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# Strategic Planning -- Task 7.1

## Topical Report
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# Disclaimer

## 7.1- STRATEGIC PLANNING

### PROJECT ACCOMPLISHMENTS

Activities under Activity 1 over the past half year consisted of the acquisition and review of source materials relevant for the revisions to the report entitled “Energy and Environmental Profile for Selected East Central European Nations” and the finalization of the report. The final report is included as Attachment A.

No work was done under Activity 2, Technical Oversight of Program Performance Under the base Cooperative Agreement, or Activity 3, Policy Tracking.

Year 2 activities are completed.

# ATTACHMENT A

# ENERGY AND ENVIRONMENTAL PROFILE FOR SELECTED EAST CENTRAL EUROPEAN NATIONS

## Final Report

# ENERGY AND ENVIRONMENTAL PROFILE FOR SELECTED EAST CENTRAL EUROPEAN NATIONS

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## INTRODUCTION

The nations of East Central Europe regained their political and economic freedom in 1989, ending nearly a half century of centrally planned economies under the hegemony of the former Soviet Union (FSU). These nations are now emerging from economic conditions marked by price distortions and a focus on heavy industry, isolation from world markets, and a lack of occupational health and environmental safeguards. Economic recovery, environmental restoration, and political stability, as well as eventual entrance into the European Community (EC), require a reordering of policies and priorities, including those bearing on energy and the environment. This report, prepared as a background document for the Second International Conference on Energy and Environment to be held in Prague in November 1994, is composed of a summary table (Table 1) and supporting text and is intended to provide a concise review of issues related to energy and the environment for the Czech and Slovak Republics, Hungary, Poland, and Bulgaria. Organized by subject and country, Table 1 contains country profiles (Row A), information on the economy (Row B), primary energy consumption, environmental priorities, energy resources, production, and utilization (Rows C, D, F, G, H, and I), electrical generation and transmission (Rows J and K), district heating (Row L), briquettes (Row M), and environmental regulations (Row N). Pertinent policy goals, issues, and trends are noted. The reports is based largely on a review of documents published by the International Energy Agency (IEA) and the U.S. Department of Energy (DOE), as well as selected sources obtained from the countries of the region. Reference citations are keyed to information presented in Table 1.

The report is based on the most recent published information available to the authors, mainly from 1991 and 1992. The evolving situation in the region will quickly outdate portions of the report. Because the report is intended as a summary, certain topics, including coal quality and specific characteristics of power plants and other facilities, were given very limited treatment, and the reader is referred to key sources in the bibliography for further information. For other topics, such as district heating and briquette manufacturing and use, the treatment here reflects the information available to the authors.

## ECONOMIC TRANSITION

While in transition to democratic political structures and free markets (Table 1, Row B), the East Central European nations are emerging from postindependence recessions. Gross domestic product (GDP) has declined since independence. The private sector share of GDP is low in Bulgaria and the Czech Republic but high (50%) in Poland. In 1993, Poland and Hungary respectively reported 7% and nearly 2% growth in industrial output. Inflation continues to be high, ranging from 11% in the Czech Republic to 35% in Poland and up to over 80% in Bulgaria. Outside the Czech Republic, unemployment also remains high, between 11% and 16%. Per capita foreign debt is high overall, ranging from $594 in the Czech Republic to $2121 in Hungary.

## RESOURCES AND ENERGY SUPPLY

The economies of East Central European nations are highly energy intensive, with total energy use ranging from 1 to 1.8 tons of oil equivalent (toe) per US$1OOO GDP, compared to 0.3 tons for the OECD (Organization for Economic Cooperation and Development) countries as a whole (Table 1, Row C). All are net energy importers with very limited domestic resources of oil and gas, which were formerly supplied by the U.S.S.R. (Table 1, Rows F, G, H, and I). Total energy consumption ranges from 0.95 exajoules (EJ) in Bulgaria and 1.13 EJ in Hungary to 4.04 EJ in Poland. Energy use is down throughout the region since the peak in the late 1980s. Coal dominates the energy mix in the Czech Republic (54%) and Poland (78%), while the mix in Hungary and Bulgaria is more evenly divided between coal, oil, gas, and nuclear. Poland has no domestic nuclear energy capacity, while nuclear energy accounts for between 10% to 15% of the energy mix in the other countries.

Political and economic reforms have changed the focus of energy policy from one of interdependence within the sphere of the FSU to self-reliance and movement toward integration into the EC (Table 1, Row D). Subsidies and barter agreements among the East Central European nations have been largely discontinued. Demand for transportation fuel, in particular, is projected to increase dramatically, whereas energy demands for electricity, space heating, and heavy equipment are expected to remain level or show modest increases. Oil and gas imports from the FSU are troubled by regional political and economic uncertainty, declining production, and the aging production and transportation infrastructure. Upgrading and maintaining the oil and gas infrastructure and continuing exploration in the FSU will require a massive investment, mainly from foreign sources and estimated at over US$10 billion dollars, in the near term. An important overall policy goal of the East Central European countries is to ensure a stable supply of oil and gas by diversification of sources, accelerated development of domestic resources, and upgraded infrastructure, including pipelines and processing and refinery units. Other high-priority goals include energy conservation, upgrading or decommissioning facilities (particularly older nuclear and coal-fired power plants), and retrofitting environmental control methods for remediating air, soil, and water pollution (Table 1, Row E).

East Central European governments have moved to support joint ventures with foreign investors in sectors requiring significant capital investment, such as upgrading or expanding existing facilities, including those for transportation fuels and service, as well as for high-risk enterprises such as oil and gas exploration and production. Governments haveretained control over energy supply in matters such as pipelines, electrical transmission grids, and import agreements. Private domestic ownership has included mining cooperatives, marketing and service businesses (including vehicle service stations), and support industries.

As shown in Table 1, Row F, East Central European coal reserves indicate an adequate supply into the next century, particularly for low-rank coal (LRC). Reserves in Bulgaria, Hungary, and the Czech Republic are predominantly LRCS, whereas Poland has large reserves of hard coal along with significant LRC deposits. The former Czech and Slovak Republics (FCSR) have recoverable reserves of hard coal totaling 3330 Mt with an annual production of nearly 26 Mt in 1987. The Ostrava-Karvina region of the Czech Republic, in the southern extension of the Upper Silesian Basin, continues to dominate hard coal production. These coals, produced from underground mines, are anthracite or low-volatile, strongly caking bituminous coals containing low levels of ash, moisture, and sulfur. Recoverable reserves of LRC (mainly brown coal) in the Czech and Slovak Republics total 8850 Mt with an annual production of around 100 Mt in 1987, mainly from surface mines. The principal reserves and production of brown coal are in Northern Bohemia in the Czech Republic, where the coals are moderate to high in ash (17%-30%), variable in sulfur (0.5%-3.0%), and highly variable in moisture content (30% average), with heating values from 9 to 18.6 MJ/kg. The Sokolov field, southwest of the Northern Bohemia region, is another significant LRC area. The Slovak Republic to the east contains only minor LRC deposits.

Poland has proven recoverable reserves of hard coal in excess of 28,700 Mt, two-thirds of which are of coking quality and all recoverable only by underground mining. Deposits in the Upper Silesian Basin in southern Poland, occurring in 1.5- to 2.5-meter-thick seams, account for 93% of reserves in developed deposits, over three-quarters of prospective hard coal reserves, and about 97% of hard coal production. Excellent average properties include a lower heating value of 23,3 GJ/t, a sulfur content of 0.75 %, 30% volatile matter, 9.7% moisture content, and 16,7% ash content. Annual production in 1987 stood at 178 Mt. Production costs are high at many of the mines, and some mines are being closed. Maintenance of production capacity requires investment in new mines and the further development of existing mines. Recoverable reserves of LRC in Poland total 11,700 Mt, mostly exploitable by surface mining with bucket-wheel excavators. The Belchatòw and Turow mines dominate production, having seams greater than 20 m in thickness (up to 60 m). Although LRC deposits are generally level or gently dipping, selective mining is often required because of local geological complexities. Production in 1987 stood at 73.2 Mt.

In Hungary, the proven hard coal reserves (100 Mt) are concentrated in the southwest portion of the country, at Pees in the Mecsek Mountains, which provides Hungary's only domestic source of coking coal. Deposits are geologically complex and mining costs are high. Hungary's LRC reserves of 3650 Mt occur along the northern border with the Slovak Republic and are exploitable by surface mining. The Matraalja field, northwest of Budapest, containing six seams of 4 to 14 meter thickness, accounts for more than three-quarters of LRC proven reserves, Mining costs are competitive, and the potential for continued development is good. Matraalja lignite is characterized by moderately high moisture (45%) and ash (22%), low sulfur (1% daf), and a relatively low heating value (6.7 MJ/kg).

In Bulgaria, proven reserves include 30 Mt of higher-rank coal (mainly bituminous) which accounts for less than 1 % of annual production. LRC reserves stand at 3700 Mt, of which two-thirds are available for surface mining. Half of the Bulgarian LRC reserves and three-quarters of the 35.3 million tons of LRC (mainly lignite) produced in 1988 are accounted for by the Maritsa East lignite deposit. The Maritsa East lignite bed, varying from 3-25 m in thickness, is high in moisture (49 %-57 %), ash (30%-45 %), and sulfur (2. 8%-4. 1 % dry) and has a lower heating value (5-7 MJ/kg).

With respect to oil and gas resources as shown in Rows G and H in Table 1, Hungary produces about a quarter of the oil it consumes, while production in the other East Central European countries is minimal. Hungary produces about 25 % of its natural gas needs, while other countries import over 90%. There exists a potential for increased domestic gas production in all of the East Central European countries, and exploration is being accelerated by foreign investment and technical assistance. Natural gas supplies are also supplemented with coal gas. As shown in Row I in Table 1, uranium deposits have been mined in the Czech and Slovak Republics, Hungary, and Bulgaria, but most of the mines have production costs much higher than world prices and are, therefore, slated to be shut down.

## ELECTRICAL GENERATION

The study countries in East Central Europe have a combined installed generating capacity of about 69 GW, which provides a per capita generating capacity of 0.94 kW (Table 1, Rows J and K). Net electrical production for the region compiled from selected sources in the period from 1990 to 1992 was about 274 TWh per annum, which equates to 3730 kWh per person annually. Generating capacity and production per person are approximately two-thirds of those in Western Europe and one-third of the U.S. The Czech Republic has the highest per capita electrical use in the region, followed by Bulgaria, the Slovak Republic, Poland, and Hungary.

Taken as a whole, the region relies on coal for 74% of its electrical generation, followed by nuclear for 19%, oil and gas for 4%, and hydropower for 3%. The contribution of brown coal and lignite to electrical generation is estimated to be about 50% in the combined Czech and Slovak Republics, 36% in Poland, 35% in Bulgaria, and 8% in Hungary; the corresponding contributions of hard coal are estimated to be 11%, 60%, 18%, and 20% respectively. Reliance on coal for electrical power has declined during the 1980s as nuclear units were installed, except in Poland, which has no nuclear power. Most countries rely on domestic supplies of coal with the exception of Bulgaria, which imports some coal from the Ukraine.

