimates of the CO_2 storage capacity in deep saline formations have not yet been fully developed, though it has been estimated that it could range between 400 and 10 000 Gt.

*Note: A gigatonne is one thousand million tonnes = 1 000 Mt

There are a number of projects demonstrating the effectiveness of CO_2 storage in saline aquifers. The Norwegian company Statoil is undertaking a project at the Sleipner field located in the Norwegian section of the North Sea. The Nagaoka project, started in Japan in 2002, is a smaller-scale, five-year project researching and demonstrating the potential of CO_2 storage in on shore and offshore aquifers.

The storage of CO_2 can also have an economic benefit by allowing increased production of oil and coalbed methane. These techniques are referred to as enhanced oil recovery (EOR) and enhanced coalbed methane recovery (ECBM). The CO_2 can be used to 'push' oil out of underground strata and is already widely used in the oil industry. The Weyburn Enhanced Oil Recovery project uses CO_2 from a lignite-fired power station in the USA and transports it through a 205 mile pipeline to the Weyburn oilfield in Canada to boost oil production. Around 5000 tonnes or 2,7 m^3 of CO_2 per day are injected into the oilfield, an amount which would otherwise have been released into the atmosphere.

ECBM allows CO_2 to be stored in unmineable coal seams and improves the production of coalbed methane as a valuable by-product. Carbon capture and storage offers the potential for the large-scale CO_2 reductions needed to stabilise atmospheric concentrations of CO_2.

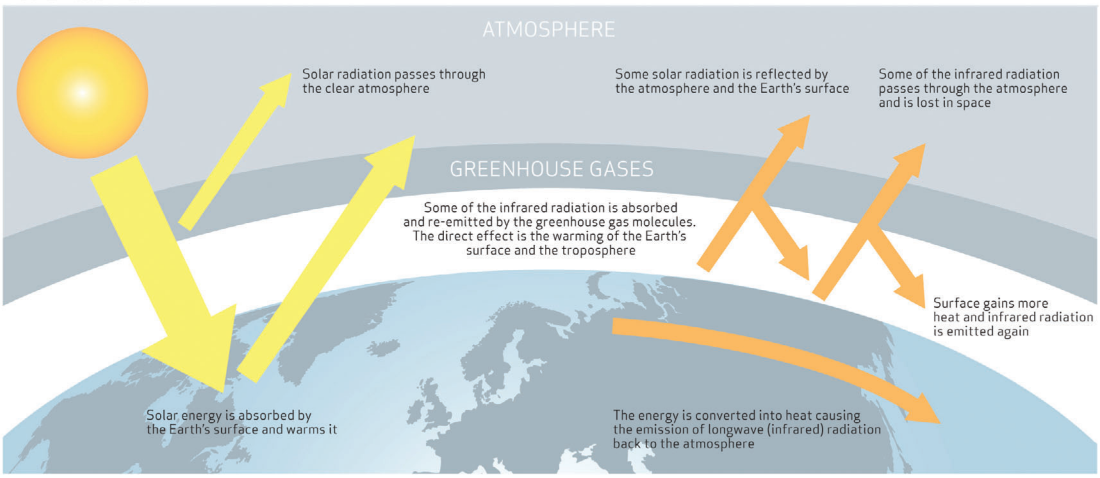
Coal and Renewable Energy

The continued development and deployment of renewable energy will play an important role in improving the environmental performance of future energy production. However, there are a number of significant practical and economic barriers that limit the projected rate of growth of renewable energy.

Renewable energy can be intermittent or unpredictable and 'site-dependent', which means they are only available at specific locations. Wind energy, for example, depends on whether and how strongly the wind is blowing and even the best wind farms do not normally operate for more than about one-third of the time. Many forms of biomass are seasonal and can be difficult to transport. Coal-fired electricity can help support the growth of renewable energy by balancing out their intermittencies in power supply. Coal can provide convenient, cheap base-load power while renewables can be used to meet peak demand. The economics and efficiency of biomass renewables can also be improved by cofiring with coal.

