Coal as an energy resource

Keith Leighfield [1]

Uhlie ako zásoba energie

V príspevku je v prvej časti prezentovaný historický vývoj uhoľného baníctva v Anglicku, ktoré v súčasnosti spravuje vrcholná inštitúcia, tzv. Coal Authority. Tu je spracovaný návrh na medzinárodnú klasifikáciu zásob, ktorý povedie Coal Authority, pričom bude evidovať činnosť banských závodov, sledovať trend rozvoja zásob, odbytov a predpovedať vývoj.

Druhá časť referátu je venovaná aplikácii nových technológií vo využívaní uhlia. Dokladuje veľké zásoby (až 13 mil. ton) metánu a uvádza, že v roku 1998 bolo realizovaných 8 vrtov orientovaných na získanie metánu z uhoľných ložísk. Uvádza tiež technológiu podzemného splyňovania pre výrobu uhoľného svietiplynu priamo v ložisku, ako aj výsledky európskeho projektu skúšok podzemného splyňovania, ktoré boli realizované v Španielsku na nízkobitumenovom hnedom uhlí, s komentárom problémov úspešnosti tejto technológie (spôsob zapálenia uhlia, vytvorenie prieduchu plynu od horiacej oblasti k vyťaženému vrtu, riešenie množstva a spôsobu pridávania kyslíka a vody). V prípade úspešného doriešenia a realizácie tejto technológie by mohol svietiplyn predstavovať významnú energetickú rezervu.

Key words: The Coal Authority, England new technologies, Coal-bed Methane, In-Seam Coal Gasification.

Introduction

I have been invited to speak to you today, from the perspective of the Coal Authority (as owner and licensing authority for coal) in relation to:

* coal mining activities and the future
* the application of new technologies to utilise coal as an energy resource

I will not attempt to give my prediction about the future market for coal or the construction of new coal-fired power generation plant. These matters are best left to others to consider and I am sure that we all await with interest the outcome of the Governments Energy Review which is expected in the autumn.

Coal mining activities and the future

The extraction of coal in this country can be traced back to Roman Times and it is said that coal has been sold as an article of commerce since the Magna Cart in 1215. The earliest form of coal extraction must have been along coal seam outcrops and one of the earliest uses of coal was for a Bronze Age cremation in South Wales.

1. Some 75 % of the coal produced in this country has been extracted under private ownership (see Figure 1). It can be seen that the industry had its most productive years around the turn of the Century with the maximum output being 287,4 million tonnes in 1013. As coal extraction intensified the patchwork of coal ownership and the interaction between adjacent collieries became more complex which led to a wide range of commercial and safety difficulties. The Coal (Registration of Ownership) Act 1937 required all persons with an acquired interest in coal to register their interest with a view to facilitating the unification of coal ownership. This was finally achieved in 1942 under the provisions of the 1938 Coal Act. In the period 1942 – 47 the than newly established Coal Commission granted leases for coal mining operations but was not allowed to work coal it self.

2. On 1 January 1947 the coal mining industry was nationalised and the interests of the Coal Commission (including ownership of coal) transferred to the National Coal Board, in accordance with the provision of the Coal Industry Nationalisation Act 1946. In the first year as a nationalised industry

[1] *Keith Leighfield*, Director of Licensing the Coal Authority, 200 Lichgield Lane, Mansfield, Notts, NG 184RG
(Received July 15, 1998)
This invited lecture is supported from the PHARE GTAF project.