Overall consumption of electricity is down because of the slowdown in the economy. Imports of electricity have decreased significantly during this time with a lesser decrease in domestic generation. Peak loads are being met in the region with the exception of Bulgaria, which has experienced power outages.

The burning of high-sulfur, high-ash coal and lignite for power generation is a leading cause of severe air pollution in some areas of East Central Europe. The problem is being addressed under phased-in emission regulations by both decommissioning some older coal burning plants and rehabilitating, retrofitting, and/or repowering other units with improved control systems, flue gas desulfurization (FGD), 10w-$NO_x$ burners, electrostatic precipitator (ESP) enhancements, and fluidized-bed combustion (FBC)—atmospheric (AFBC) and circulating (CFBC).

Each of the study countries in the region is planning additional capacity using gas-fired combined cycle plants for peaking service in the period of 1995-2000. New baseload plants are typically needed only after 2000, with either coal or nuclear units likely to be selected. Some countries, most notably Poland, Bulgaria, and the Slovak Republic, have significant untapped hydroelectric potential, but expansion in capacity is limited by high capital cost and environmental concerns.

**Czech Republic and Slovak Republic**

Prior to 1990, the power industry in the Czech Republic was organized in a single state-owned company, the Czech Power Works (CEZ), which generated, transmitted, and distributed electricity from plant to end user. Since then, the industry has been decentralized and partially privatized with the establishment of eight regional distribution companies and other independently operated heat and cogeneration plants, leaving the CEZ (now 30% privately owned) with generation and transmission.

Power demand decreased by about 8 % to 9 % in the two republics from 1990 to 1992 after rising during the 1980s, but growth is expected to resume as the economy recovers. In the Czech Republic, the installed generating capacity of 14,500 MW is 77 % coal-fired, 12% nuclear, and 11% hydropower. In the Slovak Republic, the 5600-MW total installed capacity is 39% coal and gas, 31% nuclear, and 30% hydro. Both republics have an ample margin of excess capacity. Nuclear facilities are the most fully utilized, supplying 21% of net generation in the Czech Republic (1992) and 50% in the Slovak Republic (1991). Hydro capacity is least utilized and is reserved for peaking service.

Nuclear power plants are currently operating at Dukovany in the Czech Republic ( 4 x 440-MW model V213 units commissioned between 1983 and 1987) and at Bohunice in the Slovak Republic (2 x 440-MW V230S, 2 x 440-MW V213s). The two older V230 type units at Bohunice are generally considered unsafe, and their decommissioning is planned for some time between 1995 and 2005. New nuclear plants are under construction at Temelin in the Czech Republic (2 x 100 MW) and at Mochovce in the Slovak Republic (4 x 440 MW). Although expansion of nuclear power is controversial, completion of those units that are already in an advanced state of construction is considered to be the least costly option for reducing the environmental impacts of fossil fuel generation and for integrating with the West European power grid system (UCPTE).

Coal-burning power plants are the largest source of air pollution in the Czech and Slovak Republics, and they represent a particularly serious problem in Northern Bohemia in the Czech Republic, where high-sulfur content lignite is burned substantially without control of $SO_2$ emissions, Part of the planned solution is to shut down older coal units as new nuclear capacity becomes available, including, by the year 2000, 14 out of the 48 coal-fired generating units operating in the Czech Republic (1790 out of 7850 MW) and five of the 16 units in the Slovak Republic (550 out of 1760 MW). The remaining coal-fired units are being retrofitted with FGD or alternatively repowered with AFBC or converted to low-sulfur fuel. In addition, 10w-$NO_x$ burners are being installed on some units.

Further development of hydroelectric power in the Slovak Republic was set back in 1990 when Hungary withdrew from the joint agreement to construct the Gabcikovo–Nagymaros Dam because of environmental concerns. As a result, Slovakia will be forced to utilize its own dam and generating station at Gabcikovo at well below design capacity.

The 220- and 440-kV transmission grids in the Czech and Slovak Republic are owned separately by the CEZ and SEP, but with significant interconnections that account for a net transfer of 6 % from CEZ to SEP and 0.3 % from SEP to CEZ measured in reference to their combined generation. The Czech Republic is interconnected with Poland and Germany, including former West Germany, The Slovak Republic is interconnected with, and is a net exporter of power to, both Hungary and the Ukraine.

**Poland**

Organization of the Polish power industry since the late 1980s has undergone dramatic changes that first reorganized the previously centralized system into an excessively large number of small independent operating units, including 32 generating companies and 33 transmission and distribution networks. A second round of restructuring is currently in progress to reconsolidate the power industry into a smaller number of joint stock companies under the Polish Power Grid Company (PPGC). The PPGC, itself established as a joint stock company in 1990, has overall responsibility for operating the power grid and developing plans for rehabilitating electrical generation and transmission systems. Plans for privatization envision a transition to a mix of state-owned and privately owned companies, starting with the privatization of the Krak6w Heat and Power Plant as a pilot project, Demand for electricity in Poland declined by 15% between 1989 and 1992, with in-country generation dropping by 9% and imports falling far more substantially by 72%. Electricity production was 132.8 million kWh in 1992.

Thermal power, which is nearly all coal-fired, with only minor amounts of oil and no gas firing, accounts for over 90% of Poland's 32,000 MW of installed generating capacity, Almost 70% of this capacity is concentrated in 15 large coal-fired plants, including major stations at Belchatòw (4320 MW) and Trvow (2000 MW) burning brown coal and stations at Kozienice (2600 MW), Dlona Odra (2600 MW), Polamic (1600 MW), and Rybnik (1600 MW) burning bituminous coal.

Poland has over 100 small hydroelectric and pumped storage plants used for peaking service, which account for most of the 10% remainder of installed capacity-but only a small increment of production (2.9 % in 1988). Poland's large hydroelectric potential of about 12 million kWh annually is only 13% exploited, due largely to the high capital cost of hydroelectric facilities,

Poland has no nuclear power plants, and all planned nuclear power projects have been canceled, including the Zarnowiec project. However, a role for nuclear power is foreseen within the next 15 to 20 years.

Electrical generating capacity will be adequate for the next several years, owing to depressed economic growth and transition to a less energy-intensive economy. Near-term priorities are to complete construction in progress on a new coal-fired plant (2160 MW) and pumped storage capacity (750 MW); to rehabilitate and retrofit aging coal-fired generating equipment (18 years average age) for improving availability, efficiency, and environmental control; and to reduce large losses of up to 10% in transmission and distribution. Flue gas desulfurization systems and low-$NO_x$ burners are beginning to be installed on coal-fired plants, with 4000 MW estimated to be retrofitted by the year 2000 and 8600 MW thereafter. In addition, coal-washing plants are being installed at 18 mines to reduce the sulfur content of hard coal burned in power stations.

The Polish transmission grid consists of a 400-kV ring (not yet completed) with 220-kV branches linking power plants and 220-/1 10-kV substations. Interconnections include 220- and 750-kV lines to the Ukraine and 220- and 440-kV lines to the Czech Republic and former East Germany.

In 1992, Poland had net electrical imports amounting to 2.7% of demand, which represented a substantial reduction from the 8.9% imported in 1989. Poland is upgrading its interconnections with the Czech and Slovak Republics and Hungary as a step toward joining the West European power grid (UCPTE).

**Hungary**

The Hungarian Electricity Works (MVM), organized in January 1992 under the authority of the Ministry of Industry and Trade, provides for a first tier of eight regional generating and six regional distributing companies controlled by a second tier of financial holding and operating functions. The second tier includes responsibility for transmission grid operations, power dispatching, wholesale power purchase contracts, and electrical imports. A somewhat complex network of current ownership involving municipalities (1% to 5%), the MVM Holding Company and its parent State Asset Holding Company (45 % to 49%), and the State Property Agency (50%) is intended to lead to a blend of private and state ownership under Hungary's liberal policies on privatization and foreign investment, although bureaucracy and pricing uncertainty have slowed this process.

Demand for electricity in Hungary peaked in 1989 at 41 TWh and has since declined by 18% to 33.5 TWh in 1993. In-country generation dropped by 11% between 1990 and 1992, whereas net electrical imports dropped 69%. Imports provided 29% of demand in 1990, compared to about 10% in 1992.

Hungary's total installed generating capacity of 7300 MW includes 2100 MW in lignite- and brown coal-fired plants (29%), 3300 MW in oil- and gas-fired plants (45%), 1840 MW at the Paks nuclear station (25 %), and 48 MW from two larger hydroelectric plants on the Tisza river and 27 mini hydro systems (0.6%). Electrical generation by MVM in 1991 was 28% coal-based, 23% oil and gas, 48% nuclear, and 0.7 % hydro. The generating mix has shifted over the last four decades, starting with construction of primarily small brown coal-fired plants in the 1950s and 1960s, followed by construction of a large lignite-fired plant in the early 1970s, oil and gas plants later in the 1970s, and a nuclear plant in the 1980s.

Hungary has a capacity margin about 25% above peak load (1991) and is placing a strong emphasis on demand-side management to maintain adequate reserve capacity in the near term. Some older coal-fired plants operating on high-cost coal will be decommissioned, and the use of coal for power generation is expected to decline in the future. Work is in progress to retrofit and repower other coal-fired boilers for life extension and emission control using technologies that include FGD, 10W-$NO_x$ burners, flue gas recirculation, and AFBC. Two boilers at the Ajka Power Plant have been converted to a hybrid pulverized coal fluidized-bed combustion system. The Gagarin plant fired on lignite and the Oroszlany plant fired on hard coal have both undergone major rehabilitation. The immediate generating need before 1997 is for 800 MW of gas-fired combined cycle capacity for peaking service. New baseload units ( 2 x 900 MW) needed by about the year 2000 may involve either lignite, hard coal, or nuclear fuel. The public is strongly opposed to the expansion of nuclear capacity in Hungary, and earlier plans for construction of 2 x 1OOO-MW units at the Paks station were cancelled in 1989. No plans for expanding hydropower have been reported after suspension in 1989 of Hungary's participation in the Slovakian-Hungarian hydroelectric project at Gabcikovo– Nagymaros. If hydro-, nuclear-, and coal-/lignite-based units are not selected, the future alternative will be greater reliance on imported oil and gas at escalating prices.

**Bulgaria**

Organization of the energy sector in Bulgaria prior to a November 1991 energy policy decree involved two vertically integrated government agencies for 1) oil and gas and 2) coal heat and electricity (the Committee on Energy [COE]). Since then a number of government-owned companies, including the National Electric Company (NEK), have been established. The NEK is responsible for the generation, transmission, and distribution of electricity throughout Bulgaria.