While clean coal technologies are improving the environmental performance of coal-fired power stations, its role as an affordable and readily available energy source offers wider environmental benefits by supporting the development of renewables.

The Greenhouse Effect



Overcoming Environmental Impacts

The environmental impact of our energy consumption is a concern for us all. Limiting the negative effects of coal production and use is a priority for the coal industry and one which has been the focus of research, development and investment. Much has been achieved – technologies have been developed and are widely used to limit particulate emissions, NO_2 and SO_2 and trace elements. Improvements in the efficiency of coal combustion have already achieved significant reductions in carbon dioxide emissions. The wider use of technologies to improve the environmental performance of coal will be essential, particularly in developing countries where coal use is set to markedly increase.

Technological innovation and advancement, such as carbon capture and storage, offers many future prospects for tackling CO_2 emissions from coal use in the future.

The UNFCCC & GHG Emissions

The United Nations Framework Convention on Climate Change (UNFCCC) sets an overall framework for intergovernmental efforts to tackle climate change. It opened for signature at the Earth Summit in Rio de Janeiro in 1992 and entered into force in 1994. Under the Convention, governments:

- gather and share information on GHG emissions, national policies and best practices
- launch national strategies for addressing GHG emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries
- cooperate in preparing for adaptation to the impacts of climate change

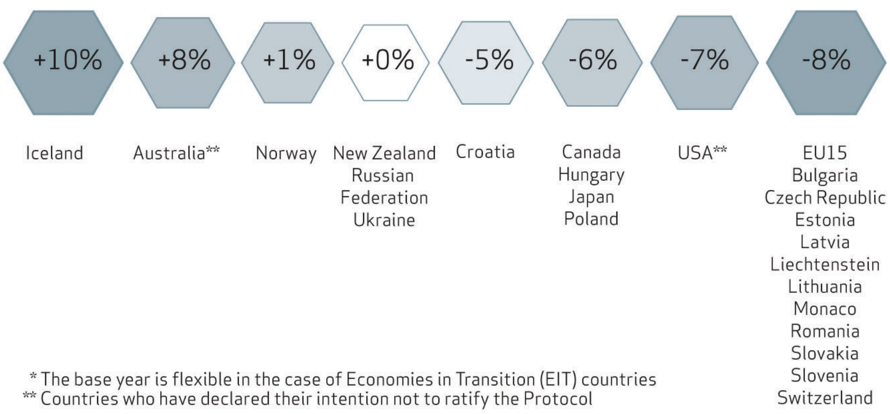
Countries that are parties to the UNFCCC meet annually at the Conference of the Parties (COP). It was at COP3, held in Kyoto in 1997, that countries negotiated the Kyoto Protocol, which set legally-binding targets for emissions reductions.

The Kyoto Protocol entered into force in February 2005. At that time there were 128 countries who were Parties to the Protocol, 30 of whom are developed countries with emissions targets. Both Australia and the USA have refused to ratify the Protocol but are undertaking their own domestic measures to stabilize GHG emissions.

Kyoto sets targets for industrialised countries 'with a view to reducing their overall emissions of such gases by at least 5% below existing 1990 levels, in the commitment period 2008-2012'.

Kyoto covers emissions of the six main greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride. (SF_6). Rather than placing a specific target on each of the gases, the overall emissions targets for all six is combined and translated into 'CO_2 equivalents', used to produce a single figure.

Kyoto Protocol Emissions Targets (1990* to 2008/2012)



This material was obtained from the World Coal Institute. Learners– if you use any part of it you need to write it in your own words and include the following in your reference list: World Coal Institute. 2005. The Coal Resource: A Comprehensive Overview of Coal. [Online]. Available: http://www.worldcoal.org/assets_cm/files/PDF/thecoalresource.pdf [28 October 2008]

South Africa's Coal

South Africa's indigenous energy resource base is dominated by coal. Internationally, coal is the most widely used primary fuel, accounting for about 36% of the total fuel consumption of the world's electricity production.

