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Ad Hoc Group of Experts on Coal
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REPORT ON THE STUDY TOUR ON CLEAN COAL TECHNOLOGIES held in the Czech Republic from 3 to 5 June 1999

Prepared by the secretariat

1. In accordance with the UN/ECE programme of work in the field of coal and thermal power, a Study Tour on Clean Coal Technologies was organized under the auspices of the Ministry of Industry and Trade of the Czech Republic by the Czech National Centre for Clean Coal Utilization (an association of Czech coal and power companies and relevant consulting and business enterprises), in cooperation with ECE.

2. The Study Tour was held following the International Conference “Clean Coal 2000", which took place in Prague from 31 May to 2 June 1999, so that interested specialists would have the possibility to attend both events. Most participants in the study tour also attended the Conference, where energy policies and strategies, the outlook for coal use in power generation, environmental and climate change issues, and the status and prospects of clean coal technologies in the implementation of energy and environmental objectives were discussed in a large international forum.

3. Twenty-five specialists from eight ECE member countries (Bulgaria, France, Greece, Romania, Russian Federation, Turkey, Ukraine and the United States of America) and one member of the UN/ECE secretariat took part in the study tour. Four specialists from the host country accompanied the participants during the tour.

4. In the last ten years, the Czech Republic has implemented important measures to reduce the harmful effects of coal use. The main aim of the study tour was to present some of these activities and their results to specialists from other ECE countries concerned with applying clean coal technologies, to discuss issues of common interest related to clean coal production and utilization and to promote international cooperation in these subjects. The programme comprised visits to two main brown coal mining companies (Most with 15 Mt and Sokolov with 10 Mt annual production) and five coal-fired power plants (Pocerady 1000 MW; Tisova 320 MW; Vresova-Sokolov 400 MW; Melnik I 330 MW and Kladno 350 MW generation capacity). The visits provided an excellent opportunity to see the implementation of clean technologies in opencast coal mining as well as coal utilization for electricity and heat generation in the Czech Republic. The visits also afforded a useful insight into the cooperative efforts which had to be made by all parties in the thermal power sector in order to achieve the objectives of the emission reduction programme within the time span accorded by the law.

5. The organization of the study tour and the hospitality extended to all the participants were of the highest level. Participants were provided with documentation about coal use and clean coal technology (CCT) development in the Czech Republic and with detailed information material about the installations visited. Lively exchanges of information and experience took place between the foreign and Czech specialists. The participants rated the study tour a most useful and successful event for promoting knowledge, professional contacts and cooperation for advancing the use of CCT throughout Europe.

6. The ECE secretariat and the participants wish to put on record their appreciation and gratitude to all the organizations and persons in the Czech Republic who contributed to the excellent programme and impressive visits, which greatly enhanced the usefulness of the work of the Ad Hoc Group of Experts on Coal and Thermal Power and the Committee on Sustainable Energy. As was evidenced by the study tour, enormous progress had been made in the Czech Republic in improving the environmental performance of the coal mining and coal-using sectors in a relatively short period of time. The participants expressed the hope that these achievements would help to maintain the share of coal in the Czech energy market and extended best wishes to all their hosts for future success in this endeavour.

Background information about the importance of coal for power generation in the Czech Republic

7. Coal is the most important primary energy and electricity source and the only significant domestic energy resource in the Czech Republic. At present, domestic hard coal and brown coal account for 56% of primary energy

consumption and 75% of electricity production. Although coal production and utilization have been decreasing during the 1990s as a result of the economic restructuring and environmental controls, coal will continue to be the principal resource for energy and electricity in the Czech Republic for a long time to come. Domestic coal is contributing to energy security, diversification of energy supplies, saving of foreign exchange and employment in the economy.

8. A new energy policy was adopted by the Government in June 1999. Its main aim is the introduction of more competition into the energy market. In the Czech Republic, the main competitors for domestic coal in electricity and heat generation will be natural gas, which has to be imported, and nuclear energy.

9. In 1998, about 70 Mt of coal, of which 20% was hard coal, were mined in the Czech Republic compared to 125 Mt in 1984, which was the peak year. 60% of the hard coal and 70% of the brown coal were consumed in the electric power and heat sector. The coal mining industry was reorganized into joint stock companies. Brown coal is mined mostly opencast by three companies: the Most Coal Company; the North Bohemian Mines Chomutov; and the Sokolov Coal Company. Hard coal is mined underground by one company, Carbon Invest, which was newly formed and comprises the coal mines in Kladno and Ostrava. The restructuring and privatization of the coal mining industry is continuing. Total coal demand is forecast to fall to about 50-55 Mt and the coal share in electricity to not less than 50% by 2010.

10. In 1997, electricity production amounted to 60 TWh, which was almost the same level as in the peak year 1989 when it reached 65 Twh. The fuel shares were coal 74%, nuclear 20% (from the 4 x 440 MW Dukovany plant), hydro 4% and gas 2%. In the period 2000-2010, electricity needs are expected to increase and the fuel shares to be as follows: coal 57%, nuclear 31% (on the assumption that the 2 x 1000 MW plant of Temelin will come into operation), gas 9% and hydro 3%.Electricity generating capacity totalled about 15 GW, of which 75% was thermal power, mostly based on brown coal and smaller capacities on hard coal, gas and oil.

11. About 75% of the installed power generating capacity is owned by the Czech Power Station Company CEZ, the successor to the former State-owned power company. CEZ retained most of the large power generation facilities and all the high-voltage transmission network. In 1998 CEZ, which is partly privatized, produced 74% of the electricity generated in the Czech Republic. The remainder was produced by independent power producers and industrial plants. The liberalization and privatization of the power generation sector in the Czech Republic is steadily progressing and attracting foreign participation.

12. Most thermal power stations in the Czech Republic are unit-type stations. The majority of CEZ's electricity produced in thermal power stations is generated by 200 MW units. CEZ's largest thermal power station is the 500 MW unit at the Melnik III power plant.

Implementation of clean coal technologies in coal mining and coal combustion in the Czech Republic

13. The production and use of coal have caused serious environmental damage in the Czech Republic. In 1990, measures were taken to resolve the urgent environmental problems. The Law No. 309/91 adopted by the Government in 1991 formed the basis for the protection of air against polluting substances. The Law stipulated emission limits and specified that the existing sources of pollution must meet the legal limits by 31 December 1998 at the latest. At the end of the 1980s, owing to the international agreements, CEZ and other power producers in the Czech Republic started an extensive programme of emission reduction and environmental improvement. This programme included the desulphurization of flue gases, reduction of nitrogen oxides, carbon monoxides and dust, and change in the methods of waste disposal. The Czech emission limits are as strict as those in the EU. The first flue gas desulphurization installation was put into operation in two blocks (2 x 200 MW) of the power plant at Pocerady in 1994. Further desulphurization and other emission abatement technologies were installed progressively in all the coal fired power plants in the Czech Republic expected to remain in operation after 1998.

14. The environmental improvements of the coal based power plants were completed within the mandatory period. They led to significant emission reductions and to noticeably better air, soil and water quality for the population. Compared to 1993, the SO_2 emissions were reduced by about 90%, NO_x by 50%, fly-ash by 90% and CO by 40% in 1999. Investments of more than 40 billion Kc were required for the programme, which were financed partly through the companies' own resources, joint ventures, domestic and foreign credits and bank loans, and public funds. International tenders and project teams were used in most instances to source and evaluate the necessary equipment and services. The technologies used for reducing the pollutants comprised flue gas desulphurization mostly with the wet limestone method, fluidized bed boilers, installation of electrostatic precipitators, improved burners and control systems as well as use of gas or coal and gas co-firing, especially in industrial plants, and power plant closures. Emission monitoring and checking systems were installed in all power plants accurately to measure and record the environmental performance as required by the law. Some of the older brown coal fired units were shut down. Since there was overcapacity, their closure did not present a power supply problem. After completion of the environmental programme, it is supposed that about 10 GW of environmentally friendly coal-fired power generation capacity remain in operation. The environmental

improvement programme also contributed to the reduction of CO_2 emissions owing to increased plant efficiencies resulting from the clean technologies and plant modernization. It thereby helped the Czech Republic to pursue its commitments under the Kyoto Protocol.

15. In the case of coal mining, too, ecological aspects are being given increased attention in the Czech Republic. Rehabilitation of the territories damaged by opencast mining is the main issue. Due to the accumulated environmental impacts and increased needs for rehabilitation and higher protection quality, the coal mining companies and also the power industry have now included ecological requirements in the technical and economic part of their activities. For this reason, the companies are spending a part of their operational budgets for land recultivation and afforestation projects to return mined-out sites and obsolete waste deposit grounds to arable or otherwise useful land for the population (e.g. housing, recreation) and to avoid environmental degradation and destruction of the ecosystem.

16. In previous years, financial reserves for recultivation were not built up, as all earnings went to the State treasury. According to the privatization law and other regulations, the necessary financial means to remedy past environmental damages should therefore be given by the State treasury. For recultivation of current and future mining sites, the means will have to come from the mining companies. To ensure that the necessary financial means are available, special reserve funds are being built up by adding the recultivation costs to the mining costs. In a democratic society, such a large infringement on the landscape as opencast mining requires the approval of the general public. With recultivation as an integral part of mining and a guarantee of ecological stability, public acceptance is expected to be more readily forthcoming in support of the opencast brown coal mining in the Czech Republic.

17. The implementation of clean coal technologies in the coal mining and coal based power generation in the Czech Republic can be rated as success stories. They demonstrate that if the technologies which now exist are systematically and broadly applied, coal can be an environmentally acceptable and ecologically sustainable energy resource for the future.

Installations visited during the Study Tour in the Czech Republic

18. **Pocerady Power Plant**: The power station, which belongs to CEZ, is situated in the northwest of the Czech Republic. The original installed capacity was 6 x 200 MW. The whole power station has been designed and built in the so-called unit-type (i.e. block) arrangement. The first unit was commissioned in 1970 and the sixth unit in 1977. The stations burns annually about 5.5 Mt of brown coal transported by rail from the open pit mines at

Vrsany in the Most coal basin. The coal characteristics are heating value 8.5-11.4 MJ/kg, water content 26-32%, ash content (in dry matter) 35-52%, ash content in original sample 27.5-28.5%, total sulphur (in dry matter) 0.8-1.8%. In 1994, unit 1 was shut down to comply with the plan to reduce coal based power station capacity. Also in 1994, desulphurization equipment (wet limestone method) was put into operation in units 5 and 6 of the plant. These were the first desulphurization power station units in the Czech Republic. The desulphurization (wet limestone method) of the remaining three units was completed by 1996. The extensive environmental programme implemented since 1990 and costing 10 billion Kc also led to the reduction of other polluting substances and an increased thermal efficiency. A large partv of the required investments were financed from CEZ's own resources as well as loans and credits from the World Bank and other international banks with repayment periods reaching up to 30 years. For about half of the residues from desuphurization, which amount to some 100 000 t per year, commercial outlets could be secured. Since 1995, a Czech-German joint venture operating in the vicinity of the power station is using the residues to produce materials for the building industry. The stabilized compound is also used in the recultivation of landscapes damaged by mining. The remainder is stored in special storage. The power plant now complies with all the environmental requirements. The station generates about 6 TWh of electricity per year, with an average specific fuel consumption of 10.25 GJ per generated MWh. The power station also provides heat for its own consumption. The Power Plant Pocerady is one of the most utilized (about 7000 operating hours per year) and cheapest thermal power stations in the Czech Republic.

19. **Most Coal Mining Company**: The company was formed by the National Property Fund in 1993 as a joint stock company by the unification of three national coal enterprises. The company is partly in foreign ownership. Its principal activities are the prospecting, mining, processing and selling of brown coal and it also engages in power and heat production. The company exploits a brown coal seam in the central part of the North Bohemian brown coal basin, i.e. the Most district. At present, it employs 9000 workers and operates four opencast mines and two deep mines, producing annually more than 15 Mt of brown coal, which is about one third of the country's total brown coal output. 60% is for electricity purposes, 30% for heat production and 10% for household use. In addition, about 60 million m^3 of top layer rocks must be removed annually to inner and outer dumps. The region worked by the Most Coal Company is extensive, with an area of about 12000 ha. The main focus of the visit was the company's exemplary and internationally known land recultivation activities. Recultivation of plots no longer used for mining has been practised in the Czech Republic since the early 1950s and new woods, parks, fields, orchards, lakes and vineyards cover former mining sites. This is how, in the region of Most, an integrated recultivation strategy for large territories developed which is now known as the "Czech recultivation school". Within the Most Coal

Company, recultivation is practised from the beginning to the end of the mining activities. This means that the mining operations are planned and carried out in a way that facilitates a reasonable renewal of the landscape for nature and for use by the population. The second aim is important because the mining is carried out in a densely populated area. For this reason, besides the basic methods of recultivation, a series of specific methods are applied in the Most region. For example, in addition to forests, there are parks, fields, vineyards and lakes. Family houses and other buildings are constructed on recultivated dumps as well as road, railway and river infrastructure, horse and car racing tracks, sports grounds, a cemetery and even an airport. The costs of recultivation are not low (some 7% of the mining costs) but the expenditure is an investment in revitalizing the environment for future generations and in sustainable development of the region. As mentioned in the introductory part, a reserve fund is being created by adding the recultivation costs to the production costs. The Most Coal Company as a large scale recultivator is proud to promote and further develop the knowledge and practice of the “Czech recultivation school” and thereby to demonstrate that coal can be mined in an ecologically sound manner.

20. **Tisova Power Station**: The power station, which belongs to CEZ, is situated near the West Bohemian town of Sokolov and is one of the oldest power stations burning brown coal. It was built in two stages. The first part of the power station came into operation between 1958 and 1960, and consisted of eight K 125 steam boilers, four 50 MW turbines, and one 12 MW turbine. The second part consisted of three 100 MW units and began operations between 1960 and 1962. In the 1980s, the first units were reconstructed and a heat distribution system for the Sokolov region was built. In the early 1990s, two 100 MW units were decommissioned in the reduction programme of brown coal based power generation and as a result, the installed capacity has been reduced to 322 MW. An additional 50 MW are to be phased out. The power station burns about 1.2 Mt of brown coal (heating value about 2200 kcal or 11 MJ) annually, which is transported directly by conveyors from the coal separating station of the neighbouring open pit mine of the Sokolov Mining Company. The power plant produces about 1.5 TWh of electricity and about 2,500 TJ of heat per year. The heat is supplied to nearby towns. The combined electricity and heat production led to increased power plant efficiency. In 1996 and 1997 two fluidized bed boilers, each with 350 tons of steam output per hour, were installed to replace the old boilers, and the largest 100 MW unit was equipped with desulphurization equipment employing the wet limestone method. The limestone comes from Central Moravia and is transported by rail some 350 km. The plant was also modernized to solve the problem of other emissions and waste disposal. A new storage site for depositing the solid stabilized compound was built in a nearby open pit mine and the compound and the fly-ash are used as building materials.

21. **Sokolov Coal Mining Company and Vresova Power Plant**: The Sokolov Coal Company was founded by the National Property Fund of the Czech Republic in 1994. The company mines about 10 Mt of brown coal in four opencast mining complexes in the Sokolov basin, and prepares and sells it. The company's environmental activities comprise reclamation of land affected by opencast mining, and waste treatment and disposal. Since the company operates in a highly built-up and densely populated area, the environmental restrictions are particularly severe. The main part of the visit was dedicated to the Vresova Power Plant, formerly the greatest lighting gas producer in the Czech Republic, which is now part of the Sokolov Coal Company. This plant uses gas made from brown coal mined from the company's opencast mines as the staple fuel and natural gas as supplementary fuel for peak hour heat and power generation. After the Government decided to have the whole lighting-gas subsystem replaced by natural gas, the need arose for a major restructuring of the existing pressure gas works. Out of a number of options, the construction of an entirely new plant prevailed, using the technology of the so-called gas-steam cycle. This solution makes maximum use of the coal gasification technology already developed and used at the Sokolov Coal Company and the gas from the coal is an environmentally friendly fuel. Construction of the CHP plant based on the gas-steam cycle technology started in 1993 in the wake of the adoption of the environmental legislation and programmes in the Czech Republic. The CHP plant consists of two blocks of 2 x 200 MW which came into operation in 1995-1996. The plant meets all the requirements for operating in the UCPTE uniform system of west European power transmission networks. It produces between 1.5 and 2.7 TWh electricity per year. It has a high thermal efficiency owing to the characteristics of the technology and an environmentally friendly power and heat production due to the use of desulphurized gas from coal plus practically sulphur-free natural gas. The waste gases discharged meet the standards of the clean air Act. The plant is a unique contribution to clean coal technology use in the Czech Republic.

22. **Melnik I Power Station**: The Melnik power stations are close to the capital Prague. They consist of three technological units built between the 1950s and 1970s as a complex of condensing power stations. They burn brown coal transported by rail from the mines of Northern Bohemia. Since the beginning of the 1990s, the entire complex has been undergoing an expensive restructuring with the aim of improving the equipment to comply with the Czech Republic's environmental laws and to allow the station to operate as an electricity and heat source for the next twenty years. In 1993, the Melnik I Power Station was transferred to the ownership of Energotrans, a joint stock company among whose shareholders are CEZ and Prague Heating Stations. The company is partly in foreign ownership. Energotrans is the third largest producer and supplier of electrical energy and heat in the Czech Republic. The company also operates the 34 km long Melnik-Prague heat feeder system, which commenced operation in 1995. The combined generation of electricity and heat

increased the energy efficiency from 30% to 60%.The Melnik I power plant consists of six 55 MW units built in the late 1950s. In 1988, the power stations underwent extensive modernization. In 1995, the contract for desulphurization was signed. In 1997, installation of desulphurization based on the wet limestone method and other improvements to increase the technological and ecological standards started and were completed in 1998. In this connection, it was necessary to devote attention to the problem of the use of the residues from desulphurization. Based on investigations, the commercial use of part of the by-products in cement works has been secured, for the rest of the residues storage possibilities have been found with minimum transport and storage costs. After this transformation, the Melnik I power plant will be able to exploit all advantages of combined production of heat and electricity from domestic energy coal with clean and efficient technologies. The technological and environmental modernization of Melnik I and the long distance heat feeder system will enable Melnik I to become a major heat and power supplier for Prague.

23. **Power Plant at Energy Centre Kladno**: The company Energy Centre Kladno Generating (ECKG), which is a joint venture of a group of investors, is rebuilding and extending an existing heating plant, which has reached the limit of its economic and technical life. The new plant will meet economic and ecological requirements and operate for at least the next two decades. According to Czech environmental law, an environmental impact assessment was performed before the start of the project and clean coal technologies have to be applied. The project was developed and financing agreements concluded in 1997.Construction started in the same year and the plant is to start production in 1999. The new coal-fired power plant with an electrical output capacity of 350 MW is designed in a classic block arrangement, consisting of two blocks. Each block has a circulating fluidized bed boiler of the Flex Tech system with a steam output of 375 t/h (currently the biggest fluidized bed boilers installed in the Czech Republic) and VAX type steam condensing extraction turbine with a maximum output of 135 MW. The fluidized bed boilers meet the limits of harmful substances in flue gas emissions prescribed by Decree No. 17/1997 of the Ministry of the Environment of the Czech Republic. Part of the power plant is a gas cogeneration unit with a GT8C gas turbine with an output of 66.9 MW and heat recovery steam generator with a steam output of 86.4 t/h. The gas turbine is capable of burning natural gas as well as light fuel oil. The cogeneration unit is designed primarily for peak period. The advantage of the cogeneration unit is a high efficiency and environmental soundness. The main power units are for both hard and brown coal use. The base fuel will be hard coal from the region of Kladno, thereby ensuring the operation of these mines at least for the next twenty years. The 350 MW thermal power plant of ECKG is the second most important power plant investment in the Czech Republic since 1989 after the nuclear power plant project of Temelin. A total of US$ 400 million will be invested by the joint

venture partners through project financing (35% equity, the remainder in structured loans with the IFC as leader of the lenders). By bringing this clean and efficient power plant into operation, harmful emissions to the environment will be substantially reduced in the Kladno region.

Recommendations

24. The report on the study tour on clean coal technologies in the Czech Republic should be widely disseminated by the ECE secretariat.

25. The study tour on clean coal technologies in the Czech Republic was an excellent opportunity to gain first-hand knowledge about the factors to be considered and the experiences obtained in implementing a country-wide clean coal programme. The tour was a continuation of previous successful events of this type organized under the auspices of ECE. Considering the need to accelerate clean coal use throughout the ECE region, member countries should organize study tours on clean coal technologies in cooperation with the ECE secretariat in the future.

26. Using clean and efficient technologies throughout the coal to energy chain will be essential for securing market shares for coal under increasing environmental stringencies. The study tour provided ample evidence that the technologies now exist to mine coal in an environmentally acceptable manner and to make coal an economically and ecologically useful and acceptable energy source for the future. They must be employed rapidly and widely to preserve the use of coal.

27. Financing is considered to be the major issue in the deployment of these technologies. The ways in which the financial and other hurdles were overcome in the Czech Republic should therefore be explored as options also for other countries. The experience of the Czech Republic highlighted that in most instances countries will have to rely firstly and foremostly on their own human and financial resources and capabilities for implementing a clean coal programme and protecting its environment.

28. The participants particularly stressed the importance of a time-framed national energy policy and legal framework with specific environmental protection targets and emission limits as the basis and driving force for ensuring clean energy production and use. This could be seen from the Czech experience. Enactment and enforcement of such legislation is the task of the Government.

29. Political and economic stability in general, a legal and institutional framework, government support in the form of public funding, financial and fiscal incentives as well as a favourable climate for domestic and foreign

investments are necessary conditions for technological modernization. The fact that domestic and foreign technical and financial cooperation could be harnessed in the Czech Republic for the implementation of the environmental improvement programme is due to the availability of these conditions. Other countries, too, should bear these requisites in mind for attracting international investments in the coal-to-energy chain.

30. The Czech Republic demonstrated that in less than ten years, sulphur and other polluting emissions from coal based power plants could be substantially reduced and environmental performance visibly increased on a country-wide scale. The mandatory environmental improvement programme carried out in the Czech Republic could serve as example for other ECE countries in their striving to implement clean coal programmes to comply with national, regional (e.g. European Union) and global (i.e. Kyoto Protocol) targets.
