THE CZECH REPUBLIC'S SECOND COMMUNICATION

ON THE NATIONAL PROCESS TO COMPLY WITH THE COMMITMENTS UNDER

THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE

1997

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Ministry of the Environment of the Czech Republic

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SUMMARY

Introduction

The Czech Republic acceded the UN Framework Convention on Climate Change on October 7, 1993, thus becoming the thirty-sixth Party to the Convention. The Czech Republic feels tied to the statutes of Article 4, § 2 of the Convention, and has been fulfilling the commitments of Annex I countries; the Czech Republic informed the depository of the Convention in 1995 about its decision to make this commitment and the Czech Republic's announcement was included in the FCCC (1996/INF. 1 Corr. 1) document.

The Czech Republic submitted its First Communication to the Secretariat of the Convention at the end of 1994, and received the „in-depth-review mission". The Secretariat of the Convention issued on October 30, 1995, a report FCCC/IDR.1/CZE about the mission. In that report, an international team of experts pointed out that the Czech Republic had met its commitments as a Party of Annex I: by including in its First Communication, information about a set of measures to mitigate the impact of climate change, by respecting the IPCC recommendations on preparing that Communication, and by making available the greenhouse gas emissions in the country.

The Czech Republic, along with the majority of countries with economy in transition, reduced its total amount of greenhouse gas emissions by more than 20% from 1990 (the base year) to 1995. This is not only a result of a markedly slowed economy in 1990-1992, but also of the reduction of primary energy sources per GDP unit, and of a change in the structure of primary energy sources.

As stated in the First Communication, the Czech Republic took advantage of Paragraph 4.6 of the Convention for the preparation of emission projections. This Paragraph allows „a certain degree of flexibility" for Parties with economy in transition. There is a significant amount of uncertainties in formulating an emission scenario. Because the scenario is the basis of responsible decision-making on commitments to the reduction or stabilization of greenhouse gas emissions after the year 2000, the Czech Republic is presently unable to fully assess the real extent of such reduction/stabilization.

The Czech Republic understands its participation in the Convention as a permanent and continuous process. A reduction of greenhouse gas emissions is possible in the Czech Republic only within the context of economic transformation and a complete improvement of the environment which has been devastated over the past 40 years. The Czech Republic is fully aware of the burden of its heritage and will meet its commitments as well as it can, within the context of its economic possibilities.

National Circumstances

The Czech Republic's national economy has been influenced by the plan to transform it into a market economy (economy in transition), a process which started in 1990. The first phase of the transition included a deep economic depression with a 22% fall in the GDP. In 1995, there was considerable economic growth, to gether with a restructured production sector and an increased number of investments. In 1994, the GDP grew by 2.6% and this increasing trend continued in 1995 with a 4.8 % growth rate. The private sector's share in the GDP increased from 12.3% (1990) to 66.5% (1995). The GDP increased by 4.4% in 1996.

Following its increase in 1990-1991, energy demand per unit of GDP started declining in 1992. In spite of the fact that domestic primary energy source consumption decreases by some 2.5% every year, it is still much greater than that of developed European countries.

In the Czech Republic, more than 90% of energy comes from fossil fuel combustion. The composition of these fuels is responsible for a greater amount of emissions per capita than in other European countries. Liquid and gaseous fuels have gradually been replacing ecologically harsh solid fuels, such as low quality light coal with a high content of sulfur and ash, as the primary energy sources. Production of light brown coal is decreasing. Production of hard coal has not decreased since 1994 due to the considerable amounts exported; exports have increased by some 33%.

The annual Reports on the Environment of the Czech Republic have been issued regularly since 1993. The

reports reflect priorities of the State Environmental Policy. It follows from these reports that the very heavy ecological loads which burdened the environment in the 1970s and 1980s are gradually being removed.

Emission Inventories and Emission Projections

In 1995 and 1996, annual emission inventories for 1991 through 1995 were worked out according to IPCC methodology; the inventory for the base year 1990 was improved. These inventories show that in the examined period (1990-1995), there was a substantial reduction in the aggregated emissions of three basic greenhouse gases (carbon dioxide, methane and nitrous oxide); emissions were reduced by 23.3%, from 193.2 million tones of CO_2 eq to 148.2 million tones of CO_2 eq CO_2 emissions decreased by 24.4%, from 163.2 million tones to 123.4 million tones within that same period. The greatest reduction occurred in 1991.

The inventory of greenhouse gas emissions shows that CO_2 is the predominant part (approx. 84%) of the total greenhouse gas emissions. It is also clear that fuel combustion is the main source of CO_2 (some 97% of all CO_2 emissions). Consequently, CO_2 emission projections from fuel combustion, representing 82% of all greenhouse gas emissions, are the central focus point. Another 4% of greenhouse gas emissions (a part of N_2O and CH_4 emissions) originate from the same source and are, to a certain extent, proportional to CO_2 emissions.

To estimate future development, two extreme scenarios have been outlined. Real development is expected to take place somewhere between the two ends of the spectrum. The base scenario (the „most pessimistic scenario“) has the greatest estimated amount of emissions. It is characterized by rapid economic growth, relatively little restructuring and no new measures. This scenario is a more accurate version of the projection described in the Czech Republic's First Communication.

The „positive development scenario“ has the smallest estimated amount of emissions and describes the other end of the spectrum. It predicts that energy will be saved as a natural result of the market economy as well as through the various considered measures. It is very difficult to estimate the influence of individual factors and their possible synergy. Therefore, the final projection is a homogeneous scenario without any analysis of individual effects.

The basic projection is for 1996-2010. We consider any projections in the years following 2010 to be too speculative and vague because of considerable uncertainties resulting from economic transition. It is expected that the GDP will continue to grow from 1995 to 2010. Several independent estimates put the growth rate somewhere between 3% and 6%. The base scenario assumes that the GDP will grow by some 4.7%, the relatively high growth having no connection with economic restructuring. This scenario expects that the national economy will develop extensively, that gaseous fuels will slowly substitute light coal, and that there will be increased export of products with a low value added tax.

In the „positive development scenario“, it is expected that the GDP would grow more slowly, by some 3%. It is also anticipated that the process of restructuring, as well as the state energy policy and environmental policy measures, will result in reduced energy consumption. The development of emissions is similar to that in the base scenario, but its start is delayed with respect to the growth of the GDP and energy consumption. This is mainly due to adherence to emission limits and the stopped growth of electricity consumption for heating in the residential and commercial spheres. A constant level of emissions is expected after 2005, as a result of consistent state policy on energy prices. The difference between the two emission scenarios increases from 1995 up to 43 million tones of CO_2 (i.e. 22% of total emissions) in 2010.

For this reason, the Czech Republic will quickly try to stabilize the reduced level of greenhouse gas emissions before the year 2000. It will try to prevent a situation in which the approximated 20% reduction in emissions achieved in 1990-1995, is reversed through a rapid increase in emissions, corresponding to the current rate of economic development (e.g. an annual increase in emissions by some 3-5% according to the growth of GDP, for instance).

Therefore, greenhouse gas emissions are expected to be significantly reduced by at least 5% between 2000 and 2005, compared with emissions in the base year 1990. The Czech Republic will decide on its further commitment to this process of stabilizing and reducing greenhouse gas emissions after the year of 2000.

Greenhouse Gas Emission Mitigation Measures

The Czech Republic's Second Communication outlines various measures („no regret measures“) that have been applied to solve the Czech Republic's economic and environmental problems. Their effects on greenhouse gas emissions are obvious. The high priority environmental problems and the measures which have been taken to solve them are defined in an important document entitled „The State Environmental Policy of the Czech Republic“. The tasks of protecting the climate through reduction in greenhouse gas emissions (by changing the structure of primary energy sources, by decreasing energy consumption, by saving energy, etc.) and absorbing these emissions through afforestation, belong among the long-term priorities of this policy, as well as being priorities for protecting the Earth's ozone layer.

The Czech Republic is harmonizing its legislation with that of the EU and is participating in international studies on measures which could mitigate the impact of climate change. The Czech Republic is consequently cooperating with other EU member countries, OECD member countries and with a great number of other Central and East European countries in an increasing extent. Through a comparison of the Czech Republic with other countries currently undergoing rapid economic transition, it can be seen that a set of flexible economic and information tools mitigating the negative impact of climate change must be aimed mainly at liberalizing the energy market, encouraging cost-effective energy consumption, supporting cleaner fuels and alternative energy sources as well as developing new and more effective technologies.

The chapter dealing with emission mitigation measures consists of two parts. The first outlines the measures mentioned in the Czech Republic's First Communication.

All of the presented measures have been implemented, except for the obligatory measurement of energy consumption. The „Programme for Saving Heat in Residential Buildings“ is evaluated within the context of the Czech Energy Agency's activities. The National Clean Air Programme and Support for Use of Renewable Energy Sources, together with the programme mentioned above play the most important role in reduction of CO_2 emissions. The total estimated contribution of all these measures to the expected reduction of CO_2 emissions in 2000 should equal 3-5Mt/year (a reduction of approx. 2-3%), assuming they would be replacing brown coal combustion.

The second part of that chapter evaluates the measures shared by the Czech Republic with other Parties to the Convention (in accordance with Article 12.1b of the Convention), as measures under consideration or preparation. Only measures that have been worked out or implemented since the Czech Republic's First Communication are presented and discussed in this section. The document thus discusses the liberalization of fuel and energy prices and activities implemented jointly (AIJ) to reduce greenhouse gas emissions.

This part of the Communication includes brief proposals for reducing emissions. The proposals mostly deal with energy consumption in the residential sector, as well as state ings. The proposals discuss international cooperation, the development of new economic support mechanisms to encourage energy savings, and they evaluate the real potential of renewable energy sources.

Vulnerability and Adaptation Measures

Vulnerability assessments show that the expected climate change would seriously influence the following three areas of the Czech Republic's economy: the water management, agriculture and forestry. If temperatures rise by 2 ^{o} C and the precipitation stays the same, the original runoff level will decrease by 10-25%. If temperatures rise by 4 ^{o} C, the runoff will be 25-30% less. A 5% decrease in precipitation together with rising temperatures would cut the runoff by 30-50%, and it is predicted as the most pessimistic scenario.

Even a steady 5% increase in precipitation would not be enough to maintain the original groundwater runoff level, if temperatures rise by 2-4 ^{o} C. With the steadily falling precipitation tendency, the groundwater runoff level could even decrease in river basins, where a notable amount of groundwater is accumulated.

Climate change influencing hydrological processes affects the management of water reservoirs, the main sources for drinking water. Reservoir storage capacity would change by tenth of percent. Based on the

current socioeconomic development and mild climate changes, it is not expected that water consumption will increase in the Czech Republic at the beginning of the latter half of the coming century. If future climatic development follows the highly pessimistic scenario (reduced precipitation, increased temperatures) and socioeconomic development creates a greater demand for natural resources, more water will be required.

Apart from changes in temperature and precipitation, the expected increase in CO_2 concentrations will also influence the growth of plants. Its impact on the main grain crop (winter wheat) has been studied. If CO_2 concentrations double and the current climatic conditions remain the same, agriculturally exploitable production of aboveground parts of grassland will rise by 30-40%, for winter wheat by 5-20%.

Conversely, environmental stress caused by more frequent high temperatures can endanger production. Agricultural production will depend mainly on sufficient regular rainfalls during the growing season, assuming that the elevated temperatures are high enough. Production estimates based on the climate change scenarios worked out until the year 2030 do not absolutely confirm increased production as described by models expecting growing concentrations of CO_2. Higher temperatures and regular precipitation create better conditions for agricultural diseases and pest development.

As the species composition of forests in the Czech Republic is strongly influenced by artificial forestry and as the forests contain a number of tree species at the edge of their ecological amplitude, these forests are very sensitive even to the slightest change in climate. This is especially the case of Norwegian Spruce. A large proportion of forests are monocultures and are consequently less stable and more vulnerable to diseases, pests and abiotic factors. Monitoring, Research, Education and Public Awareness

As stated in the Government of the Czech Republic Resolution No. 323/93, the Minister of the Environment and the Minister of Industry and Trade are responsible for meeting the Czech Republic's commitments to the Convention. At the beginning of 1994, when the Czech Republic's First Communication was under preparation, the Minister of the Environment initiated the establishment of an Interministerial Commission on the UN Framework Convention on Climate Change. The commission currently consists of representatives of the two ministries mentioned above, representatives of the Ministry of Transport and Communication, Ministry of Finance and Ministry of Agriculture.

The Deputy Environment Minister is the Commission's chairperson. The Commission supervises the fulfillment of the Czech Republic's commitments. The commission was a partner of the „in-depth-review“ team that visited the Czech Republic in May, 1995.

In 1995, a department to collect all necessary data and prepare an annual national inventory of emissions was established within the Czech Hydrometeorological Institute. It adheres strictly to IPCC methodology.

In 1995 and 1996, the data on emissions up to the year 1995 was completed and the original data from 1990 (the base year), which was included in the Czech Republic's First Communication, was improved. The results of the emissions inventories are submitted to the Secretariat of the Convention. The government and citizens of the Czech Republic are regularly informed, about the country's fulfillment of commitments to the Convention through the annual Reports on the Environment of the Czech Republic.

Research on climate change is financed by grant agencies (which mainly finance basic research) and by grants the Ministry of the Environment and the Ministry of Agriculture (these grants mostly address urgent problems).

Most of the research on climate change is coordinated by the National Climate Programme (a non-governmental organization), with the participation of the Czech Hydrometeorological Institute, academic institutes and universities. A large research base exists within the Academy of Sciences of the Czech Republic, including projects such as „The Influence of Climatic and Anthropogenic Factors on the Environment“ and core projects like „Global Changes and Terrestrial Ecosystems“, „Biospheric Aspects of the Hydrological Cycle“ and PAGES „Past Global Changes“. Some international programmes also contribute to this research.

In the Czech Republic, there are many activities for children and youth which address global environmental problems, including programmes on climate change. 'The Blue Sky' (Modré z nebe) and 'GLOBE' are the

most important ones. These activities are mainly coordinated by non-governmental environmental organizations, especially environmental education centers. The Ministry of the Environment supports projects established by ecological organizations, some of them related to climate change (energy savings, promotion of environmentally-friendly products, information campaigns, etc.).
global climate change mainly by the mass media in particular (TV, radio, newspapers). The support and dissemination of objective and understandable information about the results of scientific research are very important. Between 1995 and 1996, the Ministry of the Environment sponsored several publications related to climate change.

2. INTRODUCTION

Global climate change is a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. Atmospheric concentrations of greenhouse gases (particularly carbon dioxide, methane and nitrogen oxide) have increased by more than one third since the industrial revolution (roughly since 1750). This increase which has caused the Earth's surface to become noticeably warmer, sea levels to rise, and which has probably also caused local changes in the distribution of temperature and precipitation may be the cause of the global change of climate. This was the conclusion of the Second Report of the Intergovernmental Panel on Climate Change (IPCC). The report was presented by IPCC Chairman B. Bollin, at the second conference of the signatories of the Framework Convention held in Geneva (1996). It pointed out the following:

There has been a substantial increase in the concentration of greenhouse gases in the atmosphere, compared with the amounts measured before the industrial revolution (the growth rate is approximately 30% for carbon dioxide, 145% for methane and 15% for nitrogen oxide); the growth is mainly due to mining and burning of fossil fuels;

The changes in greenhouse gas concentrations have a long-term character, because these gases persist in the atmosphere for tens to hundreds of years;

The mean global surface air temperature has increased by 0.3 to 0.6 ^{o} C since the end of the 19th century. Temperatures above the average were measured in the late 1980s and the early 1990s. In addition, there are a greater number of anomalies in precipitation patterns, and occurrences of anomalous weather patterns have also been observed (deep frosts, drought, heavy rainfalls, etc.);

Over the past 100 years, sea levels have risen by some 10 to 25 cm; this may be related to the increased temperature of the Earth's surface; however the increased temperature causes greater evaporation from water surfaces;

Mathematical models of natural processes show that the stabilization of atmospheric carbon dioxide concentrations at a level of 450, 650 or 1000 ppmv could only be achieved if CO_2 emissions drop to 1990 levels in 40, 140 or 240 years from now, respectively, and subsequently drop substantially below those levels;

Climate models project a 2 to 3.5 ^{o} C increase in mean surface air temperature and a 15 to 95 cm rise in sea levels by the year 2100, at the current growth rates of emissions;

Both the speed and scope of those changes pose a considerable risk to natural and artificial ecosystems, as well as to the human society at large. For example, permanent temperature and precipitation changes in productive agricultural areas may cause population migrations, as well as floods and rising sea levels.

Despite the fact that there are uncertainties in assessing the type and extent of problems triggered by the growth of greenhouse gas concentrations, the conclusions of the IPCC Report are to be taken very seriously.

As a developed country, the Czech Republic an OECD member and a country affiliated with the European Union acceded the UN Framework Convention on Climate Change (UN FCCC) on October 7, 1993. This was done on the basis of the Government of the Czech Republic Resolution No. 323 of June 16, 1993, and the country thus became the thirty-sixth Party to the Convention. The Czech Republic feels tied to the statutes of Article 4, § 2 of the Convention, and has been fulfilling the commitments of Annex I countries; the Czech Republic informed the depository of the Convention in 1995 about its decision to make this commitment and the Czech Republic's announcement was included in the FCCC (1996/INF. 1 Corr. 1) document.

On the basis of the Government of the Czech Republic Resolution No. 530, passed on October 18, 1995, the Minister of Foreign Affairs, in his letter of November 17, 1995, requested the UN General Secretary and the FCCC depositor to take the following measures:

that Czechoslovakia be left out of Annex I, because Czechoslovakia does not exist anymore and has never been a Party to the Convention;

that the Czech Republic be included in the list of Annex I countries.

Aware of its responsibility as a developed country beeing a Party to the Convention, the Czech Republic presented on October 17, 1994 its First Communication to the Secretariat of the Convention. Thus it ranged among the first countries presenting a report. It was also one of the first Annex I countries to receive the „in-depth-review mission“ on May 2-5, 1995. The Secretariat of the Convention issued a report about the mission on October 30, 1995 as its document FCCC/IDR.1/CZE. In that report, the international team of experts observed that the Czech Republic had met its commitments as an Annex I country. The report points out that the Czech Republic’s First National Communication outlines a set of measures to mitigate the impact of climate changes. The report also states that both the First Communication and the method in which it makes available the information about greenhouse gas emissions, respect IPCC recommendations.

The mission further found that the Czech Republic assumes a considerable reduction of emissions in 2000, when compared with 1990 levels, mostly as a result of restructuring industry (ceasing high energy demand production, implementing new low emission technologies, etc.), more efficient energy cycles and the use of potential energy saving devices and renewable energy sources. Experts expect that carbon dioxide emissions will decrease when the nuclear power plant Temelín (2000 MW) is put into operation. Increased energy consumption (consumption increased by 5% in 1995) and intensified use of transport will have a negative impact. The mission stated that the Czech Republic has no specific goal for reduced emissions, but has simply declared its attempt to stabilize emissions as outlined in Paragraph 4.2 (b) of the Convention.

Since the publication of the Czech Republic’s First Communication in 1994, the annual inventory of emissions has become more precise. The forecasts for economic development have become more accurate, due to conceptions of the influence of economic transition on greenhouse gas emissions. These factors have enabled to make more precise projections beyond the year 2000. In the First Communication, complete emissions inventories (according to IPCC methodology) were only available for the base year of 1990, while rough emission estimates were available for 1991, 1992, and 1993; nonetheless, the emissions reduction estimates in this Communication turned out to be accurate.

It must be emphasized that the Czech Republic, like most countries with an economy in transition, has reduced total greenhouse gas emissions by more than 20% from the base year of 1990 to 1995. This reduction is thought to have been the result of both a slowed economy from 1990 to 1992, a decreased consumption of primary energy sources per GDP unit, and the changing structure of those sources (increased use of natural gas, decreased use of coal). Investment into production technologies is helping to replace gradually energy demanding technologies by more efficient ones.

As stated in the First Communication, the Czech Republic took advantage given by Paragraph 4.6 of the Convention, for preparation of emission projections. This Paragraph allows „a certain degree of flexibility“ for the Parties with economy in transition. The Czech Republic took advantage of this paragraph because the country’s economy was undergoing rapid changes and with the division of Czechoslovakia on January 1, 1993, the Czech Republic has recently become an independent state. There is a significant amount of uncertainties in formulating an emission scenario. Because the scenario is the basis of responsible decision-making on commitments to the reduction or stabilization of greenhouse gas emissions after the year 2000, the Czech Republic is currently unable to assess the real extent to which emissions can be reduced or stabilized, or estimate precisely the impact of the measures taken.

It was stated in the First Communication that the Czech Republic understands that its participation in the Convention is a permanent and continuing process. This understanding was repeated by the heads of the Czech delegation at both the first and the second Conferences of Parties to the Convention (COP-1, COP-2). The reduction of greenhouse gas emissions can only be possible within the context of economic transition and the recovery of an environment devastated over the past 40 years. While fully aware of the burden of such a heritage, the Czech Republic is prepared to meet its commitments as best as it can (under the present economic conditions), and plans to utilize any opportunities outlined in the Convention, for international cooperation.

This Second Communication also shows a number of measures used by the Czech Republic to solve its economic and environmental problems. It has been proven that the influence of these measures on greenhouse gas emissions levels is significant, and that there is synergy between economic transformation and environmental protection (including global climate). „The State Environmental Policy“ of the Czech Republic, a document approved by the Government of the Czech Republic Resolution No. 472/1995, outlines the most important environmental problems and the measures taken to solve these problems.

The Czech Republic will make a great effort to stabilize, before the year 2000, the achieved 20% reduction of greenhouse gas emissions, thus preventing a sharp increase in emissions resulting from rapid economic development (an annual increase of 3-5% in emissions is plausible, if emissions were to grow at the same rate as the GDP). The total amount of greenhouse gas emissions for the period 2000-2005 is expected to be considerably lower in comparison with emissions in the base year of 1990. Any further commitments made by the Czech Republic following the year 2000 will depend on the results of this attempt to stabilize greenhouse gas emissions, which should subsequently lead, in the long-term, to their reduction.