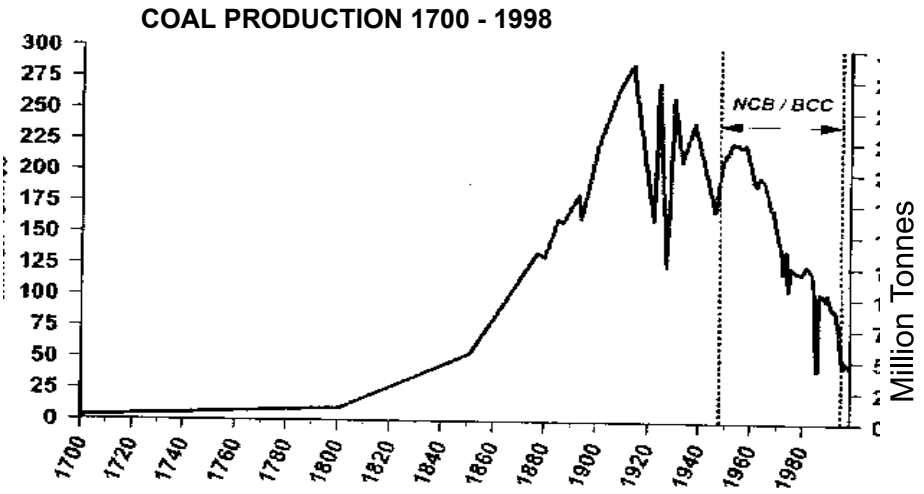

Fig.1. Coal Production 1700 - 1998.

the National Coal Board produced approximately 187 million tonnes of coal from some 958 collieries which was supplemented with some 10 million tonnes from opencast activity, under the control of the Ministry of Fuel and Power. By 1952 the Government had decided that the National Coal Board should become responsible for opencast coal working coal working and set up the Directorate of Opencast Coal Production. As opencast production increased the need for legislation became evident and this led to the 1958 Opencast Coal Act.

In 1987 the National coal Board became British Coal Corporation and in 1988 the Government announced its intention to privatise the industry. At that time the industry was producing some 85 million tonnes of coal from 86 working deep mines with an additional 17 million tonnes from opencast and licensed activities. In the light of increasingly difficult marketing conditions British Coal announced the intention to cease production at 31 collieries on 13 October 1992 which was followed by an announcement by the Department of Trade and Industry of a Coal Review on 19 October 1992. This in turn led to the Government publishing a White Paper on 25 March 1993 “The Prospects for Coal – Conclusions of the Governments Coal Review”. At that time some 50 operating collieries were producing some 61,8 million tonnes out of a total production of 80,8 million tonnes. The Government White Paper had referred to British Coal's commitment to offer to the private sector those collieries which it no longer wished to operate, and as a result 28 collieries were made available which resulted in 9 being acquired as licensed operations.

The Coal Industry Bill, seeking Parliamentary approval for the privatisation of British Coal, was given its First Reading in December 1993 and had received its Third Reading in the Commons by the end of the financial year. The Bill provided for the restructuring of the coal industry and the establishment of a new body, the coal Authority, which would hold, manage and dispose of interests and rights in unworked coal and coal mines. At the end of the financial year 1993/94 British Coal were operating 19 mines which had produced 29,3 million tonnes of the annual output of 56,2 million tonnes. In June 1994 potential bidders were given access to information relating to the 5 regional companies which covered the operational and care and maintenance activities of British Coal. By October 1994 the new successors were announced and with limited exception took possession of British Coal's mining activities on 29 – 30 December 1994, statistics associated with the foregoing are shown in Table 1.

Tab.1. Privatisation of british coal mines, Preferred Bidders - October 1994.

Description	***R.J.B.***	***Mining Scotland***	***Celtic Energy***
Producing Underground Mines	15	1	0
Producing Opencast Sites	14	9	9
Opencast Disposal Points	15	8	5
Colliery Reserves (million tonnes)	222	21	0
Opencast Reserves (million tonnes)			
Approved Sites	25,1	17,2	7,9
Prospective Sites	125	35	45

Annesley Bentinck Colliery, Nottinghamshire offered to Coal Investments plc
Tower Colliery, South Wales offered to T.E.B.O.

On 5 July 1994 the Coal Industry Act 1994 received Royal Assent and provided for:

* the establishment of the functions of the Coal Authority
* the restructuring of the coal industry
* the transfer of property, rights and liabilities from British Coal to the Coal Authority
* the licensing of coal mining operations
* amendments to the Coal Mining Subsidence Act 1991 and the Opencast Coal Act 1958

The Coal Authority became a legal entity on 19 September 1994 and became the owner of unworked coal (that previously vested in British Coal) and other assets on 31 October 1994. Accordingly the Coal Authority became responsible for discharging the following functions from that date:

- holding, managing and disposing of interests and rights in, or in relation to, unworked coal and other property transferred to or acquired by the Coal Authority
- carrying out functions with respect to the licensing of coal mining operations
- carrying out functions with respect to coal mining subsidence and in connection with other matters incidental to the carrying on of any opencast or other coal mining operations
- facilitating the establishment and maintenance of arrangements for the information to which persons are entitled under the 1994. Act to be made available to them.

