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Coal Case Study

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1 Introduction

Coal is one of the worlds major energy sources providing in 2000 24.9% of the worlds primary energy requirements. This compares with oil at 40% and natural gas at 24.7% (BP Statistical Review June 2001)

Significant deposits of coal exist in all of the world's major continents and production is wide spread, including some of the world's most stable economies.

The following table describes the distribution of known coal reserves across the world.

	Reserves billion tonne	% of total
North America	256.5	26.1
Europe	122.0	12.4
Former Soviet Union	230.2	23.4
Asia Pacific	292.3	29.7
Rest of World	83.2	8.4

Source BP Energy Statistics June 2001

On this basis the world has over 200 years of coal reserves at current rates of consumption

World hard coal production in 2000 was 3639 million tonne and production of brown coal was 895 million tonne (IEA Coal information 2001). The international trade in hard coal totalled 574 million tonne representing 16% of the total world production. 84 % of the coal produced is therefore consumed in its country of origin. Virtually all of the world's brown coal is consumed in its country of origin.

Two distinct categories of coal exist. Steam coal or energy coal employed for electricity generation or conversion into other forms of secondary energy and coking coal employed by the steel industry in the production of blast furnace iron.

Coking coal production in 2000 was 497 million tonne representing 13.7% of the total. A significantly higher percentage of this coal is traded internationally. In 2000 the figure was 192 million tonne that amounts to 38.6%.

The largest coal consuming and producing economies are:

China 1171 million tonne
USA 899 million tonne
India 310 million tonne

Over 95% of their production is consumed domestically.

Coal Categorisation.
Coal has been formed from the compression of millions of years of vegetable matter growth under the earth's surface as it evolves.

The first stage in the production of coal is peat, progressing through brown coal and sub bituminous coal to bituminous coal.

As a generality the locked in moisture and volatile matter in the coal falls with the length of time that the coal has been forming and the pressure exerted by the rock overlying the coal body. Volcanic activity can also play a part in effectively driving moisture and volatile matter from coal bodies in the close vicinity of volcanic activity.

All categories of coal can be used for electricity generation, although power plants have to be designed to handle specific types of coal. For example a plant designed to burn bituminous coal would not be capable of burning brown coal.

Because of the high moisture content it is uneconomic to transport brown coal over long distances and most of this coal is burnt local to the mine. The grades most favoured in international trade are sub bituminous and bituminous coals.

Coking coal always comes from the bituminous category. To be used as a coking coal it has to be capable of being converted to coke in a coke oven or other carbonisation process. This limits the number of coals that can be categorised as coking coal. Whilst all coking coals can be burnt in suitably designed power plants to generate electricity the reverse is not true in that not all bituminous steam coals can be converted into coke. An important feature of all coals used by the steel industry is that they should have as low a level of ash and sulphur as possible.

2 Production and demand

Domestic Coal Production.

Over 80% of the world's coal production is used in its country of origin. Some economies such as China and Poland are heavily reliant on coal since they have limited alternative energy sources.

Whilst coal production in Europe is declining rapidly this is not true of the whole of the developed world. Coal production in the USA for example increased from 710 million tonne in 1980 to 899 million tonne in 2000. By contrast in the same period European

production fell from 500 million tonne to 207 million tonne. The following table illustrates the progress of domestic coal production amongst some of the worlds leading coal users.

Country	1980	2000
USA	710	899
Former USSR	553	322
China	620	1171
India	114	310
Poland	193	102
Germany	94	37
United Kingdom	130	32
Europe	**500**	**207**
World	**2810**	**3639**

Source IEA Coal Information 2001

Demand Growth.

Steam Coal.

The demand for steam coal for electricity generation in the world's developed nations is tending to fall. Notable exceptions are Japan and the USA.

In Europe the availability of cheap gas has resulted in coal fired power stations being demoted from base load to mid merit operation and smaller less efficient stations being closed.

The cost of mining coal in the European nations is greater than in the case of new mines being opened in countries such as Colombia, Australia and Indonesia. Subsidies to support coal mining in Europe are being reduced and coal production is declining. The decline in production, however, is greater than the fall in demand and as a consequence imports into the major European nations are increasing.

The major area for growth is the Pacific region. Here industrial growth and rising living standards are driving the need for greater electricity generation. Unlike Europe the ability to develop gas infrastructure is limited and the need for higher levels of electricity generation means that new coal fired power stations are needed.

The following table illustrates total demand growth in the major coal consuming countries.

Country	1980	2000
USA	608	891
China	626	115
India	110	354
Poland	164	89
Germany	96	62
United Kingdom	123	60
EU15	**348**	**246**
World	**2781**	**3738**

Source IEA Coal Information 2001

Coking Coal.
The above table includes figures for coking coal. Demand for coking coal is linked closely to pig iron output across the world.

In the period 1990 to 2000 pig iron output has increased from 523 million tonne to 576 million tonne (Source IISI). Total world production of coking coal, however, declined from 548 million tonne to 497 million tonne.