3.NATIONAL CIRCUMSTANCES

Demographic, Geographic and Climatic Conditions

The Czech Republic became an independent country on January 1, 1993, as a result of splitting of the former Czechoslovakia. The Czech Republic is formed by Bohemia, Moravia and a part of Silesia. The country covers an area of 78 866 km^2 and has a population of 10.321 million (as of December 31, 1995). Its capital city, Prague, has a population of 1.21 million; 23% of the total population lives in Prague and six other cities exceeding 100000 inhabitants (Brno, Ostrava, Plzeò, Olomouc, Liberec and Hradec Králové). The average population density is 131 inhabit./km^2 (36 inhabit./ km^2 in the Éesky Krumlov District and 824 inhabit./km^2 in the Karviná District). Demographic projections do not predict any significant population changes over the next ten to twenty years. Fig. 3.1 shows cities with populations over 100 000, district capitals, main waterways and national borders.

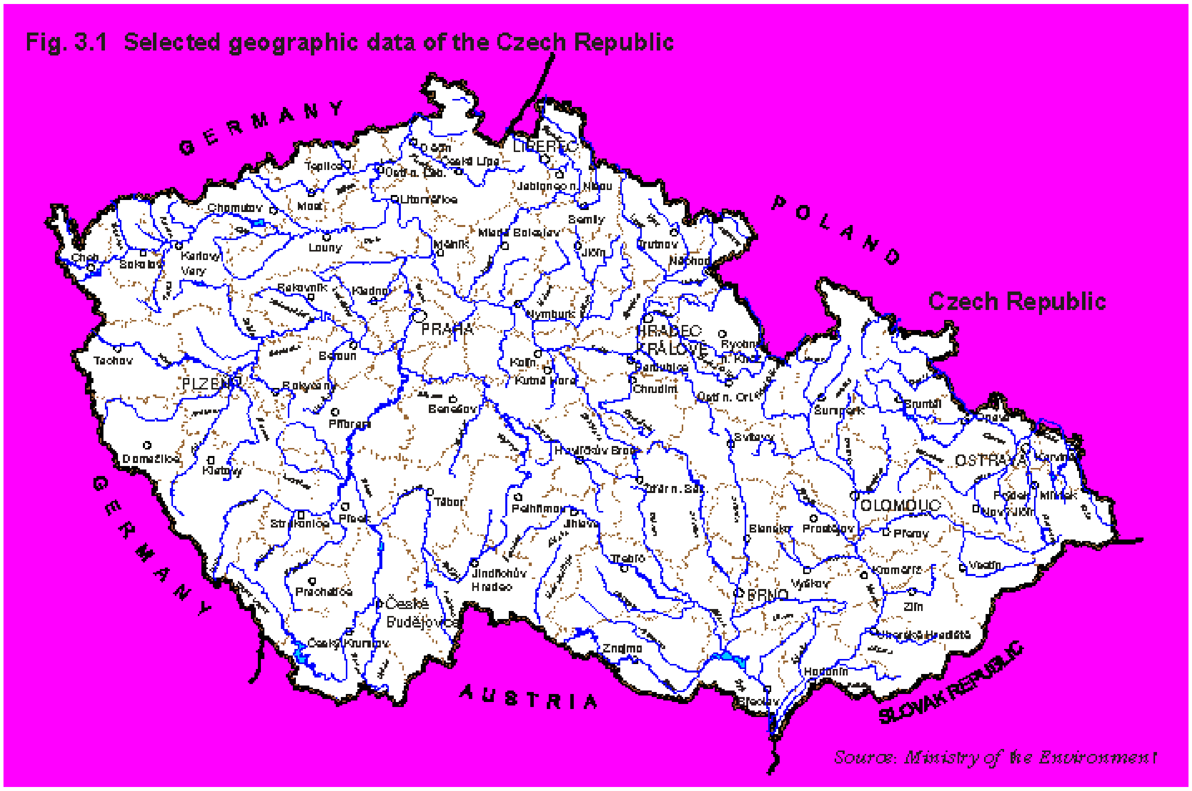


Fig. 3.1 Selected geographic data of the Czech Republic

Approximately 54 % of the Czech Republicís area is arable land (43 000 km^2). In a European context, the country has an average amount of arable land per capita (0.41 hectares). The proportion of arable land has decreased from 75.3% in 1989 to 73.8%, but it is still substantially higher than the European average. Forests cover 33% of the land (0.26 hectares per capita) and urban areas make up 7% of the land. The remaining 10% represents primarily waters (no large natural lakes can be found, but the country abounds in ponds, fishponds and artificial water reservoirs); devastated areas (results of raw material extraction, and uncultivated areas) cover 1.5% of the Czech Republic's territory.

The Czech Republic's climate belongs to the northern moderate zone. The mean annual temperature in the warmest lowlands of southern Moravia does not exceed 10 o C (the town of HodonÌn, 180 m a.s.l., 9.5 o C). The lowest temperatures are recorded at the top of mountains (highest mountain Snìka, 1602 m a.s.l.) but the mean annual temperature still does not drop under the freezing point in these areas (Pradìd, 1491 m a.s.l., 0.9 o C). The mean annual precipitation for the entire Czech Republic is 693 mm. Precipitation is distributed unevenly because it is strongly influenced by the countryís relatively complex orography. A significantly greater amount of precipitation has been registered in the mountainous border zones, while low precipitation

levels are typical of southern Moravia and northwest Bohemia (caused by the precipitation shadow cast by the Krusné Mountains) [see Fig. 3.2]. The driest areas receive just over 400 mm of precipitation annually, while precipitation in the mountains approaches 1500 mm. The average snow cover and its duration are also highly variable in lowlands.

Fig. 3.2 Annual precipitation totals in the Czech Republic in 1995 (in % of the precipitation average based on 1961-1990 values)

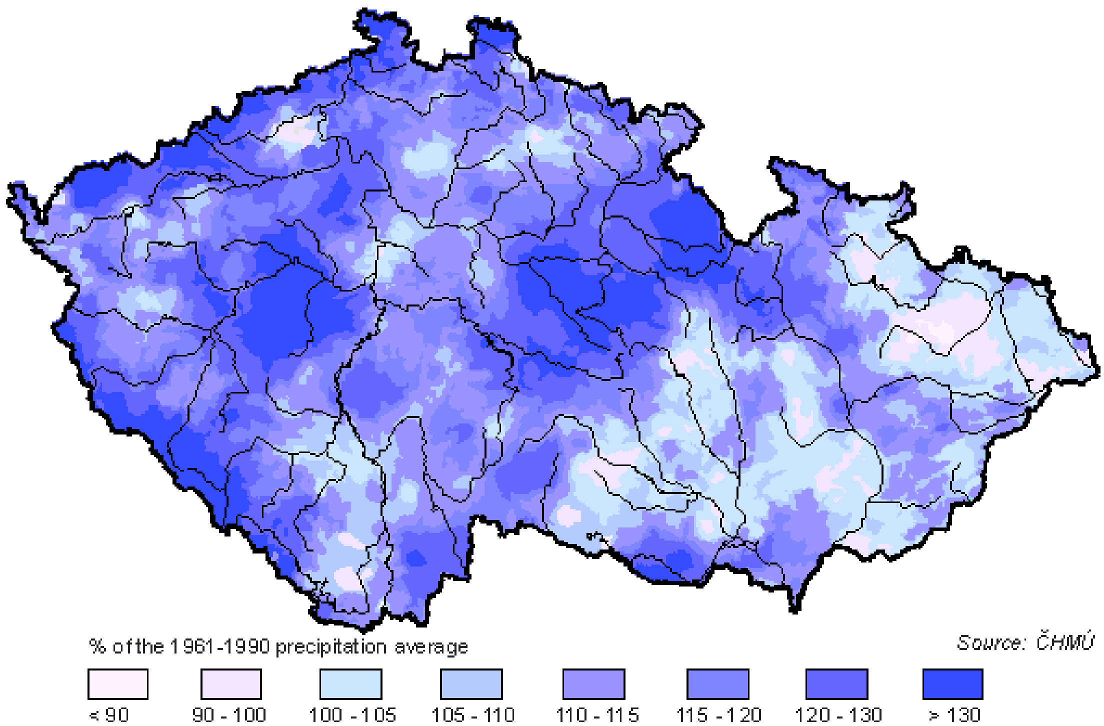
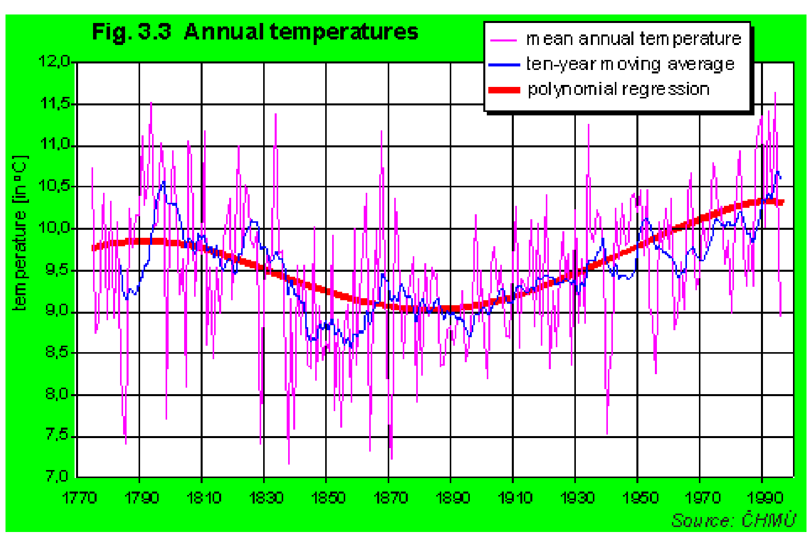
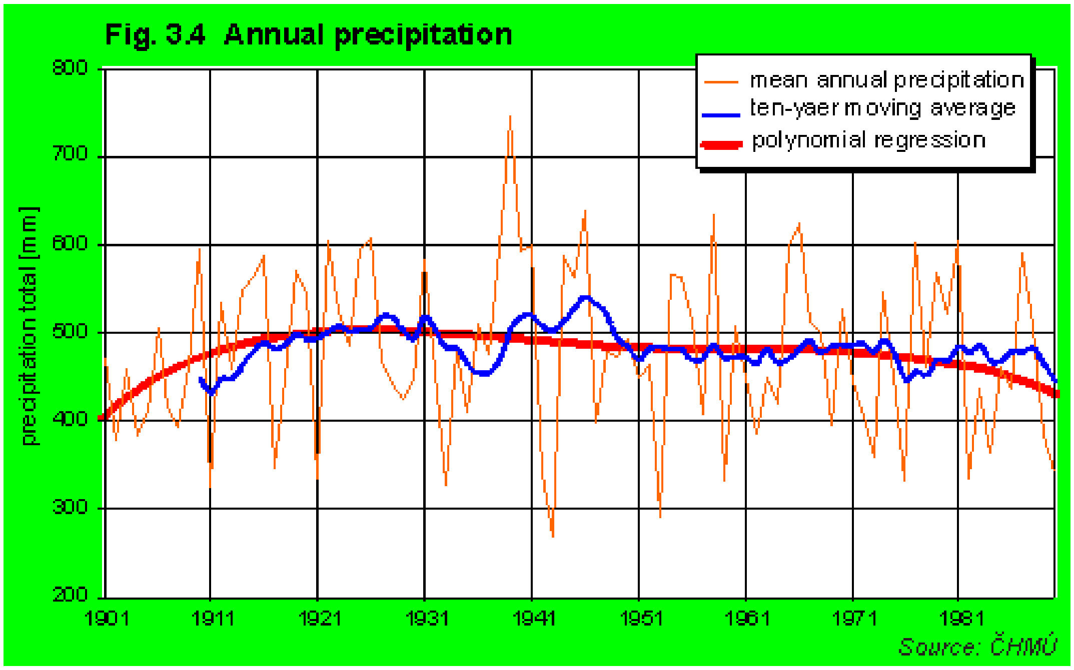


Fig. 3.3 shows a time series of mean annual temperatures (1775 to 1996). Plotted in Fig. 3.4 is a time series of mean annual precipitation (1901 to 1990) as measured at the Prague-Klementinum station. Both series exhibit considerable time variables; shown are moderately rising mean annual temperatures from the beginning of the 20th century and a slight drop in precipitation totals since the 1920s. It is difficult to distinguish between anthropogenic and natural influences in these two time series.





The country’s relatively complex orography is the cause of considerable variability in local and regional climates. A typical occurrence throughout most of the country during the winter months, is that of ground-level or elevated inversions, which may often last uninterruptedly for several days. Their average elevation is approximately 300 m to 500 m above ground level, and they mainly occur in northwestern and central Bohemia and the Ostrava region. Since a substantial part of the Czech Republic’s industrial potential is concentrated in those areas, this particular regional climate feature has negative impacts on air quality.

Three European watersheds cross the Czech Republic. The western part of the country (Bohemia) mostly uses water from the Labe River, which empties into the North Sea; a smaller northeastern part (mostly Silesia) is supplied by the Odra River, which runs into the Baltic Sea; and the southeastern part (a larger part of Moravia) is supplied by the Morava and Danube rivers, which flow into the Black Sea. Most of the springs for these rivers are in the Czech Republic, and thus the countryís water resources are quite limited.

Fig. 3.5 lists a time series of mean total runoffs (1888 to 1995) at the DÏËÌn gauging site (the final river basin gauging site on the Labe (Elbe) River before the river flows out of the Czech Republic), which measures the runoff from a 51103 km2 area. This time series does not imply any long-term trend, since total runoffs vary considerably from year to year. For example, in the hydrological year 1995, the total runoff was 18209 million m3, while runoffs in the Labe River Basin were mostly above average (105 - 155% of the long-term average), runoffs in the Odra River Basin were average, and runoffs in the Dyje River Basin were slightly below average (70 - 80% of the long-term average). In the series of measurements of mean annual flow over the past ten years, 1995 was the first, significantly above-average year.

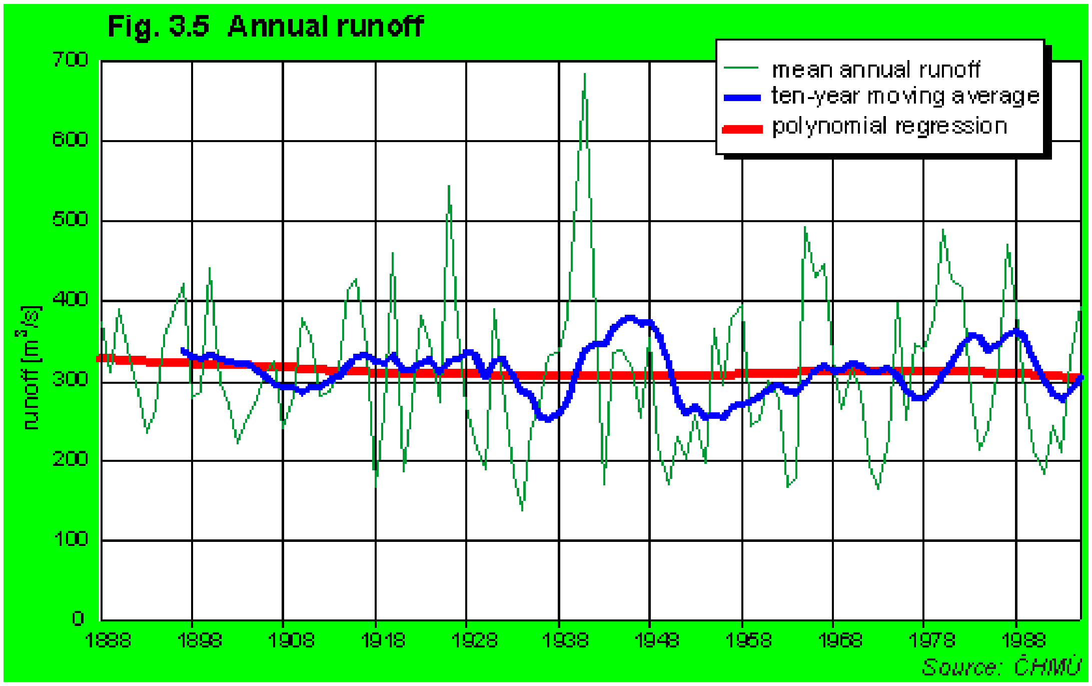


Fig. 3.5 Annual runoff

There has been a deficit in the groundwater supply since 1990, despite a moderate increase since 1994. The degree to which water is used - expressed as the ratio between the total amount of offtakes and total runoff - declined from 22% in 1993 to 13.4% in 1995.

Development of the State of the Environment

The environment was seriously damaged over the 40 years previous to 1989. During that period when the so called controlled and centrally directed economy was applied, there was: an attempt to achieve maximum production without any regard for the environment or for natural resources; an excessively high energy demand and uneconomical use of raw materials; imperfect or non-existent environmental legislation; inefficient economic tools; shrouded information, even in cases when human health was acutely threatened; a total disregard for public opinion and; an untenable state policy of subsidizing the prices of commodities such as energy, drinking water and food. This distorted economy resulted in disproportionately high emissions of principal pollutants, thereby causing extensive damage to human health and natural ecosystems, including forests in the republicís northwestern regions. Approximately 50% of the countryís population lived in areas with heavy environmental damage, and the Czech Republic was therefore ranked as one of the most polluted countries.

Profound changes in environmental protection begun after the political changes of November 1989. The Ministry of the Environment, the Federal Committee on the Environment and various other environmentally linked institutions were established. The first objective report on the state of the environment was published. An important international event held in the country was the first conference of European Environment Ministers, which took place in Dobøís in 1991; this event marked the beginning of a cooperative European programme on environmental issues. At that time, the foundations were laid for the legal protection of the environment in the Czech Republic, encompassing areas which until then had not been regulated by legislation (waste management, for example); new economic tools were also adopted.

In 1995, the Czech Government approved an important document - The State Environmental Policy of the Czech Republic - in which the premises, principles and priorities of the countryís environmental policy are formulated. The policyís long-term priorities include climate protection through a reduction of greenhouse gas emissions (making changes in the structure of primary energy sources, reducing energy demand, promoting energy savings, etc.), measures for absorption of greenhouse gas emissions (through afforestation), and protection of the Earthís ozone layer. Reports on the Environment of the Czech Republic have been published annually since 1993; these reports include the steps taken by the country to meet the commitments outlined in the State Environmental Policy. The reports suggest that the deterioration in the quality of the environment seen in the 1970s and 1980s has been stopped, or stabilized and that the quality of the environment is now gradually improving.

By 1995, total emissions of principal had dropped by 36% in comparison with 1990; the amount of solid pollutants had decreased by as much as 68%. Mean annual concentrations of SO_2 and solid substances in the atmosphere showed a downward trend in 1995, while mean annual concentrations of NO_x had not gone up significantly. However, there are still certain places in the Czech Republic that report higher concentrations of air pollutants during periods when weather conditions are unfavorable for pollutant dispersion. These primarily include industrial areas in the country's northwest border zone, at the foot of the Krušné Mountains (here there are increased sulfur dioxide and nitrogen oxide concentrations), and in the Ostrava region (solid substances are the predominant pollutant here). Yet, it is apparent that there is a gradual decline in mean annual values.

In urban agglomerations (Prague, Ostrava, Plzeò), the total mean annual load of sulfur dioxide and solid substances has decreased. However, the total load of NO_x has remained virtually unchanged over the past few years, while the number of days with increased concentrations of nitrogen oxides (during unfavorable dispersion conditions) has actually been increasing. The above areas are the center of the state administration's long-term attention.

The values of most of the important water pollution parameters (organic pollution, ammonium nitrogen, phosphates) at the main sampling sites on the Labe, Vltava, Morava and Odra rivers had dropped by 1995; nitrate levels remained stagnant. The improvement in ammonium nitrogen and microbial pollutant levels has not yet become visible in small streams. The proportion of treated waste water released into the sewage system has increased by 16% in comparison with 1990. Between 1990 and 1995, the amount of monitored pollutants released into streams decreased: BOD5 by 59%; insoluble substances by 54%; oil products by 69%; dissolved inorganic salts by 16%; and the apparent acidity/alkalinity by 78%.

A new law was passed on July 31, 1996, stating that uncontrolled dumps would no longer be permitted. In 1992, 2044 dumps were operating in the Czech Republic; that figure dropped to 1511 in 1994 and 1278 in 1995. The number of controlled dumps is expected to stabilize at about 300. The predominant method in which waste is disposed is dumping (60% of all the waste produced), because of lower costs.

However, a number of problems continue to exist despite the aforementioned positive trends. SO_2 emissions remain high (106 kg annually per capita, in comparison with 28 kg annually per capita in European OECD countries). The increasing use of road vehicles is the cause of rising NO_x levels.

In almost 5000 communities (population 100 to 10000), the connection to public sewage networks and waste water treatment plants continue to be unsolved problems. Most of the major waste water treatment plants now in operation have not installed any equipment for the elimination of nitrogen or phosphorus. As a result, approximately one-third of the total length of waterways monitored have been categorized as having heavily" and very heavily polluted water".

There continues to be a considerable ecological load on forests from air pollution, causing them to grow thinner or even to die, thereby prompting premature afforestation.

Table 3.1 Production indices and GDP.