3. Since privatisation in 1994 there has been a continuing interest in the acquisition of mining rights as demonstrated by the number of applications received by the Coal Authority which are represented graphically at Figure 2. However, there have also been some company failures, in particular, Coal Investments (February 1996) with six large underground mines (two mines were assigned to Midlands Mining and four closed). RJB Mining has announced the closure of Bilsthorpe, Point of Ayr and Asfordby and the filling of the two Whitemoor shafts at Selby. In addition the closure of Monktomhall occurred in 1997 and in April of this year Midlands Mining announced its intention to cease mining activities at Silverdale mine before the end of the year.

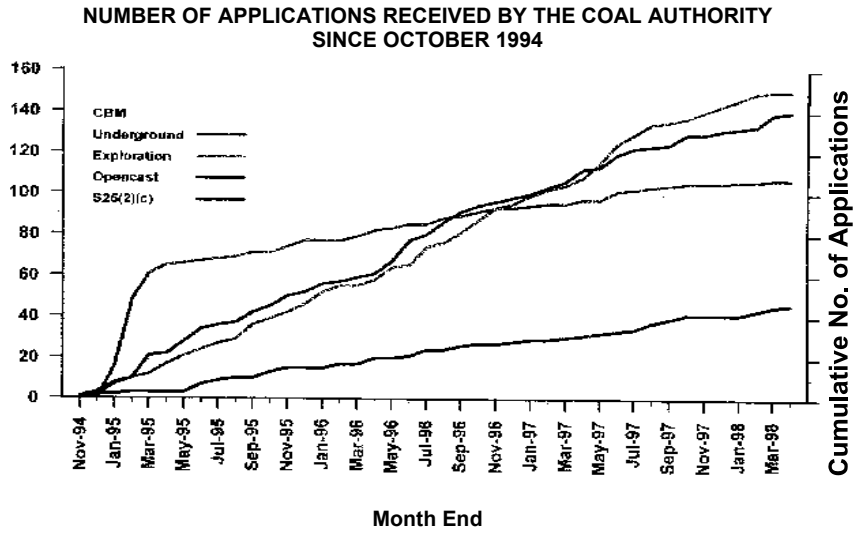

Fig.2. Number of Applications received by the Coal Authority since october 1994.

4. Although it is disappointing to see these mines close it should also be noted that there have been initiatives in relation to the opening of new large underground mines. In June 1997 a conditional licence and an option for a lease were granted to RJB Mining for the Witham Project located on the Nottinghamshire/Lincolnshire border to exploit some 300 million tonnes of coal in the Top Hard seam. In May 1998 offers of conditional licences and options for mining leases were made to Celtic Energy and Modal Limited in relation to their Margam and Abbey Mine prospects to exploit some 47 and 97 million tonnes respectively from several seams of coal near Margam Steel Works in South Wales.

Variations in the number of licences in grant since 1995 are shown in the table at Figure 3, this excludes the recent licences offered for Margam and Abbey mines.

5. It should also be noted that opencast production and licensing activities has remained reasonably constant throughout the period since privatisation. The Coal Authority has also responded to expressions of interest in relation to 2 of the 11 prospective opencast sites (see Table 2) transferred to the Coal Authority at privatisation.