The reasons for the decline are twofold. Firstly the efficiency of blast furnace operations have improved and coke requirements on a per tonne of iron basis have decreased.

Secondly, increasingly stringent environmental controls have resulted in coke oven batteries being retired rather than rebuilt. To compensate for this the steel companies have introduced coal injection equipment that injects coal directly into the blast furnace in substitution for coke. It is estimated that currently 32 million tonne of coal is being injected into blast furnaces worldwide.

World	1990	2000
BF Iron Production	523	576
Coking Coal production	548	497
PCI Use	11	31`

Source IEA Coal Information 2001

Coal for injection purposes does not require coking properties. It does, however, need the same levels of chemical purity as coking coal.

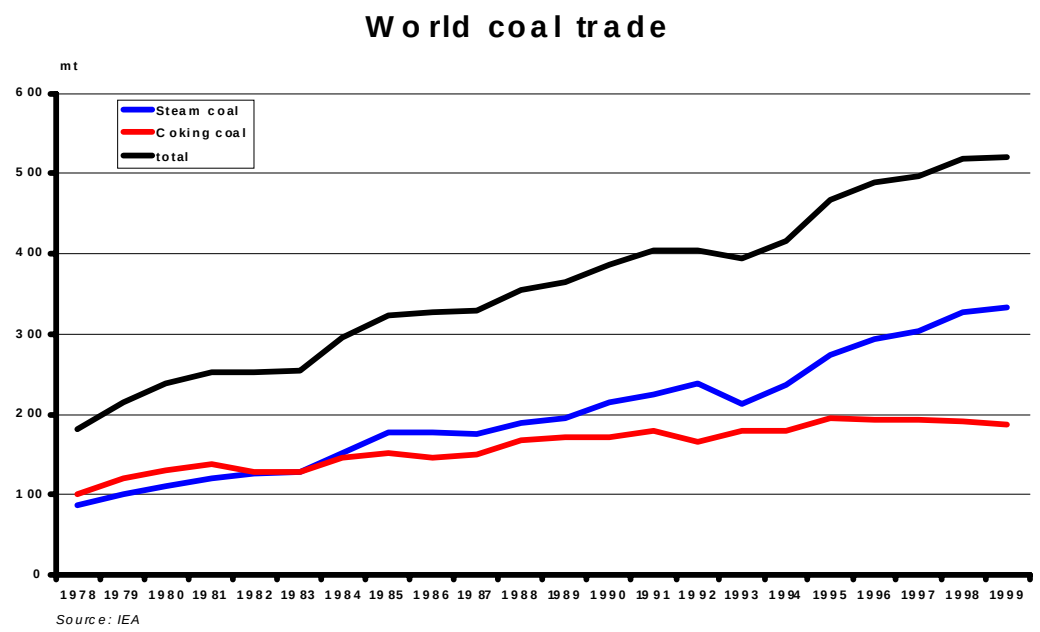
The technology of coke making has been developed so that poorer coking coals can be used at increasing levels in the mix of coals being fed to coke ovens. These coals are often the same as those employed for injection and have resulted in a second category of coking coal being established. This category is often referred to as semi-soft coal in contrast to high quality coking coals that are referred to as hard coking coals.

It is anticipated that the technology of coke making will be developed to increase the quantity of semi soft coals in the coke oven blends across the world. Currently the technology is employed mainly in Asia and South America.

3 The World Trade in Coal

The tonnage of coal that now crosses national borders by land routes or the predominant trade, by sea, has increased dramatically over the last 20 years.

Prior to the 1970s the major trade was that in coking coal. Following the oil price shocks of the 70's electricity utilities turned away from oil to coal and by 1983 the trade in steam coal passed that of coking coal.



The international trade in steam coal has risen from 125 million tonne in 1980 to 414 million tonne in 2000. By contrast traded coking coal has only grown from 141 million tonne to 196 million tonne in the same period. (Source IEA Coal information 2001).

The international coal market can be split into two distinct areas, the Pacific and the Atlantic. The Pacific region is dominated by Asia as the customer with the major importers being Japan, Korea and Taiwan. The Atlantic region is dominated by Europe with the major importers being the United Kingdom, Germany, Spain and the USA.

The patterns of supply differ by region and by category of coal. The major suppliers of steam coal into the Pacific region are Australia, China and Indonesia, whereas the major suppliers into the Atlantic region are South Africa, Colombia and Russia. The major suppliers of coking coal into the Asian market are Australia and Canada whereas in the Atlantic it is Australia, the USA and Canada.

The following tables illustrate the differing supply patterns in the Atlantic and Pacific regions for both steam and coking coal.