Coal meets about 88% of South Africa's primary energy needs. Eskom announced its intention to begin diversifying its primary energy mix (using less coal) five years ago. By mid-2007, it was building open-cycle gas turbines at Atlantis and Mossel Bay, of which 1 029 MW was expected to be commissioned. In addition, Eskom plans to build a 100 MW wind facility in the near future, pending licensing approvals, and will upgrade the Gariep Hydroelectric Power Station (80 MW). Feasibility studies continue regarding other renewable-energy and gas plant initiatives.

Many of the deposits can be exploited at extremely favourable costs and, as a result, a large coal-mining industry has developed. In addition to the extensive use of coal in the domestic economy, some 28% of South Africa's production is exported internationally, mainly through the Richards Bay Coal Terminal, making South Africa the fifth-largest coal-exporter in the world.

South Africa's coal is obtained from collieries ranging from among the largest in the world to small-scale producers. Operating collieries decreased to 60 during 2006. Of these, a relatively small number of large-scale producers supply coal primarily to electricity and synthetic fuel producers.

About 46,5% of South African coal mining is done underground and about 53,5% is produced by opencast methods.

The coal-mining industry is highly concentrated, with six companies, namely Anglo Coal, BHP Billiton, Sasol Mining, Eyesizwe Coal, Kumba Coal and Xstrata Coal accounting for 90% of the saleable coal production. The eight largest mines account for 61% of the output.

South African coal for local electricity production is among the cheapest in the world. The beneficiation (crushing and separation of ore into valuable substances or waste by any of a variety of techniques) of coal, particularly for export, results in more than 65 million tonnes of coal discards being produced annually.

The remainder of South Africa's coal production feeds the various local industries. About 109 million tonnes is used for electricity generation; 44 million tonnes for petrochemical industries such as Sasol; 9,7 million tonnes for general industry; and 5,7 million tonnes for the metallurgical industry. Coal merchants buy 8,4 million tonnes to sell locally or abroad.

The key role played by South Africa's coal reserves in the economy is illustrated by the fact that Eskom ranks first as a steam-coal user and seventh as an electricity generator in the world. Sasol is the largest coal-to-chemicals producer.

Total discards on the surface could reach more than two billion tonnes by 2020, should none of this material be used. As a result, the Department of Minerals and Energy is investigating ways to promote and encourage the economic use of discards. Environmental concerns pose the main challenge to coal as an energy source. Not only does the burning of coal cause air pollution, but the extraction of coal also affects the environment negatively. The Department and coal-mining industry are fostering the introduction of clean coal technologies in South Africa. Eskom has successfully commissioned an underground coal-gasification pilot plant next to Majuba Power Station in Mpumalanga. The underground coal-gasification process uses a matrix of wells drilled into the coal bed. Air is injected and the coal is ignited underground, thus producing a synthetic gas, which is harvested and used as fuel for either boilers or turbines. Gas from the pilot plant was successfully flared in January 2007, demonstrating that the process works. The technology promises a commercially competitive combustible gas, and has synergies with conventional mining, that would enable mines to exploit coal reserves that could not normally be mined. This application is a first for Africa and the frontrunner in terms of Eskom's research into clean coal technologies.

This material was obtained from the South Africa Yearbook 2007/08. Learners – if you use any part of it you need to write it in your own words and include the following in your reference list: Government Communication and Information System. 2008. The South Africa Yearbook 2007/08. [Online]. Available: http://www.gcis.gov.za/docs/publications/yearbook/ [28 October 2008]

South Africa's Coal

Clean Coal Utilisation

Environmental concerns pose the main challenge to coal as an energy source. Particulate emissions from household burning of coal and the mining activities to extract coal impact negatively on the environment.

The DME and the coal-mining industry are fostering the introduction of clean coal technologies. The South African National Low Smoke Fuel Programme, which forms part of the Clean Air Strategy, includes the Basa njengo Magogo technique, which addresses particulate emissions.