Index	1990	1991	1992	1993	1994	1995
Industrial production	100	78	72	68	70	76
Construction	100	72	87	80	86	94
Annual GDP change [%]	-1.2	-14.2	-6.4	-0.7	2.6	4.8

Source: The Czech Statistical Office

Tab 3.2. Survey of selected indicators in the energy sector

Indicator	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Domestic consumption of primary energy sources [PJ]	2076	1938	1796	1750	1669	1710
GDP expressed in fixed prices of 1984 (billion CZK]	503.7	432.1	404.5	400.7	411.2	431.1
Energy demand [PJ/billion CZK GDP]	4.12	4.48	4.44	4.37	4.06	3.97
Emission of CO_2 [t/capita]	15.8	14.3	13.0	12.5	12.0	11.9
Emission of $(CO_2)_{eq.}$ [t/capita]	18.7	17.0	15.5	14.9	14.3	14.3
Emission of SO_2 [t/capita]	0.181	0.172	0.149	0.137	0.123	0.105

Source: The Czech Statistic Office, ÈHMÚ (emissions of CO_2.)

Tab. 3.3 The structure of the primary energy sources consumed in the Czech Republic (%)

Year	1990	1991	1992	1993	1994	1995
Solid fuels	65.5	64.3	62.6	60.4	58.5	56.8
Liquid fuels	17.2	15.5	17.8	17.5	18.5	18.7
Gaseous fuels	10.9	13.2	12.5	14.3	14.4	16.1
Primary heat [a)] and electricity	6.4	7.0	7,2	7.8	8.7	8.4

[a)] primary heat - nuclear energy, hydro energy and I/E energy

Source: The Czech Statistical Office

Tab. 3.4 Carbon dioxide emissions for individual types of vehicles.

Type of traffic	1990	1991	1992	1993	1994	1995
Road vehicles - total	85,7	82,8	87,0	97,8	104,1	110,3
• passenger cars	47,6	44,0	47,7	52,1	52,5	55,3
• public intercity transit vehicles	6,8	6,0	5,6	4,7	4,0	3,6
• public city transit vehicles	2,3	2,4	2,2	2,0	1,9	1,7
• public freight vehicles	15,2	18,1	19,4	25,8	30,3	35,0
• private freight vehicles	13,8	12,4	12,0	13,2	15,4	14,7
Railway vehicles	9,9	7,4	7,0	5,7	5,5	5,9
Aircrafts	3,7	4,3	3,0	2,2	2,5	2,6
Watercrafts	0,7	0,6	0,6	0,6	0,6	0,6
Total	100,0	95,2	97,6	106,2	112,6	119,5

Source: CDV

Development of the National Economy

Since 1990, the Czech Republic's economy has been undergoing a transition from a centrally planned to a market economy; the country's economic development has, in addition, been influenced by the January 1, 1993 division of Czechoslovakia into the Czech and Slovak Republics. The first stage of economic transformation was marked by a deep recession; at that time, the GDP decreased by roughly 22%. The country's economy regenerated again in 1995, and its growth was spurred by industrial restructuring and revitalized investments. While the GDP rose by 2.6% in 1994, it went up by as much as 4.8% in 1995 [see Tab. 3.1]. The non-governmental sector's share of the GDP increased to 66.5% in 1995, compared with 12.3% in 1990. The GDP increased by 4.4% in 1996.

Using the nominal exchange rate, per capita GDP amounted to approximately 3500 USD in the mid-1990s; it was approximately 8100 USD when using the purchasing power parity (Human Development Report, UNDP,

Prague, 1996). The exchange rate between the Czech and US currencies was roughly 27 CZK/USD in 1996. Table 3.2 lists some indicators that reveal the changes in the country's national economy and their effects on the environment.

Consumption of Fuel and Energy

Following its increase in 1991-1993, energy demand per unit of GDP started declining again in 1994. Its 1995 level was 3.5% lower than in 1990. However, energy demand in the Czech Republic is markedly higher than that in West European countries, despite a 2.5% annual decrease since 1991.

Over 90% of the energy used in the Czech Republic comes from fossil fuel combustion. The structure of these fuels is the cause of high emissions per capita, in comparison to other European countries. Nevertheless, the structure of primary energy sources has been slowly changing since 1990, as can be seen in Tab 3.3; specifically, environmentally unfriendly solid fuels like low grade light coal with high sulfur and ash content, have gradually started to be replaced by liquid and gaseous fuel.

Transport

The total length of railroads is 9.430 km, 29% of which is electrified. Economic factors, the falling volume of transported goods, and growing energy prices, are all factors contributing to the fact that further electrification of railroads is not currently under consideration. Close to 71.8% of the total amount of kilometers traveled by passenger trains in 1995 was traveled on electrified railroads; 85.3% of the total number of ton-kilometers traveled by goods trains was also traveled on electrified railroads.

The total length of roads is 55418 km (414 km of this consists of highways). The volume of goods transported via rail decreased by 45.8% from 1990 to 1995, while the volume of goods transported via road increased by 24.7% within the same period. In 1995, goods transported via rail represented 42.9% of the total volume of goods transported, goods transported via road represented 38.7% of the total and goods transported via waterways represented 2.1% of the total volume of transported goods. There has been a considerable increase in passenger cars; their number increased from 261 cars/1000 inhabitants in 1990 to 332 cars/1000 inhabitants in 1995).

Traffic has a negative impact on the atmosphere as well as on other parts of the environment. It produces 47% of total NO_x emissions, one third of total CO emissions, roughly 6% of total CO_2 emissions and about 10% of total NMVOC emissions. Carbon dioxide emissions increased by 20% between 1990 and 1995 due to a sub stantial increase in road traffic [see Tab. 3.4].

Agriculture

In 1995, there were 4.28 million hectares of agricultural land and 3.16 million hectares of arable land in 1995. About one half of the arable land is used for planting crops. Economic transition and restitution have been in progress in the sphere of agriculture since 1990. The ways in which agricultural land is used do not change significantly. The amount of pastures is increasing. Changes in the sown areas, in the volume of crops harvested, and in the number of livestock, can be seen in Tab. 3.5.

Agriculture's share in the GDP has decreased from 6.5% in 1990 to 4.5% in 1994 and 3.1% in 1995.

The number of livestock (which are a significant source of methane) and the consumption of nitrogen fertilizers (a source of nitrous oxide) are also included in Tab. 3.5.

Table 3.5. Selected indicators for the agricultural sector.

Indicator	1990	1991	1992	1993	1994	1995
Gross production (percent)	100	91	80	78	74	
Areas with grain crops (mill. ha)	1,65	1,62	1,59	1,63	1,75	1,58
Areas with technical-use crops (mill. ha)	0,28	0,31	0,31	0,32	0,36	
Harvested grain crops (mill. t)	8,95	7,85	6,56	6,60	7,21	6,60
Harvested potatoes (mill. t)	1,76	2,04	1,97	2,40	1,23	1,33
Cattle (mill. Heads)	3,36	2,95	2,51	2,16	2,03	1,99
Pigs (mill. heads)	4,57	4,61	4,60	4,07	3,87	4,02
Nitrogen fertilizers (kg/ha)	86,3	46,0	50,0	40,0	57,6	55,6
Herbicides (thous. t)	6,23	4,09	3,16	2,09	2,45	2,41

Source: The Czech Statistical Office and the Ministry of Agriculture

Forestry

In the Czech Republic there are 2.63 million hectares of forested land. The annual volume logged changed between 13.3 million m3 in 1990 and 12.4 million m3 in 1995. Forestry was responsible for 1% of the GDP. All forests in the Czech Republic are heavily affected by human activity. This fact can be seen through the present composition of forests. Norwegian Spruce is the prevailing tree species due to its high quality wood (Norwegian Spruce cover 55% of forested land, while only 11% of these forests was covered by spruce in the forests' natural state). The current state forestry policy aims at increasing the percentage of broad-leaved species (it increased by 3.5% between 1994 and 1995, currently they comprise 27.4% of forested area). Nevertheless, uniform forest stands (monocultures) are responsible for the decreased stability of forests, particularly during extreme climatic conditions. This uniformity also makes them more vulnerable to climatic extremes, insects, parasitic fungi, wind and to snow. As a result of these facts, over 60% of forests in the Czech Republic are, damaged to some extent.

Forested areas with stands partly damaged by emissions decreased from 63% in 1994 to 61.6% in 1995; 57.4 % of this area is only slightly damaged. The improvement is due to higher precipitation levels in 1995 and to the reduction of harmful gaseous emissions. During the winter of 1995/96, some areas (Krušné Mountains in particular) were enormously damaged. In total, 17500 hectars of spruce forests was partly or totally damaged as a result of very negative climatic conditions and high levels of harmful pollutants. Approximately 1.1% of forested land is reforested annually, while 42% of forested land must be reforested twice or even more times. This is mainly the case of broad-leaved species; up to 80% of losses are the result of human influence.

Timber supplies have nearly doubled within the last 60 years in the Czech Republic. Logging has increased in proportion to the increased supply of wood. The greatest amount of logging took place in the mid 1980s - without exceeding logging limits; over the past few years, there has been a significant increase in salvage logging.

Industry

Industry employed 32.5% of the active working population in 1995. The following branches of industry played the most important role in the production of goods (turnover) in 1995: food industry formed 17.9% of total production, metal production and the metal-processing industry were responsible for 16.1% of the total, and production and distribution of electricity, gas and water formed 7.6% of the total production. Despite of the upward trend since 1993, in 1995, industrial production had only reached 75% of the 1990 level. The construction industry differs less from the 1990 level [see Tab. 3.1]. Table 3.6 shows lime and cement production, which is a considerable source of carbon dioxide. Table 3.7 indicates iron and steel production between 1989 and 1995.

Tab.3.6 Cement and lime production between 1988 and 1995.

Year	Cement [thousand tons]	Lime [thousand tons]
1988	6 870,7	2 071,3
1989	6 792,7	2 103,7
1990	6 430,3	1 801,2
1991	5 601,1	1 217,0
1992	6 125,7	1 204,1
1993	5 383,9	1 132,5
1994	5 288,3	1 196,0
1995	4 774,6	1 157,1

Source: The Union of Cement and Lime Producers of the Czech Republic

Ever since new legislative measures have been implemented to limit air and water pollution, as well as the production of solid waste, the environment is being polluted less by the industry sector. Also, the reduction and restructuring of industrial production play both positive roles. The consumption of products that have a detrimental effect on the Earth's ozone layer (substances from Group I, Appendix A of the Montreal Protocol) has decreased by 86% between 1992 and 1995. The total consumption was 2700 tons in 1992, 670 tons in 1994 and 380 tons in 1995.

Tab. 3.7 Iron and steel production between 1989 and 1995.

Year	Raw iron [thousand of tons]	Steel [thousand of tons]
1989	6 396	10 724
1990	6 106	10 098
1991	5 316	7 972
1992	5 082	7 349
1993	4 668	6 732
1994	5 280	7 075
1995	5 289	7 184

Source : The Ministry of Industry and Trade of the Czech Republic

4 INVENTORIES OF ANTHROPOGENIC EMISSIONSAND SINKS OF GREENHOUSE GASES

Introduction

This chapter gives a summary of inventories of greenhouse gases in the Czech Republic. The survey includes the following greenhouse gases: CO_2, CH_4, N_2O, NO_x, NMVOC, CO, HFCs, PFCs, and SF6. The IPCC 1995 Guidelines for National Greenhouse Gas Inventories were used in drawing up the emission balance. Inventories were completed separately for the years 1990 through 1995. The trend in developing an overall balance is followed with reference to the year 1990. Because of slight differences in the methods employed, the original emission balance for 1990 was recalculated; this emission balance was given in the Czech Republic's First Communication (FCCC/IDR.1/CZE).

Emissions of Carbon Dioxide
Table 4.1 gives the values of total emissions and sinks of carbon dioxide in the Czech Republic between 1990 and 1995.

Table 4.1 Total carbon dioxide emissions and removals in 1990-1995 (Gg).

CO_2 emissions						
	1990	1991	1992	1993	1994	1995
Fuel combustion	160 100	148 800	135 600	130 700	123 600	124 600
Industrial processes	5 400	4 300	4 600	4 200	4 100	4 200
Total CO_2 emissions	*165 500*	*153 100*	*140 200*	*134 900*	*127 700*	*128 800*
CO_2 removals						
Land use change	2 300	5 000	6 000	5 600	3 900	5 400
Total CO_2 removals	*2 300*	*5 000*	*6 000*	*5 600*	*3 900*	*5 400*
Total national CO_2 emissions balance						
Total emissions balance	***163 200***	***148 100***	***134 200***	***129 200***	***123 800***	***123 400***

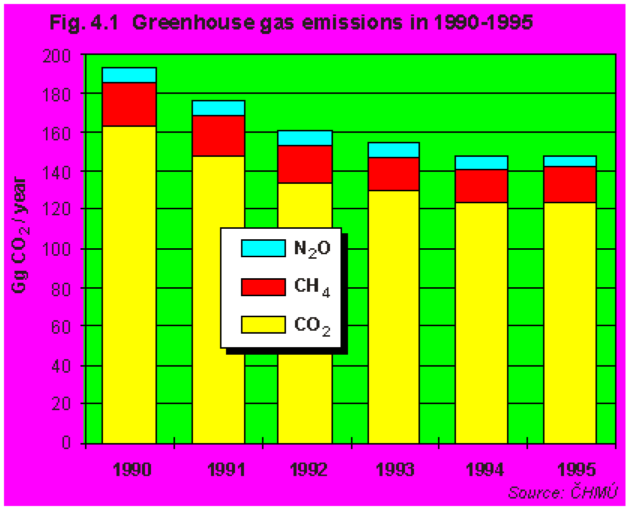
*Source**:** ÈHMÚ, VUPEK*

The inventories were completed with an utmost attempt to employ methods avoiding double counting. The total carbon dioxide balance was drawn up as follows:

In the Fuel Consumption category, overall CO_2 emissions from fuel combustion were determined by the „IPCC Reference Approach“ method. Fuel consumption was based on energy balance as the sum of mined and imported fuels minus the volume of fuel exported and the documented change in fuel stockpiles.

Partial CO_2 emissions from individual sectors of the energy-production industry (see the Summary Tables in Appendix A) were calculated on the basis of actual fuel consumption in individual categories of sources. This approach is also based on the energy balance for the Czech Republic, and constitutes a modified „Detailed Technology-Based Calculation“ procedure; it can be considered as a „top down“ procedure.

Both methods consider the fact that a small amount of fuel is used for purposes other than energy production (e.g. petrochemical raw materials or lubricating oils). For other fuels it is assumed that almost all the carbon is burned to yield carbon dioxide (a correction for unburned carbon is included). The differences in the CO_2 emission values obtained, using the two methods, are minimal and lie within the emission balance's margin of error. Emissions from burned biomass were not included in the total sums, in accordance with the IPCC 1995 Guidelines for Preparation of Inventories of Greenhouse Gases.



Emissions of CO_2, where the carbon is derived from fossil fuels (especially emissions from the production of coke), corresponding to the category of Industrial Processes, are for technical reasons included in the Fuel Combustion sector. In contrast, the Industrial Processes sector consists of emissions derived from the production of hydrogen by gassification of carbonaceous fuels by water vapor and subsequent conversion (gassification of masout), as these emissions are derived from uses other than energy production, and were thus not included in the Fuel Combustion sector.

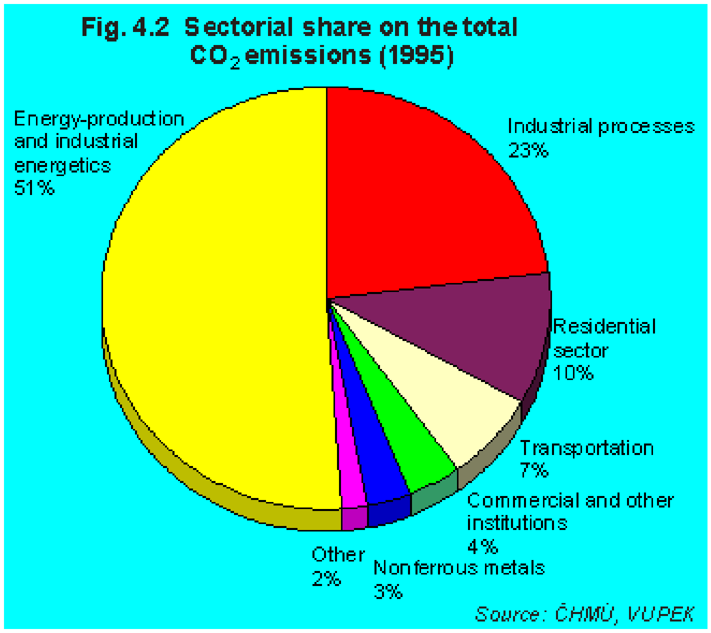
Emissions up to 1993 from centralized heat production (steam and hot water) in heating plants are given in Tab. 4.2 in the Energy and Transformation sector, in accordance with the method employed by the Czech Statistical Office. Following the transition to methods employed by the International Energy Agency (IEA), emissions after 1994 are included in the Industry Sector (with the exception of emissions from the production of heat outside of the plant premises). The overall emission balance includes emissions, or removals, in forest management (Land Use Change and Forestry).

Table 4.2 Energy related CO_2 emissions in 1990-1995 (Gg).

Fuel combustion activities (Gg)						
	1990	1991	1992	1993	1994	1995
Energy and transformation	94 100	90 000	84 500	83 700	61 400	66 600
Industry	23 100	23 300	20 300	17 000	33 400	30 100
Transport	8 000	6 900	8 100	8 300	8 300	8 900
Commercial/institutional	9 500	7 400	6 200	5 900	5 100	4 900
Residential	21 500	19 000	15 400	15 300	13 600	12 600
Agricultural/forestry	4 900	3 600	2 200	1 700	1 900	1 500
Total energy related CO_2 emissions [1]	***160 100***	***148 000***	***135 600***	***130 400***	***123 600***	***124 600***

[1] determined by the "IPCC Reference Approach" ; other data were calculated using a modified " Detailed Technology-Based Calculation" procedure

Source: ÈHMU, VUPEK



Tab. 4.2 and Fig. 4.2 inform on CO_2 emissions from energy production (Fuel Combustion); Tab. 4.3 gives emissions from non-energy production (Industrial Processes), classified according to the individual sectors of economic activity. Emission values are based on information on fuel consumption from the Czech Statistical Officeís energy balances, following conversion to the internationally comparable IEA method (in the entire balance range from 1994). The emission factors employed were taken from the IPCC Guidelines for Preparation of Inventories of Greenhouse Gases, 1995.

Table 4.3 Non-energy related CO_2 emissions in 1990-1995 (Gg).

Indusrtial processes (Gg)						
	1990	1991	1992	1993	1994	1995
Iron and steel (incl. coke production)	3091	2735	2432	2238	2531	2541
Inorganic chemicals	509	489	471	518	518	540
Non-metallic mineral products	4908	3846	4120	3672	3596	3630
Total CO_2 emissions from industrial processes [1]	***5417***	***4335***	***4591***	***4190***	***4114***	***4170***

1 except for iron and steel

Source: ÉHMU, VSCHT

More detailed results corresponding to individual sectors are given in Appendix A. Combustion processes are the primary ways by which carbon dioxide is formed, producing more than 95% of total emissions. A significant amount of carbon dioxide is also created through cement production. The only way to remove carbon dioxide in the Czech Republic is to increase the biomass of forested land. National studies in the Czech Republic indicate that the amount of carbon removed is always less than 5% of the overall amount of carbon dioxide emitted.

The trend in CO_2 emissions is apparent from Tab. 4.4 and Fig. 4.1, in which a decrease of 24.5% in the Czech Republic's overall carbon dioxide emissions can be seen between 1990 and 1995.

Studies determining the carbon dioxide emission balance have been among the most precise so far; the margin of error (8-10%) is comparable to that of the Czech Republic's overall energy balance studies.

Table 4.4 Trends in CO_2 emissions in the Czech Republic in 1990-1995.

	1990	1991	1992	1993	1994	1995
Total CO_2 emission balance *(Gg)*	163 200	148 100	134 200	129 200	123 800	123 400
Percent. change comp. to 1990	**100**	**90,8**	**82,2**	**79,2**	**75,9**	**75,5**

Source ÈHMÚ, VUPEK

Emissions of Methane

The method employed to determine the overall emission balance of methane in the Czech Republic is based on the standard IPCC method. The main source of methane in the Czech Republic is mining, post-mining treatment and the distribution and processing of all kinds of fossil fuels, i.e. brown and black coal, lignite, petroleum and natural gas (more than 50%); approximately the same amount of emissions are derived from agricultural production (enteric fermentation, animal waste) and waste management (less than 20%).

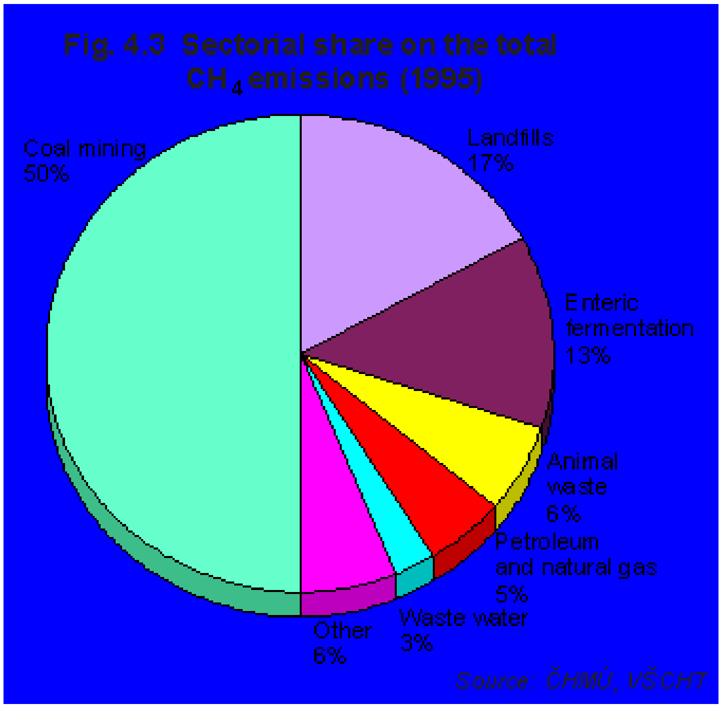
The preparation of inventories of methane from fugitive processes was mostly based on emission factors that are valid for local conditions. Emissions were determined in the agriculture and waste sectors using emission factors from domestic sources. If emission factors of domestic origin were not available, then the „Default“ values from the IPCC guidelines recommended for developed countries or for Western Europe were used. This corresponds to the development of the Czech economy, the geographical position and climatic conditions.