PACIFIC				
Steam Coal million tonne				
Exporter	**Importer**			
	Pacific	**Japan**	**Korea**	**Taiwan**
3.1.1.1.1 Australia	76.04	47.36	11.45	10.03
China	45.02	12.59	17.73	9.08
Indonesia	39.69	9.85	4.68	12.83
South Africa	14.3	1.65	2.94	3.66
Coking Coal million tonne				
	Pacific	**Japan**	**Korea**	**Taiwan**
3.1.1.1.2 Australia	61.44	39.26	10.35	6.27
Canada	15.94	12.09	3.85	-
China	6.55	3.31	2.78	-

Derived from IEA Data

ATLANTIC					
Steam Coal million tonne					
Exporter		**Importer**			
	Atlantic	**Germany**	**France**	**Spain**	**UK**
3.1.1.1.3 South Africa	52.79	6.27	5.91	9.50	3.06
Colombia	29.78	2.70	1.49	-	5.65
Russia	13.52	0.10	-	1.24	6.20
Coking Coal million tonne					
	Atlantic	**Germany**	**France**	**Italy**	**UK**
Australia	20.63	2.62	3.78	2.98	5.49
Canada	7.97	0.79	0.59	1.17	1.10
USA	24.82	0.42	2.20	3.30	2.04

Derived from IEA Data

Currently one of the major changes that are occurring in supply a pattern is the reduction in supplies of US steam coal into the Atlantic market. Having peaked at 36 million tonne in 1995 exports declined to 23 million tonne by 2000. The fall is even more dramatic when sea born exports are considered since the figure minus cross border sales into Canada has declined from 27 million tonne to 8 million tonne in this period.

South African and South American coal have replaced US coal. US producers are unable to compete against the lower production costs in these countries.

Whilst Australia is still the major exporter of steam coal into the Pacific market it is coming under increasing pressure from lower priced exports out of Indonesia and China. The year 2001 saw Indonesian exports increase by 15 million tonne and Chinese exports by 27 million tonne (Source 'Steam Coal Forecaster' Mccloskey Group). Whilst Indonesian growth came from brown field expansion and the opening of small mines, Chinese expansion came as a result of large export dedicated mine and infrastructure projects.

Considerable reserves exist in Australia, Indonesia, China and Eastern Russia to meet predicted forecasts of steam coal demand in the Pacific region.
Australia, however, is becoming increasingly dominant in coking coal supplies in both the Atlantic and Pacific regions. High freight costs mean that US coking coal is unable to compete for business with the major Asian steel mills.

Canada supplies into both markets having made a conscious decision to diversify into the European market in the mid 80's.

The USA is still a major supplier of high volatile coking coal into the European market because European coke oven practice requires the special qualities offered by this type of coal.

Rationalisation of the Coal Industry.
A feature of the last five years has been the degree of rationalisation that has occurred amongst the worlds coal exporting companies. Four companies;

- Rio Tinto
- Anglo Coal
- BHP Billiton
- Glencore

Are estimated to supply in excess of 70% of the worlds steam coal markets and one company BHP Billiton supplies more than 25% of the world's coking coal.

The industry has been characterised by over development for the last twenty years. It is probable that with concentration of ownership there will be more discipline in the market and it will move towards iron ore in terms of returns and behaviour.

4 Environmental Advances

Probably more than any other fuel coal has had to suffer the most hostility regarding its environmental performance.

Two areas have to be considered. The first of these is the actual coal mining process. The world has many areas that have been blighted by the remains of past industrial activities and the remains of coal mining operations feature in these areas.

Conscious of this unfortunate heritage, coal mining activities in the developed world now operate to extremely stringent standards from an operational and reclamation standpoint. Increasingly coal miners have to post bonds that will cover the cost of returning mine sites to their original or better than original state. Mining operations are also controlled to reduce their impact on local populations.

These standards also apply to new mining operations in the developing nations.

The greatest problem that coal faces is in the perception that it is a major contributor to global warming. Clearly it is not alone amongst fossil fuels, in this respect, but it probably suffers from the greatest level of criticism.

Coal has the highest carbon to hydrogen ratio amongst the fossil fuels therefore producing a higher proportion of CO2 than fuels such as oil or natural gas.

Conventional modern coal fired power stations operate at efficiencies of c. 38% compared with modern combined cycle gas fired plants that operate at 55% or more

Older coal fired plants operate at much lower efficiencies and their steady replacement in countries such as China is improving coals overall environmental performance from the standpoint of greenhouse gases.

The technology exists whereby, newly constructed, conventional coal fired power stations can operate at much higher efficiency levels. It is possible by increasing internal operating pressures and by using more sophisticated alloys to raise efficiencies to the mid 40's.

A large amount of effort is also being expended in perfecting clean coal technology. With this technology coal can improve its performance substantially.

The next step in coal-fired technology is to convert coal into gaseous form and then burn it in a combined cycle gas plant. By employing this route overall efficiency levels in the region of 50% can be achieved. The major problem associated with this technology is cost and without government support it is difficult to see private companies making the investment in this new technology.

Problems also associated with coal such as dust emissions and gaseous emissions such as NOx and SO x can be easily controlled employing well established technology.

Therefore by replacing older coal fired plant, improving the technology of conventional plant and installing high technology plant in the next phase of power station construction to improve coals environmental performance overall.