The principle thrust for clean coal utilisation is addressing the high levels of air pollution provided by the combustion of coal in households.

Coal is expected to maintain its share of the overall electricity generation market until 2020. Total discards on the surface could reach more than two billion tonnes by 2020 should none of this material be used. However, the DME is investigating ways to promote and encourage economic use of the discards.

Carbon Sequestration

South Africa has joined the Carbon Sequestration Leadership Forum that investigates technologies to sequestrate carbon. Carbon sequestration refers to processes that remove carbon from the atmosphere in order to store it.

In addition, South Africa has acceded to the Kyoto Protocol as a non-Annex I country, and its participation is scheduled to be through the Clean Development Mechanism, once the Protocol comes into force.

Coal Resources and Reserves

The uncertainty of the availability of significant amounts of economically extractable coal reserves for future use means that the generally expected dependence on coal well into the foreseeable future is also uncertain. So it is imperative to re-evaluate the national coal resource and reserve base to assist the government in formulating an efficient energy policy with regard to future coal energy supply.

In 1987, the Bredell report estimated South Africa's coal reserves as 55 billion tonnes and 115 billion tonnes of resources. The study to ascertain the amount of coal reserves and resources in South Africa is in progress. The efficient utilisation of coal reserves demands the production of different but very specific saleable products to satisfy the market requirements.

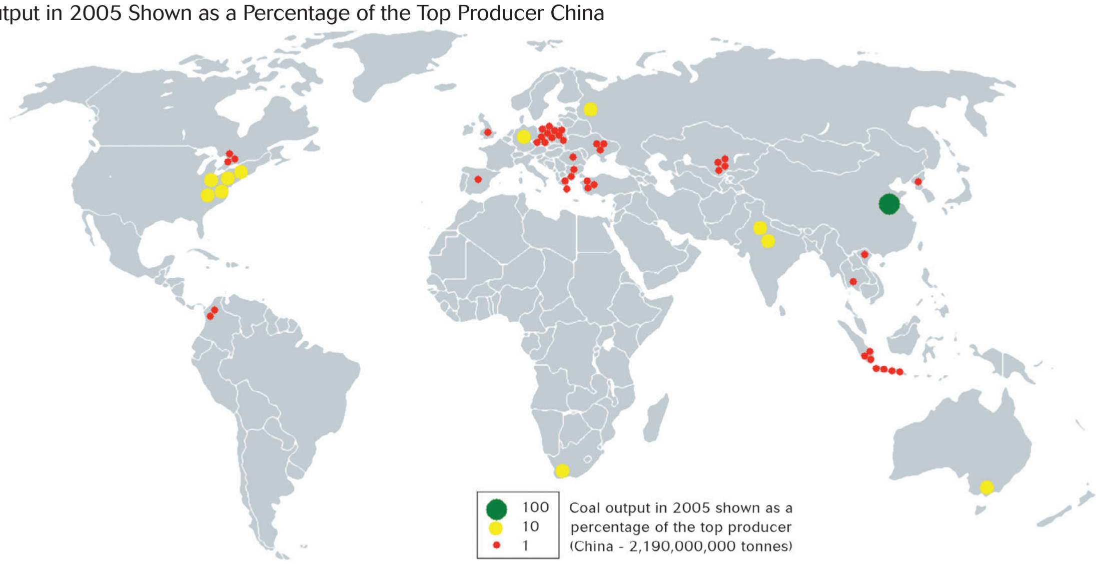
Coal Discards

The result of the beneficiation of South African coals are the generation of approximately 60 million tonnes per annum of discard coal, which is estimated to have already accumulated to more than 1 billion tonnes.

While these large amounts of carbonaceous material negatively affect the environment, they also contain significant amounts of usable coal. Discard coal is a major concern to the DME regarding the potential environmental impact in the future. It should also be seen as a major resource that could provide economic opportunities.