Tab. 4.5. and Fig. 4.3 inform on methane emissions classified on the basis of selected activities between 1990 and 1995. More detailed information based on IPCC 1995 Guidelines for Preparation of Inventories of Greenhouse Gases, can be found in Appendix A.

Table 4.5 Methane emissions and sinks in 1990-1995 (Gg).

	1990	1991	1992	1993	1994	1995
Energy, total	519	466	439	428	417	437
Fuel combustion	59	50	41	39	44	32
Fugitive fuel emissions	460	416	399	388	373	405
Coal mining	427	381	363	353	338	367
Oil & natural gas	32	35	36	35	35	38
Industrial processes	14	12	11	10	12	12
Agriculture, total	204	186	169	148	139	139
Enteric fermentation	156	138	122	106	100	99
Animal waste	48	48	47	41	39	40
Land use & forestry	2	2	2	2	2	2
Waste, total	149	148	147	144	144	144
Landfills	125	125	125	125	125	125
Waste water	24	24	22	19	19	19
Total CH_4 emissions	**888**	**814**	**768**	**732**	**713**	**733**

Source: ÈHMÚ, VŠCHT



The trend from 1990 to 1995 in the CH4 emission balance can be found in Tab. 4.6. Emissions reached a minimum in the Czech Republic in 1994, when an almost 20% reduction in overall methane emissions compared with 1990 occurred. Overall emissions increased by 2% to 1995; in relation to the estimated margin of error, this can be taken to indicate a practically constant state for the years 1993 to 1995.

There is still insufficient information to calculate the margin of error for the CH_4 emission balance. In the agriculture sector, for example, a 20-30% margin of error can be estimated in determining emissions from enteric fermentation, while the margin of error for fuel mining data is roughly 40-50%. The margin of error for determining the overall emissions balance for methane can be estimated at about 40%.

Table 4.6 Trends in CH_4 emissions in the Czech Republic in 1990-1995.

	1990	1991	1992	1993	1994	1995
Total CH_4 emissions (Gg)	888	814	768	732	713	733
Percent. change comp. to 1990	**100**	**91,7**	**86,5**	**82,4**	**80,3**	**82,5**

Source: ÉHMU, VSCHT

Emissions of Nitrous Oxide

Compared with the previous greenhouse gases, sources and sinks of nitrous oxide are not defined exactly. Although a certain amount of progress in recognizing relevant sources has been made since 1993, when the first N_2O inventories were carried out in the Czech Republic, there are still a great many unidentified sites (e.g. the formation of N_2O as a consequence of high NOx concentrations in the boundary layer of the atmosphere). This is also true for the current knowledge about relevant emission factors, that are particularly valid for processes in the agricultural sector.

The greatest source of N_2O originates from combustion processes, particularly the combustion of coal (about 70%). The emission factor employed was taken from the CORINAIR method. However, latest research indicates that the value used for this factor is probably higher than that corresponding to the combustion facilities and fuel used in the energy-production industry in the Czech Republic. Thus the values for the N_2O balance given are apparently higher than the real values. Emissions from combustion processes in transportation should be mentioned. The current rounded-off emission inventory value equals 1 Gg N_2O p.a. However, it has been shown that increased use of three-way catalyzers increases the amount of N_2O emitted.

As the Czech Republic has in the last few years seen a rapid increase in the use of three-way catalyzers, we consider it important that this subject should be placed as a priority research item in the near future.

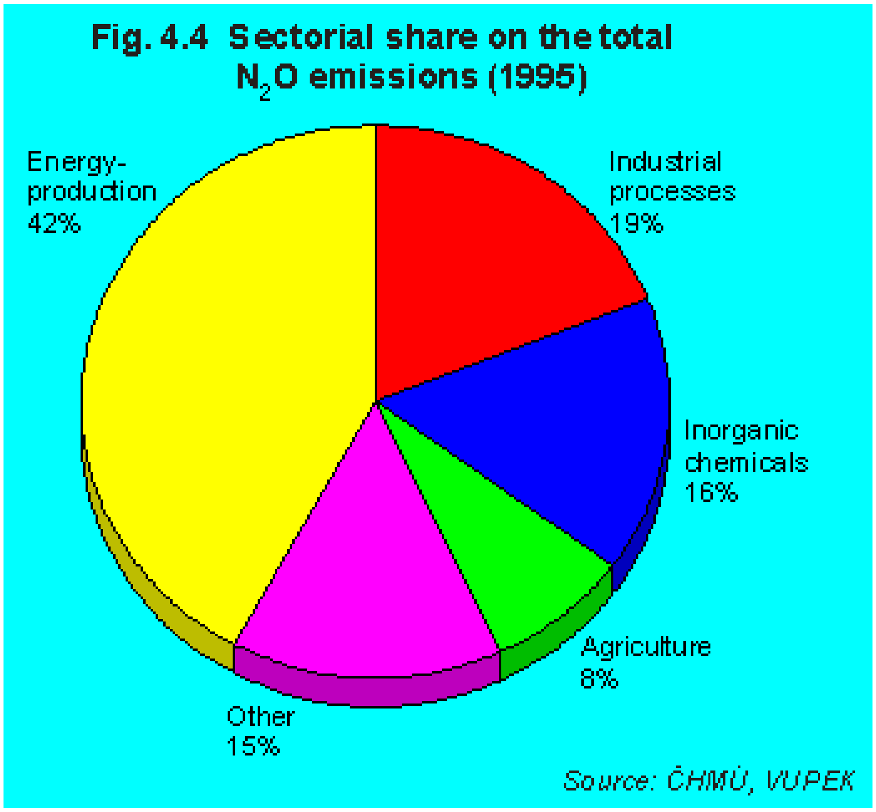
Tab. 4.7 and Fig. 4.4 inform on nitrous oxide emissions, classified according to the relevant activities of the sectors for the years 1990-1995. More detailed information can be found in Appendix A. As in most countries, the margin of error for absolute values of emissions of this greenhouse gas in the Czech Republic is undoubtedly the highest of all and equals about 80-100%.

Source: ÉHMU, VSCHT

Table 4. 7 Nitrous oxide emissions in 1990-1995 (Gg).

	1990	1991	1992	1993	1994	1995
Energy / *Fuel combustion*	21	18	17	16	17	17
Industrial processes / *Inorganic chemicals*	3	3	4	3	3	3
Agriculture / *Agricultural soil*	2	2	2	2	2	2
Total N_2O emissions	**26**	**23**	**23**	**21**	**22**	**22**

Source: ÉHMU, VUPEK



The trend in the changes of the N_2O emissions balance over this period is apparent from Tab. 4.8. The values given indicate that there was an approximate 10% reduction in emissions after 1990; nonetheless, this number cannot be viewed as very significant because of the above-mentioned high margin of error.

Table 4.8 Trends in N_2O emissions in the Czech Republic in 1990-1995.

	1990	1991	1992	1993	1994	1995
Total N_2O emissions *(Gg)*	26	23	23	21	22	22
Percent. change comp. to 1990	**100**	**88**	**88**	**81**	**85**	**85**

Source: ÈHMÚ, VUPEK

Other Gases Important for the Greenhouse Effect

Tab. 4.9 shows the overall emissions of other gases which are either precursors to the formation of ground-level ozone (NO_x, NMVOC and CO) or have elevated radiation properties (HFCs, PFCs and SF6). Detailed information for NO_x, CO and NMVOCs is given for the individual activity sectors in Appendix A.

Combustion processes in the energy production industry remain the chief source of NO_x emissions in 1990 (over 50%), with about a 30% contribution from transportation. Over the years this ratio has changed. In 1993 and 1994, these two activity sectors contributed almost equal amounts. In 1995 the contribution from transportation predominated (about 45%), while the fraction from the energy production sector decreased to about 30%.

Table 4.9 Total NO_x, CO, NMVOC, HFCs, PFCs a SF_6 emissions in the Czech Republic in 1990-1995.

	1990	1991	1992	1993	1994	1995
NO_x [Gg]	742	725	698	574	435	412
CO [Gg]	1055	1102	1045	967	1026	874
NMVOCs [1] [Gg]	311	243	234	229	263	241
NMVOCs [2] [Gg]	*435*	*398*	*359*	*338*	*310*	*286*
HFCs [Mg]	0,0	0,0	0,0	0,0	0,0	0,7
PFCs [Mg]	0,0	0,0	0,0	0,0	0,0	0,0
SF_6 [Mg]	2,5	2,5	2,5	2,5	2,5	2,6

[1] emissions according to the IPCC method *Source: ÈHMÚ, VŠCHT, Ministry of the Environment*

[2] emissions given in the CR inventories for EEC

The stationary sources in the fuel combustion sector remain the predominant source of CO emissions; here emissions from local heating systems predominate. The second main source is the transportation sector, which is becoming increasingly important.

The largest fraction of overall NMVOCs emissions comes from the solvent use sector (more than 50%) and the second largest amount is derived from combustion processes, where transportation and local heating units make approximately equal contributions (15-10% each).

It can be seen from Tab. 4.9 that the emissions of these other substances affecting global climate exhibit a decreasing tendency. Total NO_x emissions decreased by about 40% over the evaluated period and CO emissions decreased by about 15%, compared with 1990. A slight increase can also be observed for NMVOCs.

However, at the present time it is not possible to attribute greater significance to the observed trends in NO_x and CO emissions, as they are to a certain degree distorted by changes in the method of determining emissions in the national database system. This is especially true of NO_x emissions, where there was a considerable increase in the amount of directly measured emissions between 1990 and 1995, especially for high-capacity stationary sources.

In order to relate the emission inventory data summary to the data that the Czech Republic provides within

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Source: ÈHMÚ, VUPEK

Other Gases Important for the Greenhouse Effect

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HFCs [Mg]	0,0	0,0	0,0	0,0	0,0	0,7
PFCs [Mg]	0,0	0,0	0,0	0,0	0,0	0,0
SF_6 [Mg]	2,5	2,5	2,5	2,5	2,5	2,6

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In order to relate the emission inventory data summary to the data that the Czech Republic provides within

the framework of regular annual inventories for the UN Economic Commission for Europe (according to the working plan for implementation of the Convention on Long-Range Transboundary Air Pollution) calculations of all relevant NO_x and CO values compared to the year 1990 were again carried out. Similar recalculations for NMVOCs have not yet been carried out due to lack of time and available technology, and thus Tab. 4.9 gives both values. Methodical harmonization will be the subject of research in the Czech Republic in the immediate future.

Emission inventories were complemented by estimates of HFCs, PFCs and SF6 emissions based imports, exports and consumption of these substances in the Czech Republic. Sulfur hexafluoride (SF6, GWP = = 23900) is not produced in the Czech Republic and is used in limited amounts in the electrotechnical industry (production of electrical distribution equipment). Consumption of this substance between 1990 and 1995 varied between 5 and 7 Mg p.a., and emissions from the production of new equipment and servicing totaled at maximum 2.6 Mg p.a. (equivalent to 62 Gg of CO_2). Also HFCs are not produced in the Czech Republic and only HFC 134a (GWP = 1300) is used as a medium for refrigeration facilities. Emissions in the production of equipment and its servicing are estimated at 0.75 Mg p.a., corresponding to 1 Gg CO_2. PFCs are not produced or used in the Czech Republic at all.

Aggregated Emissions of Greenhouse Gases

The emission of individual greenhouse gases can be expressed in an aggregated form taking into consideration their various radiation properties. The global warming potential (GWP) values were used for comparison, for a time period of 100 years, based on the latest IPCC data for 1995 (Tab. 4.10). The trend in aggregated emissions for the Czech Republic can be seen from Tab. 4.11. There was a near 25% reduction between 1990 and 1995; this reduction was greatest between 1990 and 1993 (20%). Following 1993 the reduction became slower and stopped completely in the last evaluated year.

Table 4.10 GWP values used for aggregated emission balances.

Greenhouse gas	CO_2	CH_4	N_2O
Global warming potential (GWP)	**1**	**24,5**	**320**

Source: IPCC

Table 4.11 Aggregated emissions of CO_2, CH_4 and N_2O in the Czech Republic in 1990-1995.

	1990	1991	1992	1993	1994	1995
CO_2 [Gg]	163 200	148 100	134 200	129 200	123 800	123 400
CH_4 [Gg]	21 800	19 900	18 800	17 900	17 500	18 000
N_2O [Gg]	8 200	7 500	7 200	6 800	6 900	6 900
$(CO_2)_{eq}$ [Gg]	**193 200**	**175 500**	**160 200**	**153 900**	**148 200**	**148 300**
$(CO_2)_{eq}$ [% 1990]	***100***	***90,9***	***82,9***	***79,7***	***76,7***	***76,7***

Source: HMÚ, VUPEK, VŠCHT

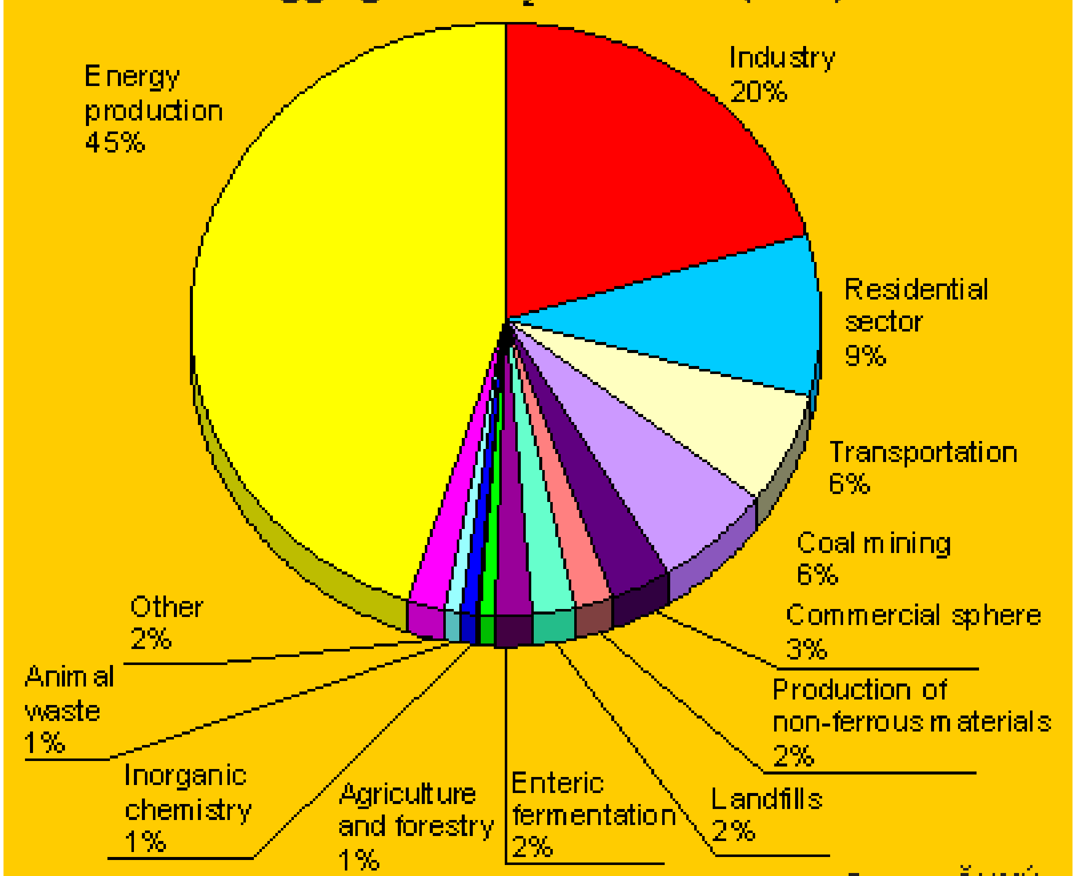
Table 4.12 Percentage contribution of main greenhouse gase emissions in the CR in 1990-1995.

	1990	1991	1992	1993	1994	1995	*Average value*	*Standard deviation*
CO_2 [%]	84,5	84,4	83,8	83,9	83,6	83,2	***83,9***	***0,4***
CH_4 [%]	11,3	11,4	11,8	11,6	11,8	12,1	***11,7***	***0,3***
N_2O [%]	4,2	4,2	4,4	4,5	4,6	4,7	***4,4***	***0,2***

Source: ÈHMÚ

The contributions of the individual greenhouse gases to the overall balance is given in Tab. 4.12. The last two columns give the average values for the 1990-1995 period and the corresponding standard deviation. It is apparent from the values that the contribution of individual greenhouse gases to the overall value of aggregated emissions did not change significantly over the evaluated period. The share of individual source categories for total aggregated emissions can be seen in Fig. 4.5.

Fig. 4.5 Sectorial share on total aggregated CO_2 emissions (1995)



Source: ČHMÚ

5.PROJECTION OF GREENHOUSE GAS EMISSIONS

The results of the inventory of greenhouse gases show that an approximate total of 84% of all greenhouse gas emissions consist of CO_2, with the largest source of CO_2 coming from combustion processes (approx. 97% of all CO_2 emissions). For this reason, the following text will mainly discuss the future projection for CO_2 emissions from combustion processes, since these comprise 82% of total greenhouse gas emissions (Tab. 4.1). Another 4% of greenhouse gas emissions (and a part of N_2O and CH_4 emissions) also originate from this source, largely in proportion to CO_2 emissions. Methane emissions (6%) from coal mining for the energy sector, as well as CO_2 emissions (3%) from iron, steel and cement production are also proportional to activities in the energy sector. The remaining 5% of all greenhouse gas emissions consist of emissions from agriculture and waste, which have nearly no relevance to the energy sector.

Methodology for Projections on CO_2 Emissions from Combustion Processes

The Czech Republic's updated energy policy outlines the energy-supply, -production and -use conditions for the next ten-fifteen years. It does not contain a projection of power production and consumption. For this reason, the following CO_2 emission projections are based on estimates by various authors, who together cover a wide spectrum of possibilities for future development. Two scenarios from opposite ends of the spectrum have been chosen, with the idea that real development will take place at some mid-point.

The base scenario, or „most unfavorable development“ scenario, has the highest volume of emissions. It is characterized by fast economic growth and a lack of both restructuring and new measures. This scenario is an adjustment of the projection used in the Czech Republic's First Communication. It takes into account the two main factors which will substantially limit CO_2 emissions in the following three years, and which were referred to marginally in the First Communication. These are:

the opening of the Temelín Nuclear Power Plant (2 x 1000 MWel)

the consistent enforcement of emission limits as outlined in the Clean Air Act and subsequent decrees

The „favorable development“ scenario outlines a path of development with the lowest volume of expected emissions. It shows emission estimates under the most favorable circumstances, i.e. in a situation where not only natural market incentives for energy savings would exist, but other considerations would also come into play (see chapter 6 C). However, it is very difficult to estimate the influence of individual factors and their possible synergy. The resulting projection is therefore a unified scenario without a specification of the impact of individual measures.

The presented projection was carried out for the years 1996-2010. Results forecasted for years past 2010 are considered speculative, because of the substantial uncertainties connected to the present economic transition.

The projection methodology consists of the following:

1.A prognosis for the national economy's development, which sets the expected development of the total GDP as well as its structure in economy sectors. The prognosis includes an estimate of the population and employment developments.

2.A demand for final energy consumption, derived from the national economy's prognosis, and an estimate of all necessary technological and economical parameters.

3.A prognosis of the structure and the necessary installed energy production capacity controlled by the demand for final energy consumption within given limits. The result is the consumption of primary energy sources (PES), from which CO_2 emissions are calculated.

The first step, a projection of macroeconomic development, is the most complicated and least reliable part of the projection, for the following reasons:

The substantial drop in both the GDP and the majority of other macroeconomic figures from 1990 to 1993 disqualify, a priori, the prediction methods based on time series.

Changes in the State Administration and changes in statistical methods, together with changes in ownership, cause a less reliable statistical data.

After 40 years of endlessly creating prognoses for a planned economy and seeing these prognoses unfulfilled, many experts are unwilling to make any predictions.

The parameters which set the final energy consumption assessed in the second step, influence the emission projection approximately to the same extent as the GDP projection. These are expert estimates based on large quantities of data, which describe:

The energy consumption in various sectors, dependent on the macroeconomic and demographic quantities or quantities characterizing development in the given industry;

The energy intensity of a process in various sectors;

The efficiency of actual or hypothetical devices, where the demand is characterized by useful energy consumption.

It is necessary that the value of all these parameters be assessed during the whole projected period. As with macroeconomic quantities, prediction methods based on time series cannot, in most cases, be used.

The third part of the projection is less uncertain than the first two. This is due to the fact that there is substantial inertia in energy sources (i.e. large equipments have a long life). In this step, several technological models for energy such as MARKAL, EFOM, LEAP were used; MARKAL played a key role. General equilibrium model or technological models with an economic superstructure (providing feedback between the energy sector and other areas of the economy) were not used in this projection.

Expected Development of the National Economy

A continual growth in GDP is expected from 1995 to 2010. According to several independent estimates, it will range from 3-6%. The development of the GDP branch structure is interpolated between the present and target structures. By the last year of the prognosis (2010), this structure should approach that of developed market economies. The main change is a decrease in industry share, from 57% (1990) to 45% (2010), which is compensated by an increase in trade and services (from 27% to 42%). Other areas remain the same: construction industry 7-8%, transport 2-3%, and agriculture 4-5%.

In the base scenario, the GDP growth (4.7% per year on an average) is not connected with economic restructuring. The base scenario follows the idea of extensive national economic development which slowly substitutes coal with gas fuels and rising exports with low added value. Furthermore, we anticipate that the population will remain constant according to the Czech Statistical Office’s projection, which only envisages a change of several tenths of a percent. The number of economically active citizens compared with the number of working age citizens decreased from 89 to 81% in 1991-1993; this percentage is expected to remain constant in the upcoming period.

