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UTILIZATION OF COAL IN THE CZECH REPUBLIC REVIEW OVERLOOK

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ABSTRACT
Review article presents utilisation of coal in industry, coal in power generation, gas production, Czech energy policy and outlook and application of clean coal technology in the Czech power stations. The further exploitation and utilisation of Czech coal resources requires the implementation of development programme aimed at the application of the new, economically effective technologies, of coal mining, utilisation, gasification. Emissions of GHG in CR.

KEYWORDS: power generation, coal, mining, GHG emissions

PRESENT SITUATION

The fuel and energy base in Czech Republic is presently in the process of substantial restructuring. The biggest contemporary problems are as follows (Kolat, 2000):

- high energy consumption per GDP (Gross Domestic Product) unit as a consequence of the period of cheap energy subsidised by the government,
- small effort for energy savings, regeneration and renewable sources,
- as a consequence of an oversized energy consumption there are relevant environment problems,
- the current economic situation in the industry doesn't enable it to provide sufficient investment capital targeted to energy savings or utilisation of renewable sources.

In the area of solid fuels management, the Czech economy will have to face unknown competitive forces on the coal market, where increasingly Canadian, Australian, American and South African coals are pushed through (Roubíček and Buchtele, 2002). A specific problem appears to be the competition of some state subsidised European coals.

Total geological hard coal and brown coal reserves and production in Czech Republic are demonstrated by Tables 1a,b and 2 (Geofond, 2003):

Table 1a Hard coal reserves in the Czech Republic (kt)

Year	1998	1999	2000	2001	2002
Reserves - total	13949612	16305887	16353961	16315084	16128871
Balanced examined	2355800	2114334	2072075	2094274	1751320
Balanced found out	6045714	7231075	7219168	7155491	5947714
Not balanced	5540098	6960478	7062718	7065319	8429837

Table 1b Brown coal reserves in the Czech Republic (kt)

Year	1998	1999	2000	2001	2002
Reserves - total	9741936	9637410	9652302	9587995	9521538
Balanced examined	3648979	3413773	3293064	3242113	3159993
Balanced found out	2078570	1956487	1945161	1943193	1942857
Not balanced	4014387	4267150	4414077	4402689	4418688

Table 2 Coal mining in the Czech Republic (kt)

Year	1998	1999	2000	2001	2002	2003
Hard coal	19521	17227	17028	14808	14097	13640
Brown coal	51283	44858	50610	51036	48834	45770

Table 3 Installed capacity of power plants : by type 1998-2003

Indicator	1998	1999	2000	2001	2002	2003
			MW_e			
Total installed capacity	15513	15216	15324	15443	16310	17344
Wind power plants		2			6	11
Steam power plants	11720	11303	11467	11923	11400	11424
Hydroel. power plants	2033	2153	2097	2145	2144	2149
Nuclear power plants	1760	1760	1760	1760	2760	3760

Table 4 Production of electric power : by type of power plant 1998-2003

Indicator	1998	1999	2000	2001	2002	2003
			mill. kWh			
Power plants, total	65112	64692	73466	74647	76348	83226
Wind power plants	-	1	-	-	2	4
Steam power plants	50050	49120	57563	57431	54762	55556
Hydroel.power plants	1884	2215	2313	2467	2845	1794
Nuclear power plants	13178	13357	13590	14749	18738	25872

COAL IN POWER GENERATION

The dominant producer of electricity in the Czech Republic is Czech Power Company ČEZ, responsible for 80 % of electricity generation. Installed capacity is over 11 thousand MW_e, in this 70 % from coal power plants, 27 % from nuclear power plants and 3 % from hydro power plants including two pumped storage plants.

Table 3 shows the fact that installed output of wind power plants is insignificant. Substantial capacity for electricity production is based on the combination of coal and nuclear power plants. The hydro-electric power plants production stagnates and there is no proposal of theirs growth.

Table 4 illustrates the fact that the total electricity production after year 2000 (covering export to EU where the demand for electricity consumption was increasing) was on the rise. The major share of the electricity production was produced by coal and nuclear power plants. The share of the nuclear power plants on the production is getting on importance mainly in accordance with the gradual putting in operation of the nuclear power plant in Temelín. Due to dependance on precipitation activity and water economics the participation of hydro-electric plants is unstable and more significant share increase is not expectable. The actual share of the wind power plants on electricity production is insignificant.

Table 5 proves the fact that taking into concideration the renewable resourses the hydro energy is the only significant when thinking of the electricity production. As for the heat production the solid biomass, industrial and municipal waste combustion is of the high importance (Noskievič et al., 2006). The biogas importance for the electricity production is insignificant.