This material was obtained from the Department of Minerals and Energy website www.dme.gov.za. Learners – if you use any part of it you need to write it in your own words and include the following in your reference list:
Department of Minerals and Energy. 2007. Clean Coal Utilisation. [Online]. Available: http://www.dme.gov.za/energy/coal.stm [28 October 2008]

Coal Output in 2005 Shown as a Percentage of the Top Producer China



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SA mining production down, but mineral sales rise

Johannesburg, South Africa

14 November 2008

Total mining production for the third quarter of 2008 in South Africa – the world's biggest precious metals producer – decreased by 3,5% from the previous three months, and by 7,1% compared to the corresponding quarter of 2007.

Releasing latest production figures here, Statistics South Africa revealed that the four biggest contributors to the 3,5% decrease were PGMs (–1,9 percentage points), gold (–1,0 percentage point), diamonds (–0,8 of a percentage point) and coal (–0,5 of a percentage point).

The actual total mining production for September 2008 decreased by 3,5% compared to September 2007, reflected by both gold and non-gold mineral production decreasing by 17,7% and 1,2% respectively.

Statistics South Africa added that the total seasonally adjusted value of mineral sales at current prices for the three months ended August 2008 had reflected an increase of 3,7% on the previous three months. This increase of 3,7% (R2 880.3 million) could be attributed to an increase of 5,8% (R3 874,7 million) in the sale of non-gold minerals.

The actual estimated total value of mineral sales at current prices for the three months ended August 2008 had increased by 53,5% compared with the same three months of 2007. The major contributors to this increase of 53,5%, year-on-year, were coal (16,0 percentage points or R8 714,7 million), PGMs (15,7 percentage points or R8 552,2 million), and manganese ore (10,0 percentage points or R5 524,1 million).

This article was published by Mining Review Africa. Learners - if you use this article you need to write it in your own words and include the following in your reference list: www.miningreview.com. 2008. SA mineral production down, but mineral sales rise. 14 November 2008. [Online]. Available: http://beta.miningreview.com/node/14299 [21 November 2008]

A typical South African mine

British MPs laud Anglo's AIDS programmes

Three British MPs recently visited Anglo Coal South Africa's Goedehoop Colliery as part of a three-day fact-finding trip to gain an insight into Anglo American's approach to the HIV and AIDS pandemic. The delegation included Anglo's Senior VP: Health, Dr Brian Brink (back row, third from the left).

Three British Members of Parliament recently witnessed first-hand how some businesses in South Africa, including Anglo American, are addressing HIV and AIDS in the workplace.

Their three-day visit to the country was part of a Business Action for Africa fact-finding trip, aimed at demonstrating the important role that business has to play – in partnership with government, civil society and donors – in the fight against HIV and AIDS.

Members of Parliament Lynne Featherstone, David Borrow and Sally Keeble – from the Liberal Democrats and ruling Labour Party – were briefed on workplace HIV and AIDS intervention programmes, at Anglo American, SABMiller, Standard Chartered and Merck. They also interacted with representatives of various NGOs, organised labour and the international development community.

Dr Brian Brink, Senior Vice President: Health at Anglo American, was among the delegation's hosts. He is responsible for guiding Anglo American's response to the HIV/AIDS epidemic, both in the workplace and in communities associated with the company's operations.

The visitors experienced the human face of HIV and AIDS during visits to shack-dwellers living with the disease in Alexandra township, near Johannesburg.

Spending a full day at Anglo Coal, the MPs toured Goedehoop colliery, which has long been regarded as a centre of best practice within the Anglo American Group for its all-embracing approach to the pandemic.

Here, John Standish-White outlined Anglo Coal South Africa's proactive AIDS response campaign, before leading the delegation to the mine's sustainable development centre and the Hope Yebo Youth facility, which educates young people on a range of social issues, not least HIV and AIDS.

They were also given an opportunity to engage with wellness peer educators, before moving on to an opencast visit at Anglo Coal's Kleinkopje Colliery and the division's Highveld Hospital in Witbank.