Bulgaria's demand for electricity decreased by 22% between the peak year of 1988 and 1992, reflecting a drop in industrial output, price increases, and capacity constraints. The installed generation capacity of 12,074 MW as of 1992 (53% thermal, 33% nuclear, and 16% hydro) should, in theory, provide a safe margin of excess capacity. However, the low operating reliability of coal-fired and nuclear plants and the reduced availability of hydropower in recent dry years have limited maximum load to about 60 % of installed capacity, which is below the level of peak demand and has resulted in power outages.

The only nuclear plant, located at Kozloduy, consists of four 440-MW units, commissioned between 1974 and 1980, and two 1OOO-MW units, commissioned in 1988 and 1991. All units have pressurized light-water reactors operating on slightly enriched uranium. The four older units do not meet International Atomic Energy Agency (IAEA) standards due to lack of redundant cooling and containment, and they are slated for closure when alternative power generating capacity becomes available. The newer 1OOO-MW units meet international standards but require improvements in instrumentation and control, Necessary improvements in the Kozloduy plant are being funded by the European Bank for Reconstruction and Development (EBRD).

Bulgaria has four major coal-fired generating plants at Maritsa East (2780 MW), Bobov Dol (630 MW), Varna (1260 MW), and Russe (340 MW). The Maritsa East complex operates on large economic deposits of low-grade lignite containing very high levels of sulfur and ash. The Maritsa complex also produces briquettes for domestic heating, which are somewhat fragile and subject to breakage and contain high percentages of sulfur. Bobov Dol operates on low-quality subbituminous coal from uneconomic mines that are slated for eventual closure. Varna and Russe operate on uncertain supplies of low-volatile bituminous coal imported from the Ukraine. Over 60% of the coal-fired units have operated for over 20 years and are candidates for decommissioning or life extension. Coal supplies are limited in respect to both availability and quality. Uncontrolled sulfur emissions from plants burning high-sulfur lignite can reach levels of 18 grams of $S0_2$/Meal (20 lb of $SO_2$/MBtu) or higher, requiring 96%-97% control to reach post-1995 requirements. The priority placed on sulfur control in the past has been low owing to the use of tall stacks for dispersion and lack of local health effects. Plants at present have no provision for controlling NO,. Large boilers are equipped with ESPS for particulate control, but significant improvements are needed to meet emission standards. A major study on thermal power plant rehabilitation by Bechtel, Energoproekt, and TOTEMA completed in October 1993 under sponsorship of the U.S. Trade & Development Agency (USTDA) placed a high priority on improving unit reliability, selectively retrofitting units with advanced wet FGD or spray dryer methods for sulfur control, enhancing particulate control by ESP modifications or gas conditioning, constructing a CFB cogeneration boiler to supply steam for briquetting, and switching some units to higher-quality U.S. or Indonesian coals (Bobov Del, Varna, and Russe). The Energy & Environmental Research Center is currently working with Energoproekt and TOTEMA to evaluate specific U. S. clean coal technologies to meet these needs, under sponsorship of DOE and AID.

Major hydropower plants are located at Chaira (735 MW), Rhodope (380 MW), and Arda (274 MW), with 84 smaller plants making up the remaining 580 MW of hydroelectric capacity. An additional 400 MW of capacity at Chaira is at or near commissioning. The availability of hydropower is estimated to be 1.9 TWh in dry years and 4.5 TWh with average precipitation, which represent only 11% and 26% respectively of the annualized capacity (installed capacity x 8760 hours/year). The economically exploitable hydropower potential in Bulgaria is estimated to be 10 to 12 TWh.

Electrical transmission in Bulgaria consists of a 200- and 400-kV grid, interconnected with the Ukraine by 750- and 400-kV lines, and with Romania, Turkey, Greece, and Serbia by 400-kV lines. The largest interconnection, with the Ukraine-3150-MW capacity, carries relatively high cost power (5. 1 ¢/kWh in 1991) both to Bulgaria and on to Romania. Peaking power of up to 400 MW is imported from a gas turbine combined cycle plant in Turkey. Power exchanges with Greece and Serbia are more limited due to differences in electrical standards for frequency and voltage regulation that disallow synchronization between the West European UCPTE system and the East European IPS system, requiring power exchanges to operate on an “isolated island” principle,

## DISTRICT HEATING PLANTS

Hot water for heating is supplied to significant portions of urban populations in the East Central European countries by central facilities that include cogeneration plants, central heating plants, and industrial heat sources (Table 1, Row L). District heating accounts for 28,133 Mtoe in the Czech Republic (72% coal), 44,960 Mtoe in Poland (98% coal), 4383 Mtoe in Hungary (71% gas), and 4120 Mtoe in Bulgaria (divided between coal, oil, and gas). Significant energy losses occur because of heat radiation and leakage, excess fluid temperature, inadequate metering, and distorted fee structures. Where coal is used, district heating plants area major source of particulate and gaseous emissions, a particular problem in urban settings.

Policy goals include evaluation of district heating systems, elimination of subsidies, encouragement of individual heating systems, substitution of oil or gas for coal, and facility and infrastructure upgrading. Installation of cogeneration facilities based on advanced technologies are underway with the support of western governments and private industry.

## BRIQUETTE FUELS

As shown in Row M of Table 1, briquettes made from LRCS are a potential source of energy mainly for domestic use. In addition, briquettes offer the potential for $SO_x$ emission reduction. Two technologies are currently available for briquette production:

- Cold briquetting of HRCS with capture additives for harmful combustibles
- Hot briquetting of LRCS along with a binder or caking coal and additives for capture of harmful combustion products

In Poland, residential heating consumes more than 25 million tons of coal annually (9.5 million tons in household stoves and 8.4 million tons in residential heating systems). Coal use in heavily populated areas contributes up to 22 % in total emissions of dust and 86% of $SO_2$. Since replacement of coal-based energy with electric or gas is not possible in the short term, coal will be replaced with less polluting coal-based briquettes. Although Poland supports no commercial briquette production at present, it is estimated that the country could sustain production of about 2.4 million tons, with about 0.4 million tons going for export.

In 1993, 650,000 tons of briquettes were made in the Czech Republic, all from pulverized lignite. The briquettes are used in small household boilers and stoves. Of the total, 50,000 tons was exported to Slovakia.

The Maritsa plant, east of Sofia, has a monopoly on production in Bulgaria with 1.5 million tons of briquettes produced from the high-sulfur lignite of the Maritsa East field. Briquettes are consumed domestically for household heating. Activities are underway to set environmental criteria for future production.

## ENVIRONMENTAL ISSUES AND STANDARDS

Past disregard for environmental protection under the centrally planned economics of East Central Europe prior to 1989 resulted in very severe pollution of air, soil, and water caused by energy extraction and processing, power generation, district heating, heavy industry, and transportation. Many of these problems are related to the use of fossil and nuclear fuels, particularly coal.

Air pollution is the greatest overall cause of concern in the region, with certain areas representing crisis conditions. Total air emissions are greater in Poland (Table 1, Row N), where nearly half the $SO_2$, a third of the $NO_x$, and a quarter of the particulate emissions result from coal-based power generation. However, sulfur dioxide emissions on either a per capita or per area basis are highest in the Czech and Slovak Republics and lowest in Poland; the regional average annual emission of about 0.1 ton $SO_2$ per person is roughly twice the 1989 level in Western Europe and 50% higher than the 1990 level in the United States. Taking into account transboundary transport of airborne pollutants, the annual average sulfur deposition per unit area is greatest in the Czech and Slovak Republics and in Poland-particularly in the areas of Northern Bohemia and Silesia bordering on the former East Germany. All of the study countries are signators to the United Nations Economic Commission for Europe (UNECE) 1979 framework convention for long-range reduction of transboundary air pollution, and all are members of the related European Monitoring and Evaluation Program, which monitors emissions and transport of sulfur and nitrogen oxide, ammonia, volatile organic compounds, and photochemical oxidants. In addition, East Central European countries have moved toward much stricter source emission standards similar to those in Western Europe in order to form a basis for affiliation with the EC.

Emission standards vary considerably depending on the size of the source and whether the facility is new or existing or burning domestic or imported fuel. The standards given in Table 1 are the lowest published levels found for large coal-fired boilers where some values varied by information source. The East Central European standards for $SO_2$ and $NO_x$ are similar to those of the EC, with the exception of the Bulgarian standards for plants existing before 1992. Particulate standards are less stringent in the East Central European countries, owing perhaps to the high level of ash in many of the coals being burned.

The coal mining and power generation industries are endeavoring to improve their handling of land reclamation after open pit mining, acid mine drainage, and disposal of coal preparation residues, combustion ash, and future FGD by-products. Problems of safety in nuclear power plants are being addressed under IAEA guidance, but problems of interim storage and permanent disposal of nuclear waste remain largely unresolved. In addition, municipalities and heavy industry are beginning to address the many sources of inadequately treated sewage and chemical or heavy metal wastes that are polluting many rivers and some agricultural lands.

The urgent need to remediate environmental problems is having to be balanced with other social and economic goals, including employment, energy supply, and privatization. Somewhat different policies and priorities are being followed in various East Central European countries, but all have adopted the underlying principle that the "polluter pays."

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TABLE 1

Energy and Environmental Summary for Selected Countries of East Central Europe

| | 1 Former Czechoslovakia (unless otherwise noted) | | 2 Poland | 3 Hungary | 4 Bulgaria | Sources |
|---|---|---|---|---|---|---|
| A Country Profiles | Czech Republic | Slovak Republic | | | | 8, 18,39,43,45 |
| • Area. km² | 78.700 | 48,000 | 312,680 | 90,030 | I 10,910 | |
| • Population, million | 10.4 | 5.3 | 38.5 | 10.3 | 8.9 | |
| • Labor Distribution. % | | | | | | |
| - Industry | 38 | 33 | 34 | 30 | 33 | |
| - Agriculture | 8 | 12 | 27 | 16 | 20 | |
| • Annual Per Capita Electrical Generation, kWh | 5160 | 3770 | 3450 | 2800 | 4310 | |
| • Currency | Koruna | Koruna | zloty | Forint | Lev | |
| B Economy | | | | | | |
| • 1991 GDP, US$ | • $44.3 billion. $2823 per capita | | • $54 billion, $1409 per capita | • $23.2 billion, $2208 per capita | • $21.4 billion, S2436 per capita | 3.24,29,42,43 |
| • GDP Trends | • Year-end 1992, Czechoslovakia divided into two countries: industrial Czech Republic and agrarian Slovak Republic; GDP changes in 1993<br>- Czech Republic (+)1 %<br>- Slovak Republic (-)9.3% | | . 1992 GDP growth of 1%, 1993 GDP growth of 4%, largest in region | • 1992 GDP declined 4.4% | • 1992 GDP decline of 5.6%, 1993 GDP decline of 2%<br>• Embargo of Yugoslavia major factor in continued GDP decline | |
| • Foreign Debt/Investment | . Foreign debt $9.3 billion in 1992, $594 per capita | | • Foreign debt $48.1 billion in 1992, $1249 per capita. Debt was reduced to $33.6 billion ($846 per capita) in agreement with Paris and London Clubs in spring 1994 ($25.7 billion to state banks and $7.2 billion to private banks). Half of trade is with EC countries. | • Foreign debt $21.9 billion in 1992, $2121 per capita<br>• 1993, foreign investment totaled $5 billion (over half of the total foreign investment in region) | • Foreign debt $12.1 billion, $1366 per capita | |
| • Inflation | • 11'% in 1992 (Czech 12.5%, Slovak 8.7'%) | | • 3570 in 1993 | • 23% in 1992 | • Nearly 83% in 1992 | |
| • Unemployment | • 3% Czech, 11 .2% Slovak (January 1 993) | | • 15.6% (December 1993) | ' Reached 13.3% in January 1993 | • Nearly 16% in December 1992 | |
| • Industry output | • Industry output - 22% (1991), early 1993 industry output -6.7% for Czech Republic | | • Industrial production growth 7%, investment growth 3% | ' Early 1993, industry output growing at 1.6% | • Early 1993, industrial output continues to decline (- 10.9%) | |
| • Privatization | • Contribution of private sector to GDP in 1992<br>- Czech Republic 20%<br>- Slovak Republic 20'%-21 % | | • In 1993, as a result of privatization program, 50% of GDP, 60% of employment, arsd 33% of productive assets are located in the private sector. | • Contribution of private sector was estimated to range from 25% to 45% of GDP (according to source); bv mid-1993 less than IO% of the state-owned industry had been privatized (main part of assets bought by foreign investors). | • Privatization of large, state-owned enterprises continues. Contribution of private sector to GDP 10% | |