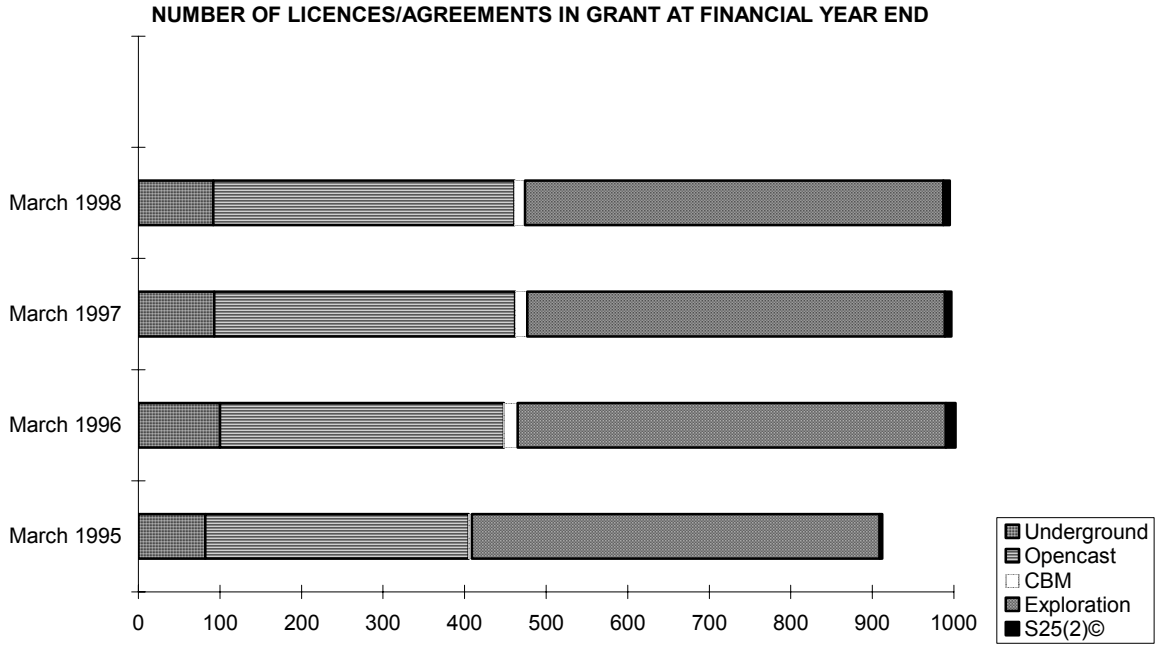

Fig.3. Number of Licences/Agreements in Grant at financial year end.

Table 2. Prospective opencast sites.

England	Scotland	Wales
Windmill Hill	Muirside	Conveyor
	Chapelhill	Bryn Defaid
	Cuttlehill	Drym Deep
	Auldton Heights	Pont Andrew
	Kirkton/Oakfield	Pwll Du

6. The classification of coal reserves has always been problematical in the absence of a single International classification system and at the time of privatisation different systems were used in the sales memoranda produced by advisers to the Government. Due to the enhanced trading and communication between international mining companies there is a growing need for a standardised system and two recent initiatives include the work undertaken by the Council for Mining and Metallurgical Institutions and the United Nations – Economic Commission for Europe. Both systems differ in their approach and it may be some time before a single International system is accepted. Nevertheless most companies are prepared to accept that:

i **a mineral resource** – is a naturally occurring concentration of mineral raw economic interest and with specified geological certainty

ii **a mineral reserve** – is the economically mineable part of the mineral resource as demonstrated by a feasibility assessment

iii **reserve depletion** - as a mine is worked the reserves become depleted unless replaced by on going assessment which converts further resource to reserves. When a mine is abandoned for economic reasons the reserves revert to being a resource.

This cycle is shown at Figure 4.

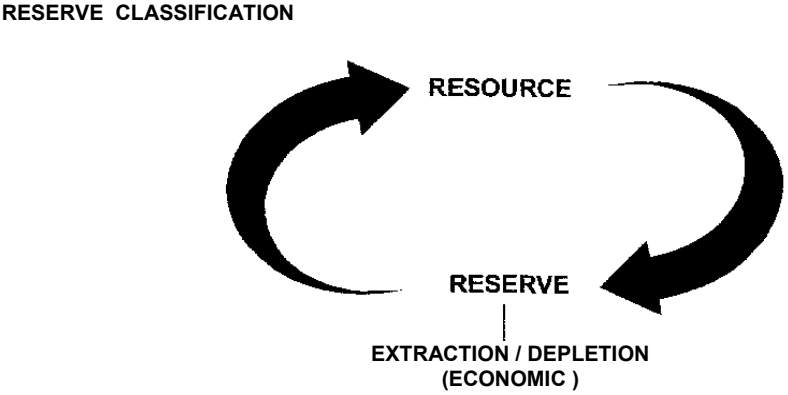

Fig.4. Reserve Classification.

