THE CZECH REPUBLIC'S THIRD NATIONAL COMMUNICATION

ON THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE

Ministry of the Environment of the Czech Republic
Czech Hydrometeorological Institute

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CONTENTS

INTRODUCTION

The Czech Republic acceded to the UN Framework Convention on October 7, 1993, thus becoming the thirty sixth party to the Convention (Resolution of the Government of CR No. 323/1993) and signed the Kyoto Protocol on November 23, 1998 (Resolution of the Government of CR No. 669/1998). The Czech Republic submitted its First National Communication[1] to the UNFCCC Secretariat in 1994, which underwent an in-depth review in 1995 (Document FCCC/IDR.1/CZE). In 1997, it submitted the Second National Communication[2] to the Secretariat, which underwent a similar process in 1999 (Document FCCC/IDR.2/CZE).

While, at the time of preparation of the First and Second National Communications, the subject of global climate change was viewed in the Czech Republic as constituting mainly a narrow issue interesting only a few professionals, the manifestations and consequences of the "unusual" variations in the weather and the occurrence of ever more frequent extremes has attracted increased interest in this issue on the part of the lay public and subsequently also the political sphere. The greater frequency and consequences of dangerous anthropogenic interference in the climate system have led to a search for new, more efficient and economically effective mechanisms to decrease detrimental consequences, both in the international context and at the national level.

Since the Second National Communication was submitted, there has been a significant breakthrough in international negotiations at the Third Conference of Parties to the Framework Convention (COP-3) in December 1997 in Kyoto. The Kyoto Protocol was adopted, with the main target of providing and creating a legal basis for a gradual decrease in emissions of greenhouse gases to a level that would decrease the risk of climate change in the future from the viewpoint of interactions of these gases with the climate system. The Protocol is concerned with establishing quantitative reduction emission targets and the means of achieving these targets. It requires that economically developed countries listed in Annex I of the Framework Convention individually or jointly decrease emissions of greenhouse gases by at least 5.2 % compared with the state in 1990 by the first review period (2008–2012). This reduction applies to emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons and perfluorocarbons (HFCs and PFCs) and sulfur hexafluoride (SF_6), expressed as aggregated carbon dioxide emissions. The Protocol sets specific reduction targets for the individual countries (Annex B of the Protocol); CR is required to decrease emissions by 8 %.

Reduction targets may also be met by using jointly adopted measures through joint projects (Articles 6 and 12 of the Protocol). The principle of these measures lies in the potential for reduction activities to be directed towards countries where the costs for emission reduction are lower. The Protocol also allows for emission trading between countries subject to emission decreases (Article 17 of the Protocol). The rules for implementing joint projects and emission trading and ensuring their transparency were discussed at international meetings in 1998–2000. A political agreement was achieved in the second part of the Sixth Conference of Parties to the Framework Convention in June 2001 in Bonn. The Kyoto Protocol generally extended the possibilities of Parties to the Convention in selecting means and instruments that are most suitable for achieving reduction targets and also take into account the specific circumstances in the individual party countries.

In Resolution No. 480/1999, the Government of CR approved the Strategy for Protection of the Climate System of the Earth in the Czech Republic, which includes protection of the climate amongst top-priority environmental issues in CR and simultaneously sets forth the main tasks to be carried out by the individual affected sectors in the framework of achieving the quantitative targets of the Kyoto

[1] First National Communication of the CR to the UN FCCC, Ministry of the Environment, Prague 1994

[2] Second National Communication of the CR to the UN FCCC, Ministry of the Environment, Prague 1997

Protocol. It contains key elements of the strategic means of decreasing emissions of greenhouse gases, which must be balanced and interconnected, and must respect both economic needs and the capabilities of both the state and its inhabitants. The greatest potential lies in a wide range of measures connected to energy savings and increased use of renewable sources of energy, which are in accord with the State Environmental Policy, the State Program of Energy Savings and Renewable Resources, the content of the State Energy Policy and the programs of the Czech Energy Agency. As a number of the means of complying with the Kyoto Protocol were not yet resolved in an international context at the time of adopting this document, it must be considered an open-ended document, concerned with the on-going activities of the individual sectors and not the subject of a one-off campaign.

The basic ideas of the document were included in specific form in the conceptual documents of the individual sectors that could contribute to a decrease in the risk of affecting the climate system of the Earth. The main responsibilities of the individual sectors as based on the relevant Government Resolution are as follows:

The Ministry of the Environment

- organizational provision for compliance with the UN FCCC and the Kyoto Protocol,
- coordination of the activities of the Interministerial Commission on the Climate Change in the sense of Resolution of the Government of CR No. 669/1998,
- implementing and coordinating of regular monitoring of emissions of greenhouse gases in accord with the valid methodologies and in accord with the approaches of the European Union; up-dating of projections of emission trends,
- coordination of scientific research tasks related to monitoring the risk of climate changes and their impact on the territory of CR and preparation of suitable adaptation measures.

The Ministry of Industry and Trade

- implementing tasks following from the State Program for Energy Savings and Greater Use of Renewable Resources.

The Ministry of Transport and Communications

- development and introduction of means of highway, rail, water and air transport that correspond to the standards laid down by the relevant international authorities for the area of environmental impact and safety,
- favouring non-motor means of transport by creating the relevant infrastructure,
- modification of systems of highway transport and development of alternative kinds of vehicle drives.

The Ministry of Agriculture

- extension of the area of forest land through suitable afforestation of unmanaged agricultural areas,
- development of new technologies of working the land and cultivation methods.

The Ministry of Finance

- creation of financial preconditions for complying with the content of the Strategy of Protection of the Climate System of the Earth in the Czech Republic.

This document gives clear priority to implementation of domestic measures to reduce emissions of greenhouse gases. The Kyoto mechanisms (according to Art. 6, 12 and 17) must be considered as a supplementary superstructure here. The document emphasizes joint projects according to Art. 6 and CR has recently been intensely engaged in preparation for emission trading according to Art. 17 of the Protocol.

The National Strategy of CR in the area of climate change has been regularly coordinated through the Interministerial Commission on the Climate Change, whose activities as an advisory body to the Minister of the Environment were renewed in December 1998; in 2000, control of compliance with Resolution of the Government of CR No. 480/1999 was commenced as the first step in preparation of this National Communication.

The Third National Communication has been prepared on the basis of the requirements set forth in FCCC/CP/1997/7, Part II – *Guidelines for the Preparation of National Communications by Parties Included in Annex I to the Convention* and analyzes current circumstances in the area of climate change in CR.

1. EXECUTIVE SUMMARY

1.1 Introduction

The Third National Communication has been prepared on the basis of the requirements set forth in FCCC/CP/1997/7, Part II – *Guidelines for the Preparation of National Communications by Parties Included in Annex I to the Convention* and analyzes current circumstances in the area of climate change in the Czech Republic. It also documents the state of compliance with obligations following from the UN FCCC and the Kyoto Protocol.

In 1999, the Government of the Czech Republic approved the National Strategy for the approach to dealing with the issue of climate change in the Czech Republic (Resolution of the Government of CR No. 480/1999). This places protection of the climate amongst the top-priority environmental issues in CR and sets forth the main tasks to be carried out by the individual affected sectors in the framework of achieving the quantitative targets of the Kyoto Protocol. The basic ideas of the document were incorporated in specific form in the conceptual documents of the individual sectors that could contribute to a decrease in the risk of affecting the climate system of the Earth. Clear priority is placed in CR on implementation of domestic measures to decrease emissions of greenhouse gases.

1.2 National Circumstances

The Czech Republic was formed on January 1, 1993 following the splitting of the former Czechoslovakia. The Constitution of 1992 provides a basic outline of the **constitutional order** that delimits the position and roles of the most important authorities of state power. On this basis, CR can be included amongst countries with a parliamentary democracy, where legislative, executive and judicial powers are separated. Executive power is provided by the Government, which is usually formed by representatives of the strongest political parties on the basis of the most recent elections. It consists of the Prime Minister, four Deputy Prime Ministers and the individual Ministers. At the present time, the central bodies consist of 14 Ministries. CR is divided into Regions, which gained some powers in 2001 that had formerly been held by the Government. They constitute an intermediate self-governing level between the municipalities and cities and the Government. Their size corresponds to the higher territorial administrative units in EU. Integration relations are currently among primary external relations of CR at the present time. CR became a member of OECD in December 1995 and a member of NATO in March 1999. This step will undoubtedly affect further progress of the process of approximation to EU.

As of December 31, 2000, CR had 10 266 546 inhabitants, making it a country with the 14th largest population in Europe. CR has medium population density in Europe, with an average population density of 131 inhabitants per km^2. It is practically homogeneous in its nationality composition, as 95 % of the population consists of Czech, Moravian and Silesian nationalities. However, since the beginning of the nineties, it has begun to be a country accepting a large number of immigrants, especially from southern and Eastern Europe and some Asian countries. The settlement structure consists in more than 15 000 mostly small settlements; almost half of them have less than 100 inhabitants and 93 % have less than 1000 inhabitants. Only seven cities have a population of over 100 thousand persons.

In 2001, the Government adopted the **State Environmental Policy**, which defines a set of basic top-priority issues (e.g. high emissions of greenhouse gases, a high fraction of surface waters with unsatisfactory water quality, decreased ability of the landscape to retain water, chemical and biological degradation of the land, low stability of ecological systems in the present cultural landscape and related alarming decrease in biodiversity). In the last decade, there has been a fundamental decrease and stabilization in the air pollution level in all the main indicators. There has been a certain worsening in the pollution levels of

nitrogen oxides in large cities and in areas with high automobile transport. There have been quite favorable trends in a decrease in the pollution of surface waters.

The **climate** of the country belongs to the Atlantic-continental area of the temperate climatic zone of the northern hemisphere. Air masses originating at central latitudes predominate. There are also fairly frequent penetrations of air masses of tropical and arctic origin. The alternation of air masses is connected with frequent passage of atmospheric fronts throughout the year. The average annual temperature varies in dependence on geographic factors from 1.0 to 9.4 °C. The Capital City of Prague is a specific area whose warm island increases the annual temperature by up to about 1 °C above the values corresponding to its geographic position. Local temperature conditions depend greatly on the elevation above sea level, the geographic coordinates and local geomorphological conditions, especially on the exposure of the terrain. Atmospheric precipitation is one of the most variable climatic features. Decisive factors for precipitation conditions in CR include primarily its geographic position in relation to the airflow bringing humidity and the frequency of occurrence of meteorological conditions under which there is large amount of precipitation. Heavy precipitation occurs primarily during the occurrence of low-pressure areas and troughs over Central Europe, moving east or northeast from the Atlantic Ocean, or moving from the Mediterranean Sea to the north or northwest. In the summer, an Azorian high-pressure area is sometimes decisive, connected with prolonged dry spells.

After 1989, the **transformation of the Czech economy** to the conditions of a market economy began. This is still continuing and is connected with the restitution and privatization processes, with a fundamental change in the economic structure of the country and with opportunities for entrance of foreign capital and also a parallel improvement in the state of environmental conditions. Following a rapid decrease in gross production in all the sectors of the economy in 1991–1993 (by up to 20–30 %), there was a renewal of growth in industry and construction after 1993 and in agriculture after 1997. Transportation is the only sector that exhibits constant growth.

In 2000, the Government approved the updated **energy policy**. In 2001, CR became a member of the International Energy Agency. In recent years, there have been an increasing number of new laws regulating the production and management of energy (e.g. the Atomic Act, regulating the operation of nuclear facilities including nuclear power plants, the Act on the conditions for operation of a business and on execution of the state administration in energy production branches, the Act on management of energy). CR is a country where the development of heavy industry was preferred prior to 1989, with high consumption of energy based on domestic solid fossil fuels, where energy from these fuels was exploited in a very ineffective manner. Conditions gradually changed after 1989. There was a transition to cleaner fuels and the construction of the NPP Temelín was renewed; its first block is currently being brought into operation. However, the complex price and tax conditions remain a problem in the energy industry. The prices of energy for the population continue to be subject to considerable subsidies, whose elimination and introduction of market conditions represent a serious social issue that can be resolved only in the long term.

Transport is based on a combination of railway and highway transport. The density of the railway network per unit area is the highest in the OECD countries. However, railway transport and its infrastructure require thorough modernization, which has already been commenced and partly completed on some internationally important sections. Modernization of the highway network continues to encounter various local conflicts of interest. Comparison of statistical information for 1990 and 2000 indicates a substantial shift from railway to highway transport. The amended transport policy is based on the current situation and defines the basic issues that must be resolved in the immediate future (e.g. increasing volumes of individual automobile transport and inadequate condition of public transport, lack of coordination of modernization of the transport network and construction of capacities, especially in highway

transport, insufficient harmonization of market conditions, lack of transformation of the railways and rather unsuitable fiscal policy of the state).

Industrial production is traditionally the main component of the economy of the Czech lands. After 1989, the importance of the various branches of industry gradually changed, with increasing emphasis on the processing sector and a decrease in the importance of heavy industry. The present-day mining industry is characterized by decreasing extraction of black and brown coal and of the related production of briquettes and coke. With further development of the industrial sector, a strategy was prepared in 2000 to increase the growth of the national economy in the immediate future, to ensure a targeted and interrelated approach with a multiplying and accelerating character.

Current conditions in the area of **waste management** can be characterized by the generation of a relatively large amount of waste. The quite unsatisfactory state of affairs is caused by the predominance of landfilling, especially of municipal waste, a low portion of utilization as secondary raw material and a low fraction of incinerated waste. The fact that only technically safeguarded landfills have been in operation since 1996 is a favorable feature. However, clean-up and reclaiming of landfills, that have been closed by law, constitute a financial problem. The adequate landfill capacity is still frequently accompanied by the lack of a technical base for waste utilization and recycling and for use of its caloric value. The first draft conception for waste management was prepared in 2000 and work was commenced in the same year on the relevant regional conceptions, based on the new Act on waste, that fully implements the contemporary EC legislation.

Agriculture in CR is typically Central European in character, with production of foodstuffs that are characteristic of the temperate zone, with the features of high intensity of land cultivation and also the favorable and unfavorable consequences of collective-type large-scale production. The location of agricultural production is zonal in character, with greater importance of altitude above sea level than latitude. Agriculture is capable of meeting domestic demand for basic agricultural products. A fraction of 54.3 % of the total land fund is classified as agricultural land. It must be stated that the Government has not approved any agricultural policy since 1989. However, there is a conception of sector policy for the period prior to accession of CR to EU.

The area of **forestland** is slowly increasing and now covers 1/3 of the area of the country. More than 3/4 of forest areas consist of conifers, and the rest is covered by broad-leaved species. In recent years, afforestation has reflected attempts to increase the fraction of broad-leaved species at the expense of conifers. 2/3 of forests are in the ownership of the state. In spite of the great decrease in pollutant emissions into the air, there has been no significant improvement in the state of health of forests. This is because of the long-term cumulative degradation of forest soils, caused jointly by pollution and unsuitable and overly intense forest management. The trend in defoliation of forest stands over sixty years in age indicates a continuing slight deterioration in the condition of conifer species with the exception of larches. In contrast, the condition of broad-leaved species is more or less unchanging. A conception for forest policy for the immediate future has been prepared in connection with preparation for accession of CR to EU.

1.3 Emission Inventories

The most important anthropogenic greenhouse gases are carbon dioxide, methane, nitrous oxide and ozone. These gases are natural components of the atmosphere; nonetheless, their concentrations in the air have recently increased significantly as a consequence of human activities. While carbon dioxide, methane and nitrous oxide are emitted directly into the air, ozone is formed in the atmosphere as a consequence of photochemical reactions. Emission inventories do not directly include ozone, but rather the precursors of its formation, i.e. carbon monoxide, nitrogen oxides and non-methane volatile organic compounds. All these gases contribute to warming of the

Tab. 1-1 Total aggregated greenhouse gases emissions in 1990 and 1995–1999
(Mt CO_2 eq.)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2	163.2	148.1	134.2	129.2	123.8	123.4	128.8	130.4	124.7	118.2
CH_4	16.3	14.9	14.0	13.3	12.9	12.6	12.0	11.8	11.1	10.9
N_2O	8.0	7.3	7.0	6.6	6.7	6.7	9.1	8.9	8.4	8.1
HFCs, PFCs, SF_6						0.2	0.3	0.6	0.5	0.5
Total	**187.5**	**170.3**	**155.2**	**149.1**	**143.4**	**142.8**	**150.2**	**151.8**	**144.8**	**137.7**
% of 1990	100.0	90.8	82.7	79.5	76.4	76.2	79.7	80.9	77.2	73.4

Source: Czech Hydrometeorological Institute

atmosphere. Inventories also include sulfur dioxide as one of the precursors of the formation of aerosols, contributing, on the other hand, to cooling of the atmosphere. Greenhouse gases also include F-gases: hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride GHG inventories in CR are drawn up on the basis of standard IPCC methods and the results are submitted annually to the Secretariat of the UN FCCC in the set formats. In this Third National Communication, the **results for the 1990–1999 period** are presented in the form of summary tables (Tab. 1-1).

During the nineties, the aggregated GHG emissions in the Czech Republic decreased from a value of 187.5 Mt of carbon dioxide in 1990 to 137.7 Mt in 1999, corresponding to arelative decrease of 26.8 %. Of the total amount of emissions, carbon dioxide constitutes 85.8 %, methane 7.9 % and nitrous oxide 5.9 %; at the present time, the fractions of F-gases correspond to less than 0.4 %. The inter-annual changes in these fractions are negligible.

1.4 Emission Mitigation Measures

A number of measures have been implemented in the Czech Republic, leading to a decrease in GHG emissions. These include measures limited to a certain specific subject or sector, as well as also framework measures. The targets and consequences of a number of adopted measures are, however, far more extensive – here measures are concerned with decreasing harmful impacts on the environment as a whole. Key measures with the greatest expected benefit include primarily framework multisectoral measures following from adopting of the Strategy of Protection of the Climate System of the Earth in the Czech Republic, inclusion of the aspect of protection of the climate and incorporation of the National Program to Mitigate Changes in the Climate of the Earth in the prepared new legislation on air protection, the adopting of a new Energy Act and of the Act on energy management. These can be divided into **adopted measures and prepared measures**, classified according to their inclusion in the activities of the sectors.

At the present time, a new **Clean Air Act** is being prepared, which is expected to come into force in 2002; this Act harmonizes and transposes the relevant valid legislation of the European Communities in relation to preparation of CR for membership in the European Union. The new air protection legislation is complex and includes protection against pollutants, protection of the ozone layer of the Earth and protection of the climate system of the Earth, and the related joint provisions on the institute of penalties and on the execution of public administration. The law also includes a part related to protection of the climate system of the Earth on the basis of the UN Framework Convention on Climate Change, the Kyoto Protocol to this Convention and on the basis of Council Decision 99/296/EC. By including a part on protection of the climate system of the Earth in the draft Act, CR has become one of the countries that are aware of the importance of activities in this area and also the necessity of creating a legislative framework.

In the area of protection of the climate, the **National Program to Mitigate Changes**

in the Climate of the Earth is included in the new Clean Air Act; this program will be approved by the Government (replacing the current Strategy for Protection of the Climate System of the Earth in the Czech Republic), and will, amongst other things, contain a provision setting reduction targets for substances affecting the climate system of the Earth and deadlines for achieving these targets. Records and evaluation of emissions and of the natural depletion of substances affecting the climate system of the Earth will be kept by the Ministry of the Environment in the register of substances affecting the climate system, which will be based on experience gained in operation of the REZZO national emission database.

A fundamental change in the area of **energy production and consumption**, which can substantially contribute to limiting emissions of greenhouse gases from energy production sources, consists in the adoption of new energy legislation, which has been prepared in the framework of harmonization of the national legislation with the EU legislation. The laws include some provisions directly connected with the structure and requirements on sources and consumption of energy that are subsequently connected with the production of greenhouse gases. The Act on energy management includes some measures that were already mentioned in the Second National Communication and thus provides for their implementation. In 1998, the Government approved the draft for the newly conceived and inter-sectorally coordinated State Program to Support Energy Savings and Use of Renewable Energy Sources, which has been promulgated in a new form since 1999. This program covers all the sectors of the national economy and is connected with the individual programs in previous years. Programs of the Ministry of Industry and Trade (implemented by the Czech Energy Agency) and programs of the Ministry of the Environment (implemented by the State Environmental Fund) play particularly key roles. Other parts of the program are included in the activities of the Ministries of Agriculture, Regional Development, Defense, Interior and other sectors.

In the framework of its programs, the Ministry for Regional Development implements **the program to support repairs, reconstruction and modernization of apartment buildings**, constructed using concrete panel technology. In the framework of the program, financial subsidies, contributions to cover interest and guarantees for activities connected with repair and reconstruction of concrete panel apartment buildings are provided; this work includes thermal insulation and reconstruction of heating systems. Preference is given to economically depressed areas and areas with poor-quality environments.

The majority of measures in the **transport** sector are applied and implemented on an on-going basis and were already described in the previous National Communications. Measures related to decreasing emissions of greenhouse gases from transport are included in the Strategy of Protection of the Climate System of the Earth in the Czech Republic and also in the approved transport policy (implementation is the responsibility of the Ministry of Transport and Communications). An increase in the input of financial means for implementation of these measures has, however, been introduced compared to previous years. Since 2000, the newly established State Fund of Transport Infrastructure has participated significantly in financing.

The introduction of Directive 96/61/EC concerning **integrated pollution prevention and control** (IPPC) and other measures in industry are implemented and supported in the framework of selected subprograms of the State Program to Support Energy Savings and Use of Renewable Sources of Energy. The new energy legislation and especially implementation of the obligations following from the Act on energy management, will contribute to a considerable increase in energy efficiency and the consequent decrease in emissions of greenhouse gases. A basic measure connected with preparation of CR for membership in EU in the industrial sector consists in introduction of EU legislative standards. Key changes will consist particularly in the transition to an integrated system of environmental protection. It is estimated that approximately 850 enterprises and 1400 installations in the Czech Republic will fall under the IPPC regime. In connec-

tion with the preparation of the Act on IPPC, at the end of 2000, the Ministry of the Environment, the Federation of Industry and Transport and the Czech Business Council for Sustainable Development concluded an agreement on cooperation leading to an action plan for 2000–2002. This action plan includes the area of introduction of new legislation, implementation of the IPPC Directive, support for and promotion of further introduction of environmental management systems (EMS/EMAS) and other voluntary instruments in industrial enterprises, which will also be favorably reflected in a decrease in emissions of greenhouse gases.

In the Czech Republic, the sector of **agriculture and forestry** lies within the competence of the Ministry of Agriculture. Measures adopted in this sector affect decreases in emissions of CO_2, CH_4 and N_2O (in agriculture) and also increases in the magnitude of CO_2 sinks (in forest management). In the Strategy of Protection of the Climate System of the Earth in the Czech Republic, the sector of the Ministry of Agriculture pledged to implement measures related to afforestation of unused agricultural land, support for maintenance of permanent grasslands, use and production of alternative motor fuels, and introduction of new soil cultivation technologies and growing methods.

GHG emissions can also be affected by the means of disposing of **waste**. The separation of waste at the level of the generator has a considerable impact and can affect energy consumption for processing raw materials from recycled waste and extend the potential for business opportunities. Key measures in the area of waste management include preparation of the new Act on waste and the Act on packaging, whose drafts were prepared and elaborated in 2001. In relation to preparation for membership in EU, CR must comply with the requirements of Directive 99/31/EC on waste landfills, which contains the requirement to substantially decrease landfilling of biodegradable wastes and also the requirements of the EU regulations related to management of packaging wastes, especially in relation to the prescribed fraction of recycling of plastics, paper and glass.

All the measures set forth in the Second National Communication continue to be implemented, including implementation in the framework of new measures.

1.5 Emission Projections and Overall Benefits of Policies and Measures

The methodology employed in preparing forecasts of trends in emissions of greenhouse gases for the Third National Communication is similar to the methodology used in the Second National Communication and includes the following order of steps: (i) GHG inventory, (ii) selection of initial and final years and cross-sectional years for emission projections, (iii) choice of methodology and model instruments for preparing projections, (iv) collection and analysis of input data for projections, (v) establishing of initial assumptions, (vi) defining of scenarios, (vii) calculation of scenarios and presentation of results and (viii) sensitivity of the analysis to selected assumptions. Year 1999 was the initial year for the inventory and, in addition, annual data on macroeconomic trends were available for 2000, together with the energy balance for 1999 and the preliminary balance of energy sources and consumption for 2000. In relation to the need to use as up-to-date information as possible, the year 2000 was selected as the initial year, where data in the area of energy consumption are preliminary. The **year 2020** was chosen as the final year for projection of emissions of greenhouse gases and the **years 2005, 2010 and 2015 were chosen as cross-section years for the projection.** For processing of projections of trends in CO_2, N_2O and CH_4 levels, emissions were divided into groups on the basis of IPCC activity categories. Summary projections were carried out for emissions of HFCs, PFCs and SF_6, NO_x, CO, NMVOCs and SO_2. **Two conceptually different scenarios of trends in emissions** of greenhouse gases were created (reference and high); for each of them, projections were prepared (i) without measures, (ii) with measures and (iii) with additional measures. A detailed description and results are given in Chapter 5.3 and basic results are given in Tab. 1-2.

Tab. 1-2 Reference scenario (RS) and high scenario (HS) without measures, with measures and with additional measures *(Mt CO_2 eq.)*

	1990	1995	1996	1997	1998	1999	2000	2005	2010	2015	2020
Emission inventory	187.5	142.8	150.2	151.8	144.8	137.7					
RS without measures							149.8	135.3	138.4	135.5	133.1
RS with measures							141.8	126.4	128.3	123.8	121.2
RS with additional measures							141.8	120.0	121.9	117.4	114.8
HS without measures							149.8	151.1	152.6	159.4	159.2
HS with measures							141.8	141.5	141.7	146.6	145.9
HS with additional measures							141.8	135.0	135.2	140.1	139.5

Source: SRCI CS s.r.o., CHMI

1.6 Estimate of Vulnerability, Impacts of Climate Change and Adaptation Measures

In estimation of the impacts of climate change, methods were used to project the impacts using biophysical empirical-statistical and process models, and sometimes also economic models. In addition, empirical analogue studies and expert estimates were employed. Validation and sensitivity analysis were carried out for the models. The climatic conditions in CR in the 1961–1990 period were employed as initial conditions. New **regional scenarios of climate change** for the Czech Republic were created in 2000 to estimate impacts. These scenarios are based on analysis of the properties of global circulation models available in the IPCC data center, that best correspond to current climatic conditions in CR. In construction of regional scenarios to the year 2050, outputs from two selected models were combined with scenarios of growth in emissions of greenhouse gases SRES A2 and B1 and, following application to the initial values of meteorological elements, lower and upper estimates were obtained for these elements to the year 2050. For example, for the current daily air temperature, the range of possible increase in the annual average equals +0.9 to +3.0 °C and, for precipitation, the range of possible decreases in the quotient of total annual precipitation equals –0.2 to –0.6 %. The completed analyses of the vulnerability and impacts of climate change concentrated on the sector of water sources, agriculture and forest management.

Total annual precipitation is the most important climatological variable for estimation of the impacts of climatic change on the **hydrological regimes**. However, in the projections of climate change, this is a quantity that is accompanied by relatively greater uncertainty than other meteorological elements. Consequently, implemented hydrological studies concentrate mainly on sensitivity analysis. A climate change caused by an increase in the greenhouse effect leads to an impact on the hydrological cycle and it cannot be excluded that the yield of water sources will decrease in part of the territory of CR, which could lead to a further worsening of the current, rather unfavorable hydrological situation. It can be expected that increased outflow during the colder parts of the year could lead to more frequent floods during the winter. More intense precipitation occurring in connection with summer thunderstorms would constitute a greater risk of major floods, even with no change in the long-term total precipitation. The consequences of climate change very significantly affect the size of reservoir capacities that would be necessary to maintain the current level of water withdrawal. Even a relatively insignificant decrease in precipitation, together with warming, could lead to a substantial decrease in guaranteed water withdrawal.

The current state of **agricultural soil** in CR is not very favorable, primarily because of the substantial decrease in humus that, amongst other things, increases the rate of warming and thus drying out of the soil

in the summer. The soil quality has also been decreased through the use of heavy machinery in cultivating agricultural land. Marginal conditions for agricultural production are arising in CR even in areas with the highest agricultural productivity. This is mainly due to unfavorable climatic conditions, where practically every other year is characterized by the danger of drought. These conditions are more detrimental for light, sandy soils. An increase in air temperature and in the sum of active and effective temperatures, and in the number of summer and tropical days, and a decrease in the number of frost and ice days can be expected. The frost-free period will increase by 20 to 30 days. The beginning of the vegetation period in a great many areas could shift to the beginning of March and the end to the end of October. Higher air temperatures will prolong the vegetation period and hasten the time of ripening and harvest by at least 10–14 days. Acceleration of vegetation in the spring could, however, increase the danger of damage to plants by late frosts. The expected temperature increase should create a sufficient temperature background for growing some thermophilic species; however, the danger exists of thermal stress through the occurrence of more frequent extremely high temperatures.

Climate change will affect the **landscape and ecological systems** as a whole. It will significantly change conditions for the development and action of agricultural pests and diseases. There will be an increase in infection stress and the occurrence of species from warmer regions. Greater occurrence of viral diseases can be expected over greater areas, e.g. of potatoes. Similarly, more extensive occurrence of some fungal diseases is expected. From the standpoint of production of crops, this results in the need for increased chemical protection, leading to an increase in these costs. Where chemical protection is insufficient, there will be a decrease in economic yields from agricultural crops.

It is clear that a change in climatic conditions will have a great impact on the physiology of trees and on forest ecosystems. It is expected that the current unsatisfactory condition of **forest stands** caused particularly by burdening by air pollution would substantially deteriorate. There is a considerable risk of potential decomposition of the unstable immature and mature stands of unsuitable spruce single-cultures and an increase in abiotic damage under extreme weather conditions. An overall increase in the temperature could also lead to dangerous stress caused by drought. Other habitat factors, such as light, air temperature, availability of nutrients or pollution of the environment could have a synergic effect with soil moisture and affect resistance to drought.

Chapter 6 also specifies the most important **adaptation measures**, which could mitigate the risk of the impacts of climate change. A portfolio of these changes has been proposed for implementation to the Ministry of Agriculture and is included in the state sectoral policy.

1.7 Financial Sources and Transfer of Technology

As CR is not a Party of Annex II to the UN FCCC, it is not obliged in the sense of Article 12.3 of the UN FCCC to adopt measures and comply with obligations following from Articles 4.3, 4.4 and 4.5 of the UN FCCC and especially to create further financial sources. Nonetheless, brief information is given in the relevant chapter on the overall volume of finances that CR contributes to the individual funds. However, it is not possible to specify which part of these means is directed towards the area of climate change.

1.8 Research and Systematic Observation

Research on the climate system is carried out in CR particularly at the following institutions: (i) the National Climate Program of CR, (ii) the National Committee for IGBP, (iii) the Committee for the Environment of the Academy of Sciences of CR, (iv) the National Forestry Committee, (v) the Institutes of the Academy of Sciences of CR

(Institute of Physics of the Atmosphere, Geophysical Institute, Institute for Hydrodynamics, Institute of Landscape Ecology, Geological Institute), (vi) the Departments of the Universities (Department of Meteorology and Protection of the Environment at the Faculty of Mathematics and Physics of Charles University in Prague, Department of Geography at the Faculty of Sciences of Masaryk University in Brno, Institute of Landscape Ecology at the Agronomic Department of the Mendel Agricultural and Forestry University in Brno) and (vii) the sectoral institutes (Czech Hydrometeorological Institute, Water Management Research Institute). Most of these institutes are members or have representatives in the National Climate Program, which is an association of legal persons entrusted with carrying out the tasks of the World Climate Program of WMO, creating research teams of professionals in the area of climate change and publishing the results obtained. Research, which is one of the basic tasks of the individual institutions, is financed from their budget. Requested special studies are financed primarily from the state budget through the grant agencies of CR and Academy of Sciences of CR or grant projects announced by the Ministries of the Environment and Agriculture. Some projects are also carried out in the framework of international cooperation and contributory financing by foreign partners. The National Climate Program, e.g., carried out a territorial study of climate change for CR in 1993–1995 on the basis of a contract with US EPA; the results of this project continue to be extensively used.

Systematic observation of the climatic system is carried out to a decisive extent by the Czech Hydrometeorological Institute, which executes the role of the state institute for the areas of air protection, hydrology, water quality, climatology and meteorology with the competence to establish and operate the state monitoring and observation networks, including international exchange of data based on the principles of WMO. Other institutions carry out monitoring only for their own purposes and usually only for a limited period of time during individual projects.

1.9 Environmental Education and Public Awareness

The State Environmental Policy is the basic, strategic and cross-sectional document for drawing up detailed programs for education and public awareness in the individual components of the environment, including climate change, and for resolving individual environmental issues. Its up-dated version of 2001 includes analysis of current circumstances and it quite specifically elaborates the main directions in environmental protection for the 2001–2005 period. It is concerned with the creation and use of an integrated system of environmental education and public awareness, including state, public-law, private and civil institutions and utilizing their mutual relations with orientation towards regional differences, capabilities and requirements. The subject of environmental education and public awareness is contained in the Act on the right to information on the environment. The state program of environmental education and public awareness in CR of the year 2000 was prepared at the initiative of the Ministry of the Environment and is a joint project of an intersectoral working group established for this purpose at the Ministry of the Environment. Its key target consists in an increase of consciousness and knowledge amongst the population of the environment, education in sustainable development and public participation in environmental issues.

CR is gradually implementing the principles of Agenda 21, whose Chapter 36 is one of the starting points for the state program. The Aarhus Convention on access to information, public participation in decision-making and access to justice in environmental matters, which CR signed in 1998, constitutes a further important basis for the creation of this program.