Continued...

# TABLE 1

## Energy and Environmental Summary for Selected Countries of East Central Europe

| | 1 Former Czechoslovakia (unless otherwise noted) | | 2 Poland | 3 Hungary | 4 Bulgaria | Sources |
|---|---|---|---|---|---|---|
| A Country Profiles | Czech Republic | Slovak Republic | | | | 8, 18, 39, 43, 43 |
| • Area, km² | 78,700 | 48,000 | 312,680 | 90,030 | 110,910 | |
| • Population, million | 10.4 | 5.3 | 38.5 | 10.3 | 8.9 | |
| • Labor Distribution. % | | | | | | |
| - Industry | 38 | 33 | 34 | 30 | 33 | |
| - Agriculture | 8 | 12 | 27 | 16 | 20 | |
| • Annual Per Capita Electrical Generation. kWh | 5160 | 3770 | 3450 | 2800 | 4310 | |
| • Currency | Koruna | Koruna | zloty | Forint | Lev | |
| B Economy | | | | | | |
| • 1991 GDP, US$ | • $44.3 billion, $2823 per capita | | • $54 billion, $1409 per capita | • $23.2 billion, $2208 per capita | • $21.4 billion, $2436 per capita | 3,24.29,42,43 |
| • GDP Trends | • Year-d 1992, Czechoslovakia divided into two countries: industrial Czech Republic ard agrarian Slovak Republic; GDP changes in I 993<br>- Czech Republic (+)1%<br>- Slovak Republic (-)9.3% | | • 1992 GDP growth of 1%, 1993 GDP growth of 4%, largest in region | • 1992 GDP declined 4.4% | • 1992 GDP decline of 5.6%, 1993 GDP decline of 2%<br>• Embargo of Yugoslavia major factor in continued GDP decline | |
| • Foreign Debt/Investment | • Foreign debt $9.3 billion in 1992. $594 per capita | | • Foreign debt $48.1 billion in 1992, $1249 per capita. Debt was reduced to $33.6 billion (S846 per capita) in agreement with Paris and London Clubs in spring 1994 ($25.7 billion to atate banks and $7.2 billion to private banks). Half of trade is with EC countries. | • Foreign debt $21.9 billion in 1992, $2121 per capita<br>• 1$93, foreign investment totaled $5 billion (over half of the total foreign investment in region) | . Foreign debt $12.1 billion, $1366 per capita | |
| • Inflation | • 11% in 1992 (Czech 12.5%, Slovak 8.7%) | | • 35% in 1993 | • 23% in 1992 | • Nearly 83% in 1992 | |
| • Unemployment | • 3% Czech, 11.2% Slovak (January 1993) | | • 15.6% (December 1993) | • Reached 13.3% in January 1993 | • Nearly 16% in December 1992 | |
| • industry Output | • Industry output - 22% (1991), early 1993 industry output -6.7% for Czech Republic | | • Industrial production growth 7%, investment growth 3% | • Early 1993, industry output growing at 1.6% | • Early 1993, industrial output continues to decline (- 10.9%) | |
| • Privatization | • Contribution of private sector to GDP in 1992<br>- Czech Republic 20%<br>- Slovak Republic 20%-21 % | | • In 1993, as a result of privatization program, 50% of GDP, 60% of employment, and 33% of productive assets are located in the private sector. | • Contribution of private sector was estimated to range frum 25% to 45% of GDP (according to source); by mid-1993 less than 10% of the state-owned industry had been privatized (main part of assets bought by foreign investors). | • Privatization of large, state-owned enterprises continues. Contribution of private sector to GDP 10%. | |

Continued...

## TABLE 1 (continued)

| | 1 Former Czechoslovakia (unless otherwise noted) | | 2 Poland | | 3 Hungary | | 4 Bulgaria | | Sources |
|---|---|---|---|---|---|---|---|---|---|
| C Primary Energy Supply (1992) | | | | | | | | | 8 |
| • Consumption. exajoules (1 EJ = $10^{18}$ J) | | | | | | | | | |
| - Coal | 1.44 | 54.2% | 3.15 | 78.0% | 0.27 | 24.0% | 0.32 | 33.2% | |
| - Petroleum | 0.48 | 18.1% | 0.56 | 13.8% | 0.31 | 27.6% | 0.28 | 29.3% | |
| - Natural Gas | 0.46 | 17.3% | 0.33 | 8.2% | 0.37 | 32.7% | 0.19 | 20.1 % | |
| - Nuclear | 0.26 | 9.8% | 0 | 0% | 0.15 | 13.3% | 0.14 | 15.2% | |
| - Hydropower | 0.01 | 0.4% | 0.01 | 0.3% | 0.00 | 0.1% | 0.01 | 1.5% | |
| - Electricity, net import/(-)export | 0.01 | 0.2% | -0.01 | -0.2% | 0.03 | 2.4% | 0.01 | 0.8% | |
| Total | 2.66 | | 4.04 | | 1.13 | | 0.95 | | |
| • 1991 Energy Intensity. toe/$k of GDP (calculated in 1987 US$) | 1.43 | | 1.78 | | 1.16 | | 1.06 | | 21 |
| • 1991 Energy Use Per Capita, toe/person | 4.05 | | 2.51 | | 2.56 | | 2.58 | | |
| D Energy Trends | | | | | | | | | |
| • General | • Energy prices raised to market levels<br>• The diversification of crude oil and natural gas and the strengthening of the strategic role of the *two* republics in European energy are of principal importance<br>- Increase the use of Adria pipeline up to 4.5 Mt/year<br>- Trans-Alpine oil pipeline from Inglostadt to Kralupy (15 Mt/year)<br>- Schwechat-Bratislava oil pipeline (2-3 Mt/year)<br>- Construction of new bunkers (0.6 Mt) and creation of a strategic crude oil reserve<br>- Increase capacities of underground gas storage<br>- The import of Iranian and Algerian natural gas through a new pipeline is considered | | • The primary energy balance reshaping:<br>Elimination of coal monoculture by increasing the share of gas and oil.<br>Contract for construction of a gas pipeline to western Europe through Poland was signed with Russia in 1993.<br>• Energy price adjustment<br>• Increasing energy production and consumption efficiency | | • The elimination of one-sided energy import dependence by import source diversification<br>• The improvement of energy efficiency<br>- Encouraging energy conservation<br>- Restructuring of production<br>• Establishment of market conditions in energy supply<br>- Development of liberalized pricing policy reflecting international value<br>• Public participation in decisions concerning the impact of energy development on whole society | | • The reorganization of energy sector by establishing the operating entities as joint stock or limited liability companies, with the government as the sole shareholder<br>• *Price reform*<br>- Petroleum and gas prices are linked to world market<br>- Prices of heat and coal are increased significantly | | D1: 2, 17, 24, 32, 46<br>D2: 26<br>D3: 17<br>D4: 5, 6, 16, 25, 28,30.42, 43.44,45 |

Continued...

TABLE 1 (continued)

| | 1<br>Former Czechoslovakia<br>(unless otherwise noted) | 2<br>Poland | 3<br>Hungary | 4<br>Bulgaria | sources |
|---|---|---|---|---|---|
| • Electrical supply | • Power generation in the nuclear plants is acceptable:<br>- Completion of nuclear plant at Temelin<br>- Necessity to establish definitive underground storage for highly radioactive waste and/or for the burnt-out fuel<br><br>. Coal-based generation of electricity in northwest Bohemia will be gradually decreased, and desulfurization and denitrification equipment will be installed in those coal-tired plants that remain in long-term operation.<br><br>• Thermal plants not meeting limits of 1991 Czech Clean Air Act by 1998 will be taken out of operation. | • Rehabilitating and retrofitting of existing power stations (4 GW up to year 2000 and 8.5 GW in the period 2001-2010)<br><br>• Tfre completion of projects in progress<br>- Opole Power Plant utilizing hard coal (2600 MW) equipped with FGD<br>- Hydro pumping storage plant (750 MW)<br><br>• Improvement of the transmission system<br><br>• Interconnection to West European UCPTE system no later than 1597<br><br>• Restructuring and privatization of Electricity System<br>- Polish Power Grid Cmnpany is the sole transmission company.<br>- Main thermal plants will bc organized in aeven major joint stock companies.<br>- Central heat and power plants will operate as 15 independent joint stock companies.<br>- All pumped storage power plants, aa the only source of peaking power, will be organized within a single stock company.<br><br>• A role for nuclear power is foreseen in *e next 15-20 years. | • Expected interconnection to UCPTE in 1997-1598<br><br>• Construction of gas-fired combined cycle plants for peak demands at Kelenfod and Dunameti; utilization of gas substituted for imported low-sulfur oil at existing dual-tired plants.<br><br>• Construction of 4-bcum per year pipeline link to the West through Austria<br><br>• After year 2000, new power plants will be needed; nuclear or hard coal power plants are considered. | • Reduction of imported fossil fuels and improved utilization of nuclear capacity<br><br>• Resolving safety concerns at Kozloduy nuclear power plant<br><br>• Upgrading of coal-tired plant to improve efficiency. availability, and emissions control | |
| E Environmental Priorities | • Air, water, and soil pollution in Northern Bohemia from mining, industry, coal-fired power production.<br><br>. Air pollution abatement is the higheat priority.<br><br>• Reclamation of coal and uranium mines | • Dispersed-source air emissions in upper Skis<br><br>• Krak6w region restoration program<br><br>. Transboundary $SO_2$ emissions<br><br>• Surface water pollution from saline mining waters in South | • $SO_2$ and particulate emissions from coal-fired electrical generation<br><br>• $NO_x$ and hydrocarbon emissions, particularly from vehicles<br><br>• Permanent and interim nuclear fuel disposal site areas | • Serious environmental problems in "hot spot" areas (12% of total arcs)<br><br>• Air pollution<br>- $SO_2$ and particulate emissions<br><br>• Land pollution<br>- Heavy metals contamination<br>- Salinity and landfill problems | E1: 2.24,32<br>E2: 26<br>E3: 17.22<br>E4: 13, 16,45 |

Continued...