7. Although there is growing acceptance that some form of economic rest should be applied to the declaration of reserves it is clear that this could vary form company to company for the same coal deposit at any given point in time. It follows that it would be difficult and potentially commercially damaging for the Coal Authority to make disclosures on reserve assessments. Nevertheless it has commissioned British Geological Services to produce a Coal Resource Map and this is expected to be published in the summer of this year.

8. Notwithstanding the difficulties facing mining companies and the Coal Authority in relation to resource assessment it is possible for the Authority to make comparisons between the amount of coal "in licence" from year to year. Such an assessment could demonstrate a trend over time and in the light of experience predictions for future life can be made. Table 3 sets out the changes in licenced tonnage since 1994 – the effect of the mine closures on tonnage in licence referred to earlier can clearly be seen.

Tab.3. Coal in licence 1995 - 1998.

	March 1995	March 1996	March 1997	March 1998
UNDERGROUND				
Operating	820.8	808.7	598.3	497.4
Closed*		3.1	51.5	117.8
Conditional			54.0	354.0
OPENCAST				
Operating	46.1	37.8	38.6	37.0
Closed*		1.3	3.0	3.1
Conditional	251.9	247.7	237.0	230.4

*Note: Closed mines & sites are those where coaling operations have ceased but the licence remains valid

The application of new technologies to utilise coal as an energy resource

I would like to look at this in two parts:

i Coal-bed Methane
ii In-Seam Coal Gasification

Coal-bed Methane

It may be debatable how and when Coal-bed Methane production emerged but there can be little doubt that today's successful applications are applying the technology that was developed in the San Juan and Black Warrior coal basins in the USA. There are generally speaking three difference applications:

* vertical wells
* gob wells
* horizontal drilling

Vertical Wells

This involves drilling vertical boreholes on a grid basis and hydrofracing the coal seams that are to produce the methane. The distance between respective boreholes will be dependent upon

experience gained from hydrofracing with the most appropriate application being an overlap of fracturing between adjacent boreholes. After fracing the coal measure water before gas flow towards the boreholes.

USA experience has shown that the water making within the fractured coal is often saline and careful consideration needs to be given to disposal arrangements. Once gas is flowing the borehole life can be of the order of 20 years.

Gob Wells

In the early days of coal fracing the underground mining companies were concerned about the potential for damage to the coal seam environment as a result of fracing which could render the coal seam unsuitable for long wall mining or adversely affect pot conditions and coal production. In 1987 the US Bureau of Mines produced a report on the Effects of Stimulation Treatments on Coal-beds and Surrounding Strata based on underground observation in mines that had encountered coal that had been hydrofractured. In general, the fracture followed the direction of cleat within the coal seam and the report concluded that the probability of adversely affecting mining conditions was minimal. This probably encouraged the development of joint ventures/partnership between mining companies and coal-bed methane operators. This led to the development of gob wells, where a series of vertical boreholes are drilled over the centre of a proposed long wall panel with the boreholing terminating just above the seam horizon. As the long wall extracts the coal fractures develop in the strata resulting in the formation of passageways to the boreholes. These boreholes produce high volumes of gas but normally over a shorter time scale than hydrofraced boreholes.

Horizontal Wells

In some cases horizontal boreholes have been drilled in coal from underground roadways within coal mines. The holes are then hydraulically fractured and surplus water drained before gas production commences. The method has achieved only limited success owing to the difficulties associated with long-hole drilling in coal and the need to install a piperange throughout the mine transport the gas. Nevertheless this is probably the system which has nearest comparability with the methane drainage practised in UK coal mines since 1950s.

The application of recent coal-bend methane technology in the UK

Government sources have said that there is some 13 million tonnes of methane within UK coal seams that could be extracted using the techniques that have proved to be successful in the USA. However, before this resource can be exploited the prospective coal-bed methane operator needs to secure the necessary rights.