COAL IN GAS PRODUCTION

Processes of coal gasification have almost a century long tradition. Between 1943-1996, the process of pressurised oxygen-steam gasification of coal in sliding bed was being developed - Lurgi process. The process Lurgi was brought to a high degree of sophistication and its research and development is focussed in company SASOL (Republic South Africa). In the long run after 2000, coal gasification processes, which in contrast to Lurgi process employ fuel dust, seem to be more prospective (Texaco, process). Although the Texaco gasification equipment is used for production of

Table 5 Electricity and Heat production from Renewable sources and Wastes 1998-2003

Indicator	Unit	1998	1999	2000	2001	2002	2003
Hydroelectric Power Plants	El. GWh	1884	2215	2313	2467	2846	1794
Wind Power Plants	El. GWh		1			2	4
Solid Biomass	El. GWh	428	528	382	381	367	360
	Heat TJ	2431	4391	3219	3362	3361	3200
Industrial Wastes	El. GWh	11	149	201	195	191	195
	Heat TJ	1143	3750	2473	2606	2568	2610
Municipal Wastes	El. GWh	-	7	5	4	4	5
	Heat TJ	-	2150	1664	1726	1727	1750
Biogas	El. GWh	159	148	135	133	127	130
	Heat TJ	630	475	384	397	386	420

Table 6 IGCC – Sokolovská uhelná Company : the production 1998-2005

Year	Coal consumption	Gas production	Electricity			Heat production
			Heat station	Gasification	Total	
	kt	10^3 m^3	GWh	GWh	GWh	TJ
1998	3428	1013000	1325	1441	2766	2639
1999	3383	999621	1350	1453	2803	2368
2000	3620	1041126	1591	1647	3238	2316
2001	3633	1086130	1480	1724	3204	2410
2002	3763	1097247	1544	1766	3310	2286
2003	4033	1171724	1610	1820	3430	2329
2004	4018	1141301	1633	1791	3424	2299
2005	4154	1187000	1698	1899	3597	2251

ammonia, town gas, heating gas, the future of this equipment is rather associated with production of electricity and heat in integrated gasification combined cycles IGCC.

The technical parameters of gas, electricity and heat production in Sokolovská uhelná Company are declared in Table 6.

Designed total output of the power plant for peak hours is 360-398 MW_e otherwise 150-192 MW_e. The electricity supply was designed as max 2750 GWh/year and min 1450 GWh/year. To cover the demanded volume of heat of surrounded town agglomerations the amount 95 t/h (74 MW_t) of steam of pressure 3.5 MPa and 130 t/h (103 MW_t) of steam of pressure is ready for their disposal. Gas is washed by undercooled methyl alcohol (Rectizol) and hydrogen sulphide, benzene, phenol, tar and partly CO_2 (to cca 25 %) taken out.

UTILIZATION OF COAL IN METALLURGY

The important buyer of coal in the Czech Republic is the metallurgy industry that uses caking hard coal mainly for the coke production. The coke is both the fuel for the blast furnaces and agglomerations and the carburizing agent for the production of steel in the converters and electric arc furnaces. There have been deep drop in coke consumption in blast furnaces during past 50 years – from nearly 1000 $kg.t^{-1}$ of pig iron to cca 460 $kg.t^{-1}$ of pig iron. At the same time the slag production went down from 800-900 $kg.t^{-1}$ of pig iron to cca 250 $kg.t^{-1}$ of pig iron. There has been no success in putting the technique of coal blowing to bottom parts of blast furnaces into practices so far. This technique would unable to lower the coke consumption in blast furnace by 150-200 kg / t of produced iron. Coke is the most expensive component of the blast-furnace charge. Lowering the coke ratio unables lowering the economicly demanding production and at the same time increasing the iron production using new alternative processes of direct reduction of ore. Structural changes in metallurgy of iron in the Czech Republic are illustrated with the help of data concerning coke, pig iron and steel production. (see Table 7).

Table 7 Trend in metallurgy in the Czech Republic 1998 – 2003

Indicator	1998	1999	2000	2001	2002	2003
Coke (kt)	4009	3332	3411	3522	3537	3461
Pig iron (kt)	4982	4023	4621	4671	4839	5206
Crude steel (kt)	6498	5615	6216	6316	6512	6783

Table 8 Total emissions of major pollutants in CR by source category 1998-2003

Indicator	Unit	1998	1999	2000	2001	2002	2003
Solid particulates	t.p.a	84388	66427	57182	53851	58746	76439
SO_2	t.p.a	438110	267995	263784	250932	237382	226457
NO_x	t.p.a	320715	313370	320502	331821	318230	329949
CO	t.p.a	765463	715631	648431	648601	546065	569088
C_xH_y hydrocarbons	t.p.a	241521	233682	227128	220000	200000	198000