Anglo Coal's chief medical officer, Dr Jan Pienaar, briefed them on the work of the hospital. However, both he and John agree that all facts and figures presented on the day were eclipsed by the hospital's first Asikhulume or 'let's talk with your permission' session. At a gathering of hospital staff, union leadership and representatives from all nine operating collieries, ten employees declared their status as being HIV- positive, and told personal stories of loss, despair and finally of hope.

John believes that these declarations contributed significantly to breaking the stigma surrounding HIV and AIDS. Several speakers stated that if they had not been urged by the company to seek out their status, they might not have been alive today.

Following the visit, Lynne Featherstone, Liberal Democrat Member of Parliament for Hornsey and Wood Green, posted a report-back on her blog:

'What firms like SABMiller and Anglo American are doing is trying to get their entire workforces to voluntarily come forward for testing for HIV and counselling,' she wrote. 'If an employee turns out to be positive, then the message is that the employee will be treated, supported – free of charge – and looked after in the health support programme.

'The objective – apart from the six thousand lives that Anglo American alone have probably saved to date – is to get to a point where no one who is HIV-negative becomes positive and no one who is found to be HIV-positive dies. 'There are still new infections occurring – but the rate is dropping. In the five years since the programmes were started, a real sea-change is occurring.'

The MPs are intending to work with Business Action for Africa in producing a 'best practice' guide on the role of the private sector in combating the pandemic in the workplace and in local communities.

This article was published by Anglo American. Learners – if you use any part of it you need to write it in your own words and include the following in your reference list: Anglo American. 27 September 2007. British MP's laud Anglo's AIDS programmes. Anglo American: South Africa.

Mining Coal in Other Places

Although it is a rock rather than a mineral (the building blocks of rocks), coal is often considered to be a mineral resource.

Coal has been mined since ancient Roman times, but only since the Industrial Revolution has it become a major energy source. It currently provides 22% of the world's energy, and is used to generate approximately 40% of electricity worldwide. Those black lumps generate more than half of all electricity in the United States. Coal is also an important ingredient in the creation of methanol, which turns up in such items as plywood (binding resin) and plastic bottles (acetic acid). Reserves are widely distributed throughout the globe, although the United States, Russia, China and India account for more than half of the world's recoverable coal reserves.

Coal is mined either through underground or surface mining. Underground mining requires digging a shaft to where the coal seam is found. The traditional room and pillar method requires leaving pillars of coal in place to help support the mine roof where miners work. Unfortunately, this method leaves more than half the coal in place. Improved mechanization and longwall mining, which uses hydraulic roof supports, have since increased the amount of coal able to be extracted.

Underground mining is more dangerous – and also more expensive – than surface mining. The primary risks occur when improperly supported walls collapse or when aquifers breach, flooding the mine. Coal mining can also be detrimental to the health of miners. The most notorious health problem is black lung, or coal workers' pneumoconiosis, a lung disease contracted from prolonged exposure to coal dust. In the early 1900s, thousands of American mine workers lost their lives each year due to mining accidents, black lung and other industry-related diseases.

In most parts of the world, coal mining has become a highly-regulated and technical operation in an attempt to mitigate environmental impacts and curb the health risks associated with mining. Safety measures, especially within the US, have increased in part due to the Federal Mine Safety & Health Act of 1977. Mine operators are now required to follow stringent safety regulations or face lawsuits and heavy fines. Disease and death rates have fallen considerably due to the tighter industrial standards and heightened awareness among mine workers.

Surface mining – including open pit or strip mining – is less dangerous than underground mining, but has a greater impact on surface landscapes. Surface mining requires the removal of massive amounts of topsoil (or overburden) in order to gain access to the coal seams, which can cause erosion, loss of habitat, and dust pollution. Approximately 25 tonnes of overburden is removed for every tonne of coal.

Mining can also cause heavy metals to dissolve and seep into both ground and surface water, which can disrupt marine habitats and deteriorate drinking water sources. Pyrite, found in rocks containing coal seams, can form sulfuric acid and iron hydroxide when exposed to air and water. When rainwater washes over these rocks, the runoff can become acidified, affecting local soils, rivers and streams. This phenomenon is called acid mine drainage.