In the UK methane gas is deemed to be petroleum and as such is owned by the crown by virtue of the Petroleum (Production) Act 1934 and is licensed in blocks (typically 10 km x 10 km) through the Oil and Gas Division of the Department of Trade and Industry. Virtually all unworked coal in the UK vested in the Coal Authority and therefore, rights must be secured to enter and hydrofrac the coal. This is achieved by the grant of an Access Agreement. In addition, there is a need to consider surface land access and perhaps the ownership of other minerals as well as the seising of planning permission and consent for the discharge of water.

The first coal-bed methane well drilled in the UK was in 1992 by way of joint venture between British Coal Corporation and Evergreen, an American based company. The borehole was some 600 metres deep, the seams were hydrograced and a small flow of gas was achieved. Today 7 wells have been drilled at various locations in the UK and their present status is shown at Table 4.

Tab.4. CBM Wells in the UK.

LOCATION	DATE DRILLED	CURRENT STATUT
Margam Forest, South Wales	1996	Borehole plugged and abandoned
Rhuddlan, North Wales	1993	Borehole capped off
Kemira Ince, Deeside	1994	Borehole capped off
Yew Tree Farm, Merseyside	1992	Borehole capped off
South Letham, Scotland (3 boreholes)	1994-97	3 more boreholes to be drilled Results being evaluated

Because coal mining has taken place in the UK for several centuries there are a large number of abandoned coal mines and a small number of these are known to vent gases to atmosphere. In some cases these contain a high proportion of methane (see Table 5). Trials are underway at present at some of these sires to evaluate the potential for generating heat and/or electricity using the technology that has been demonstrated to work at UK landfill sites.

Tab.5. Summary of Methane and Carbon Dioxide Flows in Vents at Coal Authority Monitoring Sites.

Site Name	Methane Flows l/s	Carbon Dioxide Flows l/s	Total Gas Flows l/s
	Mean	Mean	Mean
Parkside No. 1 Shaft	1138,4	15,2	1517,9
Allerton Bywater No 2 Shaft	285,6	130,5	1019,9
Ashington No 2	0,0	50,3	837,7
Shirebrook	531,2	87,6	717,8
Hickleton No 2 Shaft	252,1	55,0	382,0
Hem Heath Shaft	201,5	16,5	305,4
Parkhill No 3	40,2	14,6	191,5
Wheldale	21,3	18,7	164,2
Nostell	39,6	15,9	146,8
Springwood	38,0	15,8	140,8
Askem No 2	85,8	17,8	136,1
Oakthorpe Bungalow	0,0	6,3	100,6

In-seam coal gasification

For many years different countries have tried to recover the energy from coal by in-seam gasification eg, Russia, America and New Zealand with varying degrees of success. The successful applications have been in seams at relatively shallow depths but these were not considered relevant to the UK and those parts of Europe where most of the unworked coal lies at considerable depths say in excess of 500 metres.

In 1989 the European Working Group as part of the European Coal Gasification programme approved the first underground coal gasification trial. It was sponsored by Spanish. Belgian and UK organisations and the European Commission and the site chosen was near Alcorisa, in the province of Tervel, Spain. The main objective of the project was to demonstrate the ability to achieve underground coal gasification in a sub-bituminous coal seam at some 600 metres depth. The basic theory being to form a connection within a coal seam between two vertical boreholes, ignite the coal to produce in the right conditions, Carbon Monoxide, Hydrogen and Methane which are all flammable and therefore capable of generating heat and power. to achieve the necessary chemical reactions Oxygen and Water must be injected down one of the boreholes which allows the second borehole to be used for gas recovery.

In the trial project the main objectives were achieved, namely:

* The drilling of an in-seam borehole for some 100 metres
* making a connection between two vertical boreholes, 100 metres apart
* coal combustion at a depth of 600 metres

There have been a number of important lessons learnt from this project and it is hoped that these can be applied to the next phase of this important work, which offers considerable potential within the UK and European Community.

Conclusions

* Coal has been extracted in the UK since Roman Times and there continues to be interest in securing the permission to undertake coal mining operations in the future
* New technologies are emerging such as coal-bed methane and in-seam coal gasification which offer the opportunity to exploit coal as an energy resource in the future, in addition to the traditional mining methods.