2. NATIONAL CIRCUMSTANCES

2.1 Structure of the State Administration

The present-day Czech Republic was formed on January 1, 1993 following the splitting of the former Czech and Slovak Federative Republic (Czechoslovakia). In spite of a number of temporary and permanent territorial and political changes (World War II and the joining of Subcarpathian Russia to USSR in 1945), Czechoslovakia existed for the period 1918–1992. The present political system arose in the years 1990–1992, after the fall of the Communist regime in 1989, i.e. still in the framework of the Czechoslovak Federation. The most important step on the path to creation of a democratic society was the holding of the first free plurality elections in 1990.

The basic profile of the constitutional order, delimiting the position and role of the most important bodies of the state authority, is provided by the Constitution of CR, which was adopted on December 16, 1992. On this basis, CR can be considered to be a parliamentary democracy with separate legislative, executive and judicial powers. The head of the country is the President, who is elected by Parliament for a period of five years. The highest legislative authority is the Parliament of CR, consisting of two chambers (the Chamber of Deputies and the Senate), which approves all draft laws and expresses consent or dissent to important international conventions, agreements, protocols, various political and strategic documents in the areas of industry, the military, the environment, agriculture, etc. Executive power is provided by the Government, which is formed on the basis of elections to the Chamber of Deputies. Its members are usually representatives of the strongest political parties, based on the previous elections. It consists of the Prime Minister (the Premier), four Deputy Prime Ministers (Vice Premiers) and the individual ministers. At the present time, there are 14 ministries.

On the basis of the Constitution, CR is divided into higher self-governing units (Regions), which gained some powers in 2001 that were originally held by the Government. Their sizes correspond to the higher self-governing units in the EU of the NUTS 3 size and they are headed by a Regional Commissioner. They constitute an intermediate self-governing level between the too-small municipalities and cities and the Government, and provide a number of functions and services to individuals in the framework of socio-economic and other development (e.g. also including the environment) on the basis of their own requirements, better knowledge of local and regional conditions and independent financial decision-making. At the present time, the municipalities constitute the only self-governing units subject to elected municipal assemblies headed by a mayor.

In the area of protection of the environment, the supreme executive body of the state administration is the Ministry of the Environment, which is divided into five professional sections: (i) the Section of Environmental Policy, (ii) the Section of Legislation and State Administration, (iii) the Section of Protection of Nature and the Landscape, (iv) the Section of Technical Protection of the Environment and (V) the Section of Foreign Relations. It also includes nine divisions of execution of the state administration, responsible for dealing with environmental issues in the newly created Regions. The Ministry also has jurisdiction over professional institutes (e.g. the Czech Environmental Institute, the Czech Hydrometeorological Institute, the T.G. Masaryk Water Management Institute, the Agency for Protection of Nature and the Landscape of CR), and also the State Environmental Fund and the Czech Environmental Inspection.

2.2 International Activities

The most important external relations of CR at the present time include integration relations. These have political, military, economic, monetary, regional and historical dimensions. After 1989, a geopolitical vacuum appeared in Central Europe, which has gradually been filled by the expansion of OECD, NATO and

EU to the east. CR became a member of OECD in December 1995 and a member of NATO in March 1999. This step will undoubtedly affect the further progress of approximation to EU. One of the main preconditions for accession to EU is fulfilling of economic and other conditions, which are considered binding (e.g. including resolving environmental issues). Harmonisation of legal and legislative aspects is gradually progressing. EU structural funds constitute a new and important aspect in connection with the approximation process. These provide financial resources, obtained from contributions of member countries, and distribute them according to exact criteria into seven areas. They are oriented particularly towards assistance for depressed regions (with less than 75 % of the average GDP per person in EU), i.e. the entire area of the country with the exception of Prague.

2.3 Population

As of December 31, 2000, CR had a population of 10 266 546 inhabitants, i.e. was the 14th largest country in Europe in terms of population. Population trends since 1990 are depicted in Tab. 2-3. CR has medium population density in Europe (average population density of 131 inhabitants per km^2). Northern part of the country and areas of large agglomerations have higher density of population given their natural and economic conditions. The population of the CR consist of 95 % Czech, Moravian and Silesian nationalities, 3.5 % of Slovaks and the rest are Polish and German minorities. There has been a decrease in the originally high birth rate over the last fifty years, along with deterioration in the age structure and losses through extensive emigration in 1948 and 1968. However, since the beginning of the nineties, CR has begun to be a country accepting a large number of immigrants, especially from Southern and Eastern Europe and some Asian countries.

2.4 Geography

In its area (78 664 km^2) CR is a medium-sized to small country and, following the formation of a number of new European countries, is now the 21st largest country in Europe. The highest point above sea level is Sněžka in Krkonoše (1603 m a.s.l.), while the lowest point is at Hřensko, where the Elbe crosses the border to Germany (115 m a.s.l.). In classification according to the altitude, lowlands and territories below 200 m a.s.l. cover 5.0 % of the area of CR, areas with an altitude of 200–500 m a.s.l. cover 74.1 % of the total area of CR, areas with an altitude of 600–1000 m a.s.l. cover 19.3 % of the area of CR, and areas with an altitude of over 1000 m a.s.l. cover 1.6 % of the area of the country. The average altitude above sea level is 450 m, which is higher than the average altitude of Europe (315 m); together with its position in the center of the continent, this means that the main European water divide passes through CR (North, Baltic and Black Seas).

The current variety in the relief of the territory of CR is a consequence of opposing internal and external geological forces. The shapes of the reliefs are also affected by the structural tectonics of the rocks (with a predominance of granite, volcanic rocks, sandstone and limestone). 97 % of the soil was formed on the surface of the weathered mantle, whose thickness varies from 0.3 to 5 m. The relief is important in soil-forming processes through the altitude, exposure and slope inclination, along with the intensity of erosion processes. Anthropogenic effects in the soil have been manifested primarily in the removal of forest stands (which originally covered 90 % of the area of CR), of which about one third remains at the present time. Additional factors leading to devastation of the soil include excessive use of industrial fertilizers, leading to a change in their chemism. Gaseous emissions in CR have a detrimental effect on about 5 % of agricultural land (over 200 thousand ha) and solid emissions affect almost 8 % of this land (about 350 thous. ha), of which almost 25 % is in the northern Bohemian region[3].

The position of CR on the main European divide is not favorable from the standpoint of water management. Most of the water courses in this country have their springs here. Thus, precipitation water becomes a decisive water

[3] Collective of authors: Geography – Czech Republic, SPN, Prague 1999

source. The long-term annual average equals 693 mm and approx. 30 % of this amount flows out of the country in water courses (the average annual outflow of water per inhabitant of CR equals about 1450 m^3, i.e. about 1/3 of the European and 1/5 of the global average). The river networks in CR have a density of 0.96 km/km^2. A major part of the territory of Bohemia is drained through the Elbe into the North Sea, while a major part of Moravia is drained by the Morava River into the Danube and the Black Sea; part of Moravia is drained by the Odra River into the Baltic Sea. The fan-like network of rivers in the Odra river basin, with the concentration of confluences of the most important rivers in the Ostrava basin, leads to an elevated danger of the occurrence of floods. Compared to the surrounding countries, there are very few lakes in CR (only in the Šumava area). Artificial water reservoirs are far more numerous, with more than 24 000 located in this country (the vast majority consist in fish ponds). There are a great many mineral springs, occurring at about 350 locations.

The current state of the biosphere is the result of natural developments over the last several thousand years. The vegetation belt in valley floodplains and lowlands consists primarily of agricultural areas. Lowland meadows cover large areas. Forests are of the greatest importance of all plant communities (covering about 1/3 of the country), creating a micro-climate and meso-climate, absorbing more solar radiation, decreasing wind speed and affecting flow-out conditions. Most of the current forest stands were planted artificially and do not correspond to the original forest composition. They consist mostly of single-species stands with a predominance of spruce and pine. The development of the present-day landscape in the territory of CR is affected primarily by secondary ecosystems. There is a minimum of the original natural ecosystems in the landscape of CR. A large part of the country consists of fields, vineyards, orchards and gardens, used to produce foodstuffs, which are classified as productive ecosystems.

The settlement structure consists of more than 15 000 mostly small settlements, almost half of which have less than 100 inhabitants and 93 % have less than 1000 inhabitants. Only seven cities have a population of over 100 thousand persons. Compared to the other countries of Central Europe, CR has fewer medium-sized and especially large cities. Territorial differences in the settlement character are significantly affected by natural conditions. There is a dense network of small settlements in the upland areas of Central, Southern and Western Bohemia, with rather unfavorable conditions for agriculture; larger rural settlements, frequently with 1 to 2 thousand inhabitants, are found in the fertile lowlands of Bohemia and especially Central and Southern Moravia. The mountain foothill areas of Northern Moravia and Northern Bohemia are characterized by small towns or villages, located in valleys along water courses and highways. The mountain border areas have quite different distribution of settlements, consisting of individual, distant settlements.

2.5 Protection of the Environment

Since 1990, a number of strategic environmental documents have been adopted, covering protection of the environment, together with the principles of sustainable development. The latest of these programs is the updated State Environmental Policy (Resolution of the Government of CR No. 38/2001). According to this document, there are 20 top-priority issues, of which the most important are (i) high emissions of greenhouse gases, (ii) high fraction of surface waters with inadequate water quality, (iii) decreased water-retention ability of the landscape, (iv) chemical and biological soil degradation, (v) low stability of ecosystems in the present cultural landscape and the related alarming decrease in biodiversity, etc. Emphasis is placed on the state and trends in the environment in the air, water and nature and the landscape[4].

[4] Report on the Environment in CR in 1997, Ministry of the Environment, Prague 1998
Report on the Environment in CR in 1998, Ministry of the Environment, Prague 1999
Report on the Environment in CR in 1999, Ministry of the Environment, Prague 2000
Report on the Environment in CR in 2000, Ministry of the Environment (in press)

Tab. 2-1 Total air emissions of principal pollutants in 1990 and 2000 *(kt/year)*

	Solid particulates	SO_2	NO_X	CO	NMVOC	CO_2 eq.
1990	631	1 876	742	1 055	435	187 500
2000	60	263	390	666	240	137 700[a)]
% change	- 90	- 86	- 47	- 37	- 45	- 27

a) year 1999 *Source: Ministry of the Environment*

Over the past decade, there has been a substantial decrease and stabilization in the level of **air pollution** in all the main indicators (Tab. 2-1). Similarly, over the same period, there has been a decrease in emissions of Cd (by 37 %), Hg (by 50 %), Pb (by 42 %), PAH (by 25 %), PCBs (by 37 %) and PCDD/PCDF (by 49 %). These trends have led to stabilization of the air quality in terms of most indicators. The pollution limit levels for sulfur dioxide were not exceeded in any District in the 1994–2000 period. Similar conditions have existed for particulate matter since 1998. After 1997, the increasing trend in the amount of nitrogen oxides stopped and a slight decrease has occurred in some areas in the 1998–2000 period. However, there has been a certain increase in agglomerations of some large cities (Prague, Plzeň and Ostrava) and at sites with more dense automobile transportation. In addition, a decrease in the concentrations of arsenic, cadmium and lead in the air was observed at the vast majority of measuring stations in the 1997–2000 period. Tropospheric ozone constitutes an exception, with a slight increase in the frequency of occurrence of exceeding of the air pollution limit values. CR is a party to the Convention on Protection of the Ozone Layer (the Vienna Convention) and the Protocol on Substances Depleting the Ozone Layer (the Montreal Protocol), including the relevant amendments (London, Copenhagen, Montreal and Peking). On the basis of these commitments, CR fulfills obligations leading to a substantial decrease in consumption of these substances.

Similar as for the air, there have been quite favorable trends in improving water quality through a decrease in the **pollution of surface waters**. These levels are affected primarily by point sources (cities and municipalities, industrial factories and sites of concentrated agricultural animal production), and also diffuse sources (agricultural management through the application of industrial fertilizers and chemical preparations, atmospheric deposition and erosion runoff). Another factor lies in contamination of water by accidents. In CR, 74.8 % of the population is connected to the public sewers, which is above the European average for the OECD countries (about 62 %); 94.8 % of waste water is treated in some manner. Amongst the main operators of waste water treatment plants, 92.9 % of waste waters are treated in facilities with satisfactory effectiveness. There was a marked decrease in the amount of pollutants discharged from point sources of waste waters from industrial activities in the 1990–2000 period; this is documented in Tab. 2-2.

Tab. 2-2 Pollutants discharged into surface water from selected industrial point sources in 1990–2000

	Total amount of waste water (mil. m^3)	BOD_5 (t)	COD_{Cr} (t)	Insoluble substances (t)	Soluble inorganic substances (t)	NH_4^+ (t)
1990	682	383 970	842 218	197 712	440 288[a)]	4 750[a)]
2000	300	46 076	277 932	81 062	246 561	1 757
% change	- 56	- 88	- 67	- 59	- 44	- 63

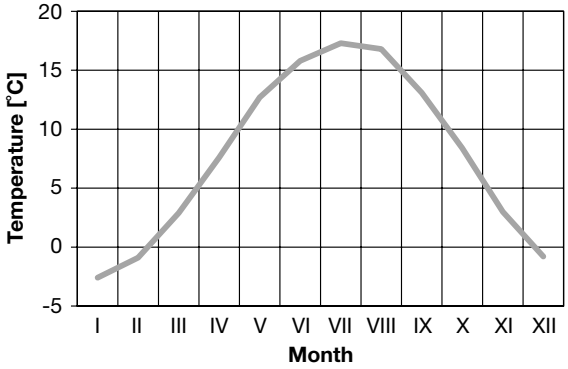
a) 1995 *Source: Ministry of the Environment*

Nature protection has a profound tradition in CR. For example, this country contains the oldest nature reserve in Europe, promulgated in the Novohradské hory in 1838 (the Žofín virgin forest). At the present time, there are four national parks in the country (Krkonoše, Šumava, Podyjí and České Švýcarsko), with an overall area of 1190 km^2, together with 24 protected landscape areas, covering a total of 14.6 % of the total area of the country. Internationally important protected areas form an important component of the natural complexes; these include particularly biosphere reserves declared by UNESCO. The Supreme Audit Institution was established in CR in 1993, which also has the obligation of controlling compliance with environmental protection laws.

2.6 Climate

From a dynamic synoptic point of view, the climate in CR belongs to the Atlantic-Continental area of the temperate climatic zone of the northern hemisphere. The average annual temperature varies over the territory of CR in dependence on geographic factors from 1.0 to 9.4 °C. The average temperature in the spring lies between –0.1 and 9.6 °C and, in the summer, between 8.8 and 18.5 °C. The average temperature in the autumn is between 2.0 and 9.6 °C and, in the winter, between –6.8 and 0.2 °C. All these values are the average values for the 1961–1990 period. The lowest average temperatures occur in the mountain areas along the northern, eastern and south-western borders of the country. The warmest areas are at altitudes of about 200 m a.s.l. (lowlands in the south-east of the territory and along the Elbe). General average annual, spring and fall temperatures are predominately of about 7–8 °C, summer temperatures of about 16–17 °C and winter temperatures of about –1 °C. The Capital City of Prague is a specific area whose warm island increases the annual temperature by up to about 1 °C above the values corresponding to its geographic position. Local temperature conditions depend greatly on the altitude above sea level, the geographic coordinates and local geomorphological conditions, especially on the exposure of the terrain.

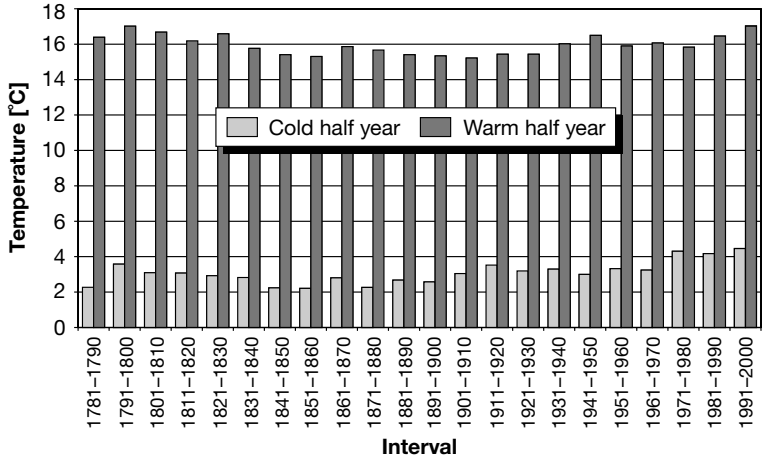
Fig. 2-1 Annual course of mean air temperature in 1961–1990



Source: Czech Hydrometeorological Institute

The spatial variation in the temperature can best be expressed as a linear regression dependence on the altitude and one or both geographic coordinates. The average annual temperature decreases with increasing altitude (by 0.56 °C/100 m), latitude (0.33 °C/deg) and longitude (0.05 °C/deg). For the dimensions of the country on the basis of these gradients, the difference between the lowest and highest altitudes corresponds to a difference in the average temperature of 8.4 °C. The average temperature decreases by 0.8 °C from the south to the north and by 0.34 °C from the west to the east. The dependence in the zonal direction is thus least marked. All the regression dependences are statistically significant. The annual variation of air temperature over the territory of CR has the shape of a simple wave with a minimum in January and maximum in July (Fig. 2-1). Processing of the temperature trends in the 1961–1990 period indicates that, if the temperature series for the 1961–1990 period is expressed using a linear regression model, most of the monitored Czech stations recorded an increase in the average annual temperatures in this period, equal to an average of 0.22 °C/10 years. At about 14 % of stations, this temperature increase can be considered to be statistically significant at a significance level of d = 0.05. The determination coefficients K2 are, however, very low; K2 > 0.1 at only 20 % of stations and it exceeds a value of 0.2 at only two stations. The last three decades of the 20th century brought a clear increase in air temperature in CR. On the basis of territorial averages, 2000 was the

Fig. 2-2 Winter and summer mean air temperature for decades of 1781–2000 (Praha – Klementinum)



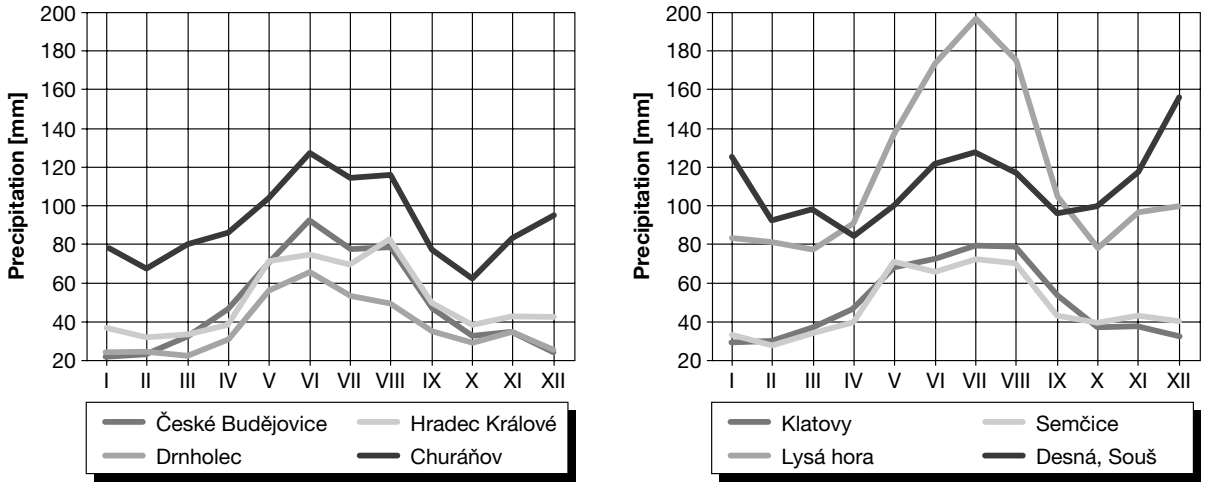
Source: Czech Hydrometeorological Institute

warmest year in the history of CR and the 1991–2000 decade was the warmest in the entire series of measurements at the secular station of the Prague-Klementinum (Fig. 2-2). The warming is apparent in both the warm and cold halves of the year; however the average temperature of the winter period exceeded all the previous decades by a value of 1 °C or more.

Atmospheric precipitation is one of the most variable climatic features. The decisive factors for precipitation conditions in CR consist primarily in the geographic position in relation to air flow bringing humidity and the frequency of occurrence of weather conditions during which a greater amount of precipitation falls. Heavy precipitation occurs in this country primarily when a low pressure area is located over Central Europe and when troughs are present over Central Europe. They are thus dependent mainly on the frequency of the occurrence of areas of low pressure moving from the Atlantic Ocean to the east or north-east, and often also on the frequency of low pressure areas moving from the Mediterranean Sea to the north or north-east. In the summer, an Azorian high pressure area is sometimes decisive, and is usually connected with prolonged dry spells.

The leeward side of the Krušné Mts. has the lowest precipitation (between the cities of Most, Chomutov, Kadaň and Žatec), along with a strip along the Ohře River in the north-east direction and a narrow strip along the Dyje River to the west of the Mikulov hills. The average annual precipitation in these regions is less than 450 mm. The areas with the highest precipitation include the windward side of the Jizerské Mts., Krkonoše

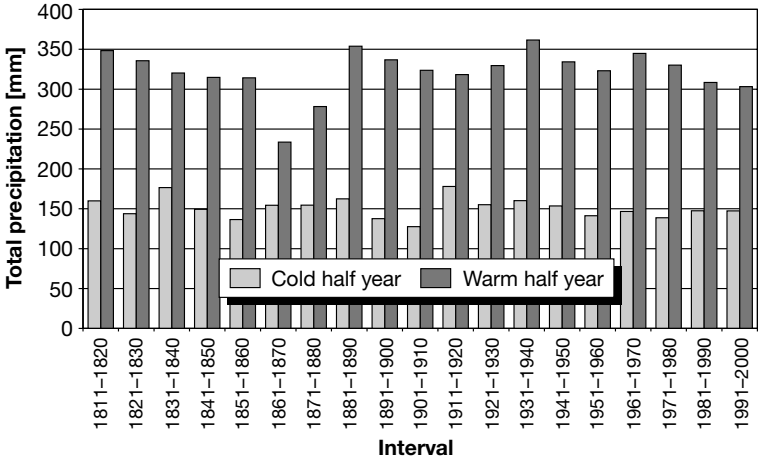
Fig. 2-3 Annual course of mean monthly precipitations



České Budějovice (388 m a.s.l.), Hradec Králové (278 m a.s.l.), Drnholec (179 m a.s.l.), Churáňov (1118 m a.s.l.), Klatovy (430 m a.s.l.), Semčice (234 m a.s.l.), Lysá hora (1324 m a.s.l.), Desná-Souš (772 m a.s.l.).

Source: Czech Hydrometeorological Institute

Fig. 2-4 Winter and summer precipitations for decades of 1844–2000 (Praha – Klementinum)



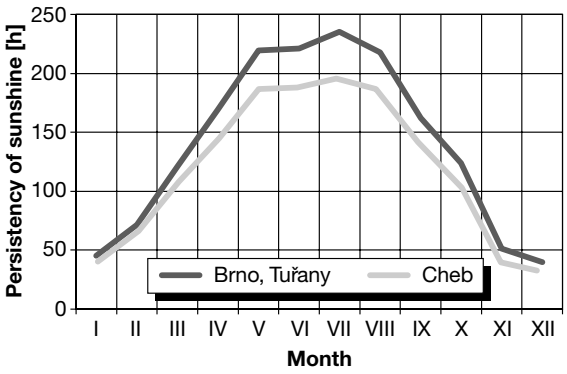
Source: Czech Hydrometeorological Institute

and the highest parts of the Moravoslezské Beskydy Mts., with an average annual precipitation of over 1300 m. The highest average annual precipitation has been recorded on Lysá hora (mountain located in the Moravskoslezské Beskydy Mts.), equal to 1390 mm. Absolutely the highest monthly total precipitation was recorded in August of 1972 on Lysá hora (Mt.), equal to 518 mm, i.e. 296 % of the monthly average, while the lowest was recorded in Staré Město (District of Uherské Hradiště) in December of the same year – only 0.3 mm, i.e. only one hundredth of one percent of the monthly average at this station. These values reflect the great variability of precipitation in the territory of CR. The annual variation of precipitation that was typical for the climate of CR in earlier periods, with the shape of a simple wave with a maximum in July and minimum in February or January, practically does not appear in the average values of total precipitation for the relevant period. The annual variation has one or two maxims in the summer (June or August) and frequently also a local maximum in November. The minimum total precipitation usually occurs in Bohemia in February or January. Only very rarely does the lowest precipitation occur in October or December. An additional minimum has appeared almost regularly in October in the 1961–1990 period (see, e.g., Fig. 2-3).

From the long-term viewpoint, total precipitation has exhibited a decrease over the last decades (Fig. 2-4), manifested most in the warmest lowland area of Southern Moravia. Extreme total precipitation values have occurred more frequently, with repeated floods, especially after 1995.

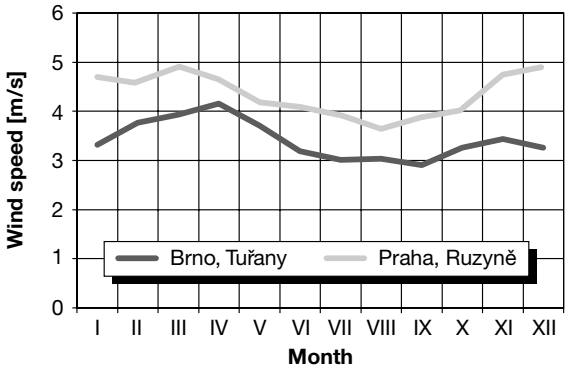
Of the other climatic features, for the sake of information, graphs are depicted characterizing the number of hours of sunshine (Fig. 2-5) and the average wind speed (Fig. 2-6). Frequent wind directions with a westerly component predominate over most of CR. Smaller areas in the east and north have a predominance of frequencies in the southern or northern sector and only a very few areas are free of a predominant wind direction. The wind speed depends on geographic conditions

Fig. 2-5 Annual course of sunshine duration in 1961–1990



Source: Czech Hydrometeorological Institute

Fig. 2-6 Annual course of mean wind speed in 1961–1990



Source: Czech Hydrometeorological Institute

and is generally greater at higher altitudes; however, the configuration of the vicinity of the station is very important. Thorough analysis of wind measurement data indicated that a trend in wind speeds cannot be demonstrated in the 1961–1990 period over the territory of CR as a whole, although statistically significant trends can be found in the time series of wind speeds at most stations in this period[5,6].

2.7 Economy

Following 1989, the transformation of the economy to market conditions began in CR; this process is still continuing. It is connected with (i) the restitution and privatization processes, characterized mainly by a limitation of state influence in the economy, (ii) a fundamental change in the economic structure of the state with opportunities for entrance of foreign capital, (iii) an increase in the quality of products in an attempt to attain competitiveness on the European and global markets and (iv) a parallel improvement in the state of environmental conditions, determined primarily by the behaviour of the economic sphere. Transformation has so far progressed most rapidly in the area of services, with slower progress in banking and slowest in energy production. The relevant economic trends are surveyed in Tab. 2-3 for the 1995–2000 period, in relation to the reference year of 1990. It follows, amongst other things, that CR attained the GDP level of 1990 only in the year 2000. The increase in foreign investments affects this level; inflation is at a more or less acceptable level.

Tab. 2-4 gives a closer view of the trends in some sectors of the economy in the 1990–1999 period. Following a rapid decrease of 20–30 % in all economic sectors in 1991–1993, growth was regained in 1993 in industry and after 1997 in agriculture. Transportation is the only sector that exhibits constant growth without respect to the level of GDP. Tab. 2-4 also reflects a phenomenon that is frequently called "decoupling" (the GDP increases, but pollutant emissions decrease). This phenomenon occurred in CR in 1994–1995 (at the present time, emissions have decreased for PM to 9.5 %, for SO_2 to 14.0 %, for NO_x to 53 % and for CO_2 to 73 % of the 1990 values). The contribution of the individual sectors of the economy to creation of the GDP (in constant 1995 prices) is apparent from Tab. 2-5.

[5] Study of the impact of climate change caused by an increase in the greenhouse effect in the Czech Republic. Ministry of the Environment CR Project VaV/740/1/00, individual report for 2000, NKP, Prague 2000

[6] Kalvoda J.: Scenarios of climate change for the Czech Republic. National Climate Program of CR. Vol. 17, CHMI Prague 1995

Tab. 2-3 Overview of demographic and economic indicators in 1990–2000

	1990	1995	1996	1997	1998	1999	2000
Mid-year population (thous. persons)	10 363	10 331	10 315	10 304	10 295	10 283	10 266
GDP (bill. CZK)	626.2	1 381.0	1 572.3	1 668.9	1 798.3	1 836.3	1 959.5
GDP (1995 bill. CZK)	1 449.4	1 381.0	1 447.7	1 432.8	1 401.3	1 397.9	1 433.8
GDP (bill. USD PPP)	107.30	127.2	134.5	135.7	135.6	135.5	144.1
GDP per cap. (thous. USD PPP)	10.35	12.31	13.04	13.17	13.17	13.18	14.04
Average income (CZK), state sector	3 286	8 172	9 676	10 691	11 693	12 655	-
Inflation rate (%)	9.7	9.1	8.8	8.5	10.7	2.1	3.9
Foreign investment (bill. CZK)	2.4	67.9	38.8	41.3	81.9	168.7	-
Foreign debt (bill. USD)	9.2[a)]	17.2	21.2	21.6	24.3	22.9	22.3
Exchange rate CZK/USD	18.6	26.5	27.1	31.7	32.3	34.6	-
Unemployment rate (%)	0.7	2.9	3.5	5.2	7.5	9.4	8.8
Foreign trade balance (bill. CZK)	- 13.7[b)]	- 99.6	- 148.9	- 148.2	- 78.6	- 68.1	- 126.8

[a)] data for former Czechoslovakia; [b)] without Slovakia *Source: Czech Statistical Office*

Tab. 2-4 Status ranking of GDP in 1991–2000

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
GDP (1995 bill. CZK)	1 180.7	1 183.7	1 197.9	1 227.4	1 290.6	1 357.5	1 345.6	1 315.2	1 315.3	1 355.1
agriculture, forestry, fishing (%)	5.4	4.3	6.4	5.2	4.7	4.5	4.9	5.0	5.3	4.7
industry (%)	33.1	36.5	30.7	32.5	33.3	35.9	37.3	38.1	36.7	37.7
construction (%)	9.3	8.7	8.6	7.5	8.6	6.4	6.3	5.4	4.6	4.2
trade, repairs, hotel services (%)	13.4	13.5	13.9	14.7	15.0	16.4	14.3	14.4	15.1	-
transport (%)	7.2	7.6	8.7	8.4	8.1	7.6	7.9	9.5	10.1	10.1
finance (%)	4.1	3.9	4.3	4.5	4.7	5.9	5.7	5.9	6.6	-
commercial services (%)	12.4	11.6	13.2	12.7	11.7	11.7	12.1	11.3	11.5	-
other services (%)	15.1	13.9	14.2	14.5	13.9	11.6	11.5	10.4	10.1	-
Total (%)	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**-**

Source: Czech Statistical Office

Tab. 2-5 GDP development index and sectoral structure in 1990–2000
(year 1990 = 100 %)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
GDP (1995 CZK)	100	88.4	87.9	88.0	89.9	95.3	99.9	98.9	96.7	96.4	98.5
GDP (USD PPP)	100	85.8	84.9	89.8	97.1	106.5	111.8	112.1	110.9	113.9	119.6
TPES[a)]	100	91.7	86.4	84.4	81.5	84.5	88.1	84.3	80.1	78.3	77.3
TPES/GDP (1995 CZK)	100	103.7	101.2	98.1	91.9	89.4	90.0	85.0	73.7	73.7	72.5
TPES/GDP (USD PPP)	100	92.2	84.4	80.8	74.5	71.3	70.2	66.7	63.4	62.0	57.5
Industry	100	78.2	72.1	68.3	69.7	75.8	80.7	83.2	83.0	80.0	85.0
Agriculture	100	91.1	80.1	78.3	73.6	77.3	76.2	72.4	73.0	73.3	70.0
Construction	100	72.5	86.8	80.4	86.4	93.7	98.7	94.9	88.3	82.6	86.0
Transport (J/USD)[b)]	100	95.5	95.9	101.6	102.9	100.8	90.9	100.7	103.8	108.8	105.8
Transport (J/CZK)[c)]	100	107.7	111.1	120.7	125.2	125.4	114.1	128.9	134.5	142.1	142.5

[a)] *Total Primary Energy Sources;*

[b)] *calculation on the base of time development of share of total energy consumption in all transport (road, rail, water and air transport) and gross domestic product in USD according to purchasing power parity;*

[c)] *calculation on the base of share of total energy consumption in all transport and gross domestic product in CZK in 1995 constant prices*

Source: Czech Statistical Office

2.8 Energy Production

The updated energy policy was approved in 2000 (Resolution of the Government of CR No. 50/2000). Simultaneously, after fulfilling a number of accession conditions, CR became a member of the International Energy Agency, located in Paris, on February 5, 2001. Since 1996, CR (together with Hungary, Poland and Slovakia – the CENTREL distribution network) has been connected to the Western European UCTE electricity distribution network. In the same year, simultaneously with acceptance into OECD, the Agreement on the energy charter was ratified and the Ingolstadt-Kralupy-Litvínov petroleum pipeline was brought into operation. In 1997, a contract was concluded on supply of natural gas from Norway. In recent years, number of new laws have been adopted, dealing with energy production and management: (i) the Atomic Act, No. 18/1997 Coll., regulating the operation of nuclear facilities, including nuclear power plants, (ii) Act No. 458/2000 Coll., on conditions for operating a business and on execution of state administration in energy branches and amending some laws (called the Major Energy Act), (iii) Act No. 406/2000 Coll., on energy management (called the Minor Energy Act) and (iv) Act No. 189/1999 Coll., on emergency supplies of petroleum.