The US also passed the Surface Mining Control and Reclamation Act in 1977. The Act specified that all mining sites be restored to their original contours and requires operators to submit a plan for restoring the land and mitigating acid mine drainage before a permit is granted for mining operations. In the US the law also provides a funding mechanism for helping to restore abandoned mines by adding a tax onto current coal production.

There are a number of issues associated with abandoned mines, and the Bureau of Land Management (BLM) estimates that there are approximately 11 400 abandoned mines on public

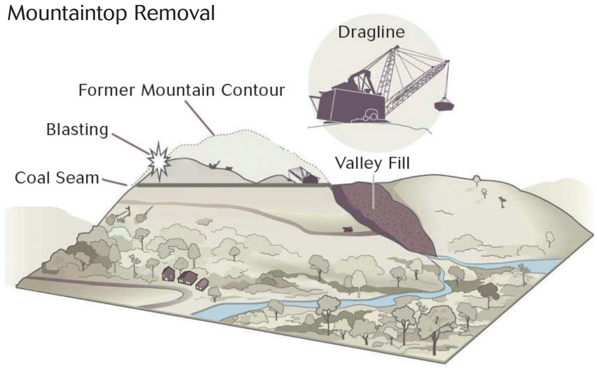
Mining Coal in Other Places

lands in the United States alone. Only about 20% have been restored to their previous state and cleansed of harmful residues; therefore most are considered to be a threat to the environment. Abandoned mines can contain acidic rocks that can lead to acid mine drainage, and a number of old mines leak methane, a greenhouse gas. The BLM continues to work throughout the US to protect the public and the environment from any potential harm that can be caused by abandoned mines.

A controversial method of coal mining is mountaintop removal, in which the entire top of a mountain is blasted away to expose a coal seam that runs through the mountain or the ridge. As with other surface mining, there is a significant amount of overburden placed in nearby valleys and valley streams that can have a considerable impact on the landscape and surrounding ecosystem. This method of removal was challenged in the courts in the late 1990s. The result was a settlement in which the Environmental Protection Agency and the US Corps of Engineers agreed to develop an environmental impact statement on the mining process. Once completed, the statement recommended that agencies work more closely to reduce the impacts from mountaintop removal and 'valley fill.'

Mountaintop removal practices are common in Kentucky, West Virginia and Virginia; areas in which some former mountains have been transformed into flat or rolling hill terrain. Many believe it is the most cost-effective method of removing large amounts of coal and, while the Surface Mining Control and Reclamation Act requires the land to be restored to its original contours, mining companies may receive a waiver if they can show that the levelled area will be developed for industrial or commercial purposes.

Mountaintop Removal



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Anglo Coal Australia

Reducing carbon emissions

As a company, we are committed to developing and utilising low-emission technology and implementing carbon management in our business. We aim to achieve this by being efficient and effective in the way energy is used, as well as endeavouring to minimise greenhouse gas emissions to the atmosphere. We have a number of upstream and downstream initiatives including methane capture and utilisation, use of biodiesel, revegetation of disturbed land, establishment of nature refuges, development of a sustainable accommodation standard, and the Monash Energy Project.

Methane Capture

The highest priority for ACA in its efforts to reduce its greenhouse gas emissions is to capture and utilise methane drained from coal seams. ACA is one of the few coal-mining companies actively involved in harvesting coal seam methane in Australia. Rather than vent drainage methane into the atmosphere, in 2004 ACA adopted a strategy to mitigate methane emissions through the long-term sale of waste mine gas-to-gas pipelines and on-site power stations. At Dawson Mine, more than 5,5 petajoules* of energy in methane drained from coal seams are sold to the electricity grid each year. If released to the atmosphere, this annual methane production would have a global warming potential equivalent to 2,2 million tonnes of