Projection for Final Energy Consumption, Primary Sources and Emissions

The expected development of aggregate energy intensity is shown in Figure 5.1. This projection is a result of an estimate of a large group of quantities which determine energy consumption (energy intensity of individual processes and subsectors as well as the efficiency of appliances). Due to this expected development of energy intensity, final energy consumption follows the GDP growth at an approximated 2% slower pace.

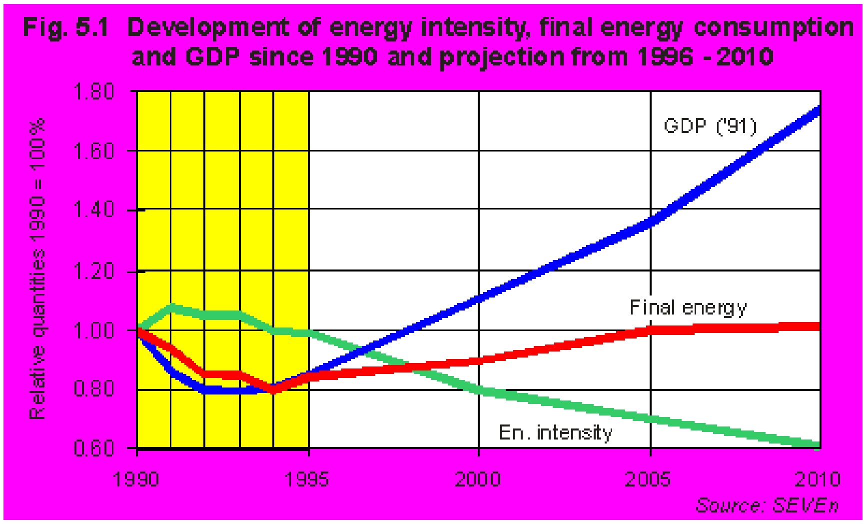


Fig. 5.1 Development of energy intensity, final energy consumption and GDP since 1990 and projection from 1996 - 2010

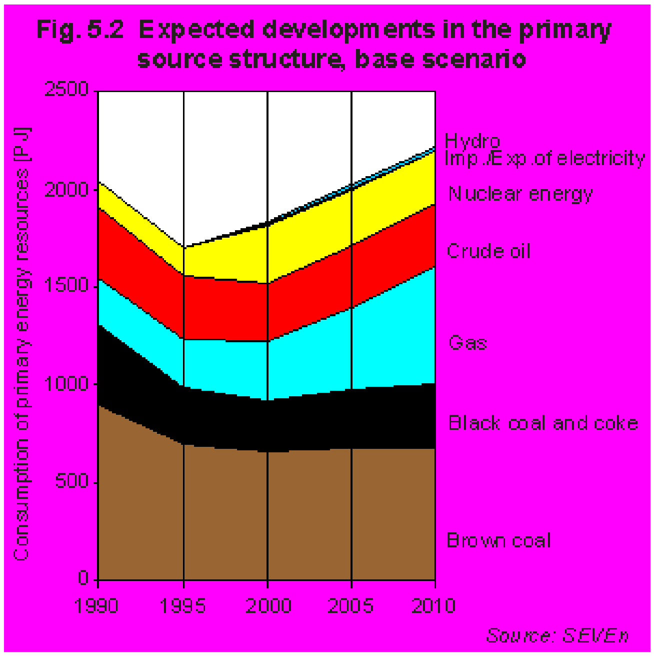


Fig. 5.2 Expected developments in the primary source structure, base scenario

Figure 5.2 shows the results of calculations of consumption of primary energy sources performed for the base scenario. Similar to the final energy consumption, the consumption of primary energy sources will grow at a slower rate than the GDP. This figure shows the expected development of the fuel structure. Essential changes that may be expected from 1997 to 2010 are as follow:

The decrease in coal consumption (mainly brown coal) in 1990-1995 will be followed by a slight increase in the next five years and will then stabilize;

The increased energy consumption is mostly covered by gas and nuclear power.

Because the import and export of electricity and secondary liquid fuels (mainly motor fuels) is relatively small, CO_2 emissions are determined by the structure and volume of primary energy consumption.

The IPCC inventory methodology defines categories of CO_2 emission sources. Distribution of emission sources according to this methodology is shown in Fig. 5.3. We must point out however, that IPCCís classifications do not provide a very good representation of the influence on emissions of individual sectors in the national

economy; for example, all emissions from electricity production are calculated in the energy transformation sector, not just those arising from energy consumed by that sector. Total CO_2 emissions projections, for both combustion processes and industrial technologies, for both scenarios are shown in Fig. 5.4.

Fig. 5.3 CO_2 emissions from combustion processes, acording to the IPCC inventory, base scenario

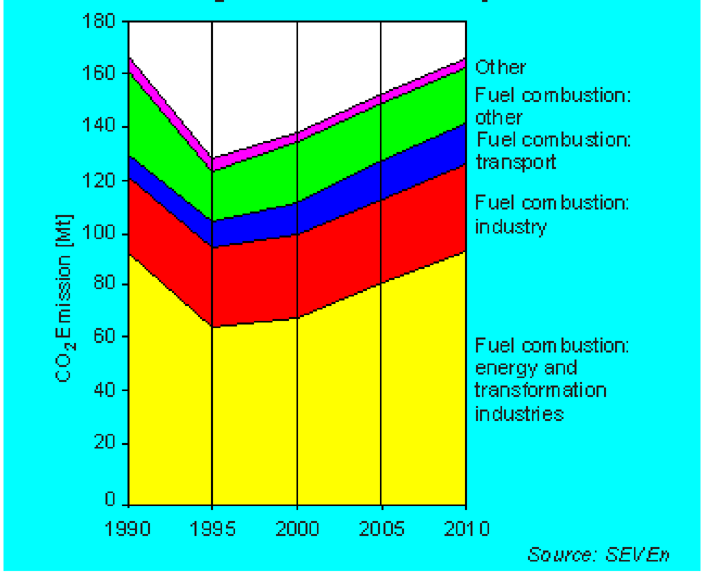
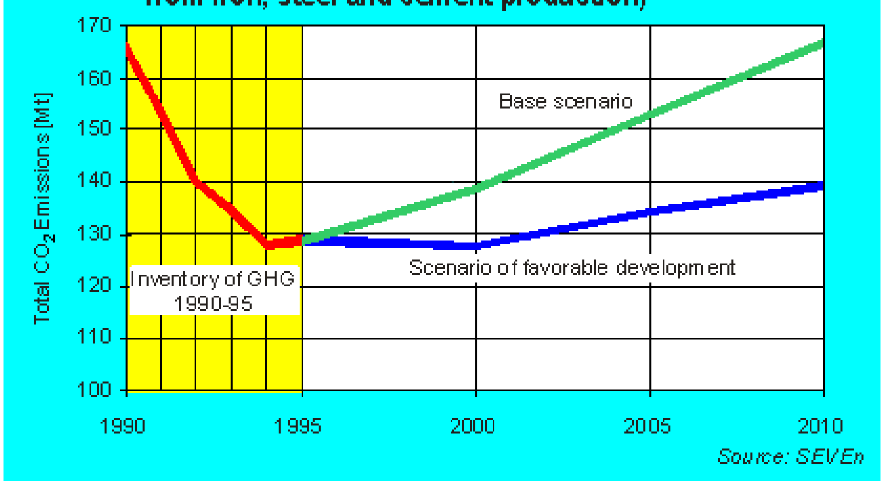


Fig. 5.4 Development of total CO_2 emissions according to the base scenario and the favorable development scenario (combustion processes and technological emissions from iron, steel and cement production)



Projection of CO_2 Emissions from Other Sources Aside from combustion processes, there are two other significant sources of CO_2 emissions in the Czech Republic: the production of iron and steel, and the production of cement. These sources combined, however, form only 3% of the total CO_2 emissions. The projection for CO_2 emissions from steel production technology corresponds to the expected slight drop in steel production, but to an increase in cement production. For this reason, their combined production remains at the same level as it was in 1995. The summary projections of CO_2 emissions can be seen in Tab. 5.1.

Methane and Nitrous Oxide Emissions

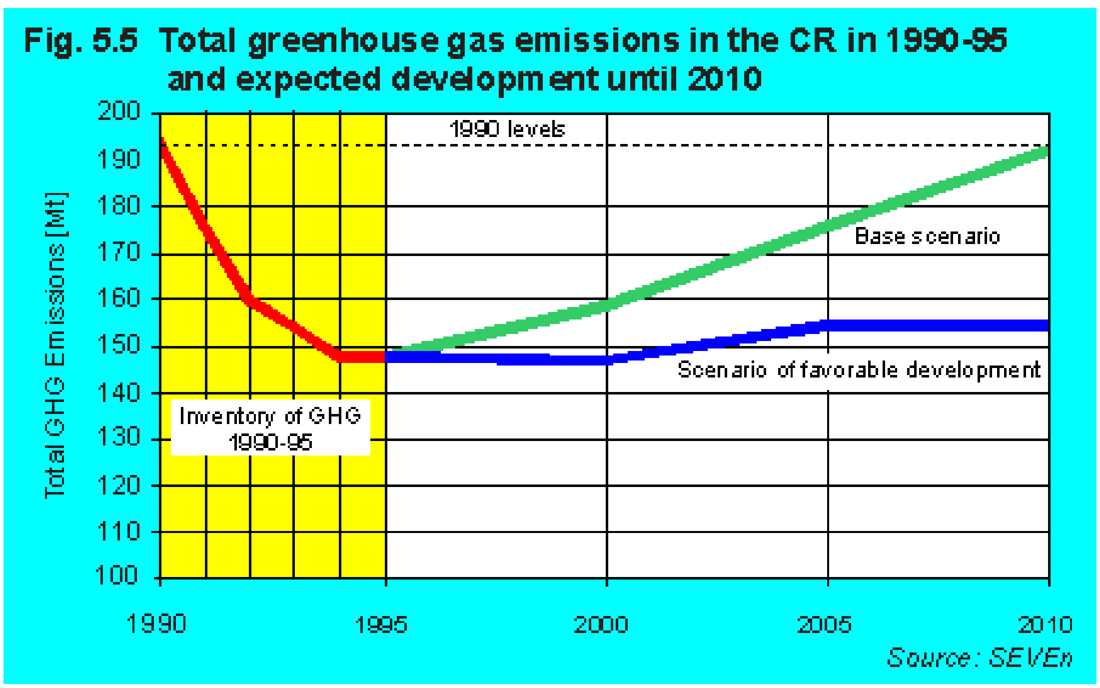
The values of emission coefficients for methane and N_2O from combustion processes are quite uncertain and for this reason the inventory results are not very reliable. Because of the great amounts of fuel combusted, methane and N_2O emissions form a total of approximately 5-10% of all greenhouse gas emissions, expressed as CO_2 emission equivalents (see Tab. 4.11). We assume that their amount is proportional to the primary energy source consumption.

Fugitive methane emissions form roughly 6% of the total greenhouse gas emissions. While a negligible amount is produced from the mining of oil and natural gas, methane is mostly emitted during the mining of black coal. This is why the amount of fugitive emissions from 1995-2010 is expected to be proportional to the volume of hard coal mined.

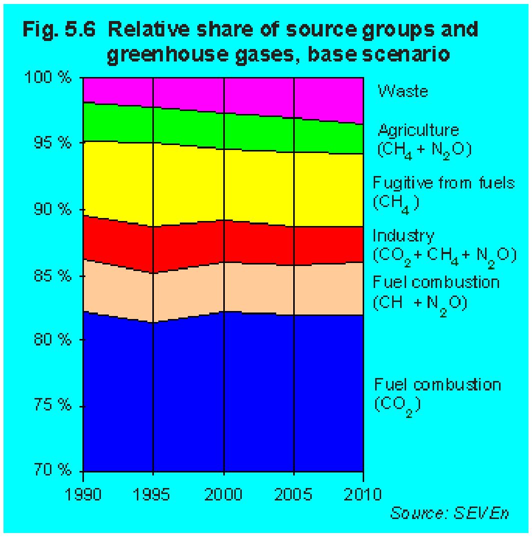
The second largest source of methane emissions is agriculture; 3% of annual methane emissions are formed in this sector, while N_2O emissions are negligible. After the decline in agricultural production at the beginning of the 1990s, we expect the level of emissions to remain stable after 1995. Methane emissions from waste are 25% smaller than those from agriculture. We assume they will increase with the growth of the GDP. The summaries of projections of CH_4 and N_2O emissions are shown in Tab. 5.2 and 5.3.

Total Emissions Projection

The values of CO_2, CH_4, and N_2O emissions, from all the aforementioned sources, were combined by means of the global warming potential (GWP = = 24.5 for CH_4 and 320 for N_2O); their expected development for both scenarios from 1990-2010 is shown in Tab. 5.4 and Fig. 5.5.



Assumptions for the base scenario were described in detail in the above text. The favorable development scenario differs in a lower (3%) GDP growth rate, a greater decrease in energy intensity as a natural result of restructuring, and in its significant contribution to governmental environmental policy measures. The development of emissions is similar to that in the base scenario, the difference being that growth of emissions begins later than growth of the GDP and energy consumption. This is mainly as a result of consistent adherence to emission limits and the stopped increase in consumption of electricity for heating in residential and commercial sectors. Fairly constant emissions are expected after 2005 as a result of consistent state policy on energy prices. The difference between the two scenarios increases from 1995 to 2010, up to 43 Mt of CO_2 (i.e. 22% of total 2010 emissions).



Tables 5.1 - 5.4 Total greenhouse gas emissions in 1990, 1995 and projections towards 2010.

	CO_2 emissions in Tg (Mt)				
Table 5.1. Summary of projections of a antrophologenic emissions of $C0_2$	1990	1995	2000	2005	2010
Fuel combustion: energy and transformation industries	94	67	70	83	83
Fuel combustion: industry	28	29	30	30	32
Fuel combustion: transport	9	10	12	14	15
Fuel combustion: other	31	19	22	21	20
Other	5	4	4	4	4
Total	**26**	**23**	**23**	**21**	**22**

Note: CO_2 emissions differ from values in Table 4.1 (source #HM/) in 1990 and 1995. This is caused by different calculation methodologies used. However, differences do not exceed expected confidential limits.

	CH_4 emissions in Gg (kt)				
Table 5.2. Summary of projections of a antrophologenic emissions of CH_2	1990	1995	2000	2005	2010
Fuel combustion:	59	32	34	40	45
Fugitive emissions from fuels	460	405	351	420	442
Industrial processes	14	12	12	12	12
Enteric fermentation	156	99	118	118	118
Animal waste	48	40	47	47	47
Rice cultivation	0	0	0	0	0
Waste	149	144	181	228	287
Other	0	0	0	0	0
Total	**26**	**23**	**23**	**21**	**22**

Table 5.3. Summary of projections of antrophogenic emissions of N_2O	N_2O emissions in Gg (kt)				
	1990	1995	2000	2005	2010
Transport	1	1	1	1	1
Other energy sources	19	15	16	18	20
Industrial Processes	3	3	3	3	3
Agriculture	2	2	2	2	2
Waste	0	0	0	0	0
Other	0	0	0	0	0
Total	25	21	22	24	26

Table 5.4. Summary of projections of antrophogenic emissions & sinks of GHGs	GHG emissions in Tg (Mt) of $CO_{2\ eq.}$				
	1990	1995	2000	2005	2010
CO_2	167	129	139	153	166
CH_4	22	18	18	21	23
N_2O	8	7	7	8	8
Total emission	197	154	164	182	198
CO_2 Sink in Forests	-2	-5	-5	-5	-5
Total Emission & Sink	194	148	158	176	192

Source: SEVEn

6.EMISSION MITIGATION MEASURES

At the outset, it should be mentioned that most of the measures that have been introduced and which are under consideration, are measures introduced primarily as a part of economic transformation or as a part of the State Environmental Policy of the Czech Republic. This framework document outlines a general long-term environmental protection strategy, containing the essential principles and goals of environment protection in the Czech Republic. Immediate priorities include:

Improvement of air quality through a reduction of emissions;

Improvement of water quality by limiting emitted pollutants;

Reduction of waste production, particularly hazardous waste;

Elimination of physical and chemical products dangerous to human health;

Cleanup of old ecological burdens (as the highest priority)

The State Environmental Policy's long-term priorities for environmental protection are the following: protection of the global climate by reduction of greenhouse gas emissions, protection of the Earth's ozone layer and the protection of biodiversity. The global climate protection is to come about specifically through a change in the structure of primary energy sources, a decrease in energy demand, and support for energy savings and reforestation. The efforts to limit greenhouse gas emissions should therefore be seen in the broader context of solving the Czech Republic's urgent environmental problems, for which about 2.5 to 2.7% of the GDP is spent annually.

In addition to this, the Czech Republic is harmonizing its legislation with EU legislation and is actively participating in various international studies focused on mitigating the impact of climate change. As a result, the Czech Republic is cooperating increasingly with EU member countries, OECD countries and a number of other Central European and East European countries (CEECs). A comparison of the Czech Republic's situation with that of other industrially developed countries, shows that a flexible set of economic and information tools are needed to mitigate the negative impact of climate change. Specifically, these tools are the following: liberalization of the energy market, support of effective energy use, use of cleaner fuels and alternative energy sources, and development of new, more effective technologies.

This chapter of the Second Communication is divided into two parts: Sections A and B discuss the measures mentioned in the Czech Republic's First Communication. Section C outlines new measures and follow-ups of already adopted measures.

A. Evaluation of Measures Mentioned in the Czech First Communication

A brief evaluation of the measures outlined in the First Communication of the Czech Republic will be presented in this part, with an explanation of how each was implemented. With the exception of compulsory measurements of energy consumption, all measures listed below were implemented. Measure A3, entitled „Programme for Heat Savings in Residential Buildings“ is assessed in the broader context of the Czech Energy Agency's activities. Aside from both Measure A1 (which was included in the base scenario) and the opening of the Temelin nuclear power plant, the greatest reduction in carbon dioxide emissions will be seen through Measures A3, A6, A7, and A10. The implementation of these measures should, by the year 2000, reduce carbon dioxide emissions by about 5 Mt per annum (a reduction of approx. 3%).

1. Clean Air Act No. 211/1994

Strict emission limits apply only to new sources until January 1, 1999. The total influence of this measure cannot be assessed until after this date. For the time being, the influence can only be assessed on the basis of the changing fuel structure used for the production of heat and electricity. The influence of this measure was included in the base scenario.

2. Compulsory Measurement of Energy Consumption

The Economy Ministry’s Decree No. 186/1991 - stating that landlords of houses using heat from a central source must measure the consumption of heat in absolute values at the building’s entry, and in relative values on radiators - was substituted by the Trade and Industry Ministry’s Decree No. 245/1995 (accompanying Act No. 222/1994 „on the conditions of enterprise and administration in the energy sector“). For this reason, a quantitative evaluation of the measure cannot be calculated. What was once a duty, has been changed to a recommendation.

3. The Czech Energy Agency (CEA)

CEA was founded by the Minister of Industry and Trade on September 1, 1995, as a publicly funded organization carrying on the work of the former Energy Agency, which was in existence in Czechoslovakia and later the Czech Republic. CEA’s main mission is to encourage and carry out activities aimed at energy savings, and mitigate negative environmental impacts due to the consumption and conversion of all kinds of energy.

State subsidy projects provide financial support for energy efficiency demonstration projects. The results of technically and economically successful and proven projects are published and distributed on a mass scale to attract future investors and to facilitate their decision to implement certain technologies.

CEA organizes programmes which:

Reduce energy consumption in public and residential buildings, as well as buildings used by the education and healthcare sectors;

Utilize greater amounts of renewable and alternative energy sources;

Implement cogeneration in small and medium-sized heat production sources;

Optimize energy supplies of residential areas;

Save energy in industry, agriculture and transport.

Other CEA programmes:

Consultation, advertising, creating educational materials for experts and for the general public, in the aforementioned fields;

Supporting the formulation and establishment of energy concepts for towns and regions.

The total amount of energy savings from 1991-1995, as a result of such programmes, is approximately 11000TJ. Roughly 557 thousand apartment units were improved through various technological measures. The reduction of CO_2 emissions in the years 1991-1995 is estimated at 1.64 million tons, as a result of the implementation of subsidized projects. A total of 1700 applications for support were received in 1996-1997, but the demand is four times greater than the supply of CEA funds. Thus CEA will continue to seek other ways of making the general public interested in both energy savings and the reduction of atmospheric pollutants from emissions caused by energy combustion processes.

4. The Czech National Council’s Act. No. 588/1992 on the Value Added Tax

This act, in its most recent amendment, which sets a lower value added tax rate for „environmentally-friendly items“, is in effect. Because the Act is influential in a range of sectors (renewable sources, energy savings etc.) it is difficult to estimate its full effect. In addition it can be expected that, due to the harmonization of the Czech tax system with that of the EU, the lower VAT rate will be annulled.

5. The Czech National Council's Act. No. 586/1992 on Income Tax

Like the previous measure, this Act, in its most recent text, reduces the economic burden of renewable source producers (see C3). However, with the exception of specific cases, this burden exceeds the profitability of these sources. Here too, it is difficult to estimate the full influence of the measure.

6. Stricter Technical Standards for Thermal Insulation of Buildings

Stricter insulation standards have been in effect since 1994. Despite the fact that they are not binding (except for cases when state money is invested), they are generally observed. Assuming that observation of the norms causes a 30% decrease in energy consumption, and assuming that roughly 15 thousand apartments are built and reconstructed yearly, this measure decreases annual CO_2 emissions by approx. 40 kt CO_2. It is difficult to make a similar estimate for commercial and administrative buildings, however, the influence is thought to be in tenths of kt of CO_2. The measure was implemented and will be permanent.