Table 9 CO_2 , CH_4 a N_2O Emissions trend 1990 – 2003 (Gg $CO_{2\ eq.}$)

Indicator	1990	1995	1998	1999	2000	2001	2002	2003
CO_2	161862	127148	124511	117692	123886	123633	118566	123276
CH_4	16763	12855	11421	10691	10714	10485	10373	10210
N_2O	11266	8754	8390	8111	8175	8291	8174	8157

Data in the Table 7 illustrates the downward trend in blast-furnace coke production in the Czech Republic. The reason for it is both the limited reserves of domestic cokable coal and demanding technological and financial aspects of the mining. The pig iron production stagnates. Due to the fact that the import of iron ore is financialy and logistically demanding the drop in the pig iron production is expected in midterm and longterm period of time. The steel production in the electric arc furnaces using scrap charge might be on the rise from the midterm period of time. In longterm period of time (2030/2040) the drop in the volume of production is expected in the czech metallurgy anyway.

CZECH ENERGY POLICY AND OUTLOOK

Czech Republic launched its program of economic reforms in 1991. The program comprised major (85 %) liberalisation of domestic prices and external trade and privatisation - firstly of small businesses through auction and then partial privatisation of state enterprises through a nation-wide voucher scheme. The Czech Republic was in a difficult situation with regard to environmental protection as illustrated in Table 8.

In 2003, the most important GHG in CR was CO_2 contributing 86.0 % to total national GHG emissions and removals expressed in $CO_{2\ eq.}$, followed by CH_4, 7.1 % and N_2O, 5.7 % contributed to the overall GHG emissions in the country.

The Energy sector accounted for 86.1 % of the total GHG emissions followed by Industrial Processes 9.1%, Agriculture 5.2 % and Wastes 2.0 %. Total GHG emissions amounted to 147203 Gg $CO_{2\ eq.}$ and decreased by 23.3 % from 1990 to 2003. Table 9 provides data on emissions by gas from 1990 to 2003.

Over the period 1990-2003 CO_2 emissions and removals decrease by 23.8 %, mainly by emissions reduction in Energy (22.2 %), although CO_2 emissions from Transport increase by about 85 % over the same period. CH_4 emissions decreased by 39.1 % during the same period mainly due to lower emissions from Energy (41.3 % relative to the base year), Agriculture (48.1 % reduction) and Waste (18.5 % reduction). N_2O emissions decreased by 27.5 % over the same period.

Such a situation was a consequence of extensive development of industry and agriculture, inefficient use of natural resources along with high emission of harmful substances, and air and water pollution. The substance of current problems rests in the past development. CR had an ineffective economy, which did not take into account environmental factors. Czech industry was structured in a way that implied high energy and raw materials consumption, and used technologies with an unacceptable impact on the

environment. The use of poor quality coal, combined with 15 years delay in construction of desulphurisation facilities has led to the present problems. Although energy production in general is the most significant pollutant source, electricity production is not the dominant source of harmful emissions - heat generating facilities including household boilers account for the majority of emissions. The remainder is caused by a variety of other sources such as surface mines, chemical plants and transport facilities.

STRATEGIC AIMS OF POWER GENERATION INDUSTRY

- **Expectation** that market conditions put down the consumption of energy per GDP unit in industry to the level on a par with EU developed countries by change in fuel utilisation, saving of power, change in fuel structure for the benefit of environmentally more suitable sources, and by restricting high-energy-consumption processes,
- **Safeguarding** domestic fuel and energy supplies with minimal cost and oriented towards environment-friendly technologies (fluidised bed combustion, coal gasification, combined steam-gas cycle, combined generation of electricity and heat, and after 2000, assuming its current problems are solved, also use of nuclear energy) ,
- **Diversification** of gas and oil supplies, particularly by joining the network of EU gas and oil pipelines, an increase of strategic reserves of fuel in CR to the level comparable with that of EU, inter-connection of Czech and West-European electricity networks,
- **Increasing** the effectiveness of geologically limited supplies of coal in CR in order to achieve their sustainability, also for future generations,
- **Providing** operational reliability for the whole energy system,
- **Defining** a market model of energy management accompanied by liberalisation of prices and transfer of all future external costs on enterprises,
- **Giving up** direct intervention of State in the decision making of enterprises - the State will regulate natural monopolies in the legislative framework,
- **Minimising** unfavourable environmental impact of the production, distribution and consumption of energy on a par with common levels in EU countries.
- **Adjustment** of energy management for an entry in the European Union concerning legislative and technical aspects. A request for the full membership in OECD (Organisation for Economic Co-operation and Development) and IEA (International Energy Agency) will accompany the integration in the European structures.

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