TABLE 1 (continued)

| | 1<br>Former Czechoslovakia<br>(unless otherwise noted) | 2<br>Poland | 3<br>Hungary | 4<br>Bulgaria | Sources |
|---|---|---|---|---|---|
| | • High contribution to transboundary pollution in Europe<br><br>• Storage capacity for spent nuclear fuel | . Effective management of coal conversion wastes through improved disposal and increased utilization | | • Water pollution<br>- Steady contamination stream<br>- Inadequate sewage systems | |
| F Coal | | | | | F1: 17,46<br>F2: 26<br>F3: 17, 18<br>F4: 1,5,6,7,8, 14, 16,44. 45 |
| • % of energy supply/uses | • 52% (1990-1991)<br><br>• 50% (1992) (21 % from high-rank coal [HRC], 33'% from low-rank coal [LRC] in 1991) | • 78% (1990-1991)<br><br>• 76% (1992) highest in Europe | • 24.0% (1990-1991)<br><br>• 19% (1992), lowest in region | • 33% (1990-1991)<br><br>• 38% (1992) (32% from LRC)<br><br>. Two-thirds for heat and power, one-quarter for industry, remainder for household | |
| • Consumption | • 102 Mt (1992) down from 143 Mt in 1984 | • 227 Mt (1992) down from 294 Mt in 1988 | • 17 Mt (1992), down frmn 28 Mt in early 1980s | • 39 Mt (1992), level since early 1980s | |
| • Goals/special needs/trends | • Reduce coal use 44% (particularly low quality brown coal) by 2000. substitute nuclear energy and natural gas<br><br>• Possibilities of delivery of coal by Danube-Main-Rhine Canal<br><br>• Reserves in developed deposits. at present production rate, are about 80 years for hard coal and 40 years for brown coal. | • Reduce rhe high level of dependence on coal and diversify energy base<br><br>• HRC, a valuable source of foreign currency, is produced mainly from underground mines; production is down by one-quarter from 1980 to 1990 because of cost/price squeeze: objectives are to close the 10% of the mining capacity with the highest costs while retaining flexibility to boost production for export, to use coal in short term for barter, and to reform costly regulations (example requiring that all seams greater than 0.8 m in thickness be mined). Production projected to be 140 Mt/yr next 20 years. After year 2000, export of 11 Mt is planned, and the import of 5-10 Mt of steam coal is under consideration to supply energy to the Baltic coast region.<br><br>• LRC production has doubled since 1980 and is projected to remain level to 2010. | • All of Hungary's coal mining and preparation capacities are divided between eight regionally based companies: Mecsek, Vesprem, Orsolany, Tatabanya, Dorog, Nograd, Borsad, and Matraalja.<br><br>• HRC mining is uneconomical because the coal has a low calorific value, deep mining conditions are generally unfavorable, and productivity is low (average output from deep mines 1.54 t per shift, per worker). In September 1990, the Coal Mining Restructuring Center was established to reorganize companies to work toward financial viability. | • Underground HRC mines have unfavorable geology with high mining costs; policy is to reduce noneconomic production of bituminous and subbituminous coals depending on social needs.<br><br>• Lignite surface mines are economical; production increase of 20% is possible without major investment, and policy is to increase production. | |
| • High-rank coal (HRC)<br>- Total recoverable reserves/annual production | 3330 Mt — 25.7 Mt (1987) | 45.040 Mt — 193 Mt (1987) | 100 Mt — 2.1 Mt (1989) | 30 Mt — 0.4 Mt (1988) | 5.38 |

Continued...

TABLE 1 (continued)

| | 1<br>Former Czechoslovakia<br>(unless otherwise noted) | 2<br>Poland | 3<br>Hungary | 4<br>Bulgaria | sources |
|---|---|---|---|---|---|
| - Main coal basin | Ostrava-Karvina field. southern extension of Upper Silesian Basin | Upper Silesia Coal Basin | Mecsek field, southwestern Hungary | HRC fields include the Balkan Basin, east central Bulgaria, and Dubrudza field in easternmost Bulgaria. | |
| - Recoverable reserves/amrual production | 22.6 Mt (1988) | 39.900 Mt 188.5 (1988) | 100 Mt 2.1 Mt (1989) | | |
| - Proximate analysis | | | Variable, weakly caking bituminous coal with high ash and sulfur; only domestic source of coking coal: deposits are steeply dipping and heavily disturbed; energy content variable 13.2-14.9 | | |
| Ash. wt% dry | 15.1 | 11.05-16.21 | | | |
| Sulfur, wt% dry | 0.6 | 0.86-1.99 | | | |
| Moisture, wt% as mined | 3.0 | | | | |
| Heating value, (MJ/kg) | 25.5 | 28.70-32.10 | | | |
| | | • Other important HRC deposits and their 1988 production include the Lower Silesia Coal Basin (2.4 Mt) and Lublin Coal Basin (0.7 Mt). | | | |
| . Low-rank coal (LRC) | | | | | |
| - Recoverable reserves/annual production | 8850 Mt 101 Mt (1987) (90% surface mined) | 1I ,700 Mt (all surface minable) 73.2 Mt (1987) | 3650 Mt (all surface minable) 18 Mt (1989) | 3700 Mt (65% surface minable) 35.3 Mt (1988) | 5,6 |
| - Main LRC regions | • Most brown coalfield in North Bohemia, Czech Republic | • Belchatòw field. central Poland | • Matraalja lignite field, northwest Hungary | • Maritsa East, south central Bulgaria | |
| - Recoverable reserves/amual production | 5135 Mt 74.1 (1987) | | 2863 Mt 5.3 Mt (1989) | 2110 Mt 27 Mt (1987) | |
| - Proximate analysis | | | | | |
| Ash, wt% dry | 26.0-44 | 37.0-40 | 39.5 | 30.1-45 | |
| Sulfur, wt% dry | 0.5-3 | 0.8-3 | 0.8 | 2.8-4.1 | |
| Moisture, wt% as mined | 30 average | 18-45 | 45.3 | 49-57 | |
| Heating value, MJ/kg | 9.0-18.6 | 6.7-15 | 6.7 | 5.5-6.7 | |
| | • 1 seam, 40-150 m deep and 20 m thick, nearby Solokov brown coalfield haa a capacity of 18 Mt/year. | • Belchatòw mine among largest in the world, single seam, 50-70 m thick, shallow and free Of disturbance, design capacity 40-50 Mt/yr; nearby Konin field has a single seam 6-20 m in thickness.<br>• Bucket-wheel excavators with overburden to coal ratios of41. | • 2 mines, 6 seams 4-14 m thick, bucket-wheel excavators for overburden removal, seam removal by power shovel or bucket-wheel excavator | ● 3aearna, rnainaeam 3-25 min thickness, overburden 30-110 m, high water content arrd variable ash content, among the lowest grade coals in use in the world | |
| G Petroleum | | | | | 8, 18,32,43,44, 45,46 |
| • % of energy supply/uses | • 18.1% (1990-1991) | • 13.8% (1990-1991) | . 27.6% (1990-1991) | • 29.3% (1990-1991) | |
| | • 17% (1992) | • 12% (1992) lowest in Europe, down from peak of nearly 16% in | • 28% (1992) | • 19% (1992) | |

Continued...

# TABLE 1 (continued)

| | 1<br>Former Czechoslovakia<br>(unless otherwise noted) | 2<br>Poland | 3<br>Hungary | 4<br>Bulgaria | sources |
|---|---|---|---|---|---|
| • Consumption | • 1992 consumption of 206 kbd (232 kbd in 1991) down from the peak of 320 in 1987 | • 1992 consumption of 227 kbd (275 kbd in 1991) down from pesk of 350 kbd in 1988 | • 1992 consumption 140 kbd (23 % domestic production) down from 161 kbd in 1991 snd a peak of 227 kbd in 1985 | • 1992 consumption 72 kbd. down from 118 kbd in 1991 and peak levels of 275-295 kbd in the mid-1980s | 8 |
| • Goals/special needs/trends | • Policy to diversify foreign supply<br><br>• Per capita oil use lower than found in OECD because of fewer automobiles per capita snd dominance of coal for hesting | • Policy to diversify foreign supply. develop domestic resources (by licensing foreign companies to explore new deposits), expand, upgrade, and privatize supply and distribution infrastructure<br><br>• Share of motor gasoline is increasing in product refining, 9.5 persons/passenger car vs. 1.7 in U. S.. but number of autos is growing: increased demand (up 75% by 2010) projected for transportation and secondarily for industry (not for domestic heating) | • Policy to diversify foreign supply, develop domestic supply, snd upgrade infrastructure and distribution<br><br>• 5.9 persons/passenger car (1989) vs. 1.7 for U.S. | • Policy to diversify foreign supply, develop domestic supply, and upgrade infrastructure snd distribution<br><br>• Foreign companies squiring arrd exploring onshore srsd offshore blocks<br><br>• Provide licensing for foreign involvement in exploration production, refining, and distribution | G1: 24<br>G2: 26<br>G3: 22<br>G4: 45 |
| • Proved reserves/production | 15 Mb year-end 1993, down from around 20 Mb in the mid-1980s<br><br>2 kbd in 1993<br>400 producing wells<br>5 bd per well | 36.8 Mb year-end 1993, down from 45.9 Mb year-end 1991<br><br>1993 production 3.4 kbd (about 1.2 Mb/yr) down 5.6% since 1992; production flat since decline in early 1980s (1981 production of 2.3 Mb/yr)<br>2302 pmrfucing wells<br>1.5 bd per well<br>Production since the mid-1800s, but industry remains underdeveloped | 139 Mb yew-end 1993<br><br>1993 production 31.7 kbd (1 1.6 Mb/yr) down 5% from 1992, 1991 production 15.6 Mb<br>1776 producing wells<br>17.8 bd pcr well<br>4 rigs active | 15 Mb year-end 1993<br><br>1993 production 1.0 kbd (0.365 Mb/yr) down from 0.423 Mb/yr in 1991<br>100 producing wells<br>10 bd per well | 12,36 |
| • Sources of supply | • 99% imported<br><br>• CIS will supply 6 Mt oil to Czech Republic in ncsr term in response to Czech purchases of North Ses natural gas from Western Europe (spring 1994).<br><br>• Adria pipeline supply lost due to unrest in Yugoslavia. | • 98.5% imported<br><br>• In 1990. CIS suoç.lied 89% of petroleum by pipeline; by 1S93, imports diversified, the Middle East is now key source.<br><br>• 40% supply through port of Gdansk and by pipeline south.<br><br>• Important domestic sources cited for 1992 include Nosowka field (discovered in 1988) with two wells | • In 1993, 77% imported, 23% domestic<br><br>• One-half domestic production (1 2'% supply), one-third cumulative production, and two-fifths producing wells from Algyo field (discovered in 1965) in the southeast near Szeged | • 99% imported | G2: 35,36 |

Continued...