7. The National Clean Air Programme

A total of 6100 million CZK was spent, between 1994 and 1997, on the Programme. Projects chosen for the programme up to now, exceed the mentioned sum and for this reason they will be cofinanced by the State Environmental Fund (SEF). The goal of this programme is to replace brown coal, briquettes, and slurry, with natural gas, electricity, or other more environmentally-friendly types of energy, for heating apartment buildings and for the public and industrial energy sector buildings with outputs up to 50 MW. In more than 95% of the projects, natural gas is replacing solid fuels. The Ministry of the Environment of the Czech Republic decided on December 31, 1996, to contribute to funding of such projects, 5 billion of the requested 6.1 billion CZK. At this point, 3.4 billion CZK in subsidies has been given out through the programme.

According to a rough estimate based on increased natural gas consumption, CO_2 emissions will decrease at a quickening pace from approx. 0.6 Mt per annum in 1997 to 1.8-2.4 Mt per annum in 2000, at which point projects within the framework of this programme will be at work. Furthermore, approximated reductions by 10% in SO_2 emissions, 6% in CO emissions, and 8% in solid particles, are expected. The programme's projects will continue while funds last (i.e. for 15-25 years).

8. The Programme for Energy Efficient Lighting

A programme subsidizing the sale of compact fluorescent lamps was a one-time event financed by CEZ profits and CEA funds. Almost 155 thousand fluorescent lamps were sold in two waves, costing roughly 20 million CZK; the result was that CO_2 emissions decreased by an estimated 9 kt per year. This programme has not been repeated since then.

9. Reforestation and Forest Management

The forest management took two essential steps, which will have long-term effects in reducing greenhouse gases. The Forest Act (Act No. 289/1995 „on forests and on the changes and completion of some acts") was adopted at the end of 1995. The Act is a new legal norm based on the new socioeconomic situation of changed ownership of forests. It outlines rules for forest regeneration, care, and protection, emphasizing the role of forest owners and the state's interest in permanent and balanced use of forests, in all their functions.

Furthermore, a state-subsidized programme was adopted to plant trees on arable farm land. Although only 1340 hectares have been forested so far, afforestation under this programme is planned to cover roughly 80 thousand hectares of land.

10. Support for Use of Renewable Energy Sources

The substitution of alternative energy sources for fossil fuels since 1990, has reduced the volume of greenhouse gases produced by fossil fuel combustion. Approximately 15% of newly built power plants utilizing renewable sources received financial support from the state. State support was provided through both subsidies and long-term low-interest loans. Support was also given for production of modern biomass

combustion technology and for construction of biomass manufacturing plants. Reduced greenhouse gas production resulting from the use of renewable sources, is 0.8-1 Mt CO_2 per year, when the sources are substituting brown coal.

Use of Biomass

Projects substituting biomass for fossil fuels are aimed almost exclusively at producing heat for the residential sector; only a small portion of investments is geared at energy production for the industry sector. The fuel used at the present time is mainly wood from forests and waste from the woodworking industry. Eight large projects for combustion of corn and rape straw were implemented. Due to a sufficient supply of highly effective technologies on the market, from 1990-1996, biomass has played the largest role in making energy from renewable sources available. Production of biodiesel is also significant (see Chapter 6.11).

Support was given predominantly through the mediation of the State Environmental Fund, the Czech Energy Agency and the Ministry of Agriculture, who supported the production of biodiesel as well as two straw combustion projects.

The total heat source capacity installed in this period exceeds 800 MW. With the equipment being used at a 60% capacity for the length of the Czech Republic's heating period, biomass produces 2200 GWh (7920 TJ) of heat yearly, using 700000 tons of biomass (dry weight). This accounts for an approximated annual reduction of 0.8 Mt CO_2.

Small Hydroelectric Power Plants

Since many small hydroelectric power plants have been constructed over the past few years, the economical potential of this source has in large parts been exhausted. The total installed capacity rose presently to 245 MW. Nevertheless, after liberalization of energy prices, it is expected that more power plants will be built. The plants account for approximately 650 GWh of average annual electricity production; 240 GWh of it is produced by devices put into operation since 1990. This production is responsible, on average, for a reduction of 600kt of CO_2 emissions per year.

Wind Energy

The conditions for generating energy from the wind are not very favorable in the Czech Republic. Devices built after 1990 were, more or less, built for testing purposes. Despite this, their 8 MW installed capacity annually produces approximately 10 GWh of electricity (an annual reduction of 8 kt CO_2 emissions).

Use of Heatpumps

The total capacity of heat pumps installed after 1990 is approximately 35 MW. They are mostly used for heating apartments, however a number of projects have been implemented in the industry sector, mostly in drying plants, and in the food and woodworking industries. Yearly, they account for 55 GWh of savings and a 20 kt reduction in CO_2 emissions.

Solar Energy

More than 76500 m^2 of solar collectors were put into operation during the assessed period. Approximately 400 kWh/m^2 of energy is obtained yearly; the total installed area accounts for 30 GWh of energy. CO_2 production is reduced by approximately 10 kt per year in this case.

11. Biodiesel

The „Oleoprogramme“ was launched with the support of the Ministry of Agriculture, as one of the first programmes of its kind in Europe. Since 1992, the Ministry of Agriculture has given zero-interest loans covering 80% of the total investment (approx. 750 million CZK) for production of fatty acid methylate from rape-seed oil (MERO). This amounts to 61t of MERO/year and represents a CO_2 emission reduction potential of approximately 170 kt/year. The construction of seventeen MERO plants has been completed. In the

agricultural year 1994-95, a total amount of 23000 tones of rape seed were processed and 8100 tones of MERO were produced. In 1995-96, 125000 tones of seed were processed and 29300 tones of MERO were produced. Emissions were reduced by about 85 kt of CO_2 per year. MERO is used for the production of „second generation“ biodiesel fuel (a mixture of hydrocarbon fuels, MERO and additives), that is more useful than pure MERO. Economic and legislative support for fermented ethanol, or its derivative ETBE, are presently being discussed.

B. Other Measures Mentioned in the Czech First Communication

In this part, the Czech Republic will inform the other parties on measures under consideration and preparation in accordance with Paragraph 12.1b of the UN FCCC. Only the measures that have been worked out or implemented since the presentation of the Czech Republic's First Communication will be discussed.

1. The European Energy Charter

The Czech Republic signed the European Energy Charter in 1993. Within its framework, the European Energy Charter Treaty was created and later ratified by the Czech Republic on June 17, 1996. The Treaty has not yet come into effect. A protocol on energy savings and related environmental issues was signed by the Czech Republic on June 8, 1995. Gradual market deregulation in the energy sector is an example of one of the conditions needing to be fulfilled in the European Energy Charter Treaty.

2. Carbon Dioxide Emissions in the Transport Sector

The following measures have been implemented in, and are supported by, the Czech Republic, within the programme to stabilize and reduce CO_2 emissions in the transport sector.

Support for the Development of Combined Transport

Continued efforts to support accompanied combined freight, particularly in international highway segments (RO-LA), and support will be given in the future to unaccompanied combined freight;

Effective use of taxation to support combined freight drivers. The law on highway tax enables differentiated tax breaks, up to total elimination of tax for combined freight utilizing railroads or waterways;

Continued development of the combined freight infrastructure (the purchase of special railway cars for this type of transport, for instance).

Applying Limits for Fuel Consumption in Newly Developed Vehicles

Limits for fuel consumption based on UN EEC accepted norms will be implemented gradually for newly developed road vehicles. Their verification will be part of the tests required to allow cars to enter the country.

Optimization of Traffic on Selected Highway Stretches

Gradual widening of narrow highway stretches, with the goal of making highways smoother and thus limiting energy losses.

Signing International Agreements on Regulations for Transport Trucks

Applying restrictions to the transit of road vehicles which fail to meet international environmental criteria.

Construction and Modernization of Bypasses and Access Roads

Gradual fulfillment of the Highway Development Programme, including the construction of ring roads and bypasses around cities as well as access roads to highways.

Support for Development of Public Transport in Cities

Continued development of integrated public transport systems in cities, through state, municipality and district subsidies and tax breaks.
Compensation for Foreign Transportation Costs

Connected to broader international guidelines aimed at real and balanced market conditions, under which more effective and environmentally-friendly use of transport would be attained, it is expected that all external costs (in other words, costs associated with air pollution, noise, accidents, land occupation, use of roads, congestion, etc.) will be included gradually into transit tariffs.

Support for Research and Introduction of Vehicles Run on Alternative Fuels

Continued search for solutions, while gradually ordering other projects within the framework of the „Stabilization and Gradual Reduction of the Transport Sector's Burden on the Environment Programme", aimed primarily at:

increased use of vehicles run on alternative fuels;

development of more environmentally-friendly transport systems;

creation of emission limits, etc.

3. Energy Saving Measures to Reduce Carbon Dioxide Emissions

The Ministry of Industry and Trade and the Ministry of the Environment of the Czech Republic are presently preparing an Act on the effective use of energy. Under the framework of the approximation process to the EU, it uses as its basis the Energy Law (Act No. 222/1994 „on conditions of enterprise and administration in the energy sector"). The Act under preparation defines the rights and duties of entities in the energy consumption sector. The Act's aim is to create conditions to reduce the overall energy intensity.

4. Programme for Encouraging Energy Savings in the Industry Sector

The „State Subsidy Programme for Energy Savings in Industry" has been on the Czech Energy Agency's list of energy saving programmes since 1996.

The idea of the programme is to support the implementation of measures which lower energy intensity, the appropriate and efficient use of energy losses from technological processes, and the application of modern technologies and materials for energy saving measures. The programme's evaluation should offer entrepreneurs information to help them further implement such measures.

The suggested measures leading to the implementation of a demonstration project must be exceptionally energy efficient and must use new environmentally-friendly energy saving ideas. A new technology project is accepted on the condition that it has been implemented successfully as a pilot project and that it has undergone a verification series.

A total of 21 saving measures in the manufacturing industry were selected for 1997, with a total investment of 131 million CZK and a state subsidy of 32 million CZK. Annual savings are expected to reach 218 TJ.

5. Liberalization of Fuel and Energy Prices

The Ministry of Industry and Trade and the Ministry of Finance are jointly preparing a plan for the gradual and differentiated increase in energy media tariffs; it aims at fully liberalized prices.

6. Use of Biogas from Dumps and Waste Water Treating Plants

During the last ten years, roughly 30 waste water treating plants, using biogas for anaerobic treatment of excrements, have been built in the Czech Republic. Biogas production in the smallest plants (those for 20 thousand equivalent inhabitants) is about 300 m3, while in the largest plants (those in Èeské Budì jovice and

Plzeò, for instance) approaches 3.5 thousand m3. The Prague plant produces roughly 20 thousand m3 of biogas. The average daily production of biogas is roughly 1500 m3.

7. Jointly Implemented Measures to Decrease Greenhouse Gas Emissions

Article 4.2 (a) of the UN FCCC mentions the following possibility of international cooperation: „ Each of these Parties shall adopt national policies and take corresponding measures on mitigation of climate change … jointly with other Parties and may assist other Parties in contributing to the achievement of the objective of the Convention….“

„Parties of the Convention“ are governments responsible for fulfilling the agreement commitments (emissions inventories, approving measures for stabilizing/reducing emissions, etc.). Thus, other subjects cannot manipulate with greenhouse gas emissions (trading with emission credits, for example) without the approval of the government. In accordance with these principles, any project which is carried out within the framework of the activities implemented jointly (AIJ) on the territory of the Czech Republic, must be announced by the Ministry of the Environment of the Czech Republic to the Secretariat of the Convention, and/or the information on this project must be submitted by the Ministry of the Environment to the Conferences of the Parties and the UN FCCC Secretariat. The Ministry of the Environment is responsible for the correctness of the information, especially with respect to calculations and records on achieved emission reductions. The announcement of these projects as pilot phase AIJ, must for this reason be judged in advance by the Czech authorities, which will decide whether the project is in full compliance with the rules accepted for the pilot phase by the Conference of the Parties and with the obligations of the Czech Republic as a Party to the Convention.

The rules for the projects have been refined by COP-1 (Decision 5/CP.1, Annex 1 „activities implemented jointly in the pilot phase“). COP will evaluate this pilot phase (of the pilot projects) in the year 2000. The AIJ will be carried out in „host countries“ with assistance of the „investor countries“ (the government, NGOs, etc.).

The Czech Republic has repeatedly expressed optimism about joint implementation of projects to reduce greenhouse gas emissions (Activities Implemented Jointly). Several preliminary project conceptions were submitted to the Ministry of the Environment of the Czech Republic. Therefore the ministry prepared rules for assessing conceptions for the pilot phase of AIJ in the CR (see Appendix B).

The motive behind AIJ is to achieve negotiable emission permission (emission credits) in the future. This will facilitate financial investments into measures in countries where the reduction of greenhouse gas emissions is achievable at the lowest cost. Decision 5/COP-1, however, does not permit a transfer of emissions in the form of credits during the pilot phase.

After the project is assessed and approved, a contract between the two Agreement Parties (the Ministry of the Environment of the Czech Republic and the appropriate body in the investor country) must be signed. There the obligations of both governments must be defined with regard to the costs connected with monitoring and assessing the project and preparing reports for the FCCC Secretariat. Guarantees ensuring project continuation for the agreed time period must be included.

The investor countries’ governments should share the cost of the project’s implementation and monitoring with the Ministry of the Environment of the Czech Republic, as well as to provide guarantees for the project. These costs will need to be evaluated in compliance with the COP requirements. The contract must specify the duties of the other project parties (i.e. home investors, owners, foreign partners, and others). Monitoring and evaluation of the project will be carried out by the Czech Republic (by the Ministry of the Environment’s Foreign Relations Department - Focal Point), which will prepare reports according to the UN FCCC secretariat’s guidelines. The Ministry of the Environment will prepare procedures for processing emissions reductions, achieved in the framework of pilot projects.

C. New Measures Amending the Czech First Communication

The following part outlines suggestions for measures aimed at mitigating GHG emissions. For the following reasons, most of them are focused on energy consumption in residential and commercial sectors and state-owned buildings:

When savings are implemented on the demand side, transformation and distribution losses are saved as well (e.g. for 1 GJ saved in electric heating, you will automatically save 2-3 times more due to losses in transformation and distribution);

In a market economy, energy prices including costs and revenues are a sufficient stimulus for savings. This does not at present apply to the Czech Republic, as prices do not take fully into consideration environmental costs and write-offs;

On the source side of the energy sector, relatively strict emission limits will come into effect on January 1, 1999. These will force owners to do technical renovations on equipment and thus decrease greenhouse gas emissions without any other state incentives.

These facts have led the Czech government to express, in the form of a special programme which is presently under preparation, its support for use of renewable energy sources.

1. International Cooperation

As a country associated with the EU, the Czech Republic will collaborate with the EU and its member countries in spheres other than just energy savings and use of renewable energy sources. The Czech Republic participates in several programmes; the PHARE programme is most developed. Czech experts will also cooperate with OECD countries and IEA in mitigation greenhouse gas emissions. The Czech Republic is optimistic about the „Energy Efficiency 2000" project, which is being prepared as part of the “Environment for Europe" process.

A number of experts and institutions in the Czech Republic are studying possible climate changes and their consequences (a great number of them are associated with the National Climate Programme). Most of their international cooperation is connected with the US Country Study Programme. The Ministry of the Environment of the Czech Republic will support mainly scientific collaboration within the IPCC framework and within the European continent (particularly regional collaboration).

Collaboration in the area of environmental education is also important. Positive results can be seen from both the Blue Sky and GLOBE programmes (see Chapter 11). Centers for environmental education in the Czech Republic, along with other non-governmental organizations working with children and youth, are interested in similar collaboration with foreign NGOs.

2. Evaluation of the Realistic Potentially of Renewable Sources

The extent to which the renewable source potential is actually used depends on many factors. Several hundred projects using renewable energy sources have already been implemented (see A10). Renewable sources used in the Czech Republic are mainly:

Biomass

Energy of small water courses

Biogas

Heat pumps

Solar energy

Many projects are financed by the State Environmental Fund and the Czech Energy Agency. It becomes

evident that the cost of electric energy produced using alternative energy sources is, in some cases, 200% higher than the cost in traditional power plants. The Ministry of the Environment of the Czech Republic will evaluate existing pilot projects, with regard to both their environmental and economic effects.

3. Creating Model Energy Concepts

According to the Law on Energy Use, which is presently under preparation, governing district and municipal bodies will be responsible for providing energy concepts as an integral part of regional planning. The aim is optimization of energy sources.

The Ministry of the Environment supports the preparation of energy concepts for municipalities and regions through its „Guidelines for Energy Concepts“ project. A total of 80% of these concepts, focused on effective use of energy and renewable sources potential, is financed by the State Environmental Fund (in 1995-1996, 5 million CZK were earmarked for this).

Concepts have been prepared for the towns of Rumburk, Hartmanice (Šumava National Park), Nuselské údolí (a part of Prague) and the Hluèín region in Morava. Implementation of these concepts could decrease the consumption of primary energy sources by approx. 20% and pollutants by approx. 35%. Concepts will also be prepared in the Nisa Euroregion, the Šumava region, the Kladno, Jeseník and Uherské Hradištì districts, and the towns of Hradec Králové, Svitavy, Šumperk, and Zlín. The Czech Energy Agency is involved in the preparation of these projects. Beside these, the rough drafts for municipal energy projects, enabling effective financing for municipal investment projects, are under preparation.

4. PHARE Fund for Financing Energy Saving Projects

Within PHARE’s energy programme, a revolving fund was established to provide advantageous loans for energy saving projects meeting specific qualification criteria. The fund will be administered by a well-established Czech bank. The bank will be fully responsible for credits, which will be granted after a standard evaluation of a client’s credit rating and a technical and economic evaluation of the project. PHARE funds (4.5 million ECU) will be combined with those of the bank. Installment payments will be reinvested into other loans. The fund’s activity will last 10 years and after that the PHARE funds will be returned to the Ministry of Industry and Trade of the Czech Republic, which is responsible for implementing the PHARE programme.

5. Introduction of Standard Energy Audits

One condition for receiving financial support from CEA sources is an energy audit, which is already a part of model energy concepts. The audit methodology for residential, public and industrial buildings has been prepared by CEA. Energy savings achieved on the basis of the audit range between 20% and 45%.

Energy audits may, in the future, be used within the context of three measures that are presently under consideration:

The energy audit and observation of its recommendations are obligatory for all buildings owned by the state and for buildings in which energy supply is financed by the state. The state is one of the largest landowners, whose buildings are used mostly as offices, schools, and hospitals. State building operators will need to abide by the energy audit recommendations and will be obligated to implement suggested measures leading to reduced energy consumption.

Energy audits are recommended for documenting the purchase or reconstruction of privately-owned buildings. The audit provides information enabling persons interested in the reconstruction or purchase of a building to compare the cost of energy consumption in such buildings with that in a „standard building“.

The obligatory energy audit is a part of a state subsidy application for the reconstruction or purchase of a building.

The energy audit is an additional condition for CEA grant applicants and is a duty imposed by the state, the aim of which is to allocate state subsidies more effectively. The decision on support can be more informed

and at the same time, people can become more experienced with audits; with this experience, there is the possibility of extended use for potential implementation of energy saving measures.

6. Implementation of Energy Standards for Appliances

Energy standards will be proposed for refrigerators, freezers, washing machines, accumulator heaters for water, clothes dryers, and household dishwashers. The standards define the minimum energy efficiency needed to be achieved by a product in a given category. If the standard is not met, either a charge will be drawn up for the product or, in some cases, its sale will not be permitted. This measure should be realized collectively with the European Commission and announced well in advance (3 years). The potential decrease in CO_2 emissions is 0.1 Mt/year.

7. Implementation of Energy Labels for Products

It will be necessary to label, according to EU guidelines, mass-produced and popularly-used energy appliances. The information on these labels must include: the absolute amount of energy used; the relative amount of energy used, when ranked among other appliances, from greatest to least amount of energy used, and; information about other environmentally-unfriendly factors - noise levels and water consumption, for instance. Labels allow consumers to choose less energy-intensive appliances, on the basis of clear and reliable information. Gradual improvement in the structure of appliances will be seen, leading towards lower electricity consumption.

Support of the Environmentally-Friendly Product Labeling Programme, launched by the Minister of the Environment of the Czech Republic in 1994, will continue. Almost 200 products are labeled; they include thermal insulation made of recycled paper, water-based paints (limiting VOC emissions), and small gas boilers for heating apartments and houses (meeting criteria for effectiveness and emission). These products, with limited greenhouse gas emissions, account for more than 80% of all labeled products. While advertising the programme, its link to the protection of the global climate system will be emphasized.

8. Support for Non-Governmental Organizations

Since 1995, the Ministry of the Environment has been subsidizing a number of non-governmental activities oriented towards energy savings and use of renewable sources. Environmental non-governmental organizations (civic associations) in the Czech Republic are given subsidies amounting to 17 million CZK yearly. Supported by the ministry and other sponsors, these organizations have formed a network of regional information and consultation centers. Besides the usual areas of interest (nature conservation, work with youth, etc.), public information campaigns, environmental education and other activities aimed at protecting the global climatic system will be supported through tenders in 1997-2000.

7.VULNERABILITY ASSESSMENT OF THE CZECH ECONOMY TO CLIMATE CHANGE

Detailed studies performed in the Czech Republic showed that possible climate change could mainly affect three sectors: water resources, agriculture and forestry. Impacts on other sectors, e.g. transport, building industry, human health, recreation and tourism were assessed to be less relevant, and therefore no exceptional results from the special studies were expected.