CR is a country where the development of heavy industry was preferred prior to 1989 (production of iron and steel), with high consumption of energy based on domestic solid fossil fuels, where, in a number of cases, energy from these fuels was exploited in a very ineffective manner. This situation led to a number of serious problems, especially for the environment. Conditions gradually changed after 1989. There was a transition to cleaner fuels (petroleum and natural gas) and the construction of the Temelín NPP was renewed, which is currently being brought into operation. Tab. 2-6 gives a survey of the roles of the individual kinds of fuel in the structure of total domestic consumption of primary energy sources (TPES)[7]. "Other sources" include nuclear energy and energy from renewable sources. Renewable sources correspond to less than 2 % of total TPES; this figure is expected to increase to 3–6 %

[7] TPES – Total Primary Energy Sources

Tab. 2-6 Structure of primary energy sources in 1990 and 1994–2000 *(%)*

	1990	1994	1995	1996	1997	1998	1999	2000
Solid fuel	65	58	58	55	56	53	51	51
Liquid fuel	17	17	19	19	17	19	20	20
Gaseous Fuel	11	14	16	18	19	19	20	20
Other sources	7	11	7	8	8	9	9	11
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Source: Czech Statistical Office

Tab. 2-7 Overall energy balance in 1990 and 1995–2000

	1990	1995	1996	1997	1998	1999	2000
Domestic sources (PJ)	1 730.5	1 409.8	1 403.3	1 346.5	1 283.5	1 156.1	1 235.0
Import (PJ)	592.1	726.1	802.9	778.7	780.1	744.3	735.0
% TPES	28.5	41.5	44.0	44.6	47.0	46.8	44.9
Export (PJ)	158.9	397.3	388.9	376.1	366.2	362.6	356.0
TPES (PJ)	2 076.1	1 749.7	1 823.4	1 744.7	1 658.8	1 621.0	1 635.0
Losses (PJ)	688.5	594.5	602.4	604.5	581.0	594.5	587.6
% TPES	33.2	40.0	33.0	34.6	35.0	37.3	35.9
Final consumption (PJ)	1 303.2	1 091.3	1 151.5	1 099.1	1 047.0	1 052.1	990.0

Source: Czech Statistical Office

by 2010. In addition, energy is being used ever more economically. For example, in 1990–2000 there was an absolute decrease in TPES by almost 23 %. The overall energy balance in CR, including domestic sources, imports, exports and losses is outlined in Tab. 2-7.

However, the complex price and tax conditions remain a problem in the energy industry. The prices of energy for the population continue to be subject to considerable subsidies, whose removal and introduction of market conditions represent a serious social issue that can be resolved only in the long term. Industry makes the greatest contribution to final energy consumption (46.5 % in 1999, 52.8 % in 1990). This is a much higher value than in average European OECD countries (30 %). Since 1990, there has been an increase in energy consumption in the transport sector from the original 8.7 % to almost 15 % in 1999. The fraction of energy consumption in the residential and commercial sector remains almost constant (34 %), which is a result, amongst other things, of poor energy management[8,9].

2.9 Transportation

Its central position in Europe has made CR an important crossroads of transport routes. Transport is fundamentally based on a combination of railway and highway transport, which together, on the basis of transport output, provided for transportation of 93 % of persons and 99 % of freight. The density of the railway network per unit area is the greatest in the OECD countries (almost 12 km of track per 100 km^2). However, railway transport and its infrastructure require thorough modernization, which has already been commenced and partly completed on some internationally important sections. Modernization of the highway network (with a density of almost 70 km per 100 km^2), and especially the construction of superhighways (with a density of 6.3 km per 100 km^2), while also required, continues to encounter various local conflicts of interest for understandable reasons. In 1990, the fraction of passenger highway transport equaled 77 % and passenger railway transport, 20 % of the total; in 2000, the fractions of these kinds of passenger transport equaled 85 % and 8 %, respectively. The corresponding values for freight highway and railway transport equaled 28 % and 69 % in 1990, and 68 % and 30 % in 2000. An abandoning of railway transport is apparent, with dramatic changes in freight transport.

Tab. 2-8 gives a survey of the numbers of motor vehicles in CR in the 1990 to 2000 period; while there were 22 passenger cars per 100 inhabitants in CR in 1990, this number had increased to 36 passenger cars per 100 inhabitants in 2000. While in 1990, less than 1 % of vehicles were fitted with catalyzers, in 2000, 32 % of vehicles had catalyzers. In 2000, 2.6 % vehicles were run on alternative power. In relation to overall conceptions and strategies, the up-dated Transport Policy of CR was approved (Resolution of the Government of CR No. 413/1998).

[8] Statistical Yearbook of the Czech Republic 2000, Czech Statistical Office, Scientia, Prague 2000

[9] Energy Policies of IEA Countries – Czech Republic 2001 Review, IEA/OECD, Paris 2001

Tab. 2-8 Structure of motor vehicles in 1990 and 1995–2000 *(thous.)*

	1990	1995	1996	1997	1998	1999	2000
Motorcycles[a)]	1 159	1 142	1 126	1 105	1 098	1 092	958
Passenger cars (up to 3.5 t)	2 285	2 967	3 313	3 349	3 548	3 687	3 696
Commercial vehicles	198	161	182	235	266	291	302
Buses and coaches	26	23	22	21	21	21	20
Other vehicles	265	286	286	281	276	271	261
Total[b)]	**3 219**	**3 913**	**4 061**	**4 326**	**4 549**	**4 716**	**4 680**

[a)] including motorcycles to capacity 50 ccm; [b)] excluding motorcycles to capacity 50 ccm

Source: Ministry of Transport and Communications

This is based on the basic conflicts in the area of transport at the present time, consisting in (i) an increasing volume of individual automobile transport and insufficient public transport, (ii) lack of harmonization of modernization of transport networks and construction of capacities, especially in highway transport, (iii) lack of harmonization of market conditions, manifested in strong competition between railway and highway transport, (iv) failure to transform the railways, (v) unsuitable fiscal policy of the state, reflected in a lack of capital available for large projects, (vi) excessive liberalization and openness of the transport markets, leading to bankruptcy of a number of transport companies. However, the main component of the document is a detailed analysis, conclusions and recommendations for 15 principles of transport policy, elaborated for the individual areas. The principle related to the connections between transport and the environment is based primarily on the obligations that CR has accepted through signing the final documents in relation to the Regional ECE/UN Conference on transport and the environment (Vienna, 1997) and other international commitments to which CR had acceded.

2.10 Industry

Industrial production is traditionally the main component of the economy of the Czech lands. At the present time, when economic and market production criteria are becoming decisive, the further existence of certain production units is decided by their competitiveness on the European and global markets. The areas along the borders with Germany and Austria are particularly experiencing new conditions since 1989; development was intentionally suppressed here in the past. The importance of the individual branches of industry is also gradually changing, with increasing emphasis on the processing sector and a decrease in the fraction of heavy industry. Following a decrease in the volume of industrial production in 1990–1993 to 83 % of the 1990 level, this figure has again increased since 1994. At the beginning of the economic transformation, the mining industry contributed about 7 % to total industrial production; this figure had decreased to 3 % by 1999, of which extraction of energy-production material constituted more than 84 %. The present-day mining industry in CR is characterized by decreasing extraction of black and brown coal and the related decrease in production of briquettes and coke, etc. In the 1991–1999 period, the mining-for-sale of black coal decreased by 26 %, brown coal by 42 %, production of brown-coal briquettes by 68 % and coke by 48 %. The main areas of these activities are Northern Bohemia and Northern Moravia. There has also been a decrease in the formerly extensive mining of uranium ores and raw materials, which is now confined to two locations. Of mineral materials, mainly limestone, sand-gravels and natural sand, construction stone, clays and brick-making materials are extracted. The mining of metal ores has been practically terminated in CR and, instead, ores are imported to CR, mainly from the Ukraine, Russia and Poland. The production and distribution of electricity, gas and water constitutes 14 % of total industrial activity. The remaining industrial output corresponds mainly to the processing industry (83 %).

In connection with further development of the industrial sector, material termed "Strategy for strengthening the growth of the national economy" was prepared during 2000 at the Ministry of Industry and Trade (Resolution of the Government of CR No. 306/2001). This material will be substantively incorporated by the relevant ministries into a set of practical measures that will have to be adopted to ensure a targeted and interconnected approach with a multiplying and accelerating character in the decisive areas of the economy of CR.

2.11 Waste

Current conditions in the area of waste management in CR can be characterized by the generation of a relatively large amount of waste, which corresponded to about 41.5 million tons in 2000, where 6.8 % of the total amount consisted in hazardous wastes. The recorded high fraction of production of this category is affected by the fact that, compared to EC regulations, the relevant legislation of CR has stricter parameters for classification of waste in the "hazardous"

Tab. 2-9 Waste production in 1996–2000 *(kt)*

	1996	1997	1998	1999	2000[a)]
Agriculture and forestry waste	3 288	4 412	8 124	7 175	6 989
Mining and quarrying waste	157	1 890	600	2 351	2 568
Industrial waste	23 232	14 083	8 900	8 867	9 375
Waste from energy production[b)]	10 279	13 306	10 409	4 941	8 989
Municipal waste	3 200	3 289	4 535	4 200	4 509
Other waste	11 906	31 538	11 550	7 935	9 045
Total	**52 062**	**68 508**	**44 118**	**35 469**	**41 475**

[a)] preliminary data; [b)] without radioactive waste *Source: Ministry of the Environment*

Tab. 2-10 Treatment of municipal waste in 1998–2000 *(kt)*

	1998	1999	2000[a)]
Treatment and/or use of physical and chemical procedures	69	73	186
Treatment and/or use of biological methods	626	540	460
Disposal by incineration	180	326	337
Landfilling	2 110	2 700	2 803
Storing	57	190	59
Use as secondary raw material	340	311	249
Deposition in underground space	0	30	-
Waste export	-	30	38

[a)] preliminary data *Source: Ministry of the Environment*

category. Tab. 2-9 gives the amount of waste produced from the standpoint of the OECD classification system for the 1996–2000 period.

The quite unsatisfactory state of affairs is caused by the predominance of landfilling of waste (especially of municipal waste), a low portion of utilization as secondary raw material (34.5 %) and a low fraction of incinerated waste (about 2.2 % of the total amount, about 10.9 % of municipal waste). It is a favorable feature that only technically safeguarded landfills have been in operation since August of 1996. However, clean-up and reclaiming of landfills, that have been closed by law, constitute a great financial problem. The adequate landfill capacity is still frequently accompanied by the lack of a technical base for waste utilization and recycling and for use of its caloric value. Three municipal waste incineration facilities were available in 2000, in Brno, Prague and Liberec, with total capacities of 240, 310 and 96 thous. t p.a., resp., with the potential for use of the heat produced. However, only 420 thousand t of waste was incinerated in them in 2000. In addition, liquid wastes with high energy content are incinerated in special combustion plants, and waste from the health-care system and hazardous wastes are incinerated in industrial combustion plants. The overall capacity of 67 industrial combustion plants is 113 thous. t. p.a. Waste is also incinerated in four cement plants. The low fraction of incinerated waste is a consequence of the much higher costs compared to landfilling. Tab. 2-10 describes management of municipal waste in the 1998–2000 period.

The first draft conception for waste management was prepared in 2000 and work was commenced on the relevant regional conceptions, based on the new Act on wastes (No. 185/2001 Coll., valid from January 1, 2002), which fully implements the contemporary EC legislation. Regulation of the Government of CR No. 31/1999 Coll., with validity from January 1, 2003, lays down a list of products and packagings that are subject to the obligation of reacceptance. These consist in waste

oil, electric batteries, galvanic cells, discharge lamps and fluorescent tubes, tires and also refrigerators.

2.12 Regional Development

The above issue (see also Chapter 2.4) lies mainly in the competence of the Ministry for Regional Development in cooperation with the Ministries of the Environment, Agriculture, Transport and Communications and Interior. In the framework of further development of the individual regions of CR and especially in relation to the process of approximation to EU, the Government has adopted several binding documents, the most important of which is the Strategy of Regional Development of the Czech Republic (Resolution of the Government of CR No. 682/2000). One of the most important instruments is land-use planning, which has a long tradition in CR, with stabilized legislation based on clearly democratic principles and good organization and a technical and professional base. In the framework of cooperation of the above central authorities, a number of complex programs have been drawn up with the target of improving the stability of the landscape from the standpoint and on the basis of the principles of sustainable development. These consist in the Program for Renewal of River Systems (1992), Program of Care for the Landscape (1994), Program of Renewal of Rural Areas (1994), Program of Care for the Natural Environment (1995) and the Program of Minor Water Management Environmental Projects (1998). In 1998, a total of 1.24 bil. CZK and, in 1999, 1.52 bil. CZK was set aside for these five programs. An important activity related to the process of approximation to EU consists in the creation of Euroregions, of which there are currently five registered in CR, and whose main target is to support the development of border areas and cross-border cooperation.

2.13 Agriculture

Agriculture in CR is typically Central European in character, with production of foodstuffs that are typical for the temperate zone, with the characteristics of high inten-

Tab. 2-11 View of production (harvest) and crops

	1980	1990	1995	1996	1997	1998	1999	2000
Cereals total (kt)	6 972	8 947	6 602	6 644	6 983	6 669	6 928	6 454
Cereals total (t/ha)	4.04	5.46	4.19	4.20	4.14	3.97	4.35	3.91
wheat total (kt)	3 466	4 624	3 823	3 727	3 640	3 845	4 028	4 084
wheat yields per hectare (t/ha)	4.42	5.64	4.60	4.67	4.41	4.21	4.65	4.21
rye total (kt)	445	558	262	204	259	261	202	150
rye yields per hectare (t/ha)	3.23	4.48	3.30	3.21	3.43	3.63	3.67	3.42
barley total (kt)	2 590	3 157	2 141	2 262	2 485	2 093	2 137	1 629
barley yields per hectare (t/ha)	3.85	5.69	3.84	3.77	3.84	3.62	3.94	3.29
grain maize total (kt)	88	98	113	169	285	201	261	304
grain maize yields per hectare (t/ha)	3.98	3.19	4.28	5.09	6.92	6.09	6.60	6.43
Potatoes total (kt)	1 922	1 755	1 330	1 800	1 402	1 520	1 407	1 476
potatoes yields per hectare (t/ha)	15.0	16.1	17.1	21.0	19.3	21.1	19.7	21.33
Industrial sugar beet total (kt)	5 105	4 026	3 712	4 316	3 722	3 479	2 691	2 809
Industrial sugar beet yields per hectare (t/ha)	33.2	34.0	39.9	41.6	40.3	42.7	45.6	45.8
Rape total (kt)	154	305	662	521	561	680	931	844
rape yields per hectare (t/ha)	2.41	2.90	2.62	2.30	2.47	2.57	2.67	2.61
Gross agriculture output (1989 bill. CZK)	95.6	106.1	82.0	80.9	76.8	77.4	77.8	74.3
crop production (%)	40.5	41.8	43.5	45.0	45.8	44.6	46.6	45.4

Source: Ministry of Agriculture

sity of land cultivation and also the favorable and unfavorable consequences of collective-type large-scale production. The location of agricultural production is zonal in character, with greater importance of altitude above sea level than latitude. Agriculture is capable of meeting domestic demand for basic agricultural products. Tab. 2-11 gives a survey of overall production (harvests) and hectare yields in the area of plant production in 1980 and 1990 to 2000.

A fraction of 54.3 % of the total land fund in CR (7.9 million ha in 2000) is classified as agricultural land. This corresponds to 0.42 ha of agricultural land per inhabitant. 3.3 % of agricultural land remained unused in 2000. Average application of industrial fertilizers remained low compared to the period prior to 1989 and is currently at the lowest level since the beginning of the nineteen sixties. This is partly because of their high price and also because of a significant trend towards environmentally sound agriculture, which was carried out by 563 farming entities over 166 thous ha (3.9 % of cultivated land) in 2000. Trends in the consumption of nutrients and lime-based fertilizers since 1989 are summarized in Tab. 2-12. The overall amount of applied nutrients remains far below the

Tab. 2-12 Consumption of fertilizers and limy fertilizers in 1989–2000 *(kg/ha)*

	1989	1990	1993	1994	1995	1996	1997	1998	1999	2000
N	103.2	89.8	40.0	57.6	55.6	61.3	55.1	53.3	51.1	58.9
P_2O_5	67.1	56.8	13.0	10.3	14.6	11.8	11.7	12.6	8.6	10.8
K_2O	59.7	50.8	10.5	13.0	12.8	8.0	10.1	7.3	5.9	6.2
CaO	661.7	616.9	47.9	54.0	75.4	75.0	76.9	74.2	78.2	75.9

Source: Ministry of Agriculture

Tab. 2-13 Livestock production and gross agricultural output

	1980	1990	1995	1996	1997	1998	1999	2000
Cattle – total (thous. pcs)	3 499	3 360	1 989	1 866	1 690	1 657	1 657	1 582
cattle (pieces/km² agricultural land)	80.0	79.4	46.5	43.6	39.5	38.7	36.7	40.0
beef production (kt)[a)]	498	515	323	310	293	246	237	208
milk production (mil. liters)	4 035	4 802	3 031	3 039	2 703	2 716	2 736	2 708
Pigs – total (thous. pcs)	5 106	4 569	4 016	4 080	4 013	4 001	3 688	3 594
pigs (pieces/km² of agricultural land)	116.7	106.6	93.8	95.3	93.3	93.3	93.4	84.0
pork production. (kt)[a)]	668	740	726	737	680	670	639	584
Sheep – total (thous. pcs)	308	430	134	121	94	86	86	90
sheep (pieces/km² of agricultural land)	7.0	10.2	3.1	2.8	2.2	2.0	2.0	2.1
Horses – total (thous. pcs)	24	25	19	19	20	23	24	26
horses (pieces/km² of agricultural land)	0.5	0.6	0.4	0.4	0.5	0.5	0.6	0.6
Poultry – total (thous. pcs)	31 472	33 278	27 875	27 573	29 010	30 222	30 222	32 043
poultry meat production (kt)[a)]	169	210	180	172	206	241	271	265
egg-laying (mil. pcs)	3 370	3 682	3 047	2 948	3 322	3 615	3 307	3 064
Gross agricultural production (1989 bill. CZK)	95.6	106.1	82.0	80.9	76.8	77.4	77.8	74.3
animal production (%)	59.5	58.2	56.5	55.0	54.2	55.4	53.4	54.6

[a)] *t of live weight*

Source: Ministry of Agriculture

hectare consumption in the advanced EU countries, which is understandably advantageous from a purely environmental point of view.

Tab. 2-13 provides a survey of animal production, giving total numbers of domestic animals, the intensity of breeding and the production of some kinds of foodstuffs. It also gives gross agricultural production, including both plant and animal production. It must be stated that the Government has not approved a new agricultural policy since 1989. However, there is a conception of the sectoral policy of the Ministry of Agriculture for the period prior to accession of CR to EU (Resolution of the Government of CR No. 49/2000)[10].

2.14 Forestry

The area of forest land has slowly increased since 1945 (Tab. 2-14) and equaled 2637 thous. ha in 2000, corresponding to 33.4 % of the area of CR; this corresponds to 0.26 ha per inhabitant. 77.6 % of forest stands consist of conifers (spruce, pine, larch, fir) and the remaining 22.4 % consist of broad-leaved species (oak, beech, birch). In afforestation, emphasis has recently been placed on attempts to increase the fraction of broad-leaved species rather than conifers. The overall stand stock of wood in the forests of CR has constantly increased over the last 70 years. While this figure equaled 307 mil. m^3 in 1930, it had increased to 625 mil. m^3 in 1999. This trend is described in greater detail in Tab. 2-15.

Basic information on forest management in CR is given in Tab. 2-16. 64 % of forests are in the ownership of the state, 13 % belong to cities and municipalities, 20 % to private natural persons and 3 % to other owners. Administration of forests owned by the state is entrusted to various organizations, the greatest portion of which are administered by Lesy České republiky s.p., Vojenské lesy s.p. and the Administrations of the individual national parks.

From the standpoint of competence, it should be emphasized that economic forests lie within

[10] Agriculture 2000, Ministry of Agriculture, Prague, 2001

Tab. 2-14 Forest land area development in 1960–2000 *(thous. ha)*

	1920	1930	1945	1950	1960	1970	1980	1990	2000
Area	2 369	2 354	2 420	2 479	2 574	2 606	2 623	2 629	2 637

Source: Ministry of Agriculture

Tab. 2-15 Total stand timber reserve development in 1960–2000 *(mil. m^3)*

	1930	1950	1960	1970	1980	1990	1998	1999	2000
Timber resource	307	322	348	445	536	564	615	625	631

Source: Ministry of Agriculture

Tab. 2-16 Comparing of total augmentation, total timber removals and salvage in the 1980 and in 1990–2000 *(mil. m^3/year)*

	1980	1990	1995	1996	1997	1998	1999	2000
Total augmentation	16.0	16.3	16.5	16.5	16.6	16.6	16.8	16.6
Total timber removals	13.6	13.3	12.4	12.6	13.5	14.0	14.2	14.4
Difference of timber removal and augmentation	0.85	0.82	0.75	0.76	0.81	0.84	0.85	0.87
Salvage	6.8	9.8	7.9	6.9	5.5	3.8	3.7	3.3
Salvage as % of total timber removals	50.0	73.7	63.7	54.8	40.7	27.1	26.1	22.9

Source: Ministry of Agriculture

the competence of the Ministry of Agriculture, while forests in National Parks and Protected Landscape Areas lie within the competence of the Ministry of the Environment. On the basis of function, economic forests (77 %), protective forests (3 %) and special-purpose forests (20 %) are distinguished. The contribution of forest management to the creation of the GDP has varied in recent years between 0.6 and 0.7 %. Of overall investments directed towards the national economy, only about 0.2 to 0.3 % was directed towards forest management.

On the basis of damage to forest stands, forests are classified in five classes (0 – to 10 % damage, 4 – 100 % damage). In spite of the great decrease in pollutant emissions into the air (mainly SO_2), there has been no significant improvement in the state of health of forests in CR, especially in mountain areas. The causes of current damage to forests lie in the long-term cumulative degradation of forest soils. This degradation is the joint consequence of the impact of pollution levels and of unsuitable and overly intense forest management, both in the past and at the present. The trends in defoliation of forest stands over sixty years in age indicate a continuing slight deterioration in the condition of conifer species with the exception of larches. In contrast, the condition of broad-leaved species is more or less unchanging. A higher degree of defoliation has been found only for oaks.

Of international activities in forest management, mention should be made especially of the pan-European process, based on an agreement amongst participating European countries in December 1999 and the preceding ministerial conferences. Its main target is sustainable forest management. It is also important to prepare forest management for accession of CR to EU. In 1999, the Council of EU adopted the EU Forest Strategy, which together with the conclusions of the above ministerial conferences constitutes an important document in the area of forest management in Europe. The SAPARD program is important for CR in this respect; this program is concerned with co-financing of activities supporting the development of agriculture, forestry and rural areas from the resources of the European Commission. Subsequently, the Ministry of Agriculture prepared the Conception for Forest Policy for the period prior to accession of CR to EU, whose key points are being gradually implemented.

3. INVENTORIES OF EMISSIONS OF GREENHOUSE GASES

3.1 Emissions of Greenhouse Gases

The most important anthropogenic greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and ozone (O_3). These gases are a natural part of the atmosphere. Their concentrations in the air have recently increased considerably as a result of human activity. While carbon dioxide, methane and nitrous oxide are emitted directly into the air, ozone is formed in the atmosphere as a consequence of photochemical reactions. Emission inventories do not include directly ozone, but rather the precursors of its formation, i.e. carbon monoxide (CO), nitrogen oxides (NO_x) and non-methane volatile organic compounds (NMVOC). All these gases have positive radiation absorption effects (contribute to warming of the atmosphere), whilst corresponding values for CO, NO_x and NMVOC are negligible compared with the values for CO_2, CH_4 and N_2O. Inventories similarly include sulfur dioxide as one of the precursors of the formation of aerosols, with negative radiation absorption effect (contributes to cooling of the atmosphere). Greenhouse gases also include fluorinated hydrocarbons and sulfur hexafluoride (SF_6). These substances originate only from anthropogenic sources and have radiation absorption effects that are two or three orders higher; nonetheless, their current concentrations in the atmosphere are low. Of this group of substances, hydrofluorocarbons and perfluorocarbons (HFCs and PFCs) and sulfur hexafluoride are included in emission inventories under the Kyoto Protocol, while the other halogenated hydrocarbons depleting the ozone layer are included under the Montreal Protocol.

GHG emission inventories under the Convention thus include CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, CO, NO_x and SO_2. However, greater emphasis is placed on correct estimation of emissions of greenhouse gases with direct radiation absorption effect, i.e. inventories of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. The overall impact of emissions of these gases can be expressed as aggregated emissions, expressed in terms of the equivalent amount of carbon dioxide and taking into account GWP values for a time period of 100 years[11]. The reduction targets of the Kyoto Protocol (Article 3) are related to these values of aggregated CO_2 emissions. According to Annex B of the Kyoto Protocol, for the Czech Republic in the first commitment period, this was set at 92 % of the values of the aggregated CO_2 emissions in the reference year 1990.

GHG emission inventories in CR are carried out according to the standard IPCC methodology and the results are submitted annually to the UN FCCC Secretariat in standard formats. The results for the 1990–1999 period are presented in the form of summary tables in Appendix I to this Third National Communication. Compared to the Second National Communication, where the results for the 1990–1995 period were submitted in a similar manner, there are slight differences as a consequence of the transition to the up-dated IPCC methodology[12]. Transition to the new methodology and gradual taking into account of further development of the IPCC methodology[13] requires that the prescribed means of calculation be employed for the results obtained earlier, in the interests of ensuring consistency over time. The original values have been recalculated particularly for fugitive emissions of methane from coal mining. Complete recalculation has not yet been carried out in some cases (e.g. for nitrous oxide for 1990–1995).

During the nineties, the aggregated emissions of greenhouse gases decreased from a value of 187.5 Mt of carbon dioxide in 1990 to 137.7 Mt in 1999, corresponding to a relative decrease of 26.8 %. Of the total amount

[11] GWP = Global Warming Potential, Climate Change 1995: The Science of Climate Change, IPCC, 1996

[12] Revised 1996 IPCC Guidelines, IPCC, 1997

[13] Good Practice Guidance and Uncertainty Management in National GHG Inventories, IPCC, 2000

of emissions, CO_2 constitutes 85.8 %, CH_4 corresponds to 7.9 % and N_2O to 5.9 %; at the present time, the fractions of F-gases (HFCs, PFCs and SF_6) correspond to less than 0.4 %. The inter-annual changes in these fractions are negligible.

3.2 Emissions of Carbon Dioxide

The most important fraction of the total aggregated values of emissions of greenhouse gases in CR consists in carbon dioxide (85.8 % in 1999). Carbon dioxide emissions from the combustion of fossil fuels equal almost the total emissions of this gas, as other sources (e.g. the production of cement and glass) are practically compensated by the sinks from forest management (about 3 Mt of CO_2 annually). The greatest amounts of emissions of carbon dioxide from combustion processes come from solid fuels, with lesser contributions from liquid and gaseous fuels. Emissions from stationary sources exceed emissions from mobile sources. Changes, which have occurred since 1999 in contributions to CO_2 emissions from the individual types of fuels and the contributions of stationary and mobile sources are listed in Tab. 3-1.

Tab. 3-1 Emissions from fossil fuels combustion: relative contributions to total CO_2 *(%)*

	1990	1999
Sources	100	100
stationary sources	94	88
mobile sources	6	12
Fossil fuels	100	100
solid fuels	79	64
liquid fuels	13	19
natural gas	8	16

Source: Czech Hydrometeorological Institute

It can be seen from Tab. 3-1 that the fraction from mobile sources has almost doubled (to 12 %); however, compared to the magnitude of emissions from stationary sources, the relative contribution from mobile sources is lower in CR than in the EU countries. From the perspective of the structure of CO_2 emissions, the decreasing fraction of solid fuels and the increase in the fraction of natural gas is a favorable factor. The values of CO_2 emissions from fuel combustion from all types of sources are based on activity data on fuel consumption presented in the energy balances of the Czech Statistical Office (CSO) following conversion to the internationally comparable methodology of the International Energy Agency, IEA (in the whole range of the balance since 1994). Determination of CO_2 emissions from the combustion of fossil fuels in the GHG emission inventory is carried out primarily on a Sectoral Approach, based on the consumption of various kinds of fuels in the individual sectors by categorization of sources and sinks according to the IPCC methodology (energy production and transformation, combustion in industry, transport, other combustion). For control reasons, a comparison calculation is also carried out using a Reference Approach, based on data on domestic consumption of primary sources of the individual kinds of fuels (TPES). The Reference Approach is very transparent and is thus used especially for control purposes. On the other hand, the method does not permit evaluation of the sector or category of source producing the emissions and consequently the Sectoral Approach is now preferred. However, in both cases, preconditions for good-quality inventories are sufficiently reliable energy statistics. The results of inventories carried out by both means do not differ by more than 2 %, which can be considered as acceptable agreement. In the inventories, both methods have so far been employed in the form described in the working manual for the methodology[14], i.e. including the values of the emission factors for carbon and the standard means of correction for incomplete combustion.

In the inventories, emphasis is placed on correct determination of the part of unburned carbon in non-energy use of fossil fuels. This stored carbon is subtracted from the total amount of carbon contained in the individual kinds of fossil fuels. In calculation of this amount, it is assumed that a certain part of the carbon contained in non-energy fuels or raw materials, remains fixed for long periods of time and is not released as CO_2.

[14] Revised 1996 IPCC Guidelines, IPCC, 1997

This is especially true for petrochemical feedstocks intended for the production of plastics, lubricating oils, asphalts and tars formed in the coking of hard coal or in gasification of brown coal. Standardly, it is assumed in relation to petrochemical substances and oils that the fraction corresponding to stored carbon corresponds to 50 %, while in tar this fraction equals 75 %. Almost one hundred percent fixation is assumed for asphalt. Similarly, it is necessary to ensure that the carbon that is converted to CO_2 in non-energy use is calculated only once. Such an example is carbon dioxide formed in the production of hydrogen used mainly in the synthesis of ammonia. Here, this consists mainly in gasification of masout using oxygen and water vapor with subsequent catalytic conversion. In order to avoid doublecounting, the carbon from the masout was calculated in the energy sector (combustion in industry).

Another rather complex area from the aspect of the possibility of reporting emissions in several sectors consists in the area of production of iron and steel. Here, the primary source of emissions is carbon contained in the coke that is mostly used in blast furnaces in the production of iron. However, the actual emission of carbon dioxide from metallurgical coke does not occur in the blast furnace, but during combustion of the blast furnace gas used for energy production purposes, usually directly in the metallurgic factories. Thus, in the inventories, all the emissions originating from coke are calculated in the energy sector (combustion in industry), including emissions that occur in the actual metallurgical process (e.g. in oxidation of carbon contained in the pig iron in the production of cast iron and steel). The calculation is in this case based on the amount of carbon contained in the coal.

In this approach, all the emissions of CO_2 originating from coal contained in fossil fuels are reported in the energy sector – combustion processes. Thus, in the sector of industrial processes, only emissions originating from the decomposition of carbonate rocks are reported, unless, of course, they are compensated by subsequent sinks (e.g. in the production and use of lime). This applies particularly to the production of cement and, to a lesser degree, to other processes (e.g. melting of glass). In accord with the IPCC Guidelines, CO_2 emissions from sulfur removal in power plants using the limestone method are reported in the sector of fugitive emissions. These emissions began to be important in 1996, when their contribution equaled less than 0.1 Mt CO_2, and further increased as a consequence of introduction of sulfur-removal technology; in 1999, this contribution equaled 0.5 Mt CO_2.

Emissions and removals of CO_2 in the individual sectors for the nineties (i.e. for 1990–1999) are given in Tab. 3-2. The production of energy and heat, similar to combustion in industrial factories, is amongst the most important sources of CO_2. The term "other combustion" denotes combustion in households, in the commercial sector and also in agriculture and forestry. The sector of agriculture and forestry also includes mobile sources (tractors, harvesters, forest machinery, etc.). Highway transport makes the largest contribution in the transport sector. In contrast to the decreasing trends in CO_2 emissions as a whole, the contribution from highway transport continues to increase. The sector of industrial processes includes only emissions from the actual process and not emissions from fuels used for heating in the industrial installations. Most of the emissions in this sector originate in the production of cement. In accord with the methodology, the inventories do not include emissions from combustion of biomass. For illustration, it can be stated that the relevant contribution would equal about 2 %.

The reliability of determination of sinks in forest management is not yet high; conditions should improve after adopting the prepared methodical IPCC Guidelines for this sector, similar to *Good Practice*, which do not yet include the sector of land use change and forestry.