# TABLE 1 (continued)

| | 1<br>Former Czechoslovakia | 2<br>and | 3 | 4 | Sou |
|---|---|---|---|---|---|
| | | producing 334 bd and Wysoka-Kanienska field (discovered in 1979) with four wells and 292 bd production. | | | |
| • Infrastructure/facilities/distribution | • 1990 refinery capacity (crude) 455 kbd (22.7 Mt/y)<br>• 6 refineries: Bratislava (162 kbd crude), Kilin, Kralupy, Pardubice, Strazke, Zaluzi, Zyolen; Kralupy refinery is undergoing expansion and upgrading (spring 1994). | • 1990 refinery capacity 385 kbd (19.2 Mt/y) of crude<br>• 9 refineries: major refineries include Plock (252.4 kbd crude, catalytic cracking 48.7 kbcd, catalytic reforming 31.2 kbcd; catalytic reforming construction spring 1994) and Gdansk (60 kb/d crude; hydrotreater expansion and catalytic reformer construction spring 1994); minor facilities include Czechowice, Glinik Mariampolski, Jasto, Jealicze, Kralaty, L. Warynski, Trzebinia, Plock (remaining 73 kbd crude capacity).<br>• Gdansk facilities changed from export to port of entry and Gdansk/Plock pipeline refitted to move product south into heartland; additional 40 Mb/yr=6 Mt/yr refinery required in the south and additional oil and product pipelines required.<br>• Distribution network for lubricants and vehicle fuels expanding with greater privatization in the distribution sector. | • 1990 refinery capacity 220 kbd (11 Mt/y)<br>• 3 refineries: Szazhalombatta (150 kbd crude, 20 kbcd catalytic cracking, 23 kbcd catalytic reforming; undergoing construction for MTBE unit spring 1994), Leninvaros (60 kbd crude), Zalaegerszeg (10 kbd crude) | • Refining capacity 300 kbd crude<br>• 3 refineries: Burgas (240 kbd crude), Pleven, Ruse | 34, 37 |
| ⋊ Natural Gas | | | | | 8, 18, 32, 43, 44, 45, 46 |
| • % of energy supply/uses | • 17.3% (1990–1991)<br>• 19% (1992) | • 8.2% (1990–1991)<br>10% (1992) | • 32.7% (1990–1991)<br>• 36% (1992) | • 20.1% (1990–1991)<br>• 25% (1992) | |
| • Consumption (dry natural gas)<br>(bcum = $10^9$ m$^3$)<br>(bcuft = $10^9$ ft$^3$) | • In 1992, consumption 13.7 bcum (463 bcuft), down from peak of 15.0 bcum (530 bcuft) in 1990 | In 1992, consumption 10.3 bcum (363 bcuft, domestic) down from peak of 13.2 bcum (465 bcuft) in 1989 | • 1992 consumption 9.7 bcum (342 bcuft) down from peak of 12.1 bcum (428 bcuft) in 1989 | • 1992 consumption 5.6 bcum (198 bcuft) down from a peak of 6.8 bcum (241 bcuft) in 1990 | 8 |
| • Goal/special needs/trend | • Diversify foreign supply, develop domestic supply, upgrade, expand, and privatize infrastructure<br>• Projected to import 21 bcum of gas | 40% residential; growth projected at 4%/yr through 2010; policy to diversify foreign supply, develop domestic supply, upgrade, expand, truc | • Diversify foreign supply, develop domestic supply, upgrade, expand, and privatize infrastructure | • Diversify foreign supply, develop domestic supply, upgrade, expand, and privatize infrastructure | |

Continued...

TABLE 1 (continued)

| | 1<br>Former Czechoslovakia<br>(unless otherwise noted) | 2<br>Poland | 3<br>Hungary | 4<br>Bulgaria | Sources |
|---|---|---|---|---|---|
| • **Reserves/production** | 14 **bcum**<br><br>6% Mcum (1990) fields at capacity | 1300 **tcum** coal bed methane resource<br><br>Domestic production 4 bcum (142 **bcuft)**, 7.9 **bcum** in 1978 | Remaining reserves **123** bcum (4349 **bcuft)**, estimated additional reserves 223 **bcum**, **175** bcum recoverable<br><br>1992 production 2.46 **bcum** (170 **bcuft) down** from 4.8 bcum in 1985 | | **H1**: 25<br>H2: **27**<br>H3: 23 |
| • **Sources** of **supply/ infrastructure/faci lities/distribution** | • About 93'% of gas supplies are imported through Brotherhood and **Transgas** pipelines from FSU, **approx.** 3% are domestic conventional production, **remainder** are manufactured gas.<br><br>• **1/93** agreement for 8 **bcum/yr CIS** gas pipeline across Czech Republic to **Stegal-Midal** pipeline in Germany; 2/94 FSU will supply 7 bcum (245 **bcuft)** to Czech Republic in **response** to competition from Western European suppliers. Increasing supply through **Transgas** pipeline system, 71% in 1991.<br><br>• **Underground** storage capacity of 3 bcum | • 1991 impmts of 7.3 bcum (258 **Bcuft) from** FSU<br>- **CIS-Western** Europe **101-cm** pipeline<br>- **Construction** underway on **Yamal CIS-Western** Europe pipeline via **Poland;** Polish purchase rights to 0.4 bcum (14 **bcuft/yr**, 3.5% 1992 **consumption)** of 1.9 bcum (67 **bcuft/yr) shipments**<br><br>• Other potential foreign sources include North Sea gas via Germany or under **the** Baltic, as well as Algerian gas via Italy and Yugoslavia.<br><br>• Coke plants produced 6.5 bcum coke **oven** gas in 1988 for domestic | • **In** I 993, gas-processing capacity **stood** at 947 **Mcuft/d** and throughput at 520 **Mcuft/d (down** from 1078 Mcf capacity and 684 **Mcf throughput** in 1989). Major processing plants include the **Szeged** plant at **Csongrad** (318 **Mcuft/d** capacity, 254 **Mcuft/d** throughput), **Ulles** plant at **Csongrad** (160 **Mcuft/d** capacity, 70.5 throughput), **Hajduszoboszlo** plant at **Hajdu-Bihar** (155 **Mcuft/d** capacity, 70.6 throughput) and the **Endrod** plant at **Bekes** (134 **Mcuft/d** capacity. 70.6 throughput). Minor plants include **Babosca, Barcs, Berekfurdo, Demjen, Heves Ebes, Kiskunhalas, Szank**, and **Tazlar**. | | Hl: 15<br>H2: 38<br>36<br><br>3,38.42,43 |
| • % of **energy** supply | • 9.8% (1990-1991) | • **None** is consumed **within Poland**. However, **Poland** participated in **construction** of nuclear power station in former Soviet **Union;** Poland now **imports** electric power from **this** source. | • 13.3% (1990-1991) | 15.2% (19$9-1991) | HI: 43<br>H3: 33<br>11: 12<br>13: 17<br>14: 13<br>9.43 |
| • Fuel **source/production** | • **Yellowcake** from domestic deposits enriched in the former Soviet Union<br><br>• Classical mining and milling technology as well as in situ acid **leaching,** foreign suppliers **under** | | • **Yellowcake** from domestic deposits . enriched in the fomter Soviet Union<br><br>• The Mccack uranium mirrc is noneconomical. | **Six** underground mines and 11 in situ leaching operations **Yellowcake** from domestic deposits was sold to the **former** Soviet Union until 1990. Operations are noncompetitive, **and** mine closings began in 1991. | |

Continued...

TABLE 1 (continued)

| | 1 Former Czechoslovakia (unless otherwise noted) | 2 Poland | 3 Hungary | 4 Bulgaria | sources |
|---|---|---|---|---|---|
| • Nuclear waste management | • Previously spent fuel rods and radioactive wastes were sent to former Soviet Union; now temporary domestic storage is used. | | | | |
| J Electricity | | | | | |
| • Consumption | • 73.6 TWh (1992), down 9% from a peak of 81.1 TWh in 1989 | • 113.6 TWh (1992), down 15% frmn a peak of 134.3 TWh in 1989 | • 34.8 TWh (1992), down 15% from speak of41 TWh in 1989 | • 38.2 TWh (1992), down 22% from a peak of 49.2 TWh in 1988 | J1: 17, 41, 43, 46<br>J2: 8,26<br>J3: 17.18<br>J4: 1, 13,43,45 8,9, 11,27, 43.44 |

| • Generating capacity (GW, %) | Czech Republic | | Slovak Republic | | Poland | | Hungary | | Bulgaria | |
|---|---|---|---|---|---|---|---|---|---|---|
| Coal | 10. I7 | 77% | 1.21 | 22% | 29.54 | 92% | 2.01 | 29% | 4.91 | 44% |
| Oil and gas | | | 0.75 | 14% | 0.42 | 2% | 3.06 | 44% | 0.45 | 4% |
| Nuclear | 1.76 | 13% | 1.76 | 33% | | | 1.76 | 26% | 3.76 | 34’% |
| *Hydropower* | 1.36 | 10% | 1.65 | 31% | 2.05 | 6% | 0.05 | 1% | 1.97 | 18% |
| Total | 13.29 | | 5.40 | | 32.00 | | 6.88 | | 11.09 | |

| • Annual electric prediction (TWh, %) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1991 | | | | 1992 | | 1991 | | 1990 | |
| Coal | 40.4 | 75% | 4.2 | 21% | 129.2 | 97.3 % | 8.2 | 28% | 20.3 | 53% |
| 011 and gas | | | (eat.) | 12% | o | | 6.6 | 23% | 1.5 | 4% |
| Nuclear | 12.1 | 23% | 2.4 | 59% | | | 13.8 | 48% | 14.7 | 38% |
| Hydropower | 1.2 | 2% | (est.) | 8% | 3.6 | 2.7% | 0.2 | 0.7% | 1.9 | 5% |
| Total | 53.7 | | 11.7 | | 132.8 | | 28.8 | | 38.4 | |
| | | | 1.7 | | | | | | | |
| | | | 20.0 | | | | | | | |

| | 1 Former Czechoslovakia | 2 Poland | 3 Hungary | 4 Bulgaria | sources |
|---|---|---|---|---|---|
| • Imports (TWh) | • No information | • 5.0 | • 7.5 (net) | • 2.7 (from Ukraine) | |
| • Transmission | • 220 kV and 440 kV grids owned separately by CEZ and SEP; district companies operate lines <220 kV. | • Major lines 400 kV and 220 kV, 750 kV to former USSR | • Grid system with 750 kV, 440 kV, and 220 kV lines, connections with Serbia, Rorrrania, and Slovak Republic (440 kV) and with the former USSR (440 kV and 750 kV) | • Grid system with 440 kV and 220 kV lines. Major connections with Romania and Turkey (440 kV) and (Ukraine 750 kV). | |
| • Goals/special needs/trends | • Electrical generation is thermal (coal) dominated; increased coal use is opposed on the domestic front because of concerns for land and air quality, while nuclear development is opposed by neighboring nations. World Bank study in favor of upgrading existing thermal plants and transmission infrastructure instead of nuclear. Czech consumption is projected to | • Completely dominated by thermal (coal) generation. Nuclear imports amount to 1%, and there are no immediate plans to initiate nuclear plants. | • Electrical sector divided between thermal and nuclear; electrical need projected to increase to 52 TWh in year 2010 (Hungarian Electricity Board “realistic” scenario); nuclear and coal optiona are under consideration nuclear capacity could double in the near term (two 1.O-GW plants). | • Domestic sector domimted by thermal (coal) with significant nuclear and hydro components; coal-baaed generation is expected to increase modestly while nuclear will remain level to 2010. Kozloduy reactor units 1-4 are designated the most deficient in region by IAEA (1991), but remain in *operation* due to lack of available replacement capacity. | |

Continued...