Water Resources

Water demand in the Czech Republic, up to the second half of the next century, will depend not only on climate change but also on the country's socioeconomic and political development. No study of long-term expectations on economic development is available, and thus the future water demand under conditions of climate change had to be estimated by assuming various alternatives. For an alternative assuming the current pace of socioeconomic development and moderate effects of climate change, the water demand estimated for 2050 should not exceed substantially the present needs in the Czech Republic. This can be demonstrated by development between 1990 and 1994, when the water demand decreased by 60% for agriculture, 30% for industrial sectors, 23% for electricity generation, and 17% for household use. A highly unfavorable climate change alternative (increased temperatures and decreased precipitation), combined with socioeconomic development requiring a growth in water consumption (e.g. for irrigation or electricity generation), would create a growing demand for water. However, such a development is not very probable.

The change in runoff varies with the climate change scenario and the model applied. Most of the runoff simulations using various models for the selected climate change scenarios predicted a decrease in runoff in response to climate warming. For an alternative assuming a 2^{o} C rise in air temperature and unchanged precipitation, runoff would decrease by about 10 to 25%; a 4^{o} C increase in air temperature would create a 25 to 30% decrease in runoff, depending on the hydrological conditions of the catchment. For the most unfavorable scenario, characterized by climate warming accompanied by a 5% decrease in precipitation, the runoff would decline to 30 to 50% of the amount calculated from the observed series. Even more severe consequences are anticipated for drought periods.

The results indicate that catchments with low precipitation would be severely affected by climate change, while less relative sensitivity has been estimated for catchments with abundant precipitation. Substantial runoff change is, therefore, predicted for catchments with medium precipitation. By using these results, a rough classification of the catchments in the Czech Republic could be made. It is anticipated that even mild climate change could cause severe water management problems in catchments where the available water resources are insufficient or excessively polluted; even major climate change does not necessarily evoke problems in other catchments. Therefore, it is assumed that the impact of climate change on water resources could exhibit significant temporal and spatial variability. Consequently, attention should preferably be paid to regions where the current water demand may already surpass the amount of available water resources.

Great attention should be paid to the Morava Basin, where the discharge of the majority of streams cannot be controlled by reservoirs. Thus, even under current conditions, the monthly flow declines which during unfavorable periods become as low as the 355-day discharge. Further deterioration related to climate change is predicted, particularly for South Moravia, where the irrigation water demand is higher than in other regions of the Czech Republic.

Increased attention must be also paid to protection against thermal pollution. The mean water temperature of main water courses, presently already about 1^{o} C higher in the last 30 years than the long-term average, continues to rise.

As far as groundwater is concerned, it would be justifiable to anticipate that with a 2-4^{o} C temperature increase, even a 5% increase in precipitation would not be sufficient to keep the groundwater runoff at the current rate. With the continuing decreasing tendency of precipitation, groundwater could decrease even in river basins and significantly affect the accumulation of groundwater in the summer season.

Reservoirs are the main source of drinking water. It has been found that their operation is very sensitive to climate change. If the annual runoff decreases by several percent for the selected scenario, the increase in the reservoir storage capacity required for retaining present reservoir yields would reach approximately tenth of percent. The required reservoir storage capacities and the reservoir yields also depend on hydrological characteristics of drought periods, which would be highly affected by climate change. However, the estimates of storage capacity, under changing hydrological conditions, are less reliable. This results from inaccuracies in low-flow observations, combined with uncertainties in both the climate change scenarios and hydrological models used in discharge series simulations.

Relevant water management measures, spurred by the climate change assumed for the beginning of the next century, could be not only costly but also time consuming, if it is assumed that the contemporary water supply methods will continue to be used.

A total of 56% of the water demand in the Czech Republic is covered by surface water, while 44% is covered by groundwater sources. All water taken from surface water has to be purified, while only 15% of the water withdrawn from groundwater resources is treated. The importance of groundwater resources in terms of economy and ecology, therefore, is obvious.

The direct economic consequences of climate change cannot be estimated reliably. Nor can the required storage capacity of the reservoirs in the Czech Republic be reliably estimated by using the results of available climate change and hydrological scenarios. The amount of potential investments can be demonstrated by an example showing the consequences of insufficient storage capacity in the Švihov Reservoir, which supplies Prague with drinking water. In this case, a completely new resource would probably have to be found.

Agriculture

In addition to the changes in temperature and precipitation, the expected growth of CO_2 concentrations will also directly affect plant production. The effect of CO_2 was mainly studied with meadow grass and winter wheat. Assuming that CO_2 concentrations will double under the present climatic conditions, the agriculturally exploitable production of aboveground parts of grassland will increase by 30-40%, for winter wheat by 5-20% (grain yield).

Along with the considerable increase in the production of biomass, an increased proportion of dry matter is expected to be allotted to roots. Due to the slower decomposition of root biomass with increased CO_2 concentrations, it can be assumed that the soil will be permanently enriched with organic matter and that the content of humus will increase.

In addition to being influenced by increasing CO_2 concentrations, plant production will be influenced considerably by the resultant change in climatic patterns. The changes in temperature given by the GISS scenario will increase the effective temperatures, which should extend to include the warmest regions at present — the Dyjskosvratecký Valley and Dolnomoravský Valley, the Bohumín region, and part of central and northwest Bohemia. By 2030, the frostless period is expected to increase by 20-30 days. In many regions, the vegetative period (currently April to September) will increase, starting in early March and ending in late October.

It has been established that higher air temperatures will lead to an earlier emergence and a faster onset of subsequent phenological stages. Compared to present conditions, maturation and harvesting will be accelerated by at least 10-14 days. On the other hand, the acceleration of vegetation in the spring will increase the danger of late frosts damaging the plants. The expected increase in temperature should provide a sufficient heat supply for thermophilic crops (e.g. semi-early varieties of maize for grain, early vine varieties).

On the other hand, there is serious danger of thermal stress due to more frequent, extremely high temperatures. Based on the estimated values of the Selyaninov moisture index, without markedly higher precipitation and with the expected growth of evapotranspiration, the majority of central and south Moravia, central and northwest Bohemia, and the lower and middle courses of the Elbe and Vltava River Basins will

be endangered by drought. This would negatively affect yields in the regions with the highest production. Sufficient amounts of rainfall during the vegetation period, and even rainfall distribution, will have the greatest effect on yields of agricultural crops under increased temperatures. More rain could partly balance the increased temperatures, as can be seen from some of the scenarios. It is very difficult to estimate rain distribution during the year. The results of simulations showed that higher precipitation would increase the probability of daily sums of precipitation by more than 10 mm, leading to an increased erosion hazard, especially in May, June, and September.

Sensitivity to weather was studied in detail with early potatoes and winter wheat. The optimal temperature for potatoes during vegetation is 17-25 ^{o} C; their growth stops when temperatures rise above 30 ^{o} C. Temperatures above 40 ^{o} C damage the plant tissues. Increased temperatures causing permanent damage to larger areas could balance out the expected increased yields because of higher CO_2 concentrations. Higher temperatures during the overwintering of winter wheat could eventually cause greater damage to the stands after sudden drops in temperature or under deeper snow covers.

Contrary to the frequent assumptions and predictions of models based only on increased CO_2 concentrations, the values calculated for the respective scenarios of climate change for the year 2030, do not absolutely confirm increased yields. Reduced mineral fertilization, particularly with nitrogen, would decrease the yields under the given temperature and precipitation conditions, in many cases by one half. Another serious factor is that the assumed climate change will considerably change the conditions for the development and action of agricultural pests and diseases. The critical stages of their development are definitely dependent on temperature.

The incidence of viral diseases is also expected to increase over large areas. For instance, potato crops may be endangered as early as May, when the potato plant is particularly susceptible to transmission of viral disease via insect-damaged tissue, by a greater number of peach aphids. Increased temperatures, coupled with the same amount of precipitation, generally provide better conditions for the development of diseases and pests, and can even result in more generations of adult pests. Similarly, the incidence of fungal diseases is expected to increase (e.g. potato blight and mildew of hops). In terms of production, chemical treatment will have to be increased, thus increasing the cost of protection. Otherwise, insufficient chemical protection will reduce the profits of agricultural crops.

Soil conditions, already damaged by previous systems of management, will be more sensitive to potential climate change. The physical condition of the subsoil has already been damaged, and both the water-bearing capacity and the microbial activity of the soils has decreased. If temperature increases, and precipitation levels either remain constant or drop, the soil moisture will change; this will thus expand the area of land endangered by moisture stress (including a fall in its biological activity). Since soil moisture directly affects plowing resistance, these changes will affect soil cultivation. With values close to critical moisture, which declines with increased air temperature and decreased precipitation in August and September, plowing will not ensure the proper preparation of seed beds. New ways of cultivating soil will have to be used, to prevent increased cultivation costs. There is also the danger that fields will be infested with perennial weeds, as many weeds are more resistant to drought than agricultural crops. It is true that the increasing concentration of CO_2 will probably increase its assimilation; however, the limiting factor is lack of water. Stronger droughts may occur in some regions due to unfavorable precipitation distribution, particularly during the vegetation period.

Forestry

The endangerment of forests in the Czech Republic through climate change is enhanced considerably by the difference in the contemporary and natural species composition of forests. This is mainly a result of forest management in the past, when - commercially valuable tree species, mainly spruce were planted, often at the edge of their ecological range. A large proportion of forest stands are uniform, and consequently, they are less stable and more vulnerable to diseases, pests, and abiotic factors. Continued atmospheric pollution with toxic products from industry, transport and intensive agriculture, is amplifying this problem, especially in the northern part of the country. This pollution, along with extreme weather conditions, adversely affects the vitality and ecological stability of forests, and is leading towards their catastrophic collapse.

The long-term load produced by air pollution disturbs the biological activity by manipulating both the

chemical and physical qualities of soils. These consequences will last even after the load disappears. The pace of decomposition and circulation of matter under the predicted changes in humidity and temperature is dependent on current conditions and on the nature of the change. Lower precipitation would lead to a deceleration in this process. Higher humidity and temperatures would accelerate these processes, especially at high altitudes. However, the potential acceleration (caused by a release of part of the nitrogen and carbon) would not mean dramatic changes in the ecosystem. The increase would be gradual, and a number of other processes in the forest ecosystem would also utilize the released substances. The intensive nutrient circulation is a reason for elevated wood increments that organically bind the carbon dioxide.

If changes in climatic conditions are relatively rapid, they may affect the current generation of tree species or forest stands. In such a case, the tree species or populations which are equipped with greater genetic variability will be the most likely to survive.

No individual tree species is in particular danger of collapse due to the anticipated warming. Norway Spruce stands that cover large areas, and which are sufficiently far from their ecological optimum, are comparatively sound if they have not yet been extremely burdened by individual stressors. A decrease in precipitation would be a greater hazard to the spruce. Scotch Pine and European Larch are even more tolerant to variations in climate, and Silver Fir is also not significantly endangered by the anticipated climate change.

A combination of increased temperatures, increased evaporation, lowered precipitation, and greater aridity, could lead to very serious consequences. In such a situation, the growth of spruce trees (in both a natural environment and in places where their growth is already impeded by strong stressors) and broad-leaved trees (e.g. Oak) could be endangered.

The health of tree stands has been impaired considerably by the continuing air pollution load, as well as by the changes of soil properties (acidity) already caused by pollution. While it is true that even very sensitive tree species can adapt to a relatively high load of gaseous air components, there is an increasing danger due to changes in the soil. This significantly increases the risk of damaged forest stands that is anticipated by the global climate change. This threatens to disintegrate non-adaptable maturing and mature forest stands, especially pure stands of pine and spruce growing under marginal ecological conditions and heavily burdened by episodic stressors.

There is already a larger threat from previously unknown or insignificant injurious agents, and a greater effect from factors that used to be adequately controlled in properly managed forests. Examples of insect pests are the northern engraver beetle (Ips duplicatus), the six-dentated bark beetle (Pityogenes chalcographus), and other bark borers and leaf-eating pests. A very significant phenomenon is the growing aggressiveness and virulence of various fungi. This is especially true of those present in tracheomycoses, but an increasing amount of damage is also attributed to the honey fungus, for example. In the future, under the more pest-friendly environmental conditions, we can expect greater losses due to a more rapid growth of various pests and diseases.

It is unlikely that a gradual change in average air temperatures would significantly increase mortality in forest stands. A greater loss may result from an increase in extreme weather conditions. This is especially true of sudden or extreme changes in temperature in winter or early spring, of occasional or regional precipitation deficits during critical vegetation periods, and of more frequent instances of powerful winds, strong rainfalls or solid state precipitation (snow, icing, etc.).

Forests have important environmental functions (water management, soil protection, climatic functions, etc.) which are not critically endangered by the anticipated changes. However, in the sphere of water and soil protection, there can be very detrimental effects unless there are improvements (optimization) in the system of logging roads. Unfavorable effects, especially erosion, may increase with precipitation changes or with also increased human economic activity in the forests. The anticipated climate change will increase the sensitivity of forest ecosystems by recreational use.

8.ADAPTATION MEASURES

Detailed vulnerability studies of main sectors stress the systematic preparation of adaptation measures. Additionally, they present evidence that there is no need to substantially change the orientation of the three most affected sectors, i.e. water resources, agriculture, and forestry. Adaptation measures proposed for water resources and forestry even fully agree with present trends set in these sectors, independently of the potential climate change. Therefore, the possible impact of climate change emphasizes the importance of actually implementing the proposed adaptation measures.

Water resources

The primary adaptation measures proposed for this sector are the following:

1. Supporting further reductions in water consumption in industry, energetics, agriculture, and households. Many concrete methods can be used, one example being a programme of water audits. Within the framework of these audits, water management authorities would explain to consumers possible ways to save water. The price of water can be taken as a very important factor. The recent, sensible price increase has substantially decreased water consumption in all sectors.

2. Reducing water losses by repairing and reconstructing the water pipe networks. Water lost through these networks represents roughly 25% of losses in the Czech Republic. In Prague, losses reach 45%.

3. Improving the efficiency of water supply systems. This would happen especially in the area of waste water treatment programmes, where the purified water could be used for purposes other than drinking. At the present time, the high cost of waste-water treatment is a factor restricting wider application of this approach, but many facilities are considering its use for the future.

4. Water marketing and water transfers. This is a method based on transferring water from one user to another. The method is applied either for continuous transfer of water or during a short-term water supply deficiency. These transfers are commonly used in developed countries under the term „water marketing“.

5. Integrating groundwater and surface water resource management. This measure depends on geographical conditions, and is aimed at preserving water accumulated in groundwater aquifers, by encouraging reasonable use of both agricultural and forested land. With some modifications, groundwater storage can be considered similar to storage in a surface water reservoir and methods for surface water reservoir management can also be used for groundwater.

Agriculture

According to regional climate change scenarios in the Czech Republic, with the gradual warming, precipitation is expected to exceed present levels by no more than 10%. It is possible that its distribution will change and that there will be reduced precipitation in the summer.
Evaporation will increase as a result of higher temperatures, causing reduced soil moisture. Periods of harmful drought may become more frequent. Infrequent, periodical weather variations may also be a problem. Typically, dry and wet spells rotate over periods of seven years. If there is significant warming, there could be an elevated risk of diseases and pests, affecting both agricultural and forest vegetation. Water supply will be the greatest limiting factor in agricultural production. For these reasons, the adaptation of agrotechnical measures for agricultural crop production must respond to this water supply problem.
Selection of Crops, their Structure and Crop Rotations

The warmer and drier conditions will require a useful selection of crops which will have to be modified according to their water demands. Plants will need to adapt to a more arid climate, the water supply during the crucial periods of vegetation will have to be ensured, and there will have to be good water management.

In terms of physiological demands and properties, it will be necessary to select crops with a low coefficient of transpiration, with a deeper and more ample root system or with a shorter and quicker growth period.

Suitable varieties which are more resistant to drought and have a shorter vegetation period, should be selected.

Perennials have a high water demand. Even though their value as forecrop is high (they provide the soil with high-quality organic matter), they dry up the soil considerably and to a very deep level. In areas with insufficient precipitation, the loss of moisture negatively affects the following winter crops, and sometimes even the spring ones.

Maize and potatoes specifically, do not require as much moisture, as they use moisture from the upper layers. They are better suited for forecrops, especially when their harvest is earlier.

Soil Protecting Minimal Soil Tillage Systems

There are many systems of minimal soil tillage. Different options are used depending on the system of soil management, and the standard of agricultural technology and machinery. In regard to the use of technology for basic and seed bed preparation, the minimal soil tillage systems can be divided into two basic groups: tillage and no-till systems.

The principle aspect of minimal soil tillage with plowing is to reduce the depth of plowing and to combine the respective operations. In no-till systems, various methods of loosening topsoil without plowing are applied, including the drilling of untreated soil.

The principal conditions for applying minimal soil tillage are that:

the good physical condition of the topsoil will not be impaired,

the topsoil will be biologically active with a sufficient number of nutrients,

weed infestation by perennial weeds will not be severe,

convenient crop rotations and sequence of crops are applied (improvement in forecrops, following crops).

Results of long-term investigations showed that minimal technologies (shallow soil tillage, drilling into untreated soil) were economically more effective for densely sown cereals in the more fertile soil of regions in which maize and sugar-beet are grown; there, their yields were similar to those using traditional plowing techniques.

Organic and Mineral Fertilization

In terms of soil fertility, it is necessary to incorporate sufficient levels of organic matter into the soil to provide enough humus to favorably affect all soil properties. Organic fertilizers are indispensable for rational agriculture and they cannot be evaluated only by their nutrient content.

A serious problem arises due to the substantial recent reduction of organic and mineral fertilization - with which a passive balance of nutrients and organic substances in the soil are connected. It is that of providing balanced plant nutrition and eliminating the negative balance of organic substances in the soil. Production of farm manure has been unfavorably affected by the reduction of farm animals. The deficit of organic substances must be improved by catch crops for green fertilizer and a higher proportion of plowed straw.

It is important to grow catch crops for green manure in cases when cereals have to be grown in succession, because they diversify the structure of crops and improve the crop rotation. If legumes are used, they create aerial nitrogen, and this is the cheapest biological nitrogen supply. The desirable level of nutrition must aim at a higher level of available nutrients in the soil, at a better uptake of nutrients by plants, and at the utilization of the uptaken nutrients for yield formation. Rational combined organic and mineral fertilization in balanced concentrations is the best way, increasing the efficiency of industrial fertilizers.

Organic matter improves the availability of phosphorus and to a certain extent inhibits the negative effect of unfavorable weather conditions, i.e. drought.

Weed Control

Weed control with a limited application of herbicides must be based on an entire group of measures. The structure of crops and correct crop rotation are very important, as is rational soil cultivation and preventive measures limiting the sources of weed infestation.

On average, weeds require twice as much water as cultivated plants. Under dry conditions, water deficiency is an even more serious problem, reducing the yields. However, weeds also reduce the amount of light, shading crops already suffering from light deprivation. Along with shade and the evaporation of water, soil temperatures decrease, negatively affecting the life of the soil edaphon. The use of large amounts of nutrients by weeds, considerably impairs crop nutrition.

Using Irrigation as an Adaptation Measure

Dry periods are typical for the country's warmer regions. That is why extensive irrigation systems were built in the 1980s, irrigating about 140000 hectares of land in the most fertile agricultural regions of the Czech Republic. Compared with irrigation in Western Europe, this is not very extensive. The reduction of large-capacity agricultural farming has also reduced the amount of irrigated land.

Using irrigation at higher temperatures increases the biological activity of the soil. Nutrients, not only from fertilizers but also from the soil, are better utilized; they increase mineralization. The potentially negative effects of excessive irrigation that have been observed in studies, are not expected to materialize.

The economic advantage of irrigation is based on special crop rotations with crops that will earn what had been invested for irrigation; e.g. vegetables, fruit tree species, vines, early potatoes, maize, perennial fodder plants, sugar-beet. We can now also rank sunflowers and other crops, which have not yet been grown under a managed irrigation system, among these crops. Nevertheless, at the present time and without subsidies, it is only possible to use these irrigation systems for crops which will potentially yield higher returns.

Nor can we disregard the fact that irrigation can help the number of pests and diseases grow; these will spread to the Czech Republic from the South. Irrigation stimulates the growth of hydrophilic pests and diseases and suppresses the xerophilic ones; this can be observed particularly when irrigation is carried out by spraying.

Forestry

Forest management has been advised to strongly promote changes that comply with current principles and measures aimed at enhancing the ecological stability of forests. The forests of the Czech Republic are already being weakened and endangered by a long-term increase in the pressures of civilization. Precautionary measures to mitigate the effects of global climate change are, to a large degree, identical to measures for assuring the stability and viability of forests, even if no climate change occurs. Such measures are in harmony with approved state forestry policy, which abides by the principles of sustainable forest management, in the interest of current and future generations.

The following adaptation measures are proposed in this sector:

1. Maintaining gene pools. To ensure the biological diversity of forest ecosystems, it is necessary to maintain biodiversity at the gene level. It is also necessary, through the country's legislative framework, to protect the genepools of stable forest ecosystems.

2. Changing species composition of forest ecosystems. It is necessary to gradually change the species composition by increasing the proportion of broad-leaved species (especially those that stabilize and improve the soil) and in this way, to approach the natural species composition of the forests.

3. Using silvicultural procedures which are as natural as possible. This mostly concerns the shelterwood system, with its greater proportion of natural regeneration.

4. Implementing the proper methods of care for young forests. The use of traditional methods, rarely applied at present because of their labor-intensity and low efficiency, should be encouraged.

5. Consistent application of the principles of integrated forest protection. More attention should be paid to the rapid spread of various pests and diseases. These problems must be researched and the research results must be followed by concrete measures.

6. Technology for logging and transporting trees. Especially urgent is the need to improve the condition of logging roads, and develop an environmentally-friendly manner of logging and transporting timber. All this calls for an expanded policy of subsidies, in compliance with the new Forest Act.

7. Monitoring and research. Coordinated monitoring of the basic indicators of forest health, and research targeted at the vulnerability and adaptation of forest ecosystems, are both extraordinarily important in light of potential climate change and our limited knowledge of its impact on forests and forest management.