Emissions from the production of centralized heat (steam and hot water) in factory sources were reported in the energy production sector until 1993, in accord with the CSO metho-

Tab. 3-2 CO_2 emissions and removals from individual sectors in 1990–1999 *(Mt CO_2)*

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Fuel combustion	160.1	148.8	135.6	130.7	123.6	124.6	130.3	132.1	125.1	118.6
energy industries					61.4	66.6	57.9	59.4	59.1	54.4
manufacturing industries & construction					33.4	30.1	43.9	43.3	35.4	34.2
transport	8.0	6.9	8.1	8.3	8.3	8.9	10.4	11.8	11.0	12.6
road transport			7.3	7.4	7.4	8.0	9.3	10.9	10.3	11.3
other fuel combustion	34.9	28.7	22.7	21.6	20.6	19.0	18.2	17.6	19.6	17.5
mobile sources			1.5	1.1	1.3	1.0	0.6	1.1	1.1	1.3
Industrial processes	5.4	4.3	4.6	4.2	4.1	4.2	2.5	2.5	2.7	2.4
Other sources							0.5	0.5	0.7	0.7
Total emissions	**165.5**	**153.1**	**140.2**	**134.9**	**127.7**	**128.8**	**133.3**	**135.1**	**128.5**	**121.6**
Forestry	-2.3	-5.0	-6.0	-5.6	-3.9	-5.5	-4.5	-4.6	-3.8	-3.4
Sources and sinks, total	**163.2**	**148.1**	**134.2**	**129.2**	**123.8**	**123.4**	**128.8**	**130.4**	**124.7**	**118.2**

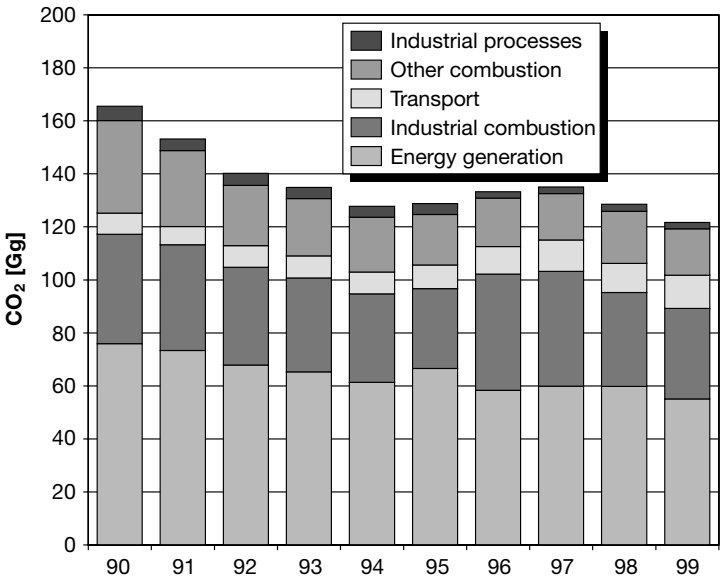
Source: Czech Hydrometeorological Institute

dology. Following transition to the methodology of the International Energy Agency, these emissions (with the exception of emissions from the production of heat sold outside of the enterprise) have been reported in the sector of combustion in industry since 1994. Consequently, in Tab. 3-2, the individual emissions from the subsectors of energy production and combustion in industry are not reported to 1994, but only their sum is given. Similarly, recalculations have not yet been carried out that would allow for clear specification of some other individual emissions. Since 1990, there has been a relative decrease in the actual CO_2 emissions by 27.6 % and this decrease equals 26.6 % for aggregated emissions expressed as CO_2. This fact is illustrated in Fig. 3-1 describing the sector-structured time trends in CO_2 emissions after 1990.

According to the IPCC methodology[15], emissions from international air transport are not reported as part of national emissions, but are reported separately. The calculation is based on the amount of fuel pumped into the aircraft tanks in the home country. In the Second National Communication the emissions from international transport were reported together with domestic data; since 1996, they have been reported separately. For the sake of consistency over time, Tab. 3-2 includes the contribution from international air transport for the entire period in the transport sector; in 1999, this contribution equaled approx. 0.5 Mt CO_2.

Since 1996, in accord with the IPCC methodology, CO_2 emissions from the use of solvents have

Fig. 3-1 Trend of CO_2 emissions in 1990–1999



Source: Czech Hydrometeorological Institute

[15] Revised 1996 IPCC Guidelines, IPCC, 1997

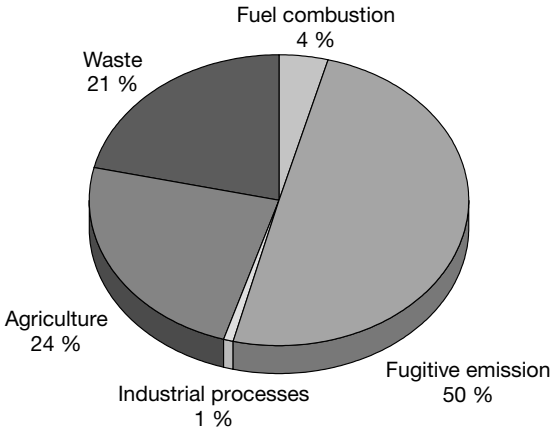
also been evaluated (NMVOCs are assumed to oxidize in the air through photochemical reactions in the year in which they were emitted). In Tab. 3-2, they are given as "other sources". These emissions were not taken into consideration in the 1990–1995 period and thus must be calculated back to that time. In 1999, the relevant contribution equaled 0.3 Mt CO_2. "Other sources" also include emissions from combustion of municipal waste (only wastes of fossil origin are considered in the inventories). These emissions were not recorded prior to 1996, but their contribution in the 1990–1995 period was almost negligible.

The precision of determining CO_2 emission inventories is the highest of all the greenhouse gases and is approximately comparable with the precision of determining the initial energy balance, i.e. 7–10 %.

3.3 Emissions of Methane and Nitrous Oxide

Methane emissions contribute 7.9 % of total aggregated emissions (data from 1999). The greatest source of these emissions consists in fugitive emissions, i.e. emissions from mining, and treatment and distribution of fuel, which are responsible for more than 50 % of methane emissions. Of these, the largest amounts of methane originate in deep mining of hard coal, which contains a relatively large amount of this gas. Methane is gradually released from the coal not only during mining, but also during post-mining treatment (crushing, grading, etc.), transport and storage. Further methane emissions originate in animal breeding, mostly emissions from digestive processes (enteric fermentation), especially from cattle and, to a lesser degree, from decomposition of excrement (animal manure). In addition, methane emissions originate from municipal waste landfills, treatment of wastewaters, combustion processes and industry. The contribution of methane emissions from mining, storage, transport and distribution of natural gas do not exceed 5 % of national emissions of methane, reflecting the effective measures implemented in this sector.

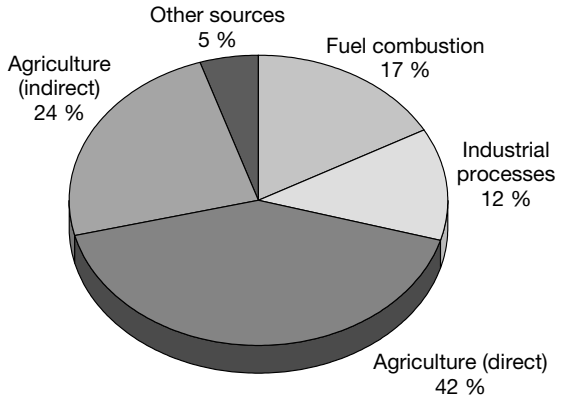
Fig. 3-2 Share of individual sectors on CH_4 emissions in 1999



Source: Czech Hydrometeorological Institute

Emissions of **nitrous oxide** contribute 5.9 % to total emissions (1999 data). The greatest contribution comes from agricultural activities, especially denitrification processes, where this element is employed as nitrogen of inorganic origin applied in the form of artificial fertilizers and also organic nitrogen, applied mainly as animal manure. This fraction calculated according to the IPCC methodology corresponds to up to 70 % of N_2O emissions. However, it should be pointed out that the reliability of this determination is not high. The remainder originates in the production of nitric acid, transport (automobiles with catalytic convertors) and combustion processes (especially fluid combustion). Fig. 3-2 and Fig. 3-3 illustrate the contributions from the main sectors to national emissions of methane and nitrous oxide, respectively.

Fig. 3-3 Share of individual sectors on N_2O emissions in 1999



Source: Czech Hydrometeorological Institute

Tab. 3-3 Key sources of CH_4 a N_2O *(%)*

	Gas	Share on total emissions
Fugitive emissions – coal mining	CH_4	3.6
Agriculture – direct N_2O emissions	N_2O	2.0
Agriculture – indirect N_2O emissions	N_2O	1.3
Enteric fermentation	CH_4	1.2
Solid waste disposal	CH_4	1.1

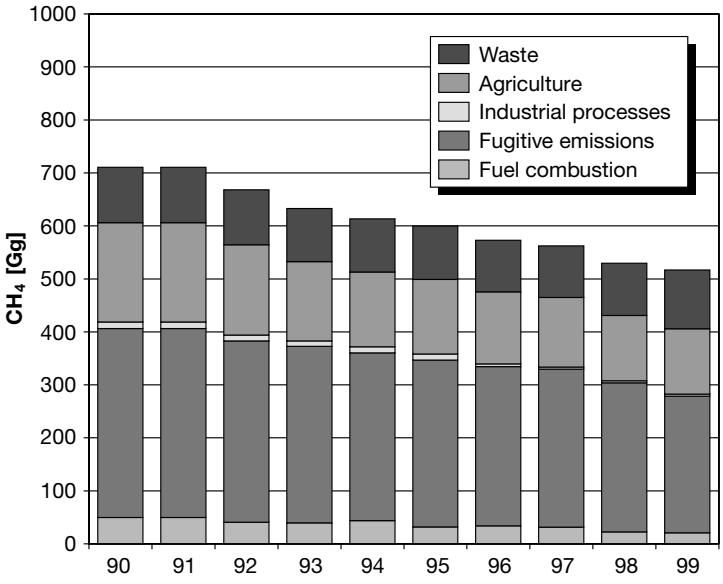
Source: Czech Hydrometeorological Institute

Tab. 3-3 gives a survey of key sources of methane and nitrous oxide emissions, as defined according to ref.[16] (according to emissions for 1998). In addition to the above-mentioned fugitive emissions of methane from coal mining, one of key sources of CH_4 and N_2O emissions is particularly agriculture. Trends in emissions of methane over the entire nineteen nineties in sectoral classification are given in Tab. 3-4 and Fig. 3-4.

Compared to the Second National Communication, the original values for methane emissions from coal mining for 1990–1995 were recalculated so that the entire time series would be consistent with the values determined for the period after 1996, based on the nationally specific emission factors. Similarly, emissions from wastes for the 1990–1995 period were recalculated in relation to the results of the national study in 1997. This calculation was further refined in 2001 and the final results will be available at the end of the year. Summary tables are given for N_2O emissions in Appendix I. The values for this greenhouse gas were affected most by the changes introduced in transition to the new IPCC methodology. Consequently, the results for N_2O emissions given for the 1990–1995 period (determined according to the original version of the IPCC methodology of 1995) are not yet fully consistent with the results determined after 1996, incl., when inven-

[16] Good Practice Guidance and Uncertainty Management in National GHG Inventories, IPCC, 2000

Fig. 3-4 Trend of CH_4 emissions in 1990–1999



Source: Czech Hydrometeorological Institute

Tab. 3-4 CH_4 emissions from individual sectors in 1990–1999 *(kt CH_4)*

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Fuel combustion	59.3	49.9	40.8	39.3	44.0	32.1	33.9	31.3	22.5	21.0
Fugitive emissions	394.1	356.4	341.9	333.3	316.6	314.6	300.7	298.4	281.2	257.7
solid fuels	361.9	321.0	306.0	298.0	282.0	276.6	268.5	263.5	253.1	229.0
Industrial processes	14.0	12.2	11.3	10.4	11.5	11.6	4.9	3.9	4.0	3.9
Agriculture and forestry	206.3	187.5	170.2	149.3	140.8	140.6	136.1	131.4	123.4	123.1
enteric fermentation	156.0	138.0	122.0	106.0	100.0	99.0	98.0	93.0	86.0	82.0
Waste	104.9	104.7	103.7	100.4	100.6	100.6	97.2	97.3	98.2	110.9
Total CH_4	**778.5**	**710.8**	**667.9**	**632.7**	**613.4**	**599.5**	**572.9**	**562.3**	**529.4**	**516.6**

Source: Czech Hydrometeorological Institute

tories were carried out according to the new method[17].

Insufficient information is available to determine the precision of the emission inventories for methane and nitrous oxide. The precision of the determination of national emissions of methane can be estimated at approximately 30 %. Similar to most countries, the value of national emissions of nitrous oxide is least precise, with an error of up to 100 %.

3.4 Emissions of HFCs, PFCs and SF_6

This part provides information on emissions of fluorinated substances affecting climate change and not controlled by the Montreal Protocol. These consist in hydrofluorocarbons, perfluorocarbons and sulfur hexafluoride, which are controlled by the UN FCCC and the Kyoto Protocol. They are not produced in the Czech Republic and consumption is covered only by imports alone. **Hydrofluorocarbons (HFCs)** are used in industry primarily in refrigeration as an important medium replacing substances depleting the ozone layer of the Earth. They are used to a far lesser extent as expanding agents in the production of foamed insulating materials, as propellants for some aerosol preparations and as fire-extinguishing agents. **Perfluorocarbons (PFCs)** are used similarly as HFCs (and also for plasmatic etching in the production of components for electrical technology); however, they are used less because of their higher price. **Sulfur hexafluoride (SF_6)** is characterized by excellent insulating properties. It is used primarily as an insulation medium in high-current electrical technology and for thermal insulation (e.g. in insulation of windows).

The IPCC methodology defines both potential emissions for the basic level (1st tier) of the inventory and actual emissions for the inventory according to the second tier. GHG emission inventories in CR at the present time are carried out on the basis of determination of potential emissions of the relevant substances, as insufficient information is currently available for determining actual emissions, for legislative reasons. Potential emissions are calculated on the basis of consumption defined as the sum of domestic production and imports. Exports and environmentally sound disposal in the current year are subtracted from this value. It is generally assumed that the actual emissions should not exceed potential emissions.

Because of the absence of production of fluorinated substances, information on imports and exports, based on information from the customs authorities, are of key importance for determining potential emissions. These substances do not have a separate customs codes in the customs tariff lists as separate individual chemical substances, and thus closer identification requires knowledge of the individual importers from the customs statistics and the amounts and kinds of substances that they import, including their use. The Directorate General of Customs does not provide this information with reference to the law on business secrecy. The last full information was provided for the inventory for 1996. Since then, only summary data are available on the entire group of substances with a given code, which contain the relevant substances. This problem could be resolved in the future only through the new legislation (e.g. the new Act on the air, which is expected to come into force on 2002). Information on imports and exports of fluorinated substances was thus obtained from the assumed major importers and users on the basis of information on users obtained in previous years.

Inventories of emissions of substances containing fluorine have been carried out since 1995, which is also defined as the base year in the sense of the Protocol. Tab. 3-5 gives the potential emissions of the HFCs, PFCs and SF_6, for the 1995–1999 period. Emissions are expressed in the table in equivalent amounts of CO_2 (kt of CO_2). For illustration, the values of the radiation absorption effect – global warming potential GWP are given for a time period of 100 years for HFC134a (GWP = 1300), which is the most important representative of HFCs, for PCF218 (GWP = 7000), which is

[17] Revised 1996 IPCC Guidelines, IPCC, 1997

the most important representative of PFCs, and for SF_6 (GWP = 23 900). Tab. 3-6 gives the emission estimates for substances containing fluorine according to use in the individual subsectors. Similar to the previous table, the emissions are expressed in CO_2 equivalents.

Tab. 3-5 HFCs, PFCs and SF_6 potential emissions in 1995–1999
(kt CO_2 eq.)

	1995	1996	1997	1998	1999
HFCs	2.2	134.1	295.6	381.8	411.9
PFCs	0.4	4.2	7.0	9.1	2.7
SF_6	166.8	183.1	323.1	131.7	110.9
Total	**169.4**	**321.4**	**625.7**	**522.6**	**525.5**

Source: Czech Hydrometeorological Institute

The results of the time series are affected by the working methodology, described above. The values for 1997 are probably least precise and overestimated somewhat. Nonetheless, the following conclusions can be drawn from these results. **HFCs** are increasing consistently in connection with their use in refrigeration as the main substitute for prohibited and regulated substances (CFCs and HCFCs), which deplete the ozone layer. In addition to the most common use of HCF134a, it is expected that the other types of HFCs will be used more extensively in coolant mixtures. On the other hand, HFCs will probably become less important in other areas as replacements for prohibited CFC and halons. Cheaper substitutes are increasingly being used (for expansion agents, replacement by CO_2; for fire-extinguishing agents, powder or foam-based fire extinguishers are becoming more common and hydrocarbons are also gradually replacing these substances as propellants). **SF_6** emissions vary in the range 100–200 kt CO_2 according to the momentary demand. SF_6 was formerly commonly used, especially in electrical industry and is now finding applications in plasmatic etching. It is commonly used as a thermal insulating material (in windows). **PFCs** are of little importance because of the limited use of HFCs, used in special cases (fire extinguishers, plasmatic etching, additives to coolant mixtures for modification of thermodynamic properties).

A slight increase in overall emissions of substances containing fluorine is expected, similar to the other industrial countries, because of the dominant role of HFCs. Nonetheless; their contribution to overall emissions of greenhouse gases (now approx. 0.4 %) will continue to be of low importance. The precision of determination of emissions of substances containing fluorine depends on the year for which the emissions were determined. In 1995 and 1996, when also non-aggregate information was made available by the customs authorities, emission determinations were most precise (about 15 %). Somewhat greater imprecision (about 30 %) can be expected for 1997 and 1998, when the individual information was not adequately available. This lack was at least partly compensated in the inventory for 1999, when a thorough investigation was carried out of importers and users and thus the precision for 1999 can be estimated at approx. 20 %. However, it is necessary to bear in mind that only potential emissions were determined. In relation to the refrigeration industry, where an increasing number of new coolants is being introduced, actual emissions could be as much as 50 % lower. Thus the resultant values can be considered to be an upper estimate.

Tab. 3-6 HFCs, PFCs a SF_6 potential emissions from individual subsectors *(kt CO_2 eq.)*

	1995	1996	1997	1998	1999
Electrical equipment	166.8	154.4	272.4	111.8	49.9
Window isolation	0	28.7	50.7	19.8	16.7
Semiconductor manufacture	0	0	0	0	45.1
Fire extinguishers	0.4	1.3	-	-	3.4
Foam blowing and aerosols	0.1	57.0	138.6	38.2	7.0
Refrigeration	2.1	80.4	164.0	352.8	403.4

Source: Czech Hydrometeorological Institute

3.5 Aggregated Emissions

Emissions of greenhouse gases with direct radiation absorption effect (global warming potential – GWP) – CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 – can be expressed in aggregated form, taking into account their differing GWP values. The comparison was carried out using the GWP values for a time period of 100 years[18], which are default prescribed by the UN FCCC Secretariat. The relative contributions of the individual gases in the individual sectors to the aggregated emissions are given in Tab. 3-7 and Tab. 3-8 for 1996 and 1999.

The relative contributions of the individual greenhouse gases to total emissions in the Czech Republic have not changed over the last few years. Fig. 3-5 depicts the contributions of individual sectors to the aggregated emissions according to conditions in 1999. Total emissions of greenhouse gases expressed as the equivalent amount of CO_2 including the contributions of the individual gases are given in Tab. 3-9 and Fig. 3-6. Emissions of CO_2 also include sinks in forest management.

[18] Climate Change 1995: The Science of Climate Change, IPCC, 1996

Tab. 3-7 Sectoral contributions to CO_2, CH_4 and N_2O emissions in 1996 *(%)*

	CO_2	CH_4	N_2O	Total
Fuel combustion	87.3	0.2	0.9	**88.4**
energy industries	38.7	0.0	0.2	**38.9**
manufacturing industries & construction	29.3	0.0	0.2	**29.5**
transport	7.3	0.0	0.4	**7.7**
other fuel combustion	12.0	0.2	0.1	**12.3**
Fugitive emissions	0.0	4.1	0.0	**4.1**
Industrial processes	1.7	0.0	0.7	**2.4**
Solvent and other product use	0.2	0.0	0.2	**0.4**
Agriculture	0.0	1.9	4.1	**6.0**
Waste	0.2	1.4	0.1	**1.7**
Land use change and forestry	-3.0	0.0	0.0	**-3.0**
Total	**86.5**	**7.5**	**6.0**	**100.0**

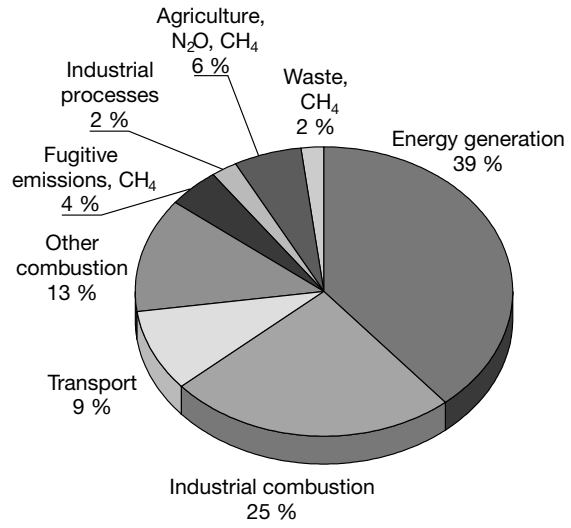
Source: Czech Hydrometeorological Institute

Tab. 3-8 Sectoral contributions to CO_2, CH_4 and N_2O emissions in 1990 *(%)*

	CO_2	CH_4	N_2O	Celkem
Fuel combustion	86.0	0.3	1.0	**87.4**
energy industries	39.2	0.0	0.4	**39.7**
manufacturing industries & construction	24.9	0.0	0.1	**25.1**
transport	9.2	0.0	0.4	**9.5**
other fuel combustion	12.7	0.2	0.1	**13.1**
Fugitive emissions	0.4	3.9	0.0	**4.3**
Industrial processes	1.7	0.1	0.7	**2.5**
Solvent and other product use	0.2	0.0	0.2	**0.4**
Agriculture	0.0	1.8	3.9	**5.7**
Waste	0.3	1.7	0.1	**2.1**
Land use change and forestry	-2.5	0.0	0.0	**-2.4**
Total	**86.2**	**7.9**	**5.9**	**100.0**

Source: Czech Hydrometeorological Institute

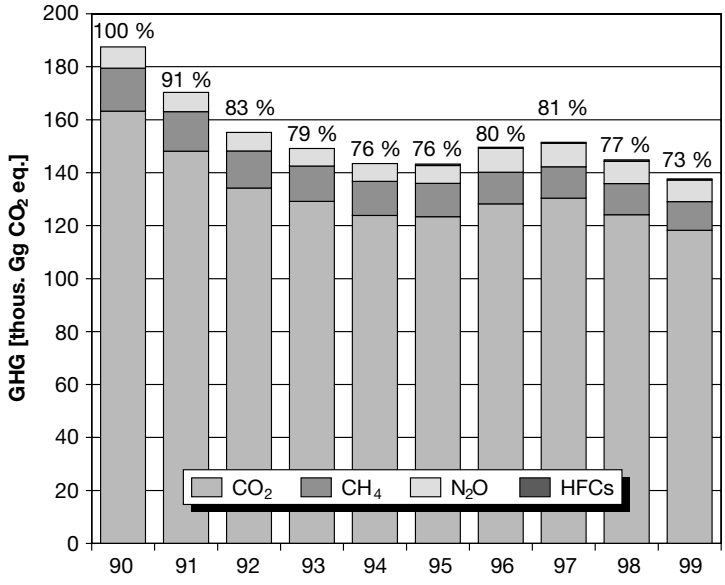
Fig. 3-5 Sectoral contributions to aggregated GHG emissions in 1999



Source: Czech Hydrometeorological Institute

The fast and then gradual decrease in overall emissions of greenhouse gases after 1990 was caused by a decrease in production and later restructuring of the economy as one of the consequences of the fundamental change in the political system. Since 1994, conditions have remained relatively stable, where the fluctuations can be attributed to various factors (e.g. different temperatures in the winter, inter-annual changes in GDP and the level of measures adopted to decrease emissions of greenhouse gases). This is understandably also manifested in a certain level of uncertainty in determination of emissions in the individual years. As total emissions of greenhouse gases decreased to 1999 by 26.8 % compared to 1990, it seems highly probably that it wčill be possible to meet the reduction commitment following from the Kyoto Protocol for the first commitment period of 2008–2012 (see also Chapter 5). Nonetheless, the indicators relating aggregated emissions to an inhabitant or GDP unit remain unfavorable in spite of this decrease since 1990.

Fig. 3-6 Aggregated GHG emissions in 1990–1999



Source: Czech Hydrometeorological Institute

Tab. 3-9 Total aggregated GHG emissions in 1990–1999 *(Mt CO_2 eq.)*

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
CO_2	163.2	148.1	134.2	129.2	123.8	123.4	128.8	130.4	124.7	118.2
CH_4	16.3	14.9	14.0	13.3	12.9	12.6	12.0	11.8	11.1	10.9
N_2O	8.0	7.3	7.0	6.6	6.7	6.7	9.1	8.9	8.4	8.1
HFCs, PFCs, SF_6	-	-	-	-	-	0.2	0.3	0.6	0.5	0.5
Total	**187.5**	**170.3**	**155.2**	**149.1**	**143.4**	**142.8**	**150.2**	**151.8**	**144.8**	**137.7**
% of 1990	100.0	90.8	82.7	79.5	76.4	76.2	79.7	80.9	77.2	73.4

Source: Czech Hydrometeorological Institute

4. MEASURES TO MITIGATE EMISSIONS OF GREENHOUSE GASES

4.1 Evaluation Method

A number of measures are carried out in the Czech Republic to mitigate emissions of greenhouse gases. These measures are concentrated on a specific aspect or sector and also include framework measures. The targets and consequences of a number of adopted measures can, however, be much broader, because it is particularly necessary to decrease detrimental impacts on the environment as a whole. Key measures with the greatest expected benefit include particularly the following framework multi-sectoral measures:

- adopting of a Strategy for protection of the climate system of the Earth in the Czech Republic,
- inclusion of the aspect of protection of the climate and incorporation of a National Program to Mitigate Changes in the Climate of the Earth in the newly prepared air protection legislation,
- adopting of a new Energy Act and new Act on energy management.

Measures included in the Third National Communication can be divided into (a) implemented measures and (b) measures being prepared, classified according to the relevant sector into:

- framework/multi-sector measures,
- measures in the sector of energy production and energy consumption,
- measures in the transport sector,
- measures in the industrial sector,
- measures in the sector of agriculture and forestry,
- measures in the waste management sector.

The individual measures are described in detail in Part 4.3, including costs and benefits, and are summarized in Tab. 4-1.

4.2 Process of Preparation of Measures

As CR is a party to the Kyoto Protocol, it was necessary to create a framework environment and provide for fulfilling obligations following from the Protocol. In the past, protection of the climate was integrated into the State Environmental Policy. In May 1999, the Government of CR approved a separate document, the Strategy of Protection of the Climate System of the Earth in the Czech Republic (Resolution of the Government of CR No. 480/1999), which places protection of the climate amongst top-priority environmental issues and sets out the main tasks for the individual sectors, which should lead to fulfilling of the quantitative tasks of the Kyoto Protocol. Key emphasis is placed in the document on a wide range of measures related to energy savings and on increasing the fraction of use of renewable energy sources. These measures are in accord with other political documents and programs, such as the State Environmental Policy (January 2001), the State Energy Policy (January 2000) and the related State program for energy savings and use of renewable energy sources (1998), and also the Transport Policy of CR (June 1998) and the Medium-Term Strategy in the Transport Sector (January 2000). It is the goal of the document to provide for fulfilling of international commitments of CR following from the Framework Convention and the Kyoto Protocol. The strategy provides a framework for measures and programs described in the following parts of this chapter. Its implementation is entrusted to the individual sector ministries, whose roles and tasks are as follows:

- the **Ministry of the Environment** coordinates and organizes provision for fulfillment of the UN FCCC and the Kyoto Protocol, carries out and coordinates regular monitoring of the emissions of greenhouse gases and up-dates forecasts of emission trends, coordinates scientific

research tasks related to monitoring risks in climate change and their impacts on the territory of CR and prepares suitable adaptation measures and, through the State Environmental Fund, implements part B of the State program for energy savings and use of renewable energy sources,

- the **Ministry of Industry and Trade** coordinates and, through the Czech Energy Agency, implements Part A of the State program for energy savings and use of renewable energy sources,
- the **Ministry of Transport and Communications** implements policies and measures in the transport sector, in particular the development and introduction of international standards in the area of environmental impact and safety, preference for unmotorized kinds of transport, modification of the systems of highway transport and development of alternative kinds of vehicle drives,
- the **Ministry of Agriculture** implements policies and measures in the area of agriculture and forestry and implements Part C of the State program for energy savings and use of renewable energy sources,
- the **Ministry of Finance** creates a financial basis for fulfilling the Strategy of Protection of the Climate System of the Earth in the Czech Republic and related programs (the State Program to Support Energy Savings and the Use of Renewable Energy Sources).

Primary targets of the measure:	decrease in emissions of greenhouse gases and provision for fulfilling commitments following from the Kyoto Protocol
Effect on greenhouse gases:	decrease in emissions of CO_2
Type of measure:	policy, framework
State of implementation:	implemented
Time period for implementation:	on-going since 1999
Extent of implementation:	at a country-wide level, all sectors
Implementor:	the Government of CR and appointed ministries
Estimate of costs:	cannot be estimated
Estimate of benefits:	cannot be estimated

4.3 Measures and Their Benefits

4.3.1 Preparation of the new Clean Air Act

At the present time, a new Clean Air Act has been prepared and should come into force on January 1, 2002. The main reason for restructuring of the current Czech air protection legislation lies in harmonization and transposition of the relevant legislation of the European Communities in relation to the preparations for accession of CR to EU. The new air protection legislation is comprehensive and includes protection against pollutants, protection of the ozone layer of the Earth and protection of the climate system of the Earth, and the related joint provision for the legal institute of penalties and execution of public administration. The Act also includes a part related to protection of the climate system of the Earth in the sense of the Framework Convention and the Kyoto Protocol to this Convention, taking into consideration Council Decision 99/296/EC. The inclusion of part on the protection of the climate system of the Earth into the law placed CR amongst countries that are aware not only of the importance of activities in this area, but also of the need for inclusion of these aspects in the legislation.

In the area of protection of the climate, the new Clean Air Act will also provide a legislative basis for the National Program to Mitigate Changes in the Climate of the Earth, approved by the Government (to replace the previous Strategy of Protection of the Climate System of the Earth in the Czech Republic), which will contain, amongst other things, also setting of reduction targets for substances affecting the climate system of the Earth and deadlines of achieving these targets. Records and evaluation of emissions and natural decreases in substances affecting the climate system will be kept by the Ministry of the Environment in the register of substances affecting the climate system, which will be based on experience gained in operation of the REZZO database. The draft Act also lays down the obligations of operators of large energy sources (over 5 MWth) to supply to this register information required

for emission records; the manner of submission will be laid down in a special Decree.

Primary target of the measure:	harmonization of the legislation of CR with EU legislation
Effect on greenhouse gases:	decrease in emissions of CO_2 and of other greenhouse gases
Type of measure:	legislative
State of implementation:	prepared
Time period for implementation:	since 2001
Extent of implementation:	at a country-wide level, all sectors
Implementor:	the Ministry of the Environment and other bodies of the state administration in the area of air protection
Estimate of costs:	cannot be estimated
Estimate of benefits:	cannot be estimated

4.3.2 New energy legislation

The adopting of new energy legislation is a fundamental change in the area of energy production and consumption, that can contribute considerably to limiting emissions of greenhouse gases from energy sources. The new energy legislation was prepared in the framework of harmonization of the national legislation with the EU legislation and replaced and extended Act No. 222/1994 Coll., on business conditions and public administration in the energy sectors (the Energy Act). In January 2001, the new Energy Act (No. 458/2000 Coll.) and Act on energy management (No. 406/2000 Coll.) came into force. These Acts contain some provisions directly connected with the structure and requirements on sources and consumption of energy, that are subsequently connected with the production of greenhouse gases. The Act on energy management provides a legislative basis for some measures described in the Second National Communication and thus provides for their implementation. The most important provisions in this context are as follows:

The Energy Act

The Act lays down the right of operators of installations for combined production of electricity and heat and installations for use of renewable energy sources and waste combustion to preferential access to the distribution networks. If the basic technical conditions are met, the operators of the distribution networks are obliged to purchase electricity and heat energy originating from renewable energy sources and combined production of heat and electricity.

The Act on energy management

This Act establishes the obligation of each of the 14 regions to prepare a regional energy conception within five years, in order to create conditions for efficient use of energy. It legislatively defines and establishes the National Program of Efficient Energy Use and Utilization of Renewable and Secondary Energy Sources. It introduces (i) some obligatory measures to increase the efficient use of energy, such as requirements on minimum level of electricity and heat production efficiency for new sources, maximum possible level of losses for new installations for energy transport and distribution, minimum technical requirements on buildings and energy-consuming units, (ii) measures to support combined production of electricity and heat, (iii) the obligation of fitting selected energy-consuming units with energy labels, (iv) the obligation to carry out an energy audit on buildings and energy management for entities in the public and commercial sector and industry with energy consumption higher than a set value.

Because of the short period of validity and the very extensive competence of the new energy legislation, it is not yet possible to exactly calculate its benefits for decreasing emissions of greenhouse gases and pollutants.

Primary target of the measure:	harmonization of the legislation of CR with EU legislation
Effect on greenhouse gases:	decrease in emissions of CO_2
Type of measure:	legislative

State of implementation:	implemented
Time period for implementation:	since 2000
Extent of implementation:	at a country-wide level, all sectors producing energy
Implementor:	the Ministry of Industry and Trade and Energy Regulation Authority
Estimate of costs:	cannot be estimated
Estimate of benefits:	cannot be estimated

4.3.3 Measures to decrease emissions of greenhouse gases introduced jointly

The year 2000 saw a continuation of activities of CR as the host country in the framework of projects of jointly implemented measures in the pilot phase of AIJ (*Activities Implemented Jointly*). These projects are concerned with meeting commitments following from the Kyoto Protocol. Their inclusion was mentioned in the Second National Communication; nonetheless, in the last few years there has been a certain progress in implementation of specific projects. In 1998, with the support of the World Bank and the Swiss Government, the study "National Strategy for measures to decrease emissions of greenhouse gases" was prepared[19]. Because of some controversial and unresolved aspects related particularly to the approval process, new rules were prepared in 2000 for projects of the pilot phase of AIJ in the Czech Republic.