# TABLE 1 (continued)

| | 1<br>Former Czechoslovakia<br>(unless otherwise noted) | 2<br>Poland | 3<br>Hungary | 4<br>Bulgaria | Sources |
|---|---|---|---|---|---|
| | nuclear consumption has quadrupled since 1982. 12% (1992): nuclear expected to increase to 5.8 GW from 3.3 GW(1991) by year 2010 as a replacement for coal-based electrical energy. Tremelin (2000 M W) nuclear station was approved in March 1993 with Westinghouse (not CIS) supplying control technologies and fuel ($320 million). | • Growth in energy demands arc foreseen by 20Mt (up to 200 TWh).<br>• Current trends<br>- Old plant modernization with regard to environmental protection<br>- Increased peaking capacity<br>- Grid modernization to improve transmission and distribution<br>- Power plant life extension | • Mid-term project of gas-fired combined cycle unit for peaking in Kalendolf<br>• World Bank loans $250 million to eliminate subsidies to energy and price controls for electricity. | • Power plants can provide only a maximum of 7.2 GW due to low availability of thermal and nuclear plants. coal production constraints, and irregular coal import from the Ukraine.<br>• In 1993, EBRD approved 250 million ECU gram to upgrade Kozloduy plant. | |
| • Actions/needs | • SEP is constructing second nuclear plant in Mochovice (880 MW by 1995 and 880 MW by 1997).<br>• The strengthening of interconnections with neighboring countries is important to SEP in order to enhance the trade of electricity.<br>• Surplus generating capacity of about 30% will delay new plant construction. Retrofitting of coal-tired plants for SO, and NO, control is under way. Future plants will be either gas-fired combined cycle, lignite-fired AFBC, PFBC or IGCC, or nuclear. | . Upgrade coal-tired plants to meet emission standards by 1998, improve plant efficiency and availability | • Implement demand-side management; retrofit or repower old coal-tired unita with FGD or AFBC: install gas-tired combined cycle peaking capacity; plan for a new baseload power station of 2000 MW based on hard coal, lignite, or nuclear power by the year 2000. | • Eliminate high cost ($0.05 kWh) imports from CIS and obtain peaking power from Turkey; complete 2x216-M W hydro units at Chaira; decommission nuclear units #1 and #2 at Kozloduy but refit units #3 and #4, upgrade safety on all 2880-M W nuclear slated for continued operation; rehabilitate coal-fired plants for life extension, emissions control, and fuel switching | |
| K Coal-Fired Power Plants | | | | | |
| • Actions/needs | • Slovakia<br>- Retrofit power plant complexes in Vojany, Novaky, and Kosice (FGD, fluidized-bed boilers, turbogenerators and de-NO, | • Modernization is needed in order to improve reliability and reduce emissions.<br>• By 2000 4 GW should be modernized, by 2010 next 8.6 GW. | • Comprehensive program of coal-fired power station rehabilitation (10 stations with 59 units), date of completion 1992. | • A study of thermal power plant rehabilitation was conducted in 1993 under USTDA sponsorship addressing 2950 M W of coal-fired capacity. High priorities were given to the following: | K1: 17,41,46<br>K2: 26<br>K3: 18<br>K4: 1, 14, 16,45 5,6,43 |

Continued...

TABLE 1 (continued)

| | 1 Former Czechoslovakia (unless otherwise noted) | | | 2 Poland | | | 3 Hungary | | | 4 Bulgaria | | | sources |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | • By 2000 a new coal-fired plain in Opole (2160 MW)<br>• 750-M W storage pump unit under construction | | | | | | - Unit reliability<br>- A cogeneration CFB boiler to supply steam for briquetting<br>- Sulfur control by advanced wet FGD or spray drier methods<br>- Particulate control enhancements<br>- Fuel switching to higher quality imported U.S. or Indonesian coals<br>Study implementation may be affected by decommissioning of the Kozloduy nuclear units (3760 MW). | | | |
| • Average age/general condition | | | | . Most units >20 years old (average 22 years)<br>• Generally no desulfurization units and $NO_x$ control | | | • Most units > 25 years old | | | • Over 60% of major equipment has been operated for more than 20 years, decommissioning or life extension necessary. | | | |
| L District Heat (DH) and Combined Heat and Power (CHP) | DH | CHP | | DH | CHP | | DH | CHP | | DH | CHP | | 24 |
| • Fuels (1991, thousand toe) | | | | | | | | | | | | | |
| - Coal | 7951 | - | | %75 | 34385 | | 338 | 602 | | 29 | 1171 | | |
| - Petroleum products | 2507 | - | | 381 | 179 | | 773 | 274 | | 1457 | 259 | | |
| - Gas | 2543 | - | | 334 | 6 | | 2223 | 873 | | 254 | 950 | | |
| Total fuel | 13,001 | - | 13,001 | 10,390 | 34,570 | 44,960 | 3334 | 1749 | 5083 | 1740 | 2380 | 4120 | |
| • **Goals/trends** | . In 1992, heat and CHP plants were separated from Czech Power Works, and privatized companies were created. District heating requires 3.5 % of total natural gas (O. I % in OECD Europe). In 1992, coal was used to heat 35% of all dwellings due to its low price:. 30% potential savings are identified in heat-only stations. heat transport and distribution by concentrating on cogeneration and reducing heat losses (15'%- 18% losses due to old piping network, high fluid temperature, and poor metering). | | | • 70'% of dwellings in urban areas are supplied with heat and 50% with hot water; 45% of this energy is supplied by cogeneration in the power industry (this trend is assumed to continue); remaining heat is from industry surplus or heating plants. Some cogeneration plants are producing only heat due to low power demand.<br>• District heating plants will continue to rely on coal except in central urban areas where natural gas will be used due to environmental concerns.<br>• Major problems are severe pollution (from smaller plants particularly), heat loses due to radiation and leakage, and improper mete | | | • 635 ,000 apartments out of 3.9 million are supplied by 59 district heating companies; 170.OCQ apartments have central heating. Several DH companies have serious debt due to unpaid bills. Heat is generated in DH plants or purchased from CHP plants.<br>• Most district-heated apartments have no metering or heat control.<br>• Transmission losses assessed to range between 30% -10%.<br>• Since 1992, prices have been controlled by municipalities. | | | • Three district heating plants require either life extension or conversion to natural gas; conversions are not foreseen in near term. | | | L1: 25<br>L2: 27<br>L3: 23<br>L4: 45 |

Continued...

TABLE 1 (continued)

| | 1<br>Former Czechoslovakia<br>(unless otherwise noted) | 2<br>Poland | 3<br>Hungary | 4<br>Bulgaria | Sources |
|---|---|---|---|---|---|
| | • U.S. Trade Development Program granted $1.5 million for power plant rehabilitation. | . World Bank loans<br>- $250 million ($60 million from EBDR) partially for DH upgrade. April 1990<br>-$340 million ($50 million from EBRD) partially for modernization of DH, 1991<br>-$120 million to promote privatization of Kraków-Łęg Heat and Power Plant (1400 MW of thermal capacity)<br>- $26 million for conversion of two coal-fired boilers in Krak6w to natural gSS | • EIB energy project: combined cycle gas turbine (district heating), $35 million of ECU<br>• World Bank loans for energy/environment, $125 million reconstruction and conversion of several gas-tired power stations to combined cycle cog-ration | | |
| • Actions/needs | • Assessment to determine which units could be converted into CHP, rebuilt, or reconstructed (to reduce energy demand by 30%).<br>. Elimination of all subsidies (direct. indirect, and cross-subsidies) | • Elimination of energy subsidies and price liberalization (households paid less than industrial users for gas, electric, and district heating and hot water)<br>• Reorganization of heat generation companies, commercialization of gas and heat distributors<br>• Switch from coal stove heating to gas heating for individual households | . Several thermal power plants have beers upgraded by installation of gas turbine CHP units (700 MW of additional electric capacity): Dunamenti, Kelenfold, Ujpest, Debrecen, and Kispest.<br>. Capital investments in DH networks and heat plants<br>. Modification of fees structure | USTDA $650,000 grant to evaluate district heating plants in Sofia, Kostov, and Pernik. | |
| M Briquettes | | | | | MI: 29 |
| • Production/consumption | • 1993 production of 650,000 tons from pulverized lignite, 50,000 tons exported to Slovakia. | . No current production<br>• Potential production 2.4 Mt with 0.4 Mt for export<br>• In the second part of 1994, Blachownia will start production of briquettes (assumed output 200,000 tons per year). | | • 1.5 Mt of Maritsa East lignite is used to make briquettes.<br>• Consumed domestically for heating | M2: 40<br>M4: 4 |
| • Goals/issues/trends | | • Demonstration plant of smokeless fuel in Institute for Chemical Processing of Coal (Zabrze) | | • Recommendation to modernize the briquetting processor switch to low-sulfur coal<br>- Major source of urban particulate and $SO_x$ emissions<br>- Attempts to remove sulfur have been unsuccessful | |
| N Environmental Issues | | | | | |
| • Emission (thousands of tons) | | | | | |

Continued...