9.MONITORING

As stated by the Government of the Czech Republic Resolution No. 323/93, the Minister of the Environment and the Minister of Industry and Trade are responsible for meeting the Czech Republic's commitments to the Convention. At the beginning of 1994, when the Czech Republic's First Communication was being prepared, the Minister of the Environment established the Interministerial Commission on the UN Framework Convention on Climate Change. The commission currently consists of representatives of the two ministries, as well as representatives of the Ministry of Transport, Ministry of Finance, and Ministry of Agriculture.

The commission meets twice annually. Besides its regular members, representatives of the Czech Hydrometeorological Institute, the National Climate Programme of the Czech Republic (an NGO of associated research institutions), the Czech Energy Agency, the energy sector and NGOs are invited to participate in the meetings. The Deputy Environment Minister chairs the commission, which monitors the way in which the Czech Republic's commitments to the Convention are met. The commission was a partner of the „in-depth-review“ team that visited the Czech Republic in May, 1995.

In 1995, a department was established within the Czech Hydrometeorological Institute, to collect necessary data and prepare an annual national emissions inventory. It adheres strictly to IPCC methodology. Coefficients derived by Czech research institutions (e.g. VUPEK - a research institute in the fuel-energy sector -, the Prague Institute of Chemical Technology - Department of Gas, Coke and Air Protection) are used to make the values of emission coefficients recommended by the IPCC more accurate.

In 1995 and 1996, the emission data up to 1995 was completed and the original data of 1990 (the reference year) - which was included in the Czech Republic's First Communication - was made more accurate (see Chapter 4). The results of the emission inventories have been sent to the Secretariat of the Convention. This project was supported by means of grants within the framework of the Environmental Protection Programme, administered by the Ministry of the Environment. The Czech Government and the public are regularly informed through an annual Environment Report of the Czech Republic about the country's fulfillment of its commitments to the Convention.

10.RESEARCH AND SYSTEMATIC OBSERVATION

A group of research projects on the impact of climate change was worked out on the basis of information received from the following institutions:

the National Climate Programme of the Czech Republic (NCP CR)

the National Committee for the IGBP (NC IGBP)

the Czech Academy of Sciences' Committee for the Environment

the Grant Agency of the Czech Republic (GA CR)

the Grant Agency of the Czech Academy of Sciences (GA CAS).

Present research is largely funded by the grant agencies, both of which primarily support basic research. Grant systems created by the Ministry of the Environment and the Ministry of Agriculture generally aim at solving urgent problems within the Czech Republic.

National Climate Programme of the Czech Republic

Most of the research on climate change is coordinated by the National Climate Programme. The institutions forming the NCP are the Czech Hydrometeorological Institute and a number of academic and educational establishments (CAS, universities). There is a large research base, with research concentrated within the CAS - namely projects in the framework of the programme „Influence of Climatic and Anthropogenic Factors on the Environment" - and the core projects of the IGBP (GCTE - Global Change and Terrestrial Ecosystems, BAHC - Biospheric Aspects of the Hydrological Cycle, and PAGES - Past Global Changes). Participants in other international programmes, such as the MAB, SCOPE, the hydrological IHP and the geological INQUA, also contribute to research activities.

The National Climate Programme (NCP) carries out activities that follow the recommendations of the World Climate Programme (WCP), coordinated by the World Meteorological Organization (WMO). They deal with the following tasks:

monitoring the climate and gathering relevant data;

processing climatological data in a manner that enables it to be used effectively by experts and government officials;

assessing the impact of climate variability on human life and vice versa;

researching the relationship between the components of the climate system, and assessing projections of climate change;

providing expert opinions for accepting and monitoring the Czech Republic's obligations, resulting from the country's acceptance of the Montreal Convention on the Protection of the Ozonosphere, the Convention on Climate Change, and other conventions related to long-term environmental issues.

The WCP was established in 1979. Gradually, the meteorological services of individual countries, with the assistance of the WMO, started to establish their own NCPs. In 1990, the directors of the Czech and Slovak Hydrometeorological Institutes proposed to the Federal Committee for the Environment that an NCP should be established.

The NCP CR is a non-governmental organization, associating 14 legal entities located in the Czech Republic: the Institute of Astronomy of the CAS, the Czech Bioclimatological Society, the Czech Meteorological Society, the Czech Hydrometeorological Institute, the Geophysical Institute of the CAS, the Dept. of Geography at the Faculty of Natural Sciences of Masaryk University in Brno, the Dept. of Hydrogeology and

Geological Engineering at the Faculty of Natural Sciences of Charles University in Prague, the Dept. of Meteorology and Environmental Protection at the Faculty of Mathematics and Physics of Charles University in Prague, SEVEn - The Energy Efficiency Center, the National Committee for Forestry, the Institute of Atmospheric Physics of the CAS, the Institute of Landscape Ecology at the Faculty of Agronomy of the Agricultural University in Brno, and the Institute of Hydrodynamics of the CAS. The members fund their own day-to-day operations. Support from the Ministry of the Environment is provided when collaborative tasks, expert studies, and more specialized studies are required. The ministry also supports publications dealing with the results of NCP activities.

From 1993 to 1995, the NCP carried out the Czech Republic's Country Study, which encompassed all the important aspects of climate change, in accordance with the Assistance Agreement of the US Environmental Protection Agency. A number of publications were issued during, and at the conclusion of, the Country Study. These discussed climate change projections and the assessment of its possible impact on agriculture, forestry, hydrology and water resources in the Czech Republic. In 1996, a plan for adaptations to climate change was created, the aim of which was to mitigate the anticipated consequences of possible climate change in the Czech Republic.

From the time it was established, and in addition to the research activities and studies mentioned above, the NKP has attempted to concentrate and coordinate the efforts of professional organizations and individuals interested in studying the climate system and documenting the results of their research.

Refining climate change projections for impact assessments

Up to now, most climate change scenarios have been based only on changes in the means of meteorological variables, although it is well-known that the impact depends rather on the changes in variability and frequency of extreme weather conditions. This is particularly true for the impact on agricultural and water resources, for which highly discriminating climate change scenarios are required in order to reach satisfactory results.

The present research projects focus on:

The assessment of possible changes in the variability and frequency of extreme events under selected variables, due to increased GHG concentrations. The creation of site-specific scenarios for $2xCO_2$ climate conditions for several time periods;

Changes in the variability and manifestation of extreme events are investigated through GCM outputs, the observed data in the framework of the validity study (control runs), and a variety of downscaling methods. The downscaling includes analyses of relations between circulation types and statistical distributions of individual characteristics. The occurrence of extreme events, including the probability of their time phases, are examined;

Scenarios created by combining several methods: the direct usage of $2xCO_2$ GCM outputs; the modification of daily data from meteorological stations for the $2xCO_2$ climate. The modifications are based on a synthesis of monthly GCM values and stochastic estimates, including analogues and synthetic time series (weather generators) for the changed climate. The resultant scenarios are supposed to be site-specific, with a time gap of one day.

Assessment of impact on the hydrological cycle

The goal of the research is to estimate more precisely the impact of climate change; this is tied to creating more precise future climate change scenarios, by refining time variables, spatial variables, and the quality of deterministic hydrological models. The effects of variable and extreme weather conditions are crucial to the vulnerability study.

The present research deals with the validation and fine-tuning of selected hydrological models (SACRAMENTO, ARNO, BROOK'90) for a few basins as well as for the complex feedback in the soil - vegetation - atmosphere transfer. Models using specific time variables (one day) and spatial variables

(individual river basins) will provide scenarios of floods, evapotranspiration, soil moisture and ground water storage.

Some projects within the framework of BAHC (IGBP), on the Lu nice river floodplain ecosystems, are in their final stages. Much of the research on aquatic ecosystems has been carried out within the framework of MAB Biosphere Reserves projects.

Assessment of impact on agriculture

High priority research areas for assessing the impact on agriculture are:

The development and application of agricultural models applicable at the regional level, their validation, testing, and comparison of alternative approaches;

The evaluation of the impact of weather variability rather than changes in the ‘mean’ climate on crop yields. Extreme weather conditions will have a severe impact on agricultural production.

Present research is aimed at validating and fine-tuning selected models of crops (CERES-WHEAT, CERES-MAIZE, MACROS), determining the relationship between the variability of agroclimatological characteristics (derived from meteorological variables) and growth and production, with an emphasis on the impact of extreme climate conditions. The input for the models will be derived from refined projections of climate change for given sites, in daily temporal resolution. Complex measurements are performed at experimental sites and phenological data, soil and agrotechnical parameters, and meteorological variables are collected.

Within the IGBP core project GCTE, the response of wheat plants and soil microbiota to increased CO_2 concentration is studied. This core project includes several other research projects which deal with biodiversity and the mapping and changes over time of the structure of various natural ecosystems (such as grasslands, wetlands etc.).

Assessment of impact on forests

The group of projects dealing with the impact of climate change on forestry, can be divided into two parts.

A number of projects recommend strategies - as declared at the Helsinki conference (1993) - for the adaptation of forests to climate change in Europe. Funding for these projects was received from a grant agency established by the Ministry of Agriculture. The monitoring of changes in forest ecosystems is based on the international monitoring of forest health, which is affected by atmospheric pollutants (IPC-Forest). Approximately 200 IPC level I and eight IPC level II experimental areas are observed in the Czech Republic. The IPC measurement network has recently been supplemented by detailed monitoring (1 km x 1 km) of forest vitality in six protected landscape areas, including two national parks;

Ecophysiological responses of trees to climate and CO_2 concentration changes, forest dynamics, and the influence of changing forest characteristics on the carbon cycle, are studied within the IGBP core project GCTE, and supported by GA CR, GA CAS, and the EC programme „Environment and Climate“. The impact of rising CO_2 concentrations and rising air temperatures on forests are the focus of these projects. Growth processes, biomass allocation, stomatal conductance, and the survival of trees with natural and increased concentrations of CO_2 are studied (also with the help of ‘mini-biospheres’). Three selected ecosystems are studied in order to describe the basic parameters of plant communities, selected animal communities (soil fauna) and their changes over time. The following types of sites serve as a monitoring network: Oak forest, beech-fir forest and spruce forest to alpine ecosystems. Special attention is devoted to soil properties (chemistry, humus, accumulation and decomposition of organic matter).

Past Global Changes

Research on past climate and paleoenvironmental changes is aimed at creating a general synthesis for the Czech Republic and its surrounding areas. This research takes place on three basic hierarchical levels:

The first level covers the last thousand years, studied by the use of written historical sources and carbonate speleothems from abandoned medieval mines. A monograph describing past climate changes (including floods droughts, even locust raids) since 1000 AD is in its final stages;

The second level covers the whole Holocene and concentrates on deducing paleotemperature data and important dry spells from calcareous tufa mounds in Bohemian Karst. Palynological research and research on the Holocene hydrological system around the Elbe is presently taking place;

The last level is aimed at understanding glacial cycle courses through an examination of loess deposits. The changes in wind patterns, paleoecology and paleosoil development are the most important topics of the loess research.

Data Collection, Climate Monitoring and Systematic Observation, Including Data Banks

Standard data are measured through a professional network of stations (synoptic and airport stations) and voluntary (climatological and precipitation) stations of the Czech Hydrometeorological Institute. A small part of the data is provided by meteorological stations run by the air force, and two professional stations belonging to the Institute of the Atmospheric Physics of CAS. The summary of this data is given in Tab. 10.1.

Specialized observatories are included among „other professional“ stations - GEMS Košetice (monitoring of the environment), the Solar and Ozone Observatory in Hradec Králové’ (radiation and ozone measurements), the Prague-Libuš Observatory (sounding, radar and satellite meteorology).

All measurements follow the recommendations of the WMO and are governed by the internal regulations of the Czech Hydrometeorological Institute. The data (with the except of special information) are archived in the CLICOM database, recommended by the WMO.

Special attention is devoted to the secular series. The series measured at the Prague-Klementinum station - which started observations in 1775 - and six other stations’ series - with over 140 years of data - are being prepared for further use.

Further Research Activities

A number of projects related directly or indirectly to climate change, are underway in the Czech Republic. They are partly funded by the Grant Agency of both the Czech Republic and the Academy of Sciences, by the Ministry of the Environment (Programme for Environment Protection) and the Ministry of Agriculture. The projects are implemented by universities (Czech Technical University - Prague, Charles University - Prague, Masaryk University - Brno, Mendel University - Brno, VŠB - Technical University of Ostrava - Ostrava, Prague Institute of Chemical Technology - Prague, and others) and research institutes (CAS Institute of Landscape Ecology, the Czech Hydrometeorological Institute, the Agricultural Engineering Research Institute, the Ornamental Gardening Research Institute, etc.).

During 1995-1996, there were over 30 projects exploring energy-saving strategies, use of biomass as a renewable energy source, and forests - including their stability and the possible impact of climate change. Research and demonstration projects in the area of alternative energy sources and energy savings, are even financed by the Czech energy greatest producer CEZ, a.s., Electric Power Company. This producer has financed projects such as the Ecological House in Brno, as well as energy tests for household appliances, and research in the field of wind energy utilization.

Within the framework of the Czech Republic’s Country Study on Climate Change and succeeding projects initiated and funded by the Ministry of Environment, remarkable progress has also been made in creating a model economy for energy in the country. Three models were developed simultaneously: MARKAL, EFOM, and LEAP. Attention was paid to the models’ calibration with respect to energy balance. The models’ structures, their possibilities and their results were compared within the above-mentioned country study, and will also be compared to the „Climate Change“ project. Very few differences have been found between the MARKAL and EFOM models, in the areas of performance and result; a better user-interface was identified

for the MARKAL model. The results of that model were used for constructing further development projections. The MARKAL and EFOM models are continually being improved and their use has also been recommended for other studies. Among other areas these models can be used, are the evaluation of technologies and emission mitigation measures.

Tab. 10.1. Number of professional and voluntary stations in the Czech Republic.

Station	Synoptic	Aviation	Other professional	Climatological	Precipitation
Total	18	11	10	165	684

Source: ÈHMÚ

11.EDUCATION AND PUBLIC AWARENESS

There are many environmental education projects for the youth in the Czech Republic, including projects on climate change. Projects such as „Modré znebe“ (The Blue of the Sky) and GLOBE are among the most important of such activities, and are usually coordinated by non-governmental environmental organizations and environmental education centers. The Ministry of the Environment gives an annual subsidy of roughly 17 million CZK for projects realized by environmental organizations; some of these projects are directly or indirectly related to climate change (energy savings, promotion of environmentally-friendly products, information campaigns, etc.).

The „Modré znebe“ Project

The idea behind this project is that primary and secondary school students monitor various environmental indicators by means of clear, simple methods. The project has been implemented in 12 European countries under the title „Air Pollution Project Europe“. Its international parts are called „Acid Rain“ and „Lichens“. The project’s outputs include the following:

1. Annual October reports on the acid levels measured in rain. The occurrence of lichens on tree trunks and their connection to long-term air pollution (Air Pollution Europe project);

2. Measurements of the amounts of surface ozone in the air, using special bio-indicative tobacco plants in the Czech Republic (OZON, the Czech part of the Air Pollution Europe project);

3. Detailed reports summarizing the measurements of spring and autumn acid rainfalls in the Czech Republic. Summaries of the occurrence of lichens during a school year. A comparison of the results measured by students with the results of professional measuring stations in the Czech Republic and of scientific research.

4. Simple energy audits in schools, a final international report summarizing the research on energy savings.

The national parts of the „Ozone“ and „Energy Savings“ projects take place in the whole of the Czech Republic since 1991. The „Modre z nebe“ project was conceived as a long-term project which takes place during the school year cycle. Acid rain is measured at 450 points in the Czech Republic, lichens (bioindicator) are inspected at 5000 places, and the amount of surface ozone is measured at 200 stations. A total of 150 schools perform energy audits. In the Czech Republic, this project is being organized by the civic organization TEREZA, with the help of the Czech Hydrometeorological Institute, the Botanical Institute of the CAS, the Czech Union of Nature Conservation (CSOP), The Czech Technical University (CVUT), the Mathematics and Physics Faculty of Charles University (MFFUK) , the Pedagogical Faculty of Charles University (PedF UK), the Charles University Environmental Center, the Nature and Landscape Protection Agency (AOPK), and environmental education centers in the Czech Republic.

The Paleta Ecocenter in Pardubice is coordinating a Czech-Dutch project entitled „Modrá oblaka“ (Blue Clouds) which stems from the „Modré znebe“ project. Within the con text of this project, two partner cities exchange information about measured data. The project is regional and attempts to educate children to citizenship as well as making them interested in local environmental problems.

The GLOBE Project

GLOBE is a worldwide project, under which students measure and monitor the quality of the environment under the supervision of specialized teachers. The US Vice President Albert Gore initiated this project in 1994 and invited other countries to take part in it. Observation results are sent regularly to the coordination center in Washington. There, the results are fed through a special computer programme and sent back to the researchers. Scientists all over the world will use the data measured by students to help them with their global research of the planet Earth. Every participating school will have the opportunity to communicate and cooperate with any other project participant. The data collected can be used locally for projects aimed at helping the environment. Altogether 45 countries are participating in the GLOBE project.

The Czech Republic was one of the first countries to join the project in 1994. Here, GLOBE activities are coordinated by the Environmental Education Association TEREZA, with the support of the Ministry of Education, Youth and Sports and the Ministry of the Environment. The project includes a nine-member board comprised of representatives of the Academy of Sciences, Charles University, the Czech Technical University and other scientific institutions. The board helps students prepare and interpret the measured data. At present, 75 schools are participating in the project. In 1996, a representative from the Czech Republic became GLOBE's European coordinator.

All measured data are sent to the GLOBE center in Washington via Internet. However, up to now, most Czech schools have no connection to Internet.

Public Awareness

The public is primarily made aware of global climate change through mass media (television, radio, newspapers). It must be pointed out that the news often portray the problem, in a sensational and catastrophic manner; the information is often distorted. Often climate change issues are talked about on hot summer days. Some radical environmental organizations use sensationalized information as a tool for being heard in the mass media. The public is often confused by contradictory information, some of which has even cast doubt on the work of the IPPC. Other sources talk about the beginning of a „glacial period", etc. For this, it is important that clear and objective information is spread widely among the public; it must stress the IPPC's research results, in particular, and must clarify the important role played by the National Climate Programme. In 1995-1996, publications discussing the global climate change were issued with the support of the Ministry of the Environment, SNAP and EPA (USA).

The Ministry of the Environment supports financially the publication of periodicals on energy savings, renewable energy sources and climate changes („Planeta", „Vì trná Energie", and others). In 1995 and 1996, the Ministry of the Environment financially supported several seminars as well as international and national conferences on global climate change.

APPENDIX A

Greenhouse Gas Inventory in 1990-1995

According with Table 7A of the IPCC Guidelines

(not available electronically)

APPENDIX B

Rules for AIJ Pilot Phase Projects Implemented in the Czech Republic

The Ministry of the Environment of the Czech Republic announces the following rules for AIJ projects in the Czech Republic:

1. The project applicant in the Czech Republic (the host country) must apply for assessment of the AIJ pilot project at the Ministry of the Environment of the Czech Republic. A written application submitted in Czech or English in three copies, must contain financial, legal, and technical documentation, namely those data which relate to the reduction of greenhouse gases.

2. The applicant should specify the financial sources, stating the share of the partner from the investor country. Enclosed in the application must be a statement by the partner from the investor country and the approval of the relevant competent body in the investor country must be enclosed in the application (which will be verified at the UN FCCC Secretariat).

3. Evidence must be given that a significant reduction of greenhouse gas emissions (at least 10% per annum) in comparison with the initial state (emission baseline) per unit amount of the final production shall occur through:

the replacement or modification of existing technology or parts of it;

the addition to the existing technology by addition of „end of pipe“ equipment (denitrification, waste gas incineration, removal of VOCs, etc.). to existing technology.

4. As for the projects resulting in long-term sequestration of carbon dioxide through afforestation, the project should increase the overall stability of forest ecosystems and respect the principles of biodiversity protection.

5. In addition to reducing greenhouse gas emissions, the project must bring about additional positive environmental impacts compliant with the State Environmental Policy of the Czech Republic, (namely with regard to the protection of human health and nature). A project might also contribute towards the development of the infrastructure, provide employment, etc. The said impacts should be documented in the submitted project documentation.

6. Foreign firms’ investments into subsidiaries located in the Czech Republic, made solely to meet emission limits, such as those outlined in the Air Protection Act, shall not be considered as AIJ projects.

7. Applications should be submitted at the following address:

„Focal Point AIJ, Czech Republic “Ministry of the Environment of the Czech Republic International Relations Department Vršovická 65100 10 Praha 10

ACRONYMS

AIJ Activities Implemented Jointly

CAS Academy of Sciences of the Czech Republic

CDV Transport Research Center

CEA Czech Energy Agency

CEED Central and East European Countries

CEZ CEZ, a.s., Electric Power Company

ÈHMÚ Czech Hydrometeorological Institute

COP Conference of the Parties

CORINAIR Coordination of Information on the Air

CR Czech Republic

CZK Czech Crown

EPA Environmental Protection Agency

EU European Union

GA Grant Agency

GCM Global Circulation Model

GDP Gross Domestic Product

GEMS Global Environment Monitoring System

GHG Greenhouse Gas

GIS Geographic Information System

GWP Global Warming Potential

IEA International Energy Agency

IPCC Intergovernmental Panel on Climate Change

MaB Man and the Biosphere

MOE Ministry of the Environment of the Czech Republic

NCP National Climate Programme

OECD Organization for Economic Cooperation and Development

PES Primary Energy Sources

PHARE Polish and Hungarian Action for Restructuring the Economy

SEVEn Center for Energy Efficiency

SNAP Support for National Action Plan

UNDP United Nations Development Programme

UN FCCC United Nations Framework Convention on Climate Change

VUPEK Research Institute for the Fuel-Energy Sector

VŠCHT Institute of Chemical Technology in Prague

WCP World Climate Programme

WMO World Meteorological Organization