In 1996–1999, five AIJ projects were implemented and approved by the Ministry of the Environment, of which two projects have taken place since 1998: (i) district heating plant burning biomass in the municipality of Hostětín in cooperation with the Government of the Netherlands and (ii) modernization of a CHP plant in the automobile company of Škoda Mladá Boleslav in cooperation with the German Government. The annual benefit from these projects led to decreasing CO_2 emissions by 49 kt and 179 kt, resp. However, no specific agreement was reached by the time of completion of the Third National Communication in connection to transition to the JI (*joint implementation*) phase of projects with crediting possibilities. This also depends the results of international negotiations on the Kyoto mechanisms, and thus it is assumed that the position of CR will be known by the end of 2001. The proposal includes particularly projects prepared in cooperation with the Government of the Netherlands.

Primary target of the measure:	decreasing of CO_2 emissions in the framework of introduction of flexible mechanisms included in the Kyoto Protocol
Effect on greenhouse gases:	decrease in emissions of CO_2
Type of measure:	economic
State of implementation:	implemented
Time period for implementation:	on-going (since 1996)
Extent of implementation:	at a country-wide level
Implementor:	the Ministry of the Environment (National Reference Center for AIJ/JI) in cooperation with implementors of projects and foreign investors
Estimate of costs:	cannot be estimated
Estimate of benefits:	cannot be estimated

4.3.4 State program to support energy savings and use renewable sources

In July 1998, a Government Resolution approved a draft for newly conceived, intersectorally coordinated State Program to Support Energy Savings and the Use of Renewable Energy Sources, which has been promulgated in new form since 1999. This program covers all the sectors of the national economy and is related to the individual programs in the previous years. A key role here is played particularly by the programs

[19] National Strategy for Joint Implementationin the Czech Republic, Swiss Government, World Bank, Ministry of the Environment, Prague 1998

Tab. 4-1 Czech Energy Agency programs – annual implementation costs *(mil. CZK)*

	1995	1996	1997	1998	1999	2000	2001	In future
State budget	211.0	229.9	362.6	341.9	315.0	209.0	102.2	250.0
Other public resources	185.0	220.0	243.0	213.0	205.0	150.0	120.0	350.0
Private resources	488.2	492.6	672.0	1 482.0	2 144.0	977.0	534.0	900.0

Source: Czech Energy Agency

of the Ministry of Industry and Trade, implemented by the Czech Energy Agency (Part A) and the programs of the Ministry of the Environment, implemented by the State Environmental Fund (Part B). Further parts of the program are implemented by the Ministry of Agriculture, the Ministry for Regional Development, the Ministry of Defense, the Ministry of the Interior and other sectors.

Programs of the Czech Energy Agency (CEA) are concerned with introduction of energy-saving measures in the area of production, distribution and consumption of energy, greater utilization of renewable and secondary energy sources and the development of cogeneration production of heat and electricity. Emphasis is placed on initiation of increased efficiency in energy use, especially in industry, increasing the use of modern innovative technologies and procedures, support for projects with highly effective use of financial means, support for consulting, education, public awareness and promotion of economical energy use for the general public. CEA provides support especially through nonreturnable financial subsidies for individual projects. CEA announces subprograms each year, to support the implementation of energy-saving projects in apartment buildings and residential homes, schools, health care, the buildings of state and public institutions, projects of renewable and secondary energy sources, development of combined production of heat and electricity, preparation of energy audits, financing of energy-saving projects from energy savings, development and use of modern technologies and materials for measures to increase the efficiency of energy use, modernization of energy production and distribution facilities, preparation of energy conceptions of cities and municipalities and optimization of supplying of settlement units with energy, energy savings in industry, transport and agriculture and also consulting, education and promotion of efficient energy use.

Primary targets of the measure:	decreasing of the energy intensity of the economy, savings of energy-production materials, minimizing of the pollution of the environment and a decrease in emissions of greenhouse gases
Effect on greenhouse gases:	decrease in emissions of all kinds of greenhouse gases
Type of measure:	economic / informative / educational / research
State of implementation:	implemented
Time period for implementation:	implementation of the measure is on-going (since 1999 in the framework of the new State Program to Support Energy Savings)
Extent of implementation:	at a country-wide level, sector of energy production and consumption
Implementor:	implementation of the measure is the responsibility of the Ministry of Industry and Trade, the program is implemented by the Czech Energy Agency
Estimate of costs:	see Tab. 4-1
Estimate of benefits:	see Tab. 4-2 and Tab. 4-3

Tab. 4-2 Czech Energy Agency programs – expected CO_2 emission reduction *(kt)*

	1995	2000	2005	2010
CO_2	150	222	297	336

Source: Czech Energy Agency

Tab. 4-3 Czech Energy Agency programs – other expected emissions reduction *(kt)*

	1995	2000	2005	2010
CO	0.42	0.63	0.84	0.96
NO_x	0.54	0.84	1.11	1.26
SO_2	3.54	2.1	2.82	3.21

Source: Czech Energy Agency

The **State Environmental Fund** (SEF) currently supports, in particular, investment projects and projects to use renewable energy sources and also enlightenment, education and consulting in the area of the use of renewable energy sources. Support provided by SEF is primarily concerned with environmental effects, particularly in areas that do not create sufficient resources for implementation of the supported projects. These areas consist particularly in local self-governing units, budgetary organizations and the general population. The amount of the support provided follows from this specific purpose; this corresponds to 2–3 times the amount of subsidies provided by CEA. SEF provides support in the form of subsidies and, in particular, soft loans[20].

[20] Evaluation of the benefits and costs of the SEF programs is available only for 1999 and 2000.Trends in further years are highly dependent on the number of applicants and quality of projects, and thus cannot be estimated with sufficient precision.

Primary targets of the measure:	decreasing of the energy intensity of the economy, savings of energy-production materials, minimizing of the pollution of the environment and a decrease in emissions of greenhouse gases
Effect on greenhouse gases:	decrease in emissions of CO_2
Type of measure:	economic / informative / educational / research
State of implementation:	implemented
Time period for implementation:	implementation of measures is on-going (since 1999 in the framework of the new State Program to Support Energy Savings and the Use of Renewable Energy Sources)
Extent of implementation:	at a country-wide level, sector of energy production and consumption
Implementor:	implementation of the measure is the responsibility of the Ministry of the Environment through the State Environmental Fund
Estimate of costs:	see tab. 4-4
Estimate of benefits:	see Tab. 4-5 and Tab. 4-6

Tab. 4-4 State Environmental Fund programs – annual implementation costs *(mil. CZK)*

	1992–1998	1999	2000
State budget	0	0	0
Other public resources	270	237	331
Private resources	430	96	484

Source: State Environmental Fund

Tab. 4-5 State Environmental Fund programs – expected CO_2 emission reduction *(kt)*

	1999	2000
CO_2	15.1	72.6

Source: State Environmental Fund

Tab. 4-6 State Environmental Fund programs – other expected emissions reduction *(kt)*

	1999	2000
CO	0.32	0.20
NO_x	0.01	0.18
SO_2	0.24	0.89

Source: State Environmental Fund

4.3.5 Support provided by the State Environmental Fund

The State Environmental Fund also supports measures related to energy savings and air protection outside of the framework of the State Program to Support Energy Savings and the Use of Renewable Energy Sources. These measures consists particularly in programs supporting the transition from solid fuels to cleaner fuel (natural gas) for small and medium-sized sources, support for the combined heat and power production

and the development of the energy infrastructure in small municipalities[21].

[21] Evaluation of the benefits and costs of the SEF programs is available only for 1999 and 2000.Trends in further years are highly dependent on the number of applicants and quality of projects, and thus cannot be estimated with sufficient precision.

Primary target of the measure:	decreasing emissions of pollutants into the air
Effect on greenhouse gases:	decrease in emissions of CO_2
Type of measure:	economic
Time period for implementation:	on-going implementation
Extent of implementation:	at a country-wide level, sector of energy production and consumption
Implementor:	implementation of the measure is the responsibility of the Ministry of the Environment through the State Environmental Fund
Estimate of costs:	see tab. 4-7
Estimate of benefits:	see Tab. 4-8 and Tab. 4-9

Tab. 4-7 State Environmental Fund financial support – annual implementation costs *(mil. CZK)*

	1999	2000
State budget	0	0
Other public resources	492	1 727
Private resources	458	1 732

Source: State Environmental Fund

Tab. 4-8 State Environmental Fund financial support – expected CO_2 emission reduction *(kt)*

	1999	2000
CO_2	336	1 160

Source: State Environmental Fund

Tab. 4-9 State Environmental Fund financial support – other expected emissions reduction *(kt)*

	1999	2000
CO	12.1	42.1
NO_x	0.6	2.4
SO_2	6.4	20.6

Source: State Environmental Fund

4.3.6 Initiative for efficient lighting

The efficient lighting initiative (ELI) is a three-year program prepared by the International Financial Corporation (IFC) and financed by the Global Environmental Facility (GEF). The target of this initiative is to decrease emissions of greenhouse gases by faster introduction of energy-saving technology onto newly emerging markets. Implementation of the program began in the spring of 2000 and the overall budget for CR equals 1.25 mil. USD. The program concentrates particularly on the public sector, households and public street lighting. The budget will be used in the individual program activities so as to stimulate local private and public resources to increment the effectiveness of the program. The expected benefits are estimated in a direct impact on savings at a total of 390 kt CO_2 in 2002–2003 and, in subsequent years, as indirect benefits at the level of 425 kt of CO_2 emissions saved annually. The measure will also have a benefit in decreasing pollutant emissions.

Primary target of the measure:	decreasing emissions of greenhouse gases through accelerated introduction of energy-saving technologies onto newly emerging markets
Effect on greenhouse gases:	decrease in emissions of CO_2
Type of measure:	economic / informative / educational
State of implementation:	implemented
Time period for implementation:	2000–2003
Extent of implementation:	at a country-wide level, sector of energy production and consumption
Implementor:	the project leader in CR is SEVEn, administration of the project is carried out by the Danish company *Danish Power Consult A/S*
Estimate of costs:	1.25 mil. USD
Estimate of benefits:	390 kt CO_2 (2002–2003), in the following years, indirect at the level of 425 kt CO_2 p.a.

4.3.7 Programs of support for reconstructuring and renewing buildings built using concrete panel technology

In the framework of its programs, the Ministry for Regional Development provides support for the repair, reconstruction and modernization of apartment buildings, constructed using the concrete panel technology, of which there are more than 1.1 million apartments in CR. In the framework of the program, financial subsidies are provided, along with contributions to cover interest and guarantees for activities related to repairs and reconstruction of concrete panel apartment buildings. Preference is given to economically depressed areas and areas with disturbed environment. Support is also provided for insulating buildings, improving heating systems, distribution pipes and sources of heat and hot tap water, and use of renewable energy sources in buildings, which would have a favorable effect on energy efficiency, and thus on emissions of greenhouse gases. The budget of the program for reconstruction of concrete panel buildings for 2001 equals about 300 mil. CZK and support is expected for the repair of about 20 000 apartments, and then for about 50 000 apartments annually. Because of the short period of time of implementation of the program, it is not yet possible to exactly calculate its benefits in decreasing emissions of greenhouse gases and pollutants.

Primary target of the measure:	the target of the measure is to support the repair, reconstruction and modernization of apartment buildings constructed using concrete panel technology
Effect on greenhouse gases:	decrease in emissions of CO_2
Type of measures:	economic
State of implementation:	implemented
Time period for implementation:	from 2000; the duration of the program is limited by the volume of financial means available
Extent of implementation:	at a country-wide and regional level, sector of energy production and consumption
Implementor:	Ministry for Regional Development, Czech-Moravian Guarantee and Development Bank, Housing Development Fund
Estimate of costs:	see description of the measure
Estimate of benefits:	cannot be estimated

4.3.8 Set of measures in the transport sector

The majority of measures implemented in the transport sector and related to decreasing emissions of greenhouse gases are implemented and carried out continually and have been described in the previous National Communications. Measures related to decreasing emissions of greenhouse gases from transport are described in the Strategy for Protection of the Climate System of the Earth in the Czech Republic and in the approved Transport Policy, whose implementation is entrusted to the Ministry of Transport and Communications. Compared to previous years, there has been an increase in financial means for implementation of these measures. Since 2000, the newly established State Fund of Transport Infrastructure has significantly participated in financing measures. Key measures in the area of transport include application of international technical standards for means of transport in the area of the environment and safety, support for gradual transfer of part of the volume of passenger and freight transport in highway and air transport to rail transport, combined transport and water transport, support for the creation of the relevant infrastructure for development of nonmotor kinds of transport, support for public mass transport, development of its infrastructure and introduction of integrated transport systems, support for improved organization and regulation of highway transport and support for research, development and application of alternative kinds of vehicle drive.

Tab. 4-10 Transport sector – annual implementation costs *(mil. CZK)*

	1995	1996	1997	1998	1999	2000	2001	In future
State budget	4 002	4 313	4 642	5 815	5 139	5 601	2 582	2 591
Other public resources	1 235	1 483	1 699	1 952	2 176	2 898	7 886	11 215
Private resources	80	90	91	102	103	112	241	651

Source: Ministry of Transport and Communications

Primary target of the measure:	decreasing emissions of pollutants (CO, NO_x, C_xH_y, SO_2, heavy metals and particulate matter) into the air
Effect on greenhouse gases:	favorable effect in decreasing emissions of CO_2, methane and N_2O
Type of measure:	regulation / legislative / economic / fiscal / informative
State of implementation:	implemented
Time period for implementation:	the measure is implemented over the long term and continually
Extent of implementation:	at a country-wide, regional and local level, transport sector
Implementor:	the Ministry of Transport in cooperation with the Ministry of Finance, the Ministry of Industry and Trade, the Ministry of the Interior and the Ministry for Regional Development
Estimate of costs:	see Tab. 4-10[22]
Estimate of benefits:	see Tab. 4-11 and Tab. 4-12

Tab. 4-11 Transport sector – expected CO_2 emission reduction *(kt)*

	1995	2000	2005	2010	2015
CO_2	1 334	1 843	2 797	3 917	5 321

Source: Ministry of Transport and Communications

[22] The contribution of the State Fund for Transport Infrastructure is included from 2000

Tab. 4-12 Transport sector – other expected emissions reduction *(kt)*

	1995	2000	2005	2010	2015
CO	181.2	281.3	276.9	347.4	413.7
NO_x	40.7	75.7	122.0	143.7	168.1
SO_2	0.9	6.8	10.7	12.4	13.2

Source: Ministry of Transport and Communications

4.3.9 Introduction of Directive 96/61/EC on IPPC and other measures in industry

Measures in the area of decreasing emissions of pollutants and greenhouse gases in industry are implemented and supported in the framework of selected subprograms of the State Program of support for energy savings and use of renewable energy sources. In addition, in the industrial sector, the Czech Energy Agency supports the introduction of methods of effective energy management, such as *Monitoring and Targeting*. The new energy legislation will also contribute considerably to a substantial increase in energy efficiency and the consequent savings in emissions of greenhouse gases, especially through application of the obligations following from the Act on energy management.

In connection with preparation for membership in EU, a fundamental measure in the industrial sector consists in introduction of the EU legislative standards. A key change will consist particularly in the transition to an integrated system of environmental protection. The target of the newly prepared Act on integrated pollution prevention and control and the integrated pollution register is to achieve the maximum possible prevention of industrial pollution of all components of the environment and thus to ensure full com-

patibility of the legal order of CR in these areas with EU law, in particular with Directive 96/61/EC, the related decisions of the European Commission and also with OECD recommendation. It is estimated that approximately 850 enterprises and 1400 installations will fall under the IPPC regime (energy production 14 %, metal production and working 20 %, mineral treatment 7 %, chemical industry 15 %, waste management 7 %, other facilities 37 %).

In connection with preparation of the Act on IPPC, the Ministry of the Environment, the Federation of Industry and Transport and the Czech Business Council for Sustainable Development concluded an agreement on cooperation at the end of 2000, which led to an action plan for 2000–2002. This plan includes the area of introduction of new legislation, implementation of the IPPC Directive, support and promotion of further introduction of environmental management systems (EMS/EMAS) and other voluntary instruments in industrial enterprises, which will also be favourably reflected in decreasing emissions of greenhouse gases. Exact enumeration of the benefits in the area of decreasing emissions of greenhouse gases has not been, however, so far possible for the above activities.

Primary target of the measure:	harmonization of CR legislation with EU legislation
Effect on greenhouse gases:	decrease in emissions of CO_2
Type of measure:	legislative
State of implementation:	prepared
Time period for implementation:	preparation to about 2002, full introduction for new installations from Jan. 1, 2003, for existing installations from 2012
Extent of implementation:	at a country-wide level, sector of industry
Implementor:	the Ministry of the Environment, the Ministry of Industry and Trade, Federation of Industry and Transport
Estimate of costs:	cannot be estimated
Estimate of benefits:	cannot be estimated

4.3.10 Support for afforestation of uncultivated agricultural areas

In CR, the sectors of agriculture and forestry lie within the jurisdiction of the Ministry of Agriculture. Measures adopted in these sectors affect the decreasing in emissions of CO_2, CH_4 and N_2O (in agriculture) and also the increase in the level of CO_2 sinks (in forest management). In the adopted Strategy of Protection of the Climate System of the Earth in the Czech Republic, the Ministry of Agriculture pledged to implement measures related to afforestation of uncultivated agricultural land, support for maintenance of permanent grasslands, use and production of alternative motor fuels, introduction of new soil cultivation technologies and growing methods. Support for afforestation of uncultivated agricultural land and agricultural land not suitable for agricultural systems (steep slopes, rocky, waterlogged, shallow soils) was already partly mentioned in the Second National Communication. The Ministry of Agriculture provides nonreturnable financial assistance for afforestation of unused agricultural properties, including protection of established forest cultures. The area of forests increased by about 5000 ha in 1990–1998. This increase is the result of two opposing processes – afforestation of nonforest (incl. agricultural) land and withdrawal of properties from fulfilling the function of forests mainly for investment construction and mining of raw materials.

Primary target of the measure:	more rational use of agricultural land
Effect on greenhouse gases:	increased bonding of CO_2 to phytosystems through increasing the area of forests
Type of measure:	economic
State of implementation:	implemented
Time period for implementation:	implementation of the measure is on-going
Extent of implementation:	at a country-wide level, agricultural sector
Implementor:	the Ministry of Agriculture in cooperation with the owners of the agricultural land fund
Estimate of costs:	see Tab. 4-13
Estimate of benefits:	see Tab. 4-14

Tab. 4-13 Afforestation – annual costs *(mil. CZK)*

	1995	1996	1997	1998	1999	2000	2001	In future
State budget	24.64	27.29	17.13	19.98	25.20	25.96	28.00	30.00
Other public resources	0	0	0	0	0	0	0	0
Private resources	0	0	0	0	0	0	0	0

Source: Ministry of Agriculture

Tab. 4-14 Afforestation – expected CO_2 emission reduction *(kt)*

	1995	2000	2005	2010
CO_2	84	84	84	84

Source: Ministry of Agriculture

4.3.11 Support for the production of alternative motor fuels

The Ministry of Agriculture provides support in the framework of its support programs for the production of alternative motor fuels based on the methyl ester of rapeseed oil (bio-diesel fuel) and bioethanol through noninvestment, direct nonreturnable subsidies. The support is provided for the production of bio-diesel fuel, i.e. production of up to 1000 t of bioethanol, used as an alternative fuel on the basis of processing of crops from agricultural production grown in this country. The amount of the support corresponds to up to 3000 CZK per ton of methyl ester, or up to 15 CZK per litre of bioethanol. In 1999, the Ministry of the Environment supported the production of 22.8 kt of bio-diesel fuel through the sum of 65.5 mil. CZK and production of 650 thous. litres of bio-ethanol through the sum of 9.75 mil. CZK. Programs of support for the production and use of alternative motor fuels will continue in the future.

Primary target of the measure:	nonfoodstuff utilization of domestic agricultural production
Effect on green-house gases:	decrease in emissions of CO_2
Type of measure:	economic
State of imple-mentation:	implemented
Time period for implementation:	on-going implemen-tation of the measure
Extent of imple-mentation:	at a country-wide level, agricultural sector
Implementor:	the Ministry of Agriculture
Estimate of costs:	see Tab. 4-15
Estimate of benefits:	see Tab. 4-15

4.3.12 Draft Act on packaging and Act on wastes, waste landfilling

The final emissions of greenhouse gases (escape of methane from landfills, waste combustion) can be affected by the means of waste disposal. Waste separation at the level of the waste generator can have a substantial benefit, also affecting consumption of energy in processing raw materials from recycled waste and extending the potential for business opportunities. Key measures in the area of waste management consist in preparation of a new Act on wastes and Act on packaging,

Tab. 4-15 Alternative motor fuels support and payoffs – annual costs and emission reduction estimation in 1999

	Supported amount (t)	Total support (thous. CZK)	CO_2 emission reduction (kt)	Pollutants emissions reduction (increase) (t/year)			
				Solids	NO_X	CO	C_XH_y
Bio-ethanol	513	9 749	1.0	2.3	43.8	16.9	2.7
Methylester	22 822	65 466	58.5	46.9	(-218.1)	157.6	77.9

Source: Ministry of the Environment

the drafts of which were prepared and elaborated during 2001. In relation to preparation for membership in EU, CR must comply with the requirements of Directive 99/31/EC on waste landfills, which contains the requirement of substantial reduction of landfilling of biodegradable wastes and also the requirements of EC regulations related to management of packaging wastes, especially in relation to the prescribed fraction of recycled plastics, paper and glass. The regulations for implementation and technical standards for landfilling are also harmonized in relation to compliance with the requirements of the European Directive on landfilling of waste. It is expected that the new legislation will substantially improve conditions for effective waste management, separation, recycling, disposal and prevention of waste generation. The new Act on wastes should come into effect as of Jan. 1, 2002. The means of ensuring reduction of the amount of biodegradable municipal waste will be laid down according to the new Act in a new waste management plan in its binding parts, which will also give the necessary investment costs and a proposal for their provision.

Primary target of the measure:	harmonization of CR legislation with the European Union legislation
Effect on greenhouse gases:	decrease in emissions of CO_2, CH_4 and N_2O
Type of measure:	legislative
State of implementation:	prepared
Time period for implementation:	preparation to approx. 2002, full introduction to approx. 2005
Extent of implementation:	at a country-wide level, sector of waste management
Implementor:	the Ministry of the Environment, the Ministry of Industry and Trade
Estimate of costs:	cannot be estimated
Estimate of benefits:	cannot be estimated

4.3.13 Use of landfill gas and biogas from waste water treatment plants

A further measure that was mentioned in the Second National Communication and which continues to be implemented consists in the use and implementation of new projects for utilization of biogas from landfills and waste water treatment plants. In recent years, a number of projects have been implemented for collecting gases from waste landfills, not only for new landfills, but in several cases also for old landfills. Gas was collected in 2001 from 12 of the total of about 250 landfills and the biogas was used for energy production from six of these. The technology of utilization of waste biogas was implemented in 1998–2001 by a number of municipal and industrial waste water treatment plants.

Primary target of the measure:	decreasing emissions of methane from landfills and waste water treatment plants
Effect on greenhouse gases:	decrease in emissions of CH_4
Type of measure:	technical
State of implementation:	implemented
Time period for implementation:	on-going
Extent of implementation:	at a country-wide level, waste management sector
Implementor:	operators of landfills and waste water treatment plants
Estimate of costs:	cannot be estimated
Estimate of benefits:	cannot be estimated

A survey of all the above measures classified according to sectors is given in Tab. 4-16.

4.4 Measures Not Yet Implemented

All the measures given in the Second National Communication continue to be implemented or the implementation of some measures (territorial energy policy, energy audits, energy labelling) is incorporated in the legislation in the framework of the Act on energy management.

Tab. 4-16 Survey of measures by sector

Name of measure	Target and/or affected activity	Affected greenhouse gases	Type of measure	State	Implementation authority	Expected benefit in decreasing emissions of greenhouse gases (for each year, not accumulated, in CO_2 equiv.)			
						1995	2000	2005	2010
Framework / multisectoral measures									
Strategy of protection of the climate system of the Earth in the Czech Republic	Provision for meeting commitments following for CR from the Kyoto Protocol	All greenhouse gases	Policy, framework	Implemented	Government of CR and entrusted Ministries	0	n/a	n/a	n/a
Preparation of the new Clean Air Act	Harmonization of CR legislation with the European Union legislation	CO_2	Legislative	Prepared	Ministry of the Environment and other bodies of the state administration in the area of air protection	New Act on Energy	n/a	n/a	n/a
New Energy Act	Harmonization of CR legislation with the European Union legislation	CO_2	Legislative	Implemented	Ministry of Industry and Trade and the Energy Regulation Authority	0	n/a	n/a	n/a
The Act on energy management	Harmonization of CR legislation with the European Union legislation	CO_2	Legislative	Implemented	Ministry of Industry and Trade	0	n/a	n/a	n/a
AIJ Project – Škoda Mladá Boleslav [a)]	*Energy savings and decreasing emissions in the framework of the AIJ project*	*CO_2*	*Economic, voluntary activities*	*Implemented*	*German Government in cooperation with Bavariawerk AG and RWE Energie*	*0*	*272*	*272*	*272*
AIJ Project – Hostětín [a)]	*Energy savings and decreasing emissions in the framework of the AIJ project*	*CO_2*	*Economic, voluntary activities*	*Implemented*	*Government of the Netherlands in cooperation with BTG Group*	*0*	*49*	*49*	*49*
Proposed JI project – biomass sources portfolio [a)]	*Energy savings and decreasing emissions in the framework of the AIJ project*	*CO_2*	*Economic, voluntary activities*	*Prepared*	*Government of the Netherlands in cooperation with BTG Group*	*0*	*0*	*263*	*244*

Name of measure	Target and/or affected activity	Affected greenhouse gases	Type of measure	State	Implementation authority	Expected benefit in decreasing emissions of greenhouse gases (for each year, not accumulated, in CO_2 equiv.)			
						1995	2000	2005	2010
Sector of energy production and energy consumption									
State program of support for savings of energy and use of renewable energy sources – Part A Program of the Czech Energy Agency	Decreasing the energy intensity of the economy, savings in energy production materials and minimization of the burdening of the environment by emissions and decreasing emissions of greenhouse gases	CO_2	Economic Information Educational Research	Implemented	Czech Energy Agency	150	222	297	336
State program of support for savings of energy and use of renewable energy sources Part B – Programs of the State Environmental Fund	Decreasing the energy intensity of the economy, savings in energy production materials and minimization of the burdening of the environment by emissions and decreasing emissions of greenhouse gases	CO_2	Economic Information Educational Research	Implemented	State Environmental Fund	n/a	73	n/a	n/a
Support from the State Environmental Fund in the area of air protection	Decreasing emissions of pollutants into the air	CO_2	Economic	Implemented	State Environmental Fund	n/a	1 160	n/a	n/a
GEF Efficient lighting initiative	Decreasing emissions of greenhouse gases through accelerated introduction of energy-saving lighting technology	CO_2	Economic Information Educational	Implemented	Global Environment Facility (GEF), SEVEn (local coordinator)	0	0	425	425
Program of support for reconstruction and recovery of concrete panel buildings	Repair and reconstruction of concrete panel buildings	CO_2	Economic	Implemented	Ministry for Regional Development	0	n/a	n/a	n/a

Name of measure	Target and/or affected activity	Affected greenhouse gases	Type of measure	State	Implementation authority	Expected benefit in decreasing emissions of greenhouse gases (for each year, not accumulated, in CO_2 equiv.)			
						1995	2000	2005	2010
Transport									
Set of measures in the transport sector	Decreasing emissions of pollutants	CO_2, methane, N_2O	Regulative Legislative Economic Fiscal Information	Implemented	Ministry of Transport and Communications in cooperation with other sectors	1 334	1 843	2 797	3 917
Industry									
Introduction of Directive 96/61/EC concerning Integrated Pollution Prevention and Control (IPPC)	Harmonization of the CR legislation with the EU legislation	CO_2, methane, N_2O	Legislative	Implemented / prepared	Ministry of the Environment Ministry of Industry and Trade	0	0	n/a	n/a
Agriculture and forestry									
Support for afforestation of unused agricultural areas	More rational use of agricultural land	CO_2	Economic	Implemented	Ministry of Agriculture	84	84	84	84
Support for the production of alternative motor fuels	Non-foodstuff use of domestic agricultural production	CO_2	Economic	Implemented	Ministry of Agriculture	n/a	60	n/a	n/a
Waste management									
Draft Act on waste and Draft Act on packaging	Harmonization of the CR legislation with the EU legislation	CO_2, methane, N_2O	Legislative	Implemented / prepared	Ministry of the Environment Ministry of Industry and Trade	0	0	n/a	n/a
Utilization of landfill gas and biogas from waste water treatment plants	Decreasing emissions of methane from landfills and waste water treatment plants	methane	Technical	Implemented	Operators of landfills and waste water treatment plants	n/a	n/a	n/a	n/a

n/a – data not available or cannot be estimated at the present time

[a)] benefits of AIJ and JI projects are not included in the overall benefit for the Czech Republic

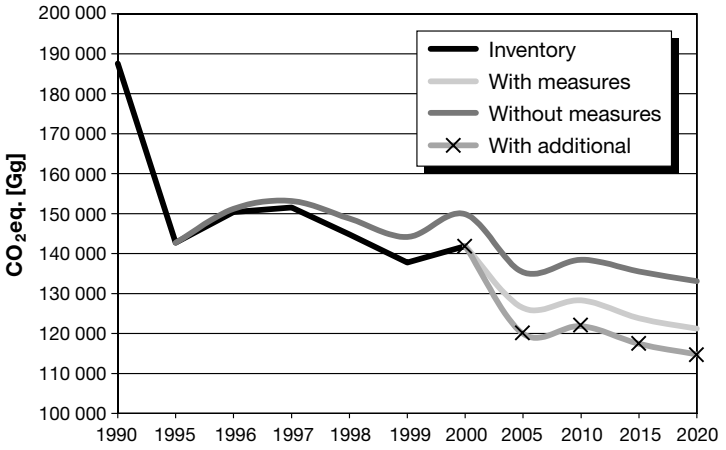
Source: SRCI CR s.r.o.

5. EMISSION PROJECTIONS AND OVERALL BENEFITS OF MEASURES

5.1 Emission Projections

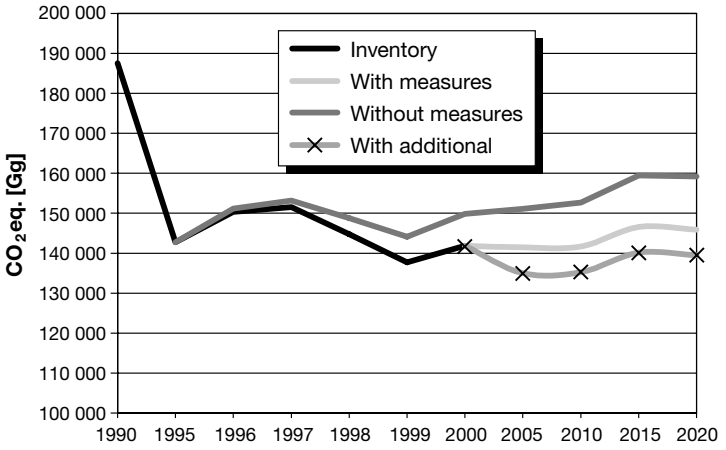
Two conceptually different scenarios of trends in emissions of greenhouse gases have been drawn up, the reference scenario (Fig. 5-1) and the high scenario (Fig. 5-2). A more detailed description of the scenarios and assumptions used for their creation are given in part 5.3. In accord with the methodical guidelines[23], the following three projections were prepared for each of these two scenarios: (i) projection without measures, (ii) projection with measures and (iii) projection with additional measures. The projections differ in the degree of implementation of measures to decrease emissions of greenhouse gases (for more details, see the text below and a description of the project in part 5.3). Fig. 5.3 depicts comparison of the results of the two scenarios employed.

Fig. 5-1 GHG emission projections – reference scenario *(kt of CO_2 eq.)*



Source: SRCI CS s.r.o.

Fig. 5-2 GHG emission projections – high scenario *(kt of CO_2 eq.)*



Source: SRCI CS s.r.o.

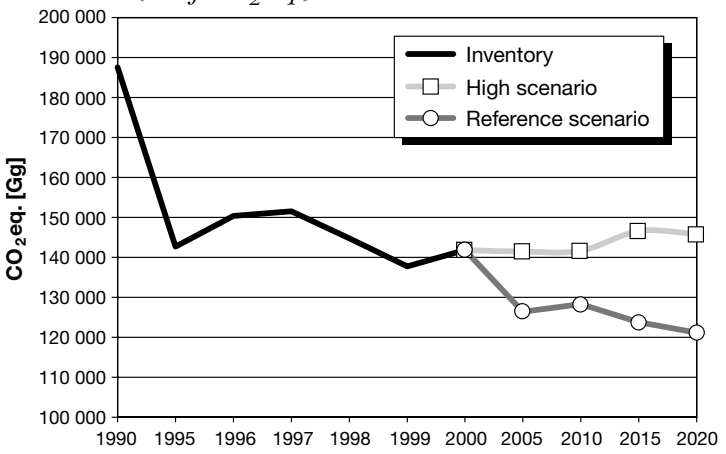
5.2 Estimation of Benefits of Selected Measures

5.2.1 Expected benefit of implemented measures

Benefit of legislation and environmental protection measures after 1995

The main measure that had a very significant impact on reducing CO_2 emissions was the adopting of new air protection legislation in 1991. The Clean Air Act and the subsequent by-laws

Fig. 5-3 GHG emission projections – high and reference scenarios with measures *(kt of CO_2 eq.)*



Source: SRCI CS s.r.o.

[23] Guidelines for the Preparation of National Communications by Parties Included in Annex I to the Convention (FCCC/CP/1997/7)

introduced limit values for emissions from the operation of all energy sources, which were especially strict for sources based on combustion of coal. State support for extensive conversion to gas also played an important role. Particularly large sources were quite successful in reducing emissions, although large investments were required into sulfur-removal technology for combustion products and installation of fluid-bed furnaces. Most of the other coal-based sources were converted to other fuels, especially natural gas. The most important changes occurred in the period up to 1999. However, this should also be seen in the context of an overall economic cut-back in the Czech Republic at the beginning of the nineties.

Another factor was the impact of adapting of the national economy to a market environment. In this process, a number of production enterprises were closed and their thermal sources were shut down. Simultaneously, there was extensive conversion of the production of heat and electricity to gas for small sources. The following examples can be given of the extensive changes in the structure of coal-based sources (see also Tab. 5-1):

- In 1994, the set of large energy sources based on brown coal (sources over 5 MW thermal output) constituted a total of 750 units; by 1998 this had decreased to 318 units and, in 1999, to only 285 units. The set of large sources include all coal-fueled sources in the energy-production system in CR and a majority of coal-fueled municipal and industrial energy sources. There has been a massive decrease particularly in sources with an output of 5 to 20 MW.
- In 1997, the set of medium-sized energy sources (0.2–5 MW) consisted of over 12 thousand furnaces based on solid fuel. It follows from the regular up-dating of the records that this number has currently decreased to 20–25 % of the number in 1997 and will probably finally decrease to 10–15 % of the original number over the next 2 to 3 years. Natural gas is rapidly replacing solid fuels with the assistance of state subsidies within this sphere of the market.
- Extensive conversion to gas has also occurred in the set of small sources (under 0.2 MW); nonetheless, the decrease in the number of coal-fueled sources and the consumption of coal have not been as extensive as amongst medium-sized sources. The continuing price advantages for solid fuels plays a considerable role here; these price advantages will continue to increase in the immediate future in connection with the equalization of the price of natural gas.

Tab. 5-1 Consumption of fossil fuel according to sources in 1990 and 1999 *(kt)*

	Sources	1990	1999	Index
Brown coal	large (over 5 MW)	60 239	39 077	0.65
	medium (0.2–5 MW)	3 420	460	0.14
	small (below 0.2 MW)	7 500	3 550	0.46
	total	**71 159**	**43 087**	**0.61**
Hard coal	large (over 5 MW)	7 370	5 624	0.76
	medium (0.2–5 MW)	150	42	0.44
	small (below 0.2 MW)	590	260	0.44
	total	**8 110**	**5 926**	**0.73**
Coke	large (over 5 MW)	3 056	2 309	0.76
	medium (0.2–5 MW)	200	105	0.53
	small (below 0.2 MW)	870	225	0.26
	total	**4 126**	**2 639**	**0.64**

Source: Czech Statistical Office, Czech Hydrometeorological Institute

The scenario without measures corresponds to the scenario with increasing emissions of greenhouse gases based on evaluation of the overall benefits of legislation and extensive conversion to gas in 1995–1999. To 1999, there was a greater decrease in consumption of coal than would correspond to the increase in the consumption of gas (Tab. 5-2). For the basis of calculations, we will thus take into account only the increase in the consumption of gas, which equals approx. 26 PJ in terms of final consumption and about 31 PJ for production of electricity and district heat. Following conversion to brown coal based on the average net calorific value, this yields an equivalent consumption of brown coal of 34 or 42 PJ annually, resp. The difference between the use of coal and gas results in overall annual savings in emissions of GHG of about 4.6 Mt, as can be seen from Tab. 5-3. In the projection period, this value for the individual sectors is adjusted using the trend in the production of electricity and district heat based on fuel and trends in final energy consumption. The resultant savings in emissions of greenhouse gases in the individual scenarios achieved with the contributions from legislative measures after 1995 are given in Tab. 5-4.

Benefits from further measures introduced after 1995

In addition to legislation and extensive conversion to gas, a number of measures and programs have been implemented or their implementation has been commenced to further contribute to decreasing emissions of greenhouse gases. Tab. 5-5 gives a summary of evaluation of further selected measures. The overall effects of the already adopted measures are reflected in the individual scenarios as described in Tab. 5-6.

Tab. 5-2 Coal and natural gas consumption in 1995 and 1999 *(TJ)*

	1995	1999	Difference 1999–1995
Final consumption of			
coal	30 664	20 856	-9 808
lignite	93 957	47 489	-46 468
natural gas	193 954	220 216	**26 262**
Electricity generation and central heat generation			
coal	127 723	122 173	-5 550
lignite	539 825	466 735	-73 090
natural gas	58 952	90 109	**31 157**

Source: Czech Statistical Office

Tab. 5-3 Coal to gas switching – emission reduction estimation *(kt)*

	CO_2	CH_4	N_2O	CO_2 eq.
Final consumption	1 928	6.581	0.133	2 107
Electricity generation and central heat generation	2 397	0.097	0.162	2 449
Total	**4 325**	**6.678**	**0.294**	**4 556**

Source: SRCI CS s.r.o.

Tab. 5-4 Contribution of legislation measures – projected emissions reduction *(kt CO_2 eq.)*

	2000	2005	2010	2015	2020
Reference scenario	4 556	4 178	4 238	4 428	4 604
High scenario	4 556	4 861	5 093	5 563	6 026

Source: SRCI CS s.r.o.

Tab. 5-5 Projected effect of other measures implemented after 1995 *(kt CO_2 eq.)*

	2000	2005	2010	2015	2020
Czech Energy Agency – National Program Part A	222	297	336	336	336
State Environmental Fund – National Program Part B	73	73	73	73	73
State Environmental Fund – Air Protection	1 160	1 000	1 000	1 000	1 000
GEF efficient lighting	0	425	425	425	425
Transport	1 843	2 797	3 917	5 321	5 321
Afforestation	84	84	84	84	84
Alternative fuels	60	60	60	60	60
Total GHG CO_2 eq.	**3 442**	**4 736**	**5 895**	**7 299**	**7 299**

Source: SRCI CS s.r.o.

Tab. 5-6 Projected total effect of measures implemented after 1995 *(kt CO_2 eq.)*

	2000	2005	2010	2015	2020
Reference scenario	7 998	8 914	10 133	11 727	11 903
High scenario	7 998	9 597	10 988	12 862	13 325

Source: SRCI CS s.r.o.

5.2.2 Expected benefits of additional measures

Additional measures or prepared measures (see Chapter 4.4) that should contribute most to decreasing emissions of greenhouse gases consist in (i) the new Clean Air Act, which is expected to come into force on January 1, 2002, (ii) the introduction of Directive 96/61/EC on IPPC and (iii) preparation of the new Act on wastes and packagings. Quantification of the benefit from these individual measures is not currently available, particularly because these measures affect a wide range of activities and it is not possible to estimate the degree of impact in decreasing emissions of greenhouse gases[24]. However, all these measures will lead to decreasing emissions.

At the present time, a National Program of economic energy management and use of renewable and secondary energy sources is being prepared, corresponding to implementing of Act No. 406/2000 Coll. on energy management. In accord with the wording of this Act, the National Program is to be a document expressing targets related to decreasing energy consumption and to the use of renewable and secondary energy sources, in accord with economic and social needs on the basis of the principles of sustainable development and protection of the environment. The program is thus an expression of the commitment of the state to support and co-finance activities that contribute to meeting the targets of sustainable development. This document is being prepared by the Ministry of Industry and Trade in cooperation with the Ministry of the Environment. The collected analytical material[25] for this program also calculates potential benefits in decreasing emissions, including emissions of greenhouse gases. As the program is related to a number of measures implemented to date described in the previous part of the National Communication, it is necessary to decrease its benefits by the benefits of these measures, with the exception of the transport sector. The benefits of the National Program

[24] The effect of the prepared Act on wastes was reflected in the scenarios with measures, where account was taken of the direct impact of expected implementation of Directive 99/31/EC on waste landfills on emissions of greenhouse gases from combustion of fuels and landfills of municipal waste.

[25] Analysis for the draft structure of the National Program. Collected analytical material as a basis for work on the National Program for economic energy management and use of renewable and secondary energy sources (SRCI, SEVEn, March Consulting, EkoWatt, June 2001, Report for CEA).

Tab. 5-7 National Program – projected maximal CO_2 emission reduction for 2005 *(kt)*

	Emission reduction by			Total emission reduction in 2000–2005
	Administrative non-investment measures	Technical measures without support	Technical measures with support	
Total CO_2	3 560.1	2 751.6	2 079.9	8 391.6

Source: SRCI CS s.r.o.

Tab. 5-8 National Program of Energy Efficiency and Renewables – projected CO_2 emission reduction *(kt)*

	2005	2010	2015	2020
Measures implemented after 1995 (without transport)	1 939	1 978	1 978	1 978
Total expected effect	8 392	8 392	8 392	8 392
Additional expected effect	6 453	6 414	6 414	6 414

Source: SRCI CS s.r.o.

are described in Tab. 5.7 and the net effect is given in Tab. 5.8. On the basis of the above data, the benefit of additional measures in decreasing emissions is thus estimated according to both scenarios at 6.4 Mt CO_2 annually over the entire projection period.

5.3 Methodology

The methodology used for the Third National Communication is similar to that in the Second National Communication. It comprises a set of the following steps: (i) inventory of greenhouse gases, (ii) selection of initial and final years and cross-sectional years for the projection, (iii) choice of methodology and model instruments for preparing the projection, (iv) collection and analysis of input data for the projection, (v) establishing of the initial assumptions, (vi) definition of scenarios, (vii) calculation of the scenarios and presentation of the results, and (viii) carrying out of sensitivity analysis under selected assumptions. A brief description is given below.

5.3.1 Inventory of greenhouse gases

The inventories of greenhouse gases are prepared by the Czech Hydrometeorological Institute; the latest available inventory is that for 1999. Summary data are given in Chapter 3 and Annex I; total emissions expressed as $CO_{2\ equiv.}$ for 1999 equal 137.7 Mt.

5.3.2 Selection of initial and final years and cross-sectional years for the projection

Choice of the correct year for the projection of emission trends has a great impact on its quality. The initial year is usually selected as the year for which official statistical data are available for activities in the areas of the economy and energy production, along with an emission inventory. In work on the Third National Communication, annual information was available on macro-economic development for 2000, on the energy balance for 1999, a preliminary balance of energy resources and energy consumption for 2000 and an emission inventory for 1999. In relation to the need to use as up-to-date information as possible, the initial year was selected as the year 2000, where the data in the area of energy consumption are preliminary data. The final year for projection of emissions of greenhouse gases was selected as the year 2020 in accord with the Methodology for Preparing National Communications[26]. The cross-sectional years for the projection were selected as the years 2005, 2010 and 2015.

[26] Guidelines for the Preparation of National Communications by Parties Included in Annex I to the Convention (FCCC/CP/1997/7)

5.3.3 Choice of methodological procedures and model instruments for preparing the projection

In preparation of developmental projection of greenhouse gases, in accord with the IPCC methodology for inventories of greenhouse gases[27], the emissions of greenhouse gases were classified as to origin into the following groups: (i) emissions from combustion processes and fugitive emissions, (ii) emissions from industrial processes, (iii) emissions from the use of solvents, (iv) emissions from agricultural production, (v) forest management and (vi) wastes. Projections for CO_2, N_2O and CH_4 emissions were calculated in these groups. In addition, summary projections were carried out of emissions of HFCs, PFCs and SF_6, NO_x, CO, NMVOCs and SO_2. The methodological procedures and model instruments employed are described below.

Emissions from combustion processes and fugitive emissions

The MARKAL linear optimization model of energy economy was employed for projection of emissions of CO_2, CH_4 and N_2O from combustion processes. The combustion of fuel in fuel conversion processes (public and industrial energy production), fuel combustion in final consumption (industrial processes, transport, households, agriculture and the sector of public and commercial services), fuel treatment processes (refineries, post-mining treatment of coal and coking) and removal of SO_2 from combustion products using limestone were included for calculation of projections of **CO_2 emissions**. Calculation of **CH_4 emissions** included coal mining and post-mining treatment; extraction, storage, transit transport and distribution of natural gas, and the mining, storage, transport and refining of petroleum. Calculation of projections of **N_2O emissions** included fuel combustion in stationary and mobile sources. Projections for these sectors were subject to complex calculation on the basis of two scenarios defined in Chapter 5.3.5.

Emissions from industrial processes

Projections of trends in emissions of greenhouse gases from industrial processes were based on a simplified approach using a tabular processor, based on projections of trends in the individual activities for these emissions and processes. The projection concentrated on activities and emissions with a major contribution to emissions of greenhouse gases. Other emissions and activities with a minor contribution were left at the level of the initial year, also in relation to the lack of information on potential future trends in these activities (e.g. the production of nitric acid). Thus, in this part, the projection was carried out only for **CO_2 emissions** from cement production, which correspond to 89.5 % of total CO_2 emissions from industrial processes. Production of glass, which is the second most important source of CO_2 emissions from industrial processes, was expected to remain at the level of the initial year. Production of cement in CR has been constantly decreasing since 1990. In 1993, production equaled 5.4 Mt, while in 1999 this

[27] Revised 1996 IPCC Guidelines, IPCC, 1997

Tab. 5-9 Projected CO_2 emissions from cement production

Year	Cement production		CO_2 emissions	
	High scenario (t/year)	Reference scenario (t/year)	High scenario (kt/year)	Reference scenario (kt/year)
1999	4 241 298	4 241 298	2 114	2 114
2000	4 092 820	4 092 820	2 040	2 040
2005	4 911 384	4 338 389	2 448	2 163
2010	5 402 522	4 858 996	2 693	2 422
2015	5 726 674	5 053 356	2 855	2 519
2020	6 013 007	5 255 490	2 997	2 620

Source: SRCI CS s.r.o.

had decreased to 4.2 Mt; according to preliminary information, production continued to decrease to 4.1 Mt in 2000. Projection of further development is based on the assumption of a more marked recovery of investment construction and cement production in CR after 2005 in the high scenario and after 2010 in the reference scenario (Tab. 5-9). The same emission factor, taken from the IPCC method, i.e. 0.4985 t CO_2/t cement, was employed in the projection.

Emissions from the use of solvents

Emissions of greenhouse gases from solvents form only a negligible part of emissions. Because of the lack of information on possible future trends in this segment, emissions for the individual scenarios were left at the level for the initial year.

Emissions from agricultural production

Projection of emissions of greenhouse gases from agriculture was based on the simplified approach using the EXCEL tabular processor employing projections of trends in the individual activities. Calculation of projections of **CH_4 emissions** took into account the impact of enteric fermentation processes occurring in management of manure, projections of **N_2O emissions** were calculated on the basis of direct emissions from agricultural land and indirect emissions from agricultural activities. Projections of emissions from agricultural production are based on trends in basic indicators, provided by the Ministry of Agriculture, i.e. on expected trends in the number of head of farm animals and trends in the land balance according to the individual kinds. The projection is monovariant and thus the projection of emissions is identical in both emission scenarios. Trends in CH_4 emissions from enteric fermentation and manure management were derived on the basis of trends in the total number of farm animals (Tab. 5-10). On this basis, projection to the year 2020 results in a slight increase in emissions by about 8 % compared to 2000. Trends in N_2O emissions were derived from expected trends in the land balance with the exception of nonagricultural and forest land

Tab. 5-10 Agriculture – projected development of livestock *(thous. pieces)*

	2000	2005	2010	2015	2020
Cattle	1 574	1 700	1 800	1 900	2 000
Pigs	3 688	3 700	3 800	3 850	3 900
Sheep and goats	116	200	220	250	270
Poultry	30 784	31 000	32 000	32 500	33 000

Source: Ministry of Agriculture

Tab. 5-11 Agriculture – projected development of land use *(thous. ha)*

	2000	2005	2010	2015	2020
Agricultural land	4 284.3	4 286	4 285	4 284	4 283
arable land	3 108.5	3 000	2 900	2 800	2 700
hop-field	5.6	6.0	6.5	7.0	8.0
vineyards	12.5	12.5	12.5	12.5	12.5
lmeadows	667.9	670	670	670	670
pasture land	284.3	285	290	300	330
gardens and plantation	200	215	220	220	220
other agriculture land	5.5	97.5	186	274.5	342.5
Non agriculture land	3 601.6	3 602	3 603	3 604	3 605
Forest land	2 633.8	2 637	2 640	2 643	2 646
Water area	158.9	159	159	160	160

Source: Ministry of Agriculture

and water areas (Tab. 5-11). Because of the slight decrease or stagnation in trends in the area of agricultural land, it is also expected that emissions will remain approximately at the level for the initial year.

Forest management

It is assumed in projection of the overall balance (production minus sinks) of **CO_2 emissions** that production from timber harvesting will not increase over the 1999 level. In contrast, there should be a gradual increase in CO_2 sinks in forest management, where the trend of recent years is expected to continue, i.e. with an increase of 1–2 % annually in sinks. Therefore, it is assumed in the reference scenario that the average inter-annual increase in CO_2 sinks or in the overall balance of CO_2 emissions will equal 0.25 % in the reference scenario and 0.5 % in the high scenario in relation to the potential higher volume of available funds for afforestation and forest maintenance. **CH_4 emissions** from burning of wood during felling in forests constitute only a small part of emissions of greenhouse gases in CR. Substantial changes are not expected in these activities and thus these emissions are left at the level for the initial year in the individual scenarios.

Emissions from wastes

Projections of greenhouse gases from industrial processes were carried out using a simplified approach employing a tabular processor, based on projections of trends in the individual activities for these emissions and processes. Calculation of the projection of CO_2 emissions took into account combustion of wastes, calculation of the projection of **CH_4 emissions** included waste landfilling, and collection and treatment of municipal and industrial waste waters, while calculation of the projection of N_2O emissions was based on collection and treatment of municipal and industrial waste waters. Management of solid municipal wastes is one of the most important activities connected with emissions of greenhouse gases. Important sources include combustion of municipal waste (CO_2 emissions)

Tab. 5-12 Municipal waste incineration – projected CO_2 emissions

High scenario	**1999**	**2010**	**2015**	**2020**
Solid municipal waste total (kt)	3 730	5 159	5 430	5 700
Capacity of incinerators needed (kt)	636	1 119	1 741	2 363
Utilization by 1999 (%)	52	52	52	52
Amount of incinerated waste (kt)	329	579	901	1 222
CO_2 emission from incineration (kt)	***357***	***628***	***977***	***1 326***
Reference scenario	**1999**	**2010**	**2015**	**2020**
Solid municipal waste total (kt)	3 730	4 912	5 037	5 162
Capacity of incinerators needed (kt)	636	**873**	**1 349**	**1 824**
Utilization by 1999 (%)	52	52	52	52
Amount of incinerated waste (kt)	329	452	698	944
CO_2 emission from incineration (kt)	***357***	***490***	***757***	***1 024***

Source: preliminary result of EC-Phare Project CZ 9811-02-02 "Implementation/Investment Strategies for EC Waste Directives".

Tab. 5-13 Landfills – projected CH_4 emissions *(kt/year)*

	1999	**2010**	**2015**	**2020**
Landfilled biologically degradable waste	1 115.2	1 046.0	697.0	488.0
CH_4 emission from landfills	81.56	76.50	50.98	35.69

Source: SRCI CS s.r.o.

and its landfilling (CH_4 emissions). The projection of emissions produced by these processes was based on the interim results of the PHARE project[28]. This project was concerned with future trends in waste management and particularly the impact of adopting Directive 99/31/EC on waste landfills, which limits the amount of biodegradable waste that may be landfilled. In the framework of this project, two scenarios were elaborated for possible trends in production and management of municipal waste to the year 2020. The individual scenarios anticipate the need for increased incinerator capacity from the current 636 kt annually to 1824 kt or 2364 kt p.a. Based on the capacity at the 1999 level, a minimum increase in CO_2 emissions from combustion of waste to 1024 kt (reference scenario) or 1326 kt (high scenario) in 2020 can be expected (Tab. 5-12). As all the scenarios assume implementation of Directive 99/31/EC on waste landfills, which limits disposal of biodegradable waste in landfills as a ratio to the amount of waste landfilled in 1995, the scenario of future trends is monovariant. It anticipates a decrease in the amount of this waste deposited by about 56 % by the year 2020 compared to 1999. This should correspond to a decrease in CH_4 emissions to as little as 36 kt (Tab. 5-13).

The last important source of emissions of greenhouse gases from waste management consists in CH_4 emissions from waste water treatment. Projection of these emissions depends on a great many factors, such as trends in the amounts of water treated, consisting of sewage water and industrial water, trends in the capacity of treatment plants, the contributions of various technologies used for processing, etc. In relation to the expected growth in industrial production, extension of the public sewer networks and capacities of waste water treatment plants, these emissions can be expected to gradually increase. On the basis of only a qualified estimate, it is expected that these emissions will increase to the year 2020 by 20 % in the high scenario and 10 % in the reference scenario.

Emissions of HFCs, PFCs and SF_6

Projections of these emissions for the Third National Communication were calculated on the basis of a detailed study[29] that was specially prepared for estimation of expected trends in emissions of industrial fluorinated substances affecting climate change in CR in the years 2000–2015. The study employs a qualified estimate of the interval of potential trends in emissions over the 2000–2015 period. These values were employed as the reference (lower estimate) and high (upper estimate) scenarios to the year 2015. For the period to the year 2020, the values for the individual scenarios were extrapolated on the basis of trends in the 2010–2015 period.

Emissions of CO, NO_x, SO_2 and NMVOCs

For the sake of comprehensive information on potential emission trends, Tab. 5-14 gives framework projections of emissions of indirect greenhouse gases for CR to the year 2020. The projections summarize a number of calculations carried out in recent years. To the year 2010, these projections are similar to the reference scenario and the values by

[28] EC-PHARE project CZ 9811-02-02 Implementation Investment Strategies for EC Waste Directives, SRCI, Prague 2000

[29] Řeháček, Vl., Estimation of expected trends in emissions of industrial fluorinated substances affecting climate change in CR in the years 2005–2015, 2001

Tab. 5-14 Framework projections of other emission pollutants *(kt/year)*

	1999	2010	2020	Emission ceiling for 2010 under CLRTAP
CO	719	583	500–550	-
NO_x	393	255	230–250	286
SO_2	269	213	180–200	283
NMVOC	248	207	150–170	220

Source: Czech Hydrometeorological Institute, SEVEn, SRCI CS s.r.o.

the year 2020 consist in an interval corresponding to the reference and high scenarios. The projections include changes in emission limits in the prepared new Clean Air Act.

5.3.4 Collection and analysis of input data for the projection

The basic sources of input data for preparing the projections of emissions of greenhouse gases consisted in the following documents.

Statistical information:

- Inventory of emissions of greenhouse gases in the Czech Republic in 1999, Czech Hydrometeorological Institute, Prague 2000,
- Energy Balance of CR in 1997, 1998 and 1999, Czech Statistical Office, Prague 2001,
- Balance of Energy Processes in Energy Sector (for fuels upgrading) in 1999, Czech Statistical Office, Prague 2001,
- Quarterly National Accounts of CR in the 4th Quarter of 2000, Czech Statistical Office, Prague 2001,
- Preliminary Energy Balance based on the documents of the Ministry of Industry and Trade of CR and the Czech Statistical Office, SRC International CS, Prague 2001,
- Individual documents from the Ministry of Industry and Trade of CR and the Czech Statistical Office.

Forecasts information:

- Annual Energy Outlook 2001 with Projections to 2020, Energy Information Administration/ US DOE 2000,
- European Union Energy Outlook to 2020, European Commission, Brussels, 1999,
- Predictions of Trends in the Basic Indicators for CR to the year 2002 with an outlook to the year 2004, Ministry of Finance of CR, Prague 2001,
- Strategy of Strengthening Growth of the National Economy, Ministry of Industry and Trade of CR, Prague 2001,
- Documents from the Ministry of Agriculture and the Ministry of Transport and Communications of CR.

Databases of input data for forecasts was prepared using these sources.

5.3.5 Establishing the initial assumptions

Following an increase in external imbalance in 1995 and 1996 and after adopting financial measures in the form of government "packages" in April and May of 1997, the gross domestic product (in constant 1995 prices) decreased by 1 % in 1997 and 2.2 % in 1998. During 1999, the real GDP continued to decrease on an interannual basis by 3.7 % in the 1st quarter and 0.8 % in the 2nd quarter. There was a slight interannual increase in the GDP in the 3rd quarter (+0.4 %) and an interannual increase of approx. 1 % in the 4th quarter. Thus, the real GDP decreased overall interannually by 0.8 % for all of 1999 (on the basis of the latest corrected data of CSO). Following a decrease for three

Tab. 5-15 GDP development for 1990–2000 (in 1995 constant prices)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
GDP in purchase prices (bill. CZK)	1449.4	1281.1	1274.5	1275.3	1303.6	1381.1	1447.7	1432.8	1401.3	1390.6	1433.8
Inter-annual change (%)	-	-11.6	-0.5	0.1	2.2	5.9	4.8	-1.0	-2.2	-0.8	3.1
GDP basic prices (bill. CZK)	1303.1	1180.7	1183.7	1197.9	1227.4	1290.6	1357.5	1345.6	1315.2	1309.1	1355.1
Inter-annual change (%)	-	-9.4	0.3	1.2	2.5	5.1	5.2	-0.9	-2.3	-0.5	3.5

Source: Czech Statistical Office

years, caused mainly by domestic factors, a change occurred in 2000. In the 4th quarter of 2000, there was a real interannual increase in GDP by 3.9 % (compared to the 3rd quarter – after elimination of the seasonal effect – by 1.3 %); thus, it was confirmed that the economy is in a phase of growth. The interannual growth in GDP in the 4th quarter (in constant prices) by 13.6 bil. CZK was affected by the increase in demand for gross capital by 18.1 bil. CZK, decrease in expenditures for final consumption by 1.0 bil. CZK and a worsening in the foreign trade balance in goods and services by 3.5 mld. CZK. In summary for the 1st to 4th quarters, GDP increased by 3.1 % compared to 1999 and increased on an interannual basis in all four quarters. Trends in industry (+6.9 %) had a decisive impact in creation of GDP in basic prices (increase by 3.5 %). The industrial gross added value increased constantly interannually in the individual quarters (by 5.8 %, 6.2 %, 7.4 % and 8.3 %, resp.). The branch of trade and commercial services also exhibited an above-average rate, while a decrease was recorded in agriculture (as a consequence of the drought) and in the construction industry, which can be considered a negative factor (Tab. 5-15).

Scenarios of demographic and macro-economic development to the year 2020

The last available projection of development of the economy published by the Ministry of Finance of CR[30] in April 2000 anticipated an increased rate of growth of GDP in the years 2001 to 2004 of 3.5 % to 4.0 % annually. However, the Czech National Bank is less optimistic for the year 2001 and gives a prediction of 2.3–3.3 %. Following a decrease for three years, caused mainly by domestic factors, predictions of the Ministry of Finance and international institutions anticipate a recovery and growth in the coming period in dependence on the rate of restructuring of the economy, input of direct foreign investments and innovative activities. At the present time in the Czech Republic, there is no long-term official projection for trends in the economy. In order to evaluate potential trends in emissions of greenhouse gases over the long term to the year 2020 for use in preparing the Third National Communication, two macro-economic scenarios were formulated – the reference and high scenarios. Both scenarios are described by a set of selected indicators, forming the basic assumptions for creation of the scenarios, i.e. demographic trends, economic growth and a change in the structure of the economy.

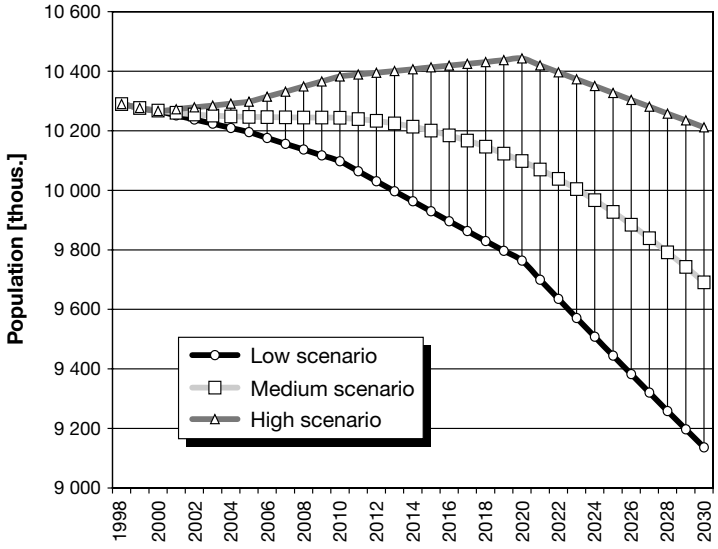
Demographic trends

In 1999, the Czech Statistical Office published a long-term demographic projection for CR[31]. This projection gives three variants of trends in the number of inhabitants to the year 2030 – the low, medium and high variants. All the variants take into account the effect of the

[30] Prediction of trends in the basic macro-economic indicators for the Czech Republic for 2001 with an outlook to 2004, MF CR, Prague 2001

[31] Projection of the population of the Czech Republic to the year 2030, Publication 0433-99, Czech Statistical Office, Prague 1999

Fig. 5-4 Demographic development until 2030 in three scenarios



Source: Population projection for Czech Republic till 2030, Prague 1999, publication 0433-99 (in Czech only)

natural growth in the population and also the effect of migration increments (Fig. 5-4). The joint medium variant was chosen for creation of the macro-economic scenario to the year 2020. This variant can be characterized as stagnation in the number of inhabitants in the 2000–2015 period and a slight decrease to 2020.

Economic growth

The **reference scenario** for trends in the economy of the Czech Republic is constructed as a prolonging of the long-term trends in the Czech economy, which can be observed for the last about 80 years. On the basis of analysis of long-term trends, it can be expected that there will be a long-term average interannual growth in GDP of about 3% (Tab. 5-16). This trend would mean no or only very slow approximation to the developed countries of the world, as most of these countries expect an annual growth in the GDP of 2-3%.

In the **high scenario**, the Strategy of strengthening the growth in the national economy prepared by the Ministry of Industry and Trade of CR (Strategy)[32] anticipates that, with substantial support for the economy on the part of the state, there would be a gradual starting up of rapid economic growth, at the level of 4–6.6 % annually. Tab. 5-17 gives the high scenario for trends in GDP to the year 2020, with implementation of the above Strategy. This scenario anticipates a gradual increase in the rate of increase of GDP from 3.1 % (in purchase prices) or 3.5 % (in basic prices) in 2000 to 4.1 % in 2001, and up to 6.4 % in 2003. CR is expected to gain full membership in EU in 2004 and it is expected that the high rate of growth of GDP will continue or possibly increase slightly to up to 6.6 % annually in 2004 and 2005. The scenarios of development in GDP with implementation of the Strategy are based on the fact that the Czech economy cannot avoid certain cyclic trends and thus, after attaining a fairly high rate of growth of GDP over 5 years, it is expected that this rate of growth will decrease for several years and stabilize at about 5–6 % annually. The high scenario is based on the fact of starting up of significant recovery of the economy in 2000, on the existence of a number of adopted strategic and conceptual national economy documents, acting on intensification of the economy, and on the government strategy to accelerate legislative steps to prepare CR for accession to EU, and finally on the assumption of full membership of CR in EU after 2004.

[32] Strategy of strengthening the growth in the national economy, Ministry of Industry and Trade of CR, Prague 2001

Tab. 5-16 GDP projections (in 1995 constant prices) by 2020 – Reference scenario

	2000	2001	2002	2003	2004	2005	
GDP in basic prices (bill. CZK)	1 355.1	1 395.8	1 437.6	1 480.8	1 525.2	1 570.9	
Annual increase (%)	3.5	3.0	3.0	3.0	3.0	3.0	
	2006	**2007**	**2008**	**2009**	**2010**	**2015**	**2020**
GDP in basic prices (bill. CZK)	1 618.1	1 666.6	1 716.6	1 768.1	1 821.1	1 875.8	1 932.0
Annual increase (%)	3.0	3.0	3.0	3.0	3.0	3.0	3.0

Source: SRCI CS s.r.o.

Tab. 5-17 GDP projections (in 1995 constant prices) by 2020 – High scenario

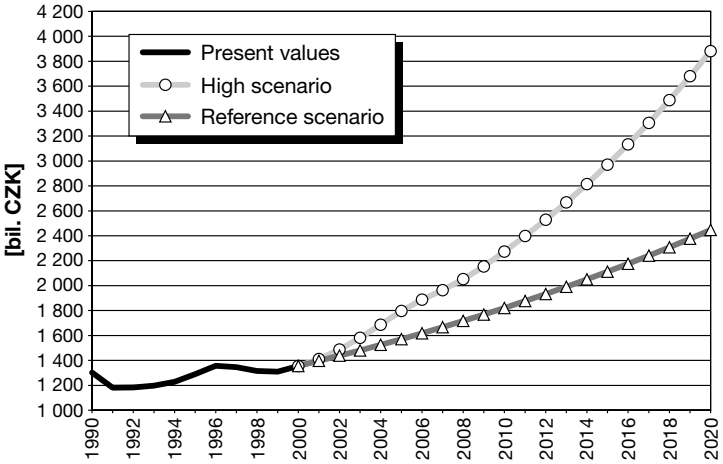
	2000	2001	2002	2003	2004	2005	
GDP in basic prices (bill. CZK)	1 355.1	1 410.7	1 486.8	1 582.0	1 686.4	1 797.7	
Annual increase (%)	3.5	4.1	5.4	6.4	6.6	6.6	
	2006	**2007**	**2008**	**2009**	**2010**	**2015**	**2020**
GDP in basic prices (bill. CZK)	1 887.6	1 963.1	2 051.4	2 154.0	2 272.5	2 970.04	3 881.72
Annual increase (%)	5.0	4.0	4.5	5.0	5.5	5.5	5.5

Source: SRCI CS s.r.o.

Comparison of trends in GDP for the reference and high scenarios

The high scenario represents an inter-annual increase in growth of GDP by 1–2.5 % greater than in the reference scenario (Fig. 5-5).

Fig. 5-5 Projection of GDP development (in 1995 constant prices) until 2020



Source: SRCI CS s.r.o.

Trends in the branch structure of creation of GDP

The branch structure of GDP in constant prices (1995) for 1999 and 2000 was taken from the publication of the Czech Statistical Office[33]. The gross domestic product for the individual branches is available in basic prices, both current and constant (1995) prices, corresponding to the method employed in EU. In contrast to GDP in purchase prices, GDP in basic prices includes FISIM (*Financial Intermediary Services Indirectly Measured)* but does not, however, include the item "taxes minus subsidies". Projections for the 2001–2020 period are based on the fact that the rate of growth of GDP in basic and purchase constant 1995 prices will be identical, i.e. the same relative ratio is retained between GDP in basic prices and GDP in purchase prices. In 2000, this ratio equaled 94.5 %. In other words, the contribution of the item "taxes minus subsidies minus FISIM" in GDP in constant purchase prices equaled 5.5 % in 2000.

The **reference scenario** for trends in the branch structure of GDP for the 2000–2020 period is based on the assumption that the reference structure of the Czech economy will approach the branch structure in the advanced countries (Tab. 5-18). This means that the contribution of the tertiary sphere will increase (i.e. transport, communications and other services), along with the construction industry and, on the other hand, the primary and secondary spheres will decrease (i.e. agriculture and industry). The contribution of agriculture in this scenario will decrease from 4.7 % in 2000 to 3.0 % in 2020 and the contribution of industry will decrease from 37.7 % to 26 %. In contrast, the contribution of the construction industry will increase from 4.2 % to 6.8 %, the contribution of transport and communications will increase from 10.1 % to 11.7 %, and the contribution of other branches will increase from 43.2 % to 52.5 %. The contribution of

[33] Quarterly national accounts of CR in the 4th quarter of 2000, Czech Statistical Office, Prague 2001

Tab. 5-18 Sectoral structure of GDP projections (at basic prices) – Reference scenario *(%)*

	1999	2000	2005	2010	2015	2020
Agriculture	5.3	4.7	4.4	3.9	3.4	3.0
Industry	36.5	37.7	35.0	32.0	29.0	26.0
Construction	4.6	4.2	5.0	5.9	6.3	6.8
Transport	10.1	10.1	11.0	11.5	11.6	11.7
Other	43.4	43.2	44.6	46.7	49.7	52.5
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Czech Statistical Office, SRCI CS s.r.o.

the sector of services (i.e. transport and communications plus "other" branches) would thus increase from 53.3 % to 62.4 %. The rate of growth of the real GDP would then correspond to the described structural changes according to the individual branches and absolute volume of GDP (in constant 1995 prices).

Implementation of the strategy in the **high scenario** is based primarily on a growth in GDP, which would be generated especially by growth in industry. This scenario thus assumes that particularly the contribution of industry to GDP will not decrease as was assumed in the reference scenario, which anticipates that the structure of the Czech economy will approach the EU average (Tab. 5-19). It is assumed in the high scenario that the contribution of industry will remain at the 2000 level of 37.7 %. In accord with trends in the EU countries, the contribution of agriculture should decrease slightly. Although the contribution of the construction industry decreased in 2000 compared to 1999, we assume that it will increase gradually as this is a necessary condition for successful implementation of the strategy and the anticipated intensive investment activities and input of direct foreign investments. This also reflects the trends in the construction industry in 2001, with relatively high inter-annual growth. This is also true of the contribution of transport, which should increase slightly. The contributions of the other branches (trade and commercial services), in contrast, would correspond in the same scenario to a slight decrease in the contribution to overall creation of GDP, which is opposite to trends in the EU countries.

Trends in electric and overall energy intensity of GDP production

There continues to be a strong dependence between GDP and consumption of electricity, especially when trends in these two indicators are compared. The two indicators can be compared in various forms (brutto or netto) for both GDP and consumption of electricity. Trends in electric intensity calculated from brutto indicators exhibit a surprising slight growth over the entire period (see the first line in Tab. 5-20). In contrast, intensity following from the brutto consumption of electricity and GDP in basic prices (netto) remains practically constant in spite of fluctuations in individual years, i.e. consumption of electricity would exactly copy trends in GDP. However, from a methodical standpoint, it is necessary to compare netto indicators, both for consumption of electricity and for GDP. The intensity following from these indicators (see line two of Tab. 5-20) exhibits a slightly decreasing trend with

Tab. 5-19 Sectoral structure of GDP projections (at basic prices) – High scenario *(%)*

	1999	2000	2005	2010	2015	2020
Agriculture	5.3	4.7	4.4	3.9	3.4	3.0
Industry	36.5	37.7	37.7	37.7	37.7	37.7
Construction	4.6	4.2	5.2	5.9	6.0	6.0
Transport	10.1	10.1	11.0	11.5	11.6	11.7
Other	43.4	43.2	41.7	41.0	41.3	41.6
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Czech Statistical Office, SRCI CS s.r.o.

Tab. 5-20 Average annual development of electric intensity of GDP production in 1990–2000 *(%)*

	1990–2000	1990–1995	1995–2000
Gross electricity consumption/GDP in purchase prices	+0.36	+0.77	-0.04
Nnet electricity consumption/GDP at basic prices	-0.53	-0.14	-0.92
Gross electricity consumption/GDP at basic prices	-0.14	0.00	-0.27

Source: Czech Statistical Office, SRCI CS s.r.o.

Tab. 5-21 Development of the overall energy intensity of GDP production

	1990	1995	1996	1997	1998	1999	2000[a)]
GDP in purchase prices (bill. CZK 1995 constant prices)	1 449.4	1 381.1	1 447.7	1 432.8	1 401.3	1 390.6	1 433.8
TPES (PJ)	2 076	1 749	1 823	1 745	1 659	1 621	1 636
Energy intensity (MJ/thous. CZK)	1 432	1 266	1 259	1 218	1 184	1 166	1 141
Inter-annual change (%)		-2.43	-0.56	-3.28	-2.79	-1.52	-2.14
Year 1990 = 100 %	100	88	88	85	83	81	80
Year 1995 = 100 %	113	100	99	96	93	92	90

a) preliminary data *Source: Czech Statistical Office, SRCI CS s.r.o.*

gradual acceleration in CR in 1999–2000. An average decrease of about 0.14 % annually is apparent for 1990–1995, while the rate of decrease increased to 0.92 % annually in 1995–2000. Thus, the electric intensity of GDP production for the entire ten-year period exhibited an average annual rate of decrease of 0.53%.

An important aspect for assessing the reality of the expected trends in Total Primary Energy Supply (TPES) consists in comparison with the GDP and assessment of trends in the overall energy intensity of GDP production. TPES gradually decreased in the nineties, both through the effect of a decrease in economic activity and also through the effect of the transition from solid fuels to cleaner kinds of fuels with greater efficiency of conversion. A slight increase is expected in 2000, which should be significantly affected by growth of the active foreign trade balance in electricity in 2000, which increases the overall energy intensity of GDP. Nonetheless, the overall energy intensity is expected to continue to decrease in 2000 (Tab. 5-21). From the long-term standpoint, the average decrease in the energy intensity of GDP production varies around 2.25 % p.a.

Projection of trends in 2000–2020

The **reference scenario** of trends in the economy of CR is constructed as a continuation of trends in overall energy intensity that have been observed over the last decade. On the basis of these trends, a long-term average decrease in overall energy intensity of about 2.5 % p.a. can be expected (the resultant average annual decrease is 2.8 % for the 2000–2020 period). This trend would mean no or only very slow approach to the developed countries of the world, because most of these countries anticipate an annual rate of decreasing overall energy intensity of GDP of 2–3 %.

The **high scenario** anticipates dynamic economic development with a high rate of increase of GDP, based primarily on an increase

Tab. 5-22 Expected development of electric intensity of GDP production *(at basic prices)*

	1999	2000	2005	2010	2015	2020
Total electric intensity of GDP (kWh/thous. CZK)						
High scenario	38.8	38.6	34.9	28.7	22.8	18.1
Reference scenario	38.8	38.6	36.3	32.6	30.1	27.0
% of average interannual change						
High scenario		-0.7	-2.0	-3.8	-4.5	-4.5
Reference scenario		-0.7	-1.2	-2.2	-1.6	-2.2
Year 2000 = 100 %						
High scenario		100.0	90.4	74.5	59.1	47.0
Reference scenario		100.0	94.1	84.4	78.0	70.0

Source: SRCI CS s.r.o.

Tab. 5-23 Overall energy intensity of GDP production *(at basic prices)*

	1999	2000	2005	2010	2015	2020
Overall energy intensity of GDP (kWh/thous. CZK)						
High scenario	1 238.3	1 207.3	1 016.0	825.5	664.9	524.9
Reference scenario	1 238.3	1 207.3	1 054.5	926.7	793.0	678.8
% of average interannual decrease						
High scenario		-2.5	-3.4	-4.1	-4.2	-4.6
Reference scenario		-2.5	-2.7	-2.6	-3.1	-3.1
Year 2000 = 100 %						
High scenario		100.0	84.2	68.4	55.1	43.5
Reference scenario		100.0	87.3	76.8	65.7	56.2

Source: SRCI CS s.r.o.

in added value in industry, however based on modern new and progressive technology. This will lead to a faster decrease in the overall energy intensity of GDP than in the reference scenario. On the basis of these assumptions, a long-term average decrease in overall energy intensity of about 4 % p.a. can be expected (the resultant average annual decrease is 4.1 % for the 2000–2020 period). This trend would mean a gradual approach to the developed countries of the world. Trends in electric and overall energy intensity of GDP formation for CR for both scenarios are given in Tab. 5-22 and Tab. 5-23).

Trends in global prices of fuel and energy

The crude oil market underwent a great change in 1999, when there was a price increase from an average monthly value of US$ 19 per barrel (in current prices) in December of 1998 to US$ 25 per barrel in January 2000 and more than US$ 30 per barrel in the middle of 2000. Following this oil shock, caused by an agreement amongst the OPEC countries and supported by other important crude oil producers, the price of crude oil was about US$ 25–30 per barrel with brief fluctuations around this level. It seems that maintenance of the price of oil around a value of US$ 25 per barrel according to the OPEC agreement is not very successful. Projections of trends in global prices of fuel are mostly based on projections of the price of crude oil prepared by various analysts. A number of forecasts are published annually. The Third National Communication was based on projections published by the US Department of Energy and processed by the *Energy Information Administration of the US Department of Energy*[34], specifically the reference and high scenarios. The reference scenario is based on the assumption of a decrease in global crude oil prices by 2020 to a level slightly in excess of US$ 20 per barrel in constant prices for 1999 (i.e. more than US$ 36 in current prices for 2020), while the high scenario is based on the assumption of an average price of about US$ 27 per barrel

[34] Annual Energy Outlook 2001 with Projections to 2020, US Department of Energy, Energy Information Administration, 2000

Tab. 5-24 Projection of world crude oil price

	1990	1995	2000	2005	2010	2015	2020	2005	2010	2015	2020
	Statistics			High scenario				Reference scenario			
Price (USD/barrel)	24.18	17.10	27.59	26.04	26.66	28.23	28.42	20.83	21.37	21.89	22.41
Price (CZK/GJ)	117	83	126								
Average interannual change (%)	-	-6.7	8.8	-1.1	0.5	1.2	0.1	-5.5	0.5	2.4	0.5

Source: SRCI CS s.r.o.

(US$ 46 in 2020). It is apparent for both scenarios that, in spite of the expected substantial increase in consumption of crude oil and oil products, the average prices of crude oil will either decrease slightly compared to the current price level (reference scenario) or will not increase above the current level (high scenario), although brief fluctuations may be possible, as indicated in trends in the last few years. This optimism is based on the assumption that the high prices of oil will stimulate a growth in sources, maintaining the price at an acceptable level that would not lead to a radical decrease in consumption through savings and alternative energy sources (Tab. 5-24).

A projection of trends in these fuels was prepared using the relations between the prices of crude oil and natural gas and coal, published by the EU Commission[35]. It is anticipated that the prices of natural gas will remain bound to the prices of oil; however, because an increase in the capacity of sources of gas is becoming rather expensive and demand is increasing quite rapidly with the general transition from coal to natural gas in a number of countries of Europe, it is expected that the prices of gas will increase slightly faster than for crude oil, leading to a gradual decrease in the difference between the prices of oil and natural gas.

It is expected that the prices of coal will remain relatively independent of the prices of crude oil and will be related to the costs of mining and transport. Thus, only a slight increase in global prices is expected, as supply will exceed demand and a number of new mines with cheap coal will be opened in the future in several coal-producing countries (Columbia, Australia, Indonesia, South America and Venezuela). Coal will remain the cheapest fuel and the price difference between coal and the chief competing fuel (natural gas) will increase. Coal will thus become a competitive fuel, unless its use is limited (e.g. through stricter emission limits, a carbon tax, etc.).

[35] European Union Energy Outlook to 2020, Special Issue – November 1999, European Commission, Directorate-General for Energy.

Trends in domestic prices of fuel and energy

The prices of energy in CR will reflect global prices, but will also be affected by internal factors. The first step in the area of fuel and energy in the Czech Republic will consist in termination of the system of officially set prices of electricity and natural gas, liberalization of the market in electricity and natural gas and regulation of this market by an independent Energy Regulatory Office. Transition to standard European conditions in the market in energy can be expected around the year 2005 and is connected with the accession of CR to EU. The following joint assumptions have been adopted for the basic scenarios of trends in the prices of fuel and energy:

- the current level of excise duties on fuel will be retained to the year 2020 with the exception of excise duties on motor fuels, for which excise duties will increase to the average value in the EU countries,
- a uniform VAT level will be introduced for all energy carriers (i.e. 22 %); i.e. the currently employed reduced rate for district heating (5 %) will be increased to the basic rate by 2005 and will then not change,
- an energy/environmental/carbon tax will not be introduced and the current level of payments for air pollution will be retained,
- the prices of electricity and natural gas for the population will be gradually administratively increased by the end of 2002 so that they cover economic costs, and further development will correspond to the trends in prices on the energy market,
- the prices of electricity and natural gas for industry and other consumers will be derived from trends in prices on the market in connection with opening of the market,
- the prices of electricity, natural gas and district heat as network forms of energy will continue to be subject to supervision by a regulator,
- the prices of solid and liquid fuels are and will be market prices without supervision by a regulator,

- the prices of fuel and energy for the end consumer do not include VAT, with the exception of households and public services.

Domestic Primary Energy Sources

CR has its own sources of fuel, in which coal predominates. Tab. 5-25 gives a survey of stocks of energy resources. Information on domestic fuel resources is employed in the formulation of the long-term strategy.

Coal remains the main domestic source of energy for the entire projection period. It is assumed that the present territorial limits on mining will be retained, leading to a limitation in the cumulative amount of coal, but not leading to a limitation in the availability of its sources, as a marked decrease in the demand for coal in final consumption will ensure adequate sources of coal for conversion processes (production of electricity and district heat in public and industrial plants). In relation to the increase in the costs of coal mining, there will also be an increase in the price for the consumer; nonetheless, domestic coal will continue to be a competitive source of energy for large district heat and power plants. If there were a marked decrease in domestic mining, a significant increase in price or environmental limitation on mining or the use of domestic coal, domestic sources could be replaced either by imports (Poland, across the sea) or conversion to some other fuel (natural gas, renewable energy sources) and partly also through energy savings. The future use of coal is also bound to the introduction of new technologies of clean use of coal in connection with environmental requirements. The limited sources of *crude oil and gas* do not permit an increase in extraction and thus mining will remain at the present level. CR has most kinds of *renewable energy sources* within its territory with the exception of those connected to the sea. Tab. 5-25 gives the potential for the use of renewable energy sources from the standpoint of their annual use. At the present time, renewable sources contribute about 1.7 % to TPES. The future use of these sources will depend both on trends in the prices of competitive energy sources and primarily on state policy in the area of support for these sources.

Import and export of energy sources

The entire domestic consumption of liquid and gaseous fuels is covered by imports and a limited volume of coal and electricity are also imported. On the other hand, brown coal, hard coal, coke and electricity are exported. CR is also an important transit country for natural gas. About 20 % (net) of fuel and energy is imported. Limitations on imported amounts are currently applied only to hard coal. No other limitations are placed on the amounts of other energy sources imported. The State Energy Policy (January 2000), requires that the sources of imports of natural gas be diversified, in the form of 2/3 from Russia and 1/3 from other areas. There are no limitations on exports of energy sources. The capacity of transport routes could limit future import and export; however, these seem adequate with the exception of natural gas, for which the transport capacity is currently being increased.

Production of electricity and district heat

The production of electricity and district heat in public and industrial plants is the main source of emissions of greenhouse

Tab. 5-25 National energy resources (1999)

	Total	Fossil fuels and mineral resources					Renewable energy resources					
		Brown coal	Hard coal	Natural gas	Crude oil	Uranium	Biomass	Solar	Municipal waste	Wind	Hydro	Geothermal
PJ	**34 749**	21 842	11 254	126	29	1 385	62	12	4	4	11	7
%	**100.0**	62.8	32.4	0.4	0.1	4.0	-	-	-	-	-	-

Source: SRCI CS s.r.o.

Tab. 5-26 Summary of key variables and assumptions in the projections analysis

	Statistics			Projection			
	1990	1995	2000	2005	2010	2015	2020
Inter-annual change of GDP (%)							
High scenario	-	-0.2	1.0	5.8	4.8	5.5	5.5
Reference scenario				3.0	3.0	3.0	3.0
World prices of crude oil (US$/barrel)							
High scenario	24.18	17.10	27.59	26.04	26.66	28.23	28.42
Reference scenario				20.83	21.37	21.89	22.41
Population (mil. persons)							
Both scenarios			10.268	10.247	10.244	10.200	10.098
Net export of electric power (TWh)							
Both scenarios			10.016	5.0	5.0	5.0	5.0

Source: SRCI CS s.r.o.

gases in the Czech Republic and thus any changes in the structure of production capacities and the fuels employed would significantly affect these emissions. This sector was analyzed in detail for future trends, including consideration of the following decisive factors:

- the Dukovany NPP will be operated at full capacity to 2020 after reconstruction and prolonging of its lifetime,
- the Temelín NPP will be brought in operation in 2001 (first block) and 2002 (second block) and will be operated over the entire period to 2020,
- no other nuclear power plant will be brought into operation to 2020,
- the existing large coal-burning power plants will be operated until their sulfur-removal equipment reaches the end of its lifetime; then they will be replaced by new sources, for which the technology and fuel base will depend on the economic competitiveness and on accord with the environmental protection requirements.

Because of the uncertain future of foreign trade in electricity, it is expected that there will be a decrease in net exports from the current approx. 10 TWh to 5 TWh by 2005. Net exports of 5 TWh are considered as a fixed quantity for the projection to the year 2020. Recently, a number of large, medium-sized and small sources with combined production of electricity and heat have been brought into operation. Further construction of these sources will depend on their competitiveness on the market in electricity and heat and on support from the state. The role of renewable energy sources in the production of electricity and district heat remains very low and can be expected to increase, especially for small sources. Actual trends will depend on their competitiveness on the market in electricity and heat and on support from the state. Tab. 5-26 gives a summary of key variables and preconditions for preparing projections of trends in emissions of greenhouse gases by 2020.

5.3.6 Definition of projections

In accord with the methodical guidelines for preparing projections (UN FCCC/CP/1997), projections were prepared without measures, with measures and with additional measures. All the projections were prepared for both the reference and the high scenario.

Projection without measures is a projection that does not include measures that came into effect after 1995 incl. (measures referred to in Chap. 4.3 as implemented). This projection is established on the basis of the calculated projection with measures, which is increased by the benefit of measures implemented after 1995.

Projection with measures includes measures that came into effect after 1995, including measures approved in 2000 (measures referred

to in Chap. 4.3 as being implemented). This projection is calculated using the MARKAL model and a tabular processor.

Projection with additional measures includes the expected effects of additional measures that are currently being prepared and are expected to be approved in the coming years, and also measures planned in connection with harmonization with EU regulations (measures identified in Chap. 4 as being prepared, e.g. introduction of the IPPC Directive). This projection is derived from the projection with measures, decreased by the expected effect of these additional measures.

5.3.7 Calculation of the projections and presentation of the results

Calculation of the projection of the emissions of greenhouse gases was carried out using the above methodology and model instruments. The results of the calculations according to the individual scenarios and greenhouse gases are given in Tab. 5-27 and 5-28 and comparison is given in Tab. 5-29. Detail results for the individual gases and scenarios are given in Annex II.

Tab. 5-27 Projection of GHG emissions – High scenario with measures

	1999 inventory	2000	2005	2010	2015	2020
Total emissions (kt) including international bunkers						
CO_2	**118 231**	122 178	121 628	122 350	127 886	127 742
CH_4	**516.758**	521.977	521.563	488.574	449.849	415.523
N_2O	**26.181**	26.304	26.354	26.332	26.428	26.399
Total emissions (kt CO_2 eq.) including international bunkers						
CO_2	**118 231**	122 178	121 628	122 350	127 886	127 742
CH_4	**10 852**	10 962	10 953	10 260	9 447	8 726
N_2O	**8 116**	8 154	8 170	8 163	8 193	8 184
HFCs, PFCs, SF_6	**525**	544	734	883	1 041	1 223
Total	**137 724**	**141 837**	**141 484**	**141 656**	**146 567**	**145 875**

Source: SRCI CS s.r.o.

Tab.5-28 Projection of GHG emissions – Reference scenario with measures

	1999 inventory	2000	2005	2010	2015	2020
Total emissions (kt) including international bunkers						
CO_2	**118 231**	122 178	107 124	109 613	106 326	103 949
CH_4	**516.758**	521.977	505.521	469.531	410.267	391.008
N_2O	**26.181**	26.304	25.803	25.873	25.696	25.670
Total emissions (kt CO_2 eq.) including international bunkers						
CO_2	**118 231**	122 178	107 124	109 613	106 326	103 949
CH_4	**10 852**	10 962	10 616	9 860	8 616	8 211
N_2O	**8 116**	8 154	7 999	8 021	7 966	7 958
HFCs, PFCs, SF_6	**525**	544	672	793	896	1 065
Total	**137 724**	**141 837**	**126 411**	**128 287**	**123 803**	**121 183**

Source: SRCI CS s.r.o.

Tab. 5-29 Comparison of GHG emission projections for reference and high scenarios with measures

	1990	1995	2000	2005	2010	2015	2020
Reference scenario with measures (kt CO_2 eq.)	187 544	142 713	141 837	126 411	128 287	123 803	121 183
High scenario with measures (kt CO_2 eq.)				141 484	141 656	146 567	145 875
Difference between high and reference scenarios with measures (kt CO_2 eq.)	-	-	-	15 073	13 369	22 763	24 692
Difference between high and reference scenarios with measures (%)	-	-	-	11.9	10.4	18.4	20.4

Source: SRCI CS s.r.o.

5.4 Sensitivity Analysis

5.4.1 Sensitivity analysis on trends in GDP

Because of the great uncertainty in future economic development in CR, sensitivity analysis was carried out on trends in GDP. The sensitivity of future trends in emissions of greenhouse gases on trends in GDP was analyzed using two scenarios for trends in GDP, the high scenario and the reference scenario. Comparison of the two scenarios indicates that there are significant differences between the two scenarios in the total value of emissions of greenhouse gases, as greater economic growth means higher emissions of greenhouse gases. In the high scenario, emissions are 13 Mt (10 %) higher in 2010 and 25 Mt (20 %) higher in 2020 compared to the reference scenario. However, there is no direct proportionality between the rate of economic growth and the rate of increase in emissions, as in 2020 GDP is about 60 % higher in the high scenario than in the reference scenario, while emissions are only 20 % higher. This is because of the faster rate of decrease in the overall energy intensity in the high scenario than in the reference scenario (4.1 % compared to 2.8 % in 2000–2020).

5.4.2 Sensitivity analysis on implementation of measures

In the Czech Republic, a number of legislative instruments and measures have been adopted to decrease energy consumption and for greater use of renewable energy sources,

Tab. 5-30 Comparison of GHG emission projections for the three reference scenario projections

	1990	1995	2000	2005	2010	2015	2020
With measures (kt CO_2 eq.)	187 544	142 713	141 837	126 411	128 287	123 803	121 183
Without measures (kt CO_2 eq.)			149 835	135 325	138 420	135 530	133 086
With additional measures (kt CO_2 eq.)			141 837	119 958	121 873	117 389	114 769
Difference between "with and without measures" (kt CO_2 eq.)	-	-	7 998	8 914	10 133	11 727	11 903
Difference between "with and without measures" (%)	-	-	5.6	7.1	7.9	9.5	9.8
Difference between "with additional and without measures" (kt CO_2 eq.)	-	-	7 998	15 367	16 547	18 141	18 317
Difference from with additional and without measures (%)	-	-	5.6	12.8	13.6	15.5	16.0

Source: SRCI CS s.r.o.

which are intended, amongst other purposes, to decrease emissions of greenhouse gases. These are discussed in greater detail in Chap. 4. Implemented measures lead to a real decrease in emissions of greenhouse gases by 8–13 Mt (i.e. 6–10 %) in the individual scenarios. Future trends in emissions will be significantly affected by the success of both existing measures and additional measures. The overall effect of implemented and prepared measures could attain a level of up to 20 Mt reduction of emissions of direct greenhouse gases annually to 2020 compared to the projection without measures, i.e. a decrease of 14–16 %. Tab. 5-30 and Tab. 5-31 give a comparison of the results of the individual scenarios.

Tab. 5-31 Comparison of GHG emission projections for the three high scenario projections

	1990	1995	2000	2005	2010	2015	2020
With measures (kt CO_2 eq.)	187 544	142 713	141 837	141 484	141 656	146 567	145 875
Without measures (kt CO_2 eq.)			149 835	151 081	152 644	159 428	159 200
With additional measures (kt CO_2 eq.)			141 837	135 031	135 242	140 153	139 461
Difference between "with and without measures" (kt CO_2 eq.)	-	-	7 998	9 597	10 988	12 862	13 325
Difference between "with and without measures" (%)	-	-	5.6	6.8	7.8	8.8	9.1
Difference between "with additional and without measures" (kt CO_2 eq.)	-	-	7 998	16 050	17 402	19 276	19 739
Difference from with additional and without measures (%)	-	-	5.6	11.9	12.9	13.8	14.2

Source: SRCI CS s.r.o.

6. ESTIMATES OF VULNERABILITY, IMPACTS AND ADAPTATION MEASURES

This chapter provides information on the expected impacts of climate change in the Czech Republic and gives a survey of activities carried out in implementing Article 4.1 of the UN FCCC, with emphasis on adaptation. The work was based on the IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations[36] and on the UNEP Handbook of Methods for Climate Change Impact Assessment and Adaptation Strategies[37]. The analyses carried out so far concentrated on the sector of water resources, agriculture and forest management.

The impact of climate change was estimated using the model of impact projections based on biophysical empirical-statistical and process models and, in some cases, also economic models. In addition, empirical analogous studies and expert estimates were also used. Attempts to employ integrated (intersectoral) models have not been successful so far, although integration of impact estimates in all the analyzed sectors was provided by creating and using uniform regional climate scenarios. Water and forest management also utilized GIS. Validation and sensitivity analysis were carried out for the models. The climate conditions in CR in the 1961–1990 period were employed as starting conditions.

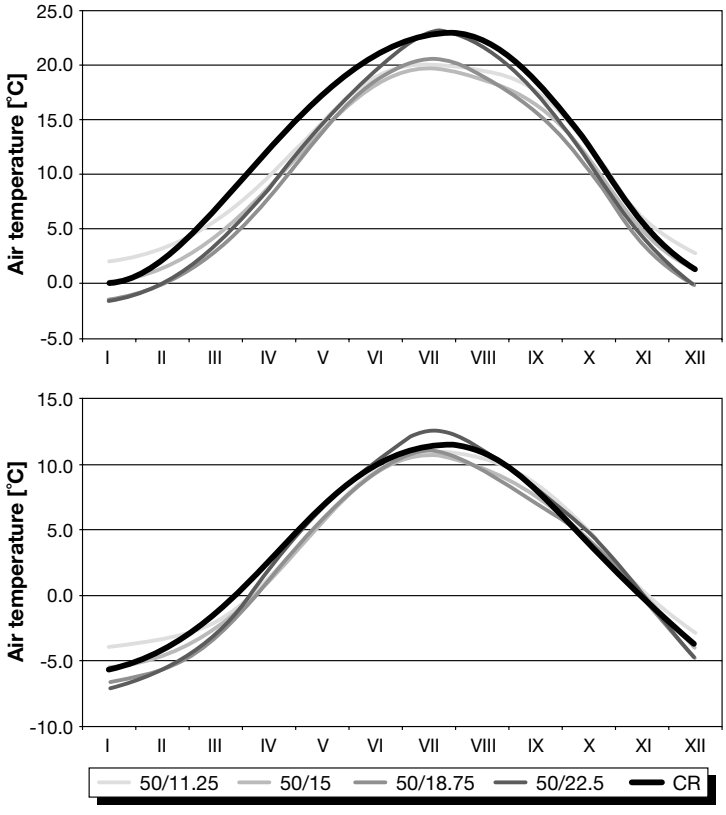
New regional scenarios of climate change were created for CR in 2000 for the purpose of estimating impact[38]. These scenarios were based on analysis of the properties of seven global circulation models available in the IPCC Data Center from two models that were tested by the analytical hierarchical process method as best describing the present climate in CR. These were the HadCM2 and ECHAM4 models. Both these models are suitable for a small distance of the nodal points, suitability of model orography and for small differences between the compared

[36] IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations, University College London and Center for Global Environmental Research, London 1994

[37] Handbook of Methods for Climate Change Impact Assessment and Adaptation Strategies. Version 2.0. UNEP, 1998

[38] Study of the impact of climate change caused by an increase in the greenhouse effect in the Czech Republic. Individual task 01 of project VaV/740/1/00, National Climate Program, Prague 2000

Fig. 6-1 Annual course of monthly mean maximum (above) and minimum (below) air temperature



Comparison of HadCM2 model results with average values for eight meteorological stations in the Czech Republic in four nearest node points

Source: National Climate Program

values of meteorological elements and values in a $1xCO_2$ climate (Fig. 6-1). In construction of regional scenarios to 2050, the output from the selected two models were combined with the scenario of increase of emissions of greenhouse gases SRES A2 and SRES B1 and, following application to the initial values of the meteorological elements, upper and lower estimates were obtained for the changes in these elements to the year 2050. For example, for the average daily air temperature, a range of possible increases in the average value of +0.90 to +3.01 °C was obtained and, for precipitation, a range of possible decreases in the quotient of total annual precipitation of –0.2 to –0.6 %. In all the scenarios, the values of possible changes are given for both the annual and monthly averages for the following meteorological features: daily temperature amplitude, atmospheric precipitation, solar radiation, daily average, minimum and maximum temperature, water vapour pressure and wind speed. The Met&Roll generator was employed to create a series of daily model values for all the named meteorological factors.

These scenarios are used for estimation of the impacts of climate change on selected sectors from 2001. The estimates of impacts given below are based on older versions of scenarios, both based on the GCM database and incremental.

6.1 Water Resources

The production and consumption of drinking water in CR has decreased constantly over the past decade[39]; the amount of drinking water produced for public water mains decreased between 1992 and 1999 by 32 % and the amount of invoiced drinking water decreased over the same period by 33 %. Trends in the production and consumption of water in the future will depend not only on natural but also on socio-economic and political conditions. No conception has been prepared for long-term development of sectors of the national economy and thus the demands for water sources in CR for the coming decades can be derived only on the basis of expert estimates. If demands on water for agricultural irrigation are not taken into consideration, it can be expected in relation to the decrease in the population that there will be a tendency towards a further decrease in consumption of drinking water. An increase in the consumption of water for irrigation will depend to a great degree on the political and economic conditions for agriculture in CR, which are difficult to predict in relation to attempts to integrate CR into EU.

6.1.1 Expected impacts

Total precipitation values are the most important climatic variable for estimation of the impacts of climate change on the hydrological regime. However, in projections of climate change, these are quantities accompanied by greater uncertainty than other meteorological factors (especially air temperature, and thus evaporation and transpiration). Thus, the hydrological studies carried out concentrated mainly on sensitivity analysis. A climate change caused by an increase in the greenhouse effect will lead to an impact on the hydrological cycle[40] and it cannot be excluded that the yield of water sources will decrease in part of the territory of CR; this could lead to further deterioration in the present, rather unfavorable hydrological situation.

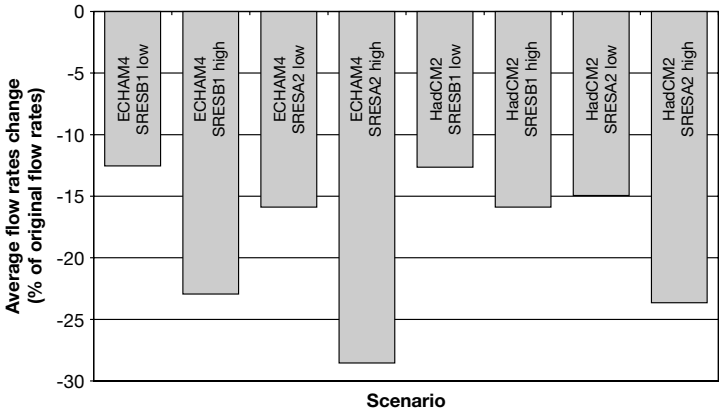
The Territorial Study of Climate Change in CR[41] employed the BILAN (CR), CLIRUN (Poland) and SAC-SMA (USA) models to determine sensitivity and estimates of impacts in parts of the river basins of the Labe, Želivka and Úpa Rivers. Emphasis was placed on the incremental scenario. Most of the results identically indicated a decrease in surface and underground water runoff. An increase is also expected in thermal pollution of the watercourses and water reservoirs. Increased

[39] Statistical Environmental Yearbook of the Czech Republic, ME CR, CSO, Prague 1977, 1998, 1999 and 2000

[40] Summary technical report on the preparatory phase of regular monitoring of climate change and its impacts, National Climate Program, Prague 1999

[41] Moldan, B., Sobíšek, B: Territorial Study of Climate Change in the Czech Republic, National Climate Program – Vol. 22, Prague 1996

Fig. 6-2 Reduction of long-term average flow rates under eight selected climate change scenarios (Labe in Brandýs nad Labem)



Source: National Climate Program

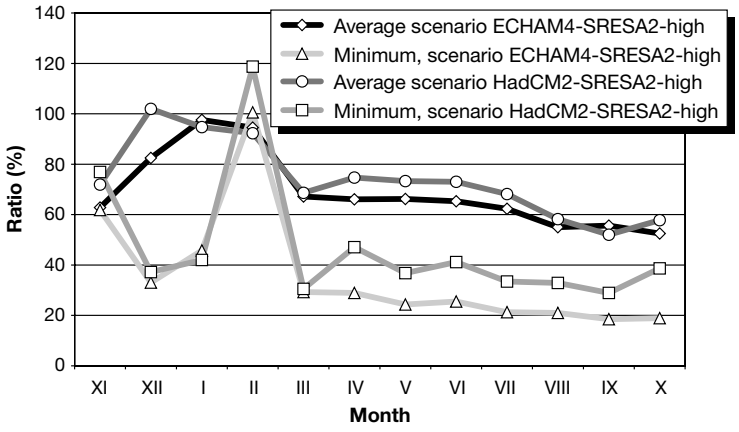
eutrophication must be expected in connection with any increase in the thermal loading of watercourses and reservoirs.

In the period following 1995, a number of projects were associated with cooperation in the framework of the Territorial Study of Climate Change in CR. The scenario of climate change from several global circulation models, provided in the framework of European cooperation (project supported by EU) was employed for the sensitivity analysis of dozens of river basins. Although various simulations yield different results, the determined trends are identical. The basic information obtained in the sensitivity analysis can be summarized as follows:

- The change in runoff is very sensitive to a change in the amount of precipitation and annual variations[42]. The relatively small changes in the long-term average atmospheric precipitation will increase (or suppress) the effects of the relatively large changes in the long-term average air temperatures. In general, it can be stated that a decrease in average runoff, caused by an increase in the average annual air temperature by 2 °C, could be compensated by an increase in precipitation by 5 % or doubled by a decrease in the precipitation amount by 5 %. If the long-term precipitation amount does not change, then an increase in the air temperature by 2 °C would cause a decrease in the average discharge rate in most river basins by 10–15 % and a temperature increase of 4 °C would cause a decrease by 20–25 %. Fig. 6-2 depicts the percentage decrease in the long-term average discharge rate of the Labe at Brandýs nad Labem for implementation of the eight variants of the scenario of 2000.

- Under the conditions of climate change, there would be a substantial change in the distribution of runoff in the yearly cycle caused by a decrease in accumulation of water in the form of snow stocks. Runoff would substantially increase in the winter, runoff from the spring melt would be smaller and discharge rates would decrease in the late summer and in the autumn. The decreases in the monthly average discharge rates in the autumn months during hydrological droughts would be much greater than the decreases in the average discharge rates – a decrease to half the present values

Fig. 6-3 Changes of annual and minimum monthly flow rates under selected climate change scenarios (Labe in Brandýs nad Labem) compared with modeled original state



Source: National Climatic Program

[42] Study of the impact of climate change caused by an increase in the greenhouse effect in the Czech Republic. Individual task 02 of project VaV/740/1/00, National Climate Program, Prague 2000

would not be exceptional. This is especially true for the case of a change in precipitation in the range –5 % ÷ +5 %. Even if the change in precipitation were in the range +5 % ÷ +10 %, runoff at the present level would not occur during the summer and autumn. The monthly changes in the amount of runoff (Labe at Brandýs nad Labem) for the pessimistic variant of the scenario of climate change drawn up in the year 2000 are depicted in Fig. 6-3. The amounts of runoff are expressed in percentages of the modelled initial state.

- On a regional scale, the discharge rates in mountain river basins in Northern Bohemia are relatively least sensitive to a change in the climatic conditions. Especially river basins where there is lower precipitation and which do not have large accumulation spaces will be characterized by a decrease in the discharge rates.

- The basic runoff that can be considered to be an indicator of runoff from ground waters mostly changes similarly to overall runoff. Winter and spring filling of stocks of ground water will end by as much as two months sooner than at the present time.

The impact of climate change on the hydrodynamics and selected water quality parameters in reservoirs has been studied using the CE-QUAL-W2 model for the conditions of the ECHAM4 ($2xCO_2$) scenario. Inflow into reservoirs was simulated using the SAC-SMA model. The results indicate the following changes compared to present conditions:

- greater decreases in water levels in the summer and autumn,
- a shortening of the winter period of stratification and interval of coverage of the reservoir by ice,
- an increase in the surface temperatures of the water in the summer,
- a decrease in the concentration of dissolved organic matter in the lake part of reservoirs,
- an increase in the trophic gradient between the inflow and the lake part of the reservoir, i.e. the nutrient-rich inflow into the reservoir and the mesotrophic conditions at the dam,
- a shift in phyto-plankton groups towards groups with a higher temperature optimum (e.g. cyanobacteria), constituting a significant risk for the production of drinking water.

A methodology has been prepared for the scenario studies of water quality in reservoirs under various conditions and has been applied to the Římov, Lipno and Švihov reservoirs.

6.1.2 Estimates of vulnerability

The increased runoff during the colder seasons can be expected to lead to more frequent autumn floods[43]. Simulations of the precipitation – runoff process also indicated that rain with greater intensity, occurring in connection with summer thunderstorms, could constitute a greater risk of flash floods even if the long-term precipitation amounts do not change. The consequences of climate change very significantly affect the size of the storage space in reservoirs required to maintain the existing level of water withdrawal. Simultaneously, relatively large reservoirs are less sensitive to climate change than smaller reservoirs with a predominantly seasonal cycle of filling and emptying. Even a relatively unimportant decrease in precipitation, together with warming, can lead to a substantial decrease in the guaranteed water withdrawal.

The amount of water in a watercourse fundamentally affects the biotope environment. The impacts of the minimum discharge rates and their expected extreme fluctuations have a decisive impact on the structure and function of the ecosystem. The amount of minimum discharge rates directly affects the production potential of ecosystems. An increased number of floods leads to a change in recovery of the relevant section of the water course. There is a change in the physical characteristics of the biotope through a shift in sediments from the higher areas, and fish are washed downstream and partly destroyed by the amount of particles being washed away. Material flushed from the river basin also

[43] Study of the impact of climate change caused by an increase in the greenhouse effect on the Czech Republic. Individual task 02 of project VaV/740/1/00, National Climate Program, Prague 2000

brings a number of undesirable substances into the system – inorganic and organic pollutants, nutrients, insoluble substances, etc.

Warming of the water leads to:

- a decrease in the number of species; groups with the greatest requirements on the oxygen content are most affected,
- an increase in the rate of processes of decomposition of organic substances, which further increases the oxygen deficit, especially in polluted water courses, with all the detrimental consequences thereof,
- an impact on the temperature stratification of reservoirs and a greater frequency of cases of excessive formation of phytoplankton, with a number of detrimental consequences,
- an acceleration in metabolism, which simultaneously increases the toxicity of some substances. As the temperature increases, there is a simultaneous increase in the accumulation of harmful substances in the biomass of organisms, with a concurrent increase in their toxicity – for both metals and pesticides.

In 2001, a team of hydrological specialists is studying the application of new methodologies for estimating the impacts of climate change on water sources in CR. This is expected to lead to specification of the proposal for adaptation measures, which is to be submitted to ME and MA.

6.1.3 Adaptation measures

Adaptation measures proposed in the TGM Water Management Research Institute are the result of analyses and comparisons of changes in water management and capacities of water sources with the current conception of development policy, with the state structure of water management and with the state of the environment in CR. Input data for each region under the management of the Povodí state enterprises will consist in an inventory of requirements, which will include particularly:

- assessment of the technical condition of the individual water management works and the potential for further intensification,
- revision of the manipulation rules of the water management systems as a consequence of changes in the requirements on use of water after 1990,
- estimation of free capacities of sources in the future and proposal for means of their use on the basis of re-evaluation of the proposed parameters of water works,
- determination of the current state of exploitation of sources as the starting state prior to climate change,
- determination of expected future requirements for the individual kinds of use of water in the region and any priorities.

In addition to these measures, formerly adopted measures also remain valid[44], i.e.

- support for a further decrease in consumption of water in industry, energy production, agriculture and households,
- reduction of losses of water through repair and reconstruction of pipeline systems,
- strengthening of programs of more effective use of withdrawn water,
- trading in water and its transfers,
- controlled management of surface and ground waters.

The measures can be divided into two groups. The first group comprises measures that are currently defined as part of the environmental policy of CR. These are concerned with provision for sustainable development and are necessary without regard to the expected climate change. The second group consists in adaptation measures that supplement the first group in the sense that they represent modifications taking into account changes in the climatic conditions in CR.

6.2 Agriculture

Czech agriculture has changed considerably over the last decade[45], as a result of changes in ownership relations and financial and trade policies.

[44] Second National Communication of the CR to the UN FCCC, Ministry of the Environment, Prague 1997

[45] Study of the impact of climate change caused by an increase in the greenhouse effect on the Czech Republic. Individual task 02 of project VaV/740/1/00, National Climate Program, Prague 2000

- A high level of exploitation of the landscape by agriculture has been abandoned, with a decrease in the originally high burdening.
- Since the 1990's, subsidies for agriculture have constantly decreased and their use has also changed. In connection with subsidy policy, there has also been a decrease in the contribution of agriculture to the creation of the gross domestic product, so that this has been less than 5 % in recent years.
- There has been a change in the crop composition. Amongst grains, the production of wheat and barley is most important, with more or less stable areas. The areas sown with sugar beets and potatoes continue to decrease every year. There are increasing areas of oil seeds, both rapeseed and also poppy seeds and sunflower seeds.
- There has been an impact on the structure of the land fund, with a slight decrease in the percentage cultivation and a gradual increase in the area of land left fallow. There has been a slight increase in the area of grasslands.
- In dependence on prices, imports from abroad and a change in the composition of foodstuffs, there has been a permanent decrease in consumption of meat, milk and dairy products. The decrease in demand has forced farmers to decrease the number of head of farm animals and this process is continuing.

The present state of agricultural land is not favorable. This is caused primarily by a substantial decrease in humus, which, amongst other things, increased the rate of heating of the soil, and thus a drying-out of the soil in the summer. The quality of the soil has further been decreased by the use of heavy machinery in cultivating agricultural land, i.e. the process of compacting, which is transferred to deeper levels of arable soil.

Marginal conditions for agricultural production also occur in CR in areas with the highest agricultural productivity. This is caused primarily by the unfavorable climatic conditions, where practically every other year with precipitation in the vegetation period of less than 300 mm leads to a real danger of drought. These conditions are borne worst by light, sandy soils, where the soil moisture levels fall below the value of the soil hydrolimit of the wilting point. In Southern Moravia in the Districts of Břeclav, Hodonín and Znojmo, about 16 % of the land is thus affected, i.e. almost 44 000 ha of agricultural land.

A fundamental change in agriculture can be expected after an accession to the EU, as production will be limited by EU regulations.

6.2.1 Expected impacts

The studies carried out to date on potential climate change, where a number of scenarios were used for these changes, lead to the following comments on the expected climate and agroclimatic evaluation for the area of Southern Moravia and Central Bohemia:

- Increased air temperature and an increase in the sum of active and effective temperatures and in the numbers of summer and tropical days can be expected. The number of frost and ice days will decrease.
- The frost-free period will be lengthened by 20–30 days. In a great many areas, the start of the vegetation period will shift to the beginning of March and the end to the end of October. Higher air temperatures will prolong the vegetation period and affect the growth and development of plants to permit earlier sprouting and the progress of further phenophases so that, compared to present conditions, the time of ripening and harvest could be hastened by at least 10–14 days. Acceleration of vegetation in the spring could, however, increase the danger of damage to plants by late frosts.
- The expected temperature increase should create suitable temperature conditions for growing some thermophilic species (such as semi-earlier varieties of maize for grain, early varieties of grapes). On the other hand, there is a serious danger of thermal stress through the more frequent occurrence of extremely high temperatures. It follows from the estimate of the values of the

humidity indices that, without a significant increase in precipitation with the expected increase in evapotranspiration, a considerable part of Central and Southern Moravia, Central and North-Western Bohemia, and the lower and central river basins of the Labe and Vltava will be endangered by droughts, which could have detrimental consequences on the amounts of yields in the most productive regions of the country.

- For sufficiently high temperatures, the yields of agricultural crops will be affected primarily by adequate precipitation in the vegetation period and an even distribution of this precipitation.
- Prediction of potential evapotranspiration (Eo) and agroclimatological characteristics for $2xCO_2$ and $1.5xCO_2$ according to the ECHAM scenario unambiguously confirms the significant increase in the dryness of the climate of CR. The results of the $2xCO_2$ scenario for the vegetation period indicate an increase in Eo values by more than 200 mm. The moisture deficiency in the summer alone in warm years would correspond to more than 300 mm and, for the vegetation period, more than 500 mm. In dry years, these values are greater than the precipitated amounts over a large part of the territory of Moravia.
- According to the results of the simulation, however, higher precipitation would also mean an increase in the probability of occurrence of daily precipitated amounts of greater than 10 mm, i.e. an increase in the erosion hazard from rain, especially in May, June and September.
- A climate change will lead to a decrease in productivity in some areas and an increase in other areas. The most productive lowland areas will probably become less fertile as a consequence of higher temperatures and evapotranspiration of moisture reserves for plants, especially in the summer, and the moisture deficiency will increase overall. Under the warmest conditions on extremely light soils, it can be expected that localities will appear that are not suitable for economical production. In contrast, areas at higher altitudes, where low temperatures currently limit agricultural production, could become more productive with the expected change in climatic conditions as they need not be as seriously affected by the lack of precipitation. The increasing temperature will permit more thermophilic species to be grown. However, in a great many cases, the cultivation of some crops could be limited by unsuitable soil and terrain conditions (depth of the soil, skeleton character, sloped terrain), and also by the absence of a processing industry.
- The climate change will affect the landscape and ecological systems as a whole. There will be a substantial change in conditions for the development and action of agricultural pests and diseases. There will be an increase in infection pressure and the occurrence of species from warmer regions. It can be expected that there will be increased occurrence of viral diseases over greater areas, e.g. of potatoes. Similarly, more extensive occurrence of some fungal diseases can be expected, e.g. potato mold and hop mold. From the standpoint of production of crops, this leads to the need for increased chemical protection, resulting in an increase in these costs. Where chemical protection is insufficient, there will be a decrease in economic yields from agricultural crops.
- Potential climate change will also be reflected in soil conditions, especially amongst soils that are disturbed by previous management methods. This is particularly true of damage to the physical condition of the subsoil, the decreased retention capacity of soils and their microbial activity.

6.2.2 Estimates of vulnerability

The sensitivity of selected agricultural crops to climate change has been studied[46,47] using growth simulation models of the CERES series (CERES-Maize, CERES-Wheat

[46] Summary technical report on the preparatory phases of regular monitoring of climate changes and their impacts, National Climate Program, Prague 1999

[47] Impacts of climate change on managing the economy, Report of the Grant Agency of CR for 2000, Prague 2000

and CERES-Barley). These models were verified and applied to these agricultural crops in the region of Southern Moravia, which is an agroclimatic warm macro-area, sufficiently warm area, very dry subarea and district with mostly mild winters.

Simulation using growth models was carried out for stressed (actual, observed) and potential (attained under optimum conditions) yields. Changes were monitored from the standpoint of the direct effect (elevated CO_2 concentration and current weather – i.e. $1xCO_2$ climate), indirect effect (current concentration of CO_2 and expected weather, i.e. $2xCO_2$ climate) and the combined effect. Scenarios of climate change were derived from the daily outputs of the German climate model ECHAM3/T42. A stochastic generator, which generates long series of data, was employed to generate the daily time series of meteorological variables for the time frames for 1.5 xCO_2 and $2xCO_2$; this permits better statistical treatment of the results. Studies have so far been carried out at two locations (based on the availability of long-term agrotechnical and climatic data), for maize for grain and winter wheat at the location of Žabčice (49° 01' N, 16° 37' E, 179 m a.s.l.) and for spring barley at the Domanínek location (49° 32' N, 16° 15' E, 560 m a.s.l.). Over a longer period of time, spatial analysis will be carried out for the entire territory of CR and a wider range of varieties.

In the framework of sensitivity analysis, a study was also carried out of the impacts of changes in the dates of sowing the individual crops on their yields for different weather conditions in the vegetation period. It has been found that changes in the sowing date can have a great impact and application of this factor can be considered to be one of the ways of adapting to the changed climatic conditions.

The growth simulation models employed yielded the following results for the test locations:

Maize for grain. The direct effect (simulated stressed yield) exhibits an increase by 36–41 % while the increase would equal 9–10 % for the potential yield. The indirect effect (simulated stressed yield) decreases by 27–29 %, while the potential yield does not exhibit a significant change. The combined effect (expected state) for double the concentration of CO_2 and "$2xCO_2$ climate" resulted in an increase in the simulated stressed yield by 17–18 % and in the potential yield by 5–14 %. Overall, it can be stated that the favorable fertilization effect of CO_2 seems more important in the model studies than the negative effect of the change in the meteorological factors (especially temperature change).

Winter wheat. The combined effect (expected state) for double the concentration of CO_2 and "$2xCO_2$ climate" resulted in a simulated stressed yield increase by 30–31 % and potential yield by 16–17 %.

Spring barley. The combined effect (expected state) for double the concentration of CO_2 and "$2xCO_2$ climate" resulted in a simulated stressed yield decrease by 13–15 % and potential yield increase by 3–4 %. The negative effect of changes in the meteorological conditions is more marked than the favorable effect of CO_2.

It should be pointed out that the results to date of modelling of yields do not take into account several negative accompanying consequences. These consist particularly in the impacts of diseases and pests that, with increasing temperature sums, can become limiting production factors in a great many areas. This could be accompanied by the occurrence of quite new diseases and pests against which a system of forecasts and signaling has not been prepared. It is also not known how the plants can come to terms with the gradually increasing CO_2 concentrations. There are additional factors that could have a decisive effect, such as gradual aridization of agricultural areas. In 2001, a team of agricultural specialists studies the application of newly selected methodologies of estimating the impacts of climate change on agriculture in CR. These methodologies are expected to yield better suggestions for adaptation measures, to be submitted to the Ministry of the Environment and the Ministry of Agriculture.

6.2.3 Adaptation measures

Adaptation measures should take into account broader circumstances[48]. They should deal not only with agricultural production, but also with the ecological stability of the landscape, its water management function, etc. The following measures are proposed:

- Change the composition of the species of agricultural crops and farm animals. Introduce some other crops and improvement/breeding procedures to improve the adaptability of selected species to the expected changes in the climatic conditions.
- Purposefully change the structure of agricultural crops so as to attain a compromise between the habitat and economic conditions, to comply with the requirements on a certain degree of variety in agroecosystems and avoid unsuitable long-term single-species cultures. In dry areas, emphasize crops that have a shorter vegetation period and lower requirements on moisture.
- Choose agrotechnical approaches that minimize the loss of soil moisture. It will be useful to prefer methods with minimum soil working. Simultaneously, it will be necessary to compensate the decreased amount of barnyard manure by some other organic matter and greater emphasis should be placed on technology using mulching and organic matter, taking into account that ploughing-in straw increases the deficit of soil moisture and that preventative measures should be preferred to decrease weed infestation.
- Choose cultivation methods that decrease the risk of erosion processes as a consequence of flash downpours and of strong winds.
- Carefully consider irrigation from the water management, production and economic standpoints. Micro-irrigation can also be considered on the basis of results to date.
- Confront the increased risk of infection diseases and pests by choice of the times for spraying based on the assumption of the formation of conditions for the development of several generations of pests during one vegetation season.

[48] Study of the impact of climate change caused by an increase in the greenhouse effect on the Czech Republic. Individual task 02 of project VaV/740/1/00, National Climate Program, Prague 2000

6.3 Forest Management

Forest land covers about one third of the area of CR, where the area of tree stands covers 22.1 % of the area of the country[49]. In the composition of tree species, there is a clear predominance of spruce (54.2 %) and pine (17.7 %). The area of forest land has not changed substantially over the last ten years (has increased by 1 %). The majority of forests are owned by the state (63.4 %), the second largest owner group are private individuals (23.0 %) and the third consists in municipalities (12.8 %). A total of 14.2 mil.m^3 was harvested in 1999, while the total average growth increment equaled 16.8 mil. m^3. There were 1402 forest fires over an area of 336 ha.

6.3.1 Expected impacts

It is clear that a change in the climatic conditions will have a great impact on the physiology of trees and on forest ecological systems[50]. It is expected that the present unsatisfactory state of forest stands, caused particularly by burdening from air pollution, would become much worse. Primarily, there is a risk of potential destruction of unstable immature and mature spruce single-species stands in unsuitable habitats and an increase in abiotic damage under extreme weather conditions accompanied by an increase in pathogens.

Several years ago, an estimate was made of changes in the vegetation zones of forest

[49] Statistical Environmental Yearbook of the Czech Republic, Ministry of the Environment CR, CSO, Prague 1997, 1998, 1999 and 2000

[50] Summary technical report on the preparatory phase of regular monitoring of climate changes and their impacts, National Climate Program, Prague 1999

stands in dependence on possible changes in air temperature and precipitation in two selected areas of CR, using an undynamic correlative model, studying the dependence between climate conditions and forest vegetation zones. The vegetation zones were determined according to the ISU biogeography register, which contains information on the percentage of superstructure units of geobiocenological type classification of the landscape in the framework of the cadastral territories of CR. Spatial changes in forest zones were estimated as trends in their changes for changed climatic conditions. The model is based on the method of spatial analogies and does not take into consideration increasing CO_2 concentrations. Fig. 6-4 depicts maps of vegetation zones in 1990 and 2030 (according to the scenario of climate changes of 1994).

Later, a number of projects were carried out in relation to study of potential impacts of climate change on forests and forest ecosystems. However, these projects were concerned with individual subjects, such as the sensitivity of the soil to climate change, the microclimate of forest communities and nutrition of forest stands. Several projects were concerned with study of the reactions of kinds of individual populations of forest tree species to changes in the environmental conditions, specifically to higher air temperature and higher CO_2 concentrations. At the present time, ecophysiological studies are concerned with the ability of forest ecosystems to adapt to climate change in the sense of maintenance of growth and development of forest tree species, with the standpoint of the availability of nutrients, with the water regime and with physiological responses to biotic and abiotic factors.

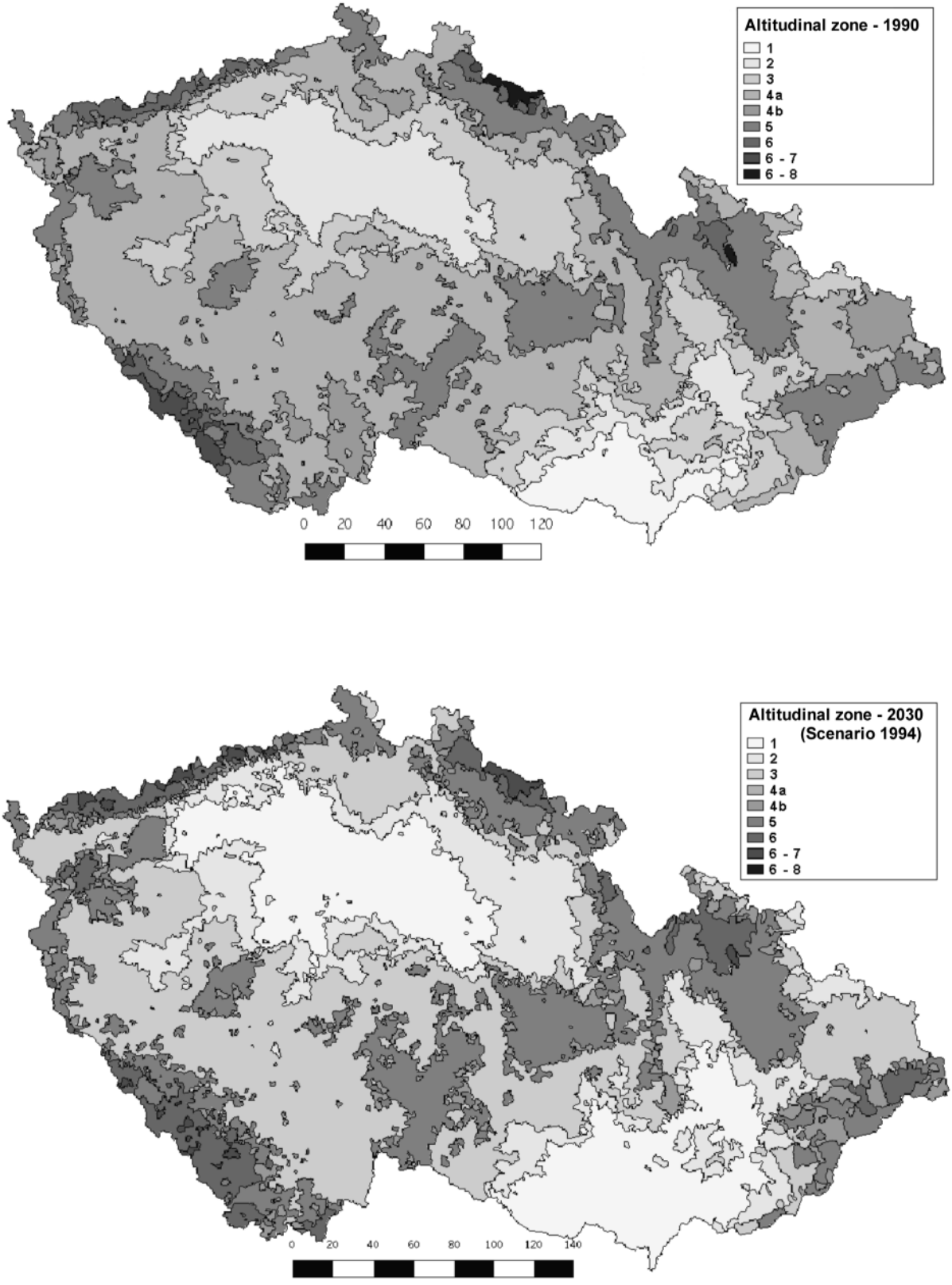
6.3.2 Estimates of vulnerability

It seems that climate warming in this country could lead to the danger of stress from drought. Other habitat factors, such as light, air temperature, and the availability of nutrients or environmental pollution could have a synergetic effect together with the soil moisture and could affect tolerance to drought. Determination of the direct effect of elevated CO_2 concentrations in the atmosphere seems to be a very difficult problem. On the one hand, it can be expected that an elevated concentration will be manifested in increased plant growth and biomass production. However, the long-term effect indicates that, especially for spruce, there could be the occurrence of an aclimatic depression in photosynthetic activity. The final effect could thus lie in the range from no effect on growth, through increased root and annual growth to a change in root and annual growth in favour of one or the other, in accord with the principle of equilibrium between the potential of the tree species to assimilate and the potential of the root system to supply nutrients.

The assimilation activity of tree stands during the vegetation season has also been studied experimentally using the MAESTRA simulation models at the Bílý Kříž location in the Beskydy Mts. The models simulate primarily physiological processes in a real forest system at several mutually interconnected levels. Successful validation and parameter assignment have been carried out for the named models for the given tree stand and the models will be used in the immediate future to estimate the impacts of climate changes on spruce stands in the Beskydy area. The standardized scenario of climate change, corresponding to the 2040–2070 time period, employs the ECHAM4 model for the IS92 emission scenario. Work on quantification of impacts in this area has not yet been completed.

In 2001, a team of forest specialists is studying applications of newly selected methodologies of estimating the impacts of climate changes on forest management in CR. These methodologies are expected to yield better suggestions for adaptation measures, to be submitted to the Ministry of the Environment and the Ministry of Agriculture.

Fig. 6-4 Altitudinal zone in 1990 (above) and in 2030 (below)



Source: National Climate Program

6.3.3 Adaptation measures

The basic logic of selected measures is based on financial sources[51,52], which are always limited. In relation to the relatively large range of uncertainty in making decisions on expenditure of funds for these measures, it is assumed that initially funds will be expended preferentially for measures that would have to be implemented in any case and that can simultaneously also be used for protective purposes against the detrimental impacts of climate change. Of other measures, preference should be given to less expensive measures.

In the framework of measures to minimize the environmental and economic risks following from environmental changes, including global climate change, it is necessary to maintain the following principles:

- ensure maximum flexibility of forest ecosystems and forest management,
- implement changes in management that are in accord with principles and measures to increase the stability and functioning of forests in the natural (landscape) environment,
- adopt the principle of sustainable management of forest natural resources.

For this, the following are necessary:

- a gradual change in the present species composition of forest stands with a greater percentage of broad-leaved species (primarily stabilization and land-improvement) in reforestation and afforestation, approaching the natural forest composition under the given environmental conditions with a decrease in the percentage of spruce and a marked increase in the percentage of beech and oak,
- utilization of undergrowth management with a greater portion of natural renewal,
- proper tending of young stands based both on the principle of production and stability as well as modification of the species composition and improvement of the state of health of the stands, and thus an increase in their adaptability to environmental changes,
- implementation of the principle of integrated forest protection and control of the spreading of detrimental factors from warmer southern areas (stricter quarantine regulations and measures),
- use of sound technology, especially harvesting and transport of timber from the standpoint of damage to trees and especially from the standpoint of danger to the water-management function of water-management forests,
- a strengthening of the environmental function of forests in the public interest, in particular increased demands on the retention water-management function of forests.

These measures are fully consistent with current trends in sustainable forest management on a scientific basis in the interest of the present generation and future generations and with the approved state forest policy and activities of the state administration. The thus-formulated measures are also in accord with the precautionary principle.

[51] Study of the impact of climate change caused by an increase in the greenhouse effect on the Czech Republic. Individual task 02 of project VaV/740/1/00, National Climate Program, Prague 2000

[52] Impacts of climate change on managing the economy, Report of the Grant Agency of CR for 2000, Prague 2000

7. FINANCIAL SOURCES AND TRANSFER OF TECHNOLOGIES

As CR is not a Party to Annex II to the UN FCCC, it is not obliged in the sense of Article 12.3 of the Convention to adopt measures and fulfill obligations following from Articles 4.3, 4.4 and 4.5 of the Convention and especially to create further financial sources.

Nonetheless, brief information is given in this chapter on the **overall volume of finances** that CR contributes to the individual funds. However, it is not possible to specify how large a part of these means is directed towards the areas covered by the Convention.

The annual financial contributions of CR to GEF funds equaled 1 mil. SDR annually in 1997–2000 (SDR is a currency used as an international reserve currency, in which accounts are kept for the International Monetary Fund).

The annual financial contributions of CR to the International Development Association (IDA) as one of the funds of the **World Bank** equaled 1.7 mil. SRD annually in 1997–2000. Contributions to the Multilateral Investment Guarantee Agency (MIGA), another fund of the World Bank, were zero in 1997 and 1998 and 323.7 thous. USD annually in 1999 and 2000. In 1997–2000, CR did not contribute to other funds of the World Bank, such as the International Bank for Reconstruction and Development (IBRD), the International Finance Corporation (IFC), and the International Center for the Settlement of Investment Disputes (ICSID).

Contributions to the **European Bank for Reconstruction and Development** (EBRD) in 1998–2000 equaled 3.05 mil. USD annually; no contribution was made in 1997.

In 1997–2000, CR contributed the sum of 1 mil. SDR annually to the **International Monetary Fund** for the HIPC programs.

8. RESEARCH AND SYSTEMATIC OBSERVATION

This chapter provides information on scientific-technical and socio-economic studies of the climate system in CR, on systematic observations and archives of climatological data. These studies are intended particularly to improve information on the causes, effects, magnitudes and time factors of climate change and their economic and social impacts. Attention is further paid to international cooperation and exchange of scientific-technical and socio-economic information (according to Article 4.1(g) and (h) of the UN FCCC). Information is also given on organization of research in the area of the climate system in CR and on international cooperation in this area, including support for developing countries (according to Article 5 of the UN FCCC).

8.1 Organization and Financing

Study of the climate system in CR is concentrated mainly in the following institutions: the National Climate Program of CR (NCP), the National Committee for IGBP, the Committee for the Environment of the Academy of Sciences CR, the National Forest Committee, The Institutes of the Academy of Sciences CR (the Institute of Physics of the Atmosphere, the Geophysical Institute, the Institute