carbon dioxide (CO_2). A gas-fired power station, owned by Energy Developments Limited, was built at the Capcoal (previously German Creek) Mining Complex to utilise coal seam methane. Construction work on the 32 megawatt power station began in early 2005 and it was commissioned in late 2006. The power station will reduce greenhouse gas emissions by 1,1 million tonnes of CO_2 equivalent per year, which has similar benefit to taking 250 000 cars off the road. At Moranbah North Mine, a coal seam methane project developed by ACA and Arrow Energy established horizontal wells capable of producing 1.4 petajoules of gas per year. The wells maximize gas extraction in advance of coal mining operations. Gas from the Moranbah North Mine is sold into the Moranbah Gas Project which currently supplies natural gas into the Townsville market. The Moranbah North Coal Mine Methane Power Project was announced in August 2007. It will be a 40 megawatt power station, also owned by Energy Developments Limited, using coal seam gas from Moranbah North Mine. The power generated will be transmitted to the Australian power grid. Construction of the power station will begin late in 2007 and it is expected that it will be operational by late 2008. The Moranbah North gas drainage project and power plant combined will reduce greenhouse gas emissions equivalent to 1,4 million tones of CO_2 per year. This has similar benefit to taking 350 000 cars off our roads.

Using Biodiesel in Mining Equipment

ACA is undertaking a trial using B20 biodiesel in heavy mining equipment at Callide Mine. The trial will determine if a 20% biodiesel/ 80% petroleum diesel blend is both technically and financially viable. It is estimated that, by the end of 2007, 1,2 million litres of biodiesel will have been used by Callide Mine since the start of the trial. ACA has engaged a third party to quantify emission reductions, with results to date showing significant reductions in particulate matter and greenhouse gas emissions compared with petroleum diesel. The Australian Greenhouse Office has quoted a reduction of 0,6 tonnes of CO_2 per 1000 litres of B20 used as compared with petroleum diesel, which equates to a reduction of 720 tonnes of CO_2 equivalent emissions for the duration of the trial.

Developing Monash Energy

The Monash Energy Project, planning for a major investment in clean coal technology, is being developed under the Anglo American-Shell Global Clean Coal Alliance, which was formed in May 2006. The core of the project is a large-scale commercial plant in Victoria's Latrobe Valley, drawing coal from its own mine and then drying and gasifying the coal for conversion into transport fuels. The project critically depends on the development of Carbon Capture and Storage (CCS) infrastructure in Victoria. CCS means collection of a concentrated stream of CO_2 that can be then transported to injection wells for secure storage in deep underground geological formations. At a production scale of 70 000 barrels per day of ultra clean synthetic diesel, the project would involve the capture and offshore geological storage of approximately 15 million tonnes of CO_2 per year.

Taking a Leadership Position

ACA is a founding member of the Australian Business and Climate Group, an affiliation of major companies which investigated Government policies needed to accelerate the development of new technologies to counter climate change. The Group produced a report entitled 'Stepping Up: Accelerating the Deployment of Low Emission Technology in Australia" which can be downloaded from the Group's website www.businessandclimate.com. We are also participating in the COAL21 Fund to support low-emission technology development, the Cooperative Research Centre for Greenhouse Gas Technologies, the Coal Industry Advisory Board, Methane to Markets and the Carbon Sequestration Leadership Forum, all of which are working to develop solutions to climate change. In addition, we have been an active participant in establishing the Sustainable Minerals Institute at the University of Queensland, which has a number of research centres developing the materials, background analysis and metrics needed to measure our progress toward sustainable development.

*Note: A petajoules is a million billion joules = 10^{15}J.

This material was obtained from Anglo Coal Australia. Learners – if you use any part of it you need to write it in your own words and include the following in your reference list: Anglo Coal Australia. 2007. Fact Sheet: Commitment to reducing greenhouse gas emissions. [Online]. Available: http://www.anglocoal.com.au/wps/wcm/resources/file/eb2ff14f75d53f1/ANG%200849%20FS%20Greenhouse%20DM-04.pdf [21 November 2008