## TABLE 1 (continued)

| | 1 Former Czechoslovakia (unless otherwise noted) | | 2 Poland | | 3 Hungary | | 4 Bulgaria | | sources |
|---|---|---|---|---|---|---|---|---|---|
| $SO_2$ | (1989) | 2814 | (1989) | 2.7643 | | 1164 | (1990) | 1030 | Nl: 25 |
| $NO_2$ | | 675 | | 600 | | 264 | | 150 | N2: 27 |
| CO | | | (1990) | 2524 | | | | 1050 | N3: 23,-- |
| $CO_2$ | | 221375 | | 383000 | | 87800 | | | N4: – |
| Particulate | | 1484 | | 1420-1930 | (1990) | - | | 808 | |
| Organic | | | (1991) | 1231 | | 200 | | | |
| | | | | | | | | | 2,5,6, 19,2120, 26,31,32 |

- Lowest published emission standards for large coal-fired boilers[1]
  Units: mg/m³ / g/GJ / lb/MBtu

| | Former Czechoslovakia | | | Poland | | | Hungary | | | Bulgaria | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | New and existing | | | New and existing after 1997 | | | | | | Coal source | New units | Existing before 1992 |
| $SO_2$ | Over 300 MW | | | | | | | | | Over 50 M W | | |
| EEC 400 / 144 / 0.30 >500 MW | 500 | 180 | 0.38 | 5.55 | 200 | 0.42 | 400 | 144 | 0.42 | domestic<br>imported | 650 / 234 / 0.48<br>650 / 234 / b.48 | 3500 / 1260 / 2.59<br>2000 / 1260 / 1.48 |
| $NO_x$ | | | | | | | | | | | | |
| EEC 650123410.48 >500 MW | 6S0 | 234 | 0.48 | 417 | 150 | 0.32 | 300 | 108 | 0.22 | domestic<br>imported | 600 / 216 / 0.44<br>600 / 216 / 0.44 | 1000 / 360 / 0.74<br>1300 / 468 / 0.96 |
| Particulate | Over 50 MW | | | | | | | | | | | |
| EEC 50118 / 0.037 >500 MW | 100 | 36 | 0.074 | 194 | 70 | 0.15 | No Standards | | | domestic<br>imported | 100 / 36 / 0.074<br>80 / 29 / 0.059 | 200 / 72 / 0.15<br>150 / 48 / 0.11 |

| | 1 Former Czechoslovakia | 2 Poland | 3 Hungary | 4 Bulgaria | sources |
|---|---|---|---|---|---|
| • Goals/issues/trends | • Air pollution<br>- Former CSFR is a major contributor to transboundary air pollution in Europe.<br>- serious pollution in Northern Bohemia and Northern Moravia<br>- Two power generating plants among the top 25 emitters of $SO_2$ cause about 80% of the total $SO_2$ and $NO_x$ emissions.<br>- In 1990 the $SO_2$ emission pcr capita was 3 times more than OECD countries.<br>- Former CSFR contributes 1.1% of total global $CO_2$ emission.<br>- Transport is attributed with about 45% of CO emissions, 15% of organic, 15%-22% of $NO_x$, and 3% of $SO_2$ emissions.<br>- By 1992 only ESPs and a few scrubbers are installed on large combustion units. | • "National Environmental Policy "since 1990 defines near-, mid-, and long-term goals<br>• Close or retrofit the most polluting manufacturing plants<br>• Reduce $SO_2$ emission to 2.9 Mt by year 2000 (achieved in 1992)<br>- FGD units in Skawina, Bełchatów, Połaniec, Opole<br>- Coal-washing at 18 mines<br>• Reduce NO, emission to 1.3 Mt by year 2000 (achieved in 1990)<br>• Reduce particulate emissions from industrial plants by 50% (compared to 1980s level)<br>• Remediate pollution in Upper Silesia aod other regions: | • Priorities of Ministry of Environmental Protection and Regional Development (in 1991)<br>• Vehicle emissions:<br>- Particulars emission and unburned hydrocarbons from diesel buses and trucks<br>- NO, emissions from transport are a lower priority.<br>- Introduce buses fueled by natural gas<br>- Reduce lead content from 0.4 to 0.15 g/L in gasoline, to raise production of unleaded gasoline and reduce the sulfur content in diesel oil to 0.2% (DKV refinery in Szazhalombatta)<br>- Promote cars with catalytic converter and four stroke engines (diuties reduction) | • serious environmental problems in "hot spot" areas devoted to heavy industry (1270 of population affected).<br>• High levels of air pollution, eroded agriculture lands, and heavy metal pollution occur in regions around the major cities (Sofia, Pernik, Burgas, Varna, and Plovdiv).<br>• Air pollution<br>- In I 991 $SO_2$ emissions were 9 times and $NO_x$ twice those of the world average.<br>- Significant air pollution due to traffic in cities (average age of cars, 14 years)<br>• Land pollution<br>- Heavy metals contamination (lead, zinc, copper, aod arsenic) | Nl: 24<br>N2: 26<br>N3: 22<br>N4: 45<br>5,22 |

Continued . . .

# TABLE 1 (continued)

| Former Czechoslovakia (unless otherwise noted) | Poland | Hungary | [illegible] |
|---|---|---|---|
| Serious problems are caused by open pit mining, acid mine drainage, and groundwater pollution.<br>- 35,000 hectares of soil devastated and approximately 65,000 occupied by solid waste<br><br>• Adverse environmental impacts result from nuclear fuel cycle. Sulfuric acid solutions from chemical leaching in situ threaten groundwater reserves (Straz-Northern Bohemia).<br><br>• Actions:<br>- About 80% of CEZ investment in 1992-1996 to reduce environmental impact<br>- Install FGD on Prunerov II, Prunerov I, Pocerady, Tusimice II, Melnik III (totally 3600 MW)<br>- CEZ's Power and Environmental Project supported by the World Bank (air pollution)<br>- By 1994 catalytic converters required in all new gasoline-fueled cars<br>- "Polluter Pays Principle" since 1991 | - "Ecological disaster" area, the most polluted region of the country<br>- U.S./Polish program of Kraków restoration (low emission)<br><br>• Reduce pollutant discharge into rivers by 50%<br><br>• Reduce saline water discharges from coal mines into surface waters by 50%<br><br>• Increase waste reutilization (ash and slag from heat and power plants, metallurgical and chemical waste)<br><br>• 10% of Polish debt (Paris Club) to be exchanged for environmental protection investment (April 1991)<br><br>• "Polluter pays", (1991) 40% of expenditures on environmental protection came from charges and fines.<br><br>• Privatization and environmental policies are in conflict. | • Reduce emissions of $SO_2$, $NO_x$, hydrochloric acid and toxic substances in highly industrialized regions:<br>- 12% of total area below standards of WHO (from Lake Balaton through Budapest to Miskolc)<br><br>• Reduce emission of $SO_2$ and $NO_x$ from coal-fired power plants<br>- Reduce $SO_2$ emission from electric power industry by 40% (in 1990 no power station equipped with FGD)<br>- MVMT plans to reduce $NO_x$ emissions through modification of boiler designs<br>- Hungary's goal was to reduce $SO_2$ emissions 30% by 1993 (from 1980 level) and limit emissions of $NO_x$ to 1987 level after 1994.<br><br>• Nuclear waste<br>- Permanent and interim fuel disposal sites are required (the spent fuel pool at Paks is only for 2.5 years in 1991). | in regions of Srednogorie, Plovdiv-Asenovgradand Kardjali (47,000 hectares contaminated in excess of norm.)<br>- Salinity affects about 40,000 hectares.<br>- Landfill problems in most Bulgarian communities, which contributes to soil and groundwater pollution<br><br>• Water pollution<br>- Contaminant streams (chemicals, heavy metals, and sewage effluents) discharged into the rivers<br>- Only minor number of sewage systems have adequate treatment facilities.<br>- Only one river is considered clean; six rivers are seriously polluted with ammonia, oil, copper, and nitrate.<br><br>• Nuclear<br>- Spent fuel storage is needed since CIS no longer accepts spent fuel rods.<br>- Management of low and intermediate level nuclear waste<br><br>• In coal-fired power stations:<br>- FGD has not been a top priority due to tall (235 m) stacks, high retrofit costs, and lack of health impacts.<br>- ESP's perform below design and require upgrade.<br>- $NO_x$ controls for high-moisture/ash lignites require site-specific study.<br>- Large volume of ash from high |

Values are approximate based on rounded conversion factors representing averages for high- and low-rank coals.
100 mg/m³ = 36 g/GJ - LHV
1 lb/MBtu = 476 g/GJ - LHV
100 mg/m³ = 0.074 lb/MBtu - HHV



Continued.

## LIST OF ABBREVIATIONS

| | |
|---|---|
| AFBC | Atmospheric fluidized-bed combustion |
| CEZ | Czech Power Works |
| CFBC | Circulating fluidized-bed combustion |
| CHP | Combined heat and power facility (cogeneration facility) |
| COE | Committee on Energy (Bulgaria) |
| DH | District heating facility |
| DOE | United States Department of Energy |
| ERBD | European Bank for Reconstruction and Development |
| ESP | Electrostatic precipitator |
| FBC | Fluidized-bed combustion |
| FGD | Flue-gas desulfurization |
| FSU | Former Soviet Union, geographical area includes the several "republics," of the former Union of Soviet Socialist Republics (USSR), including Russia; Commonwealth of Independent States (CIS) corresponds only to Russia |
| GDP | Gross domestic product |
| HRC | High rank coal, includes anthracite and bituminous coal |
| IAEA | International Atomic Energy Agency |
| IEA | International Energy Agency, an agency within the OECD |
| IGCC | Integrated gasification combined cycle |
| IMF | International Monetary Fund |
| LRC | Low rank coal, includes subbituminous or brown coal, and lignite |
| MTBE | Methyl tertiary-butyl ether |
| MVM | Hungarian Electricity Works |
| NEK | National Electric Company (Bulgaria) |

| | |
|---|---|
| OECD | Organization for Economic Cooperation and Development |
| PFBC | Pressurized fluidized-bed combustion |
| PPGC | Polish Power Grid Company |
| SEED | Support for East European Democracy Act of 1989 administered by the U.S. Agency for International Development |
| SEP | Slovak Power Works |
| UCPTE | West European Power Grid |
| UNECE | United Nations Economic Commission for Europe |
| USTDA | United States Trade and Development Agency |
| WB | World Bank |

## UNITS AND CONVERSIONS

| | |
|---|---|
| b | barrel (42 U.S. gallons), gallon = 3.785 L |
| B | $10^9$, billion, giga (G) |
| Btu | British thermal unit |
| cal | calories |
| cd | calendar day |
| cu | cubic |
| cum | cubic meter |
| daf | dry, ash-free |
| EJ | exajoules |
| ft | feet |
| g | gram, mg = milligram ($10^{-3}$ grams) |
| GW | gigawatt, $10^9$ watt |
| J | Joules |
| k | $10^3$, thousand, kilo |
| kbd | thousands of barrels per day |
| m | meter |
| M | $10^6$, million, mega |
| t | ton |
| toe | tons of oil equivalent |
| TWh | terrawatt ( $10^{\prime 8}$ watt) hours |
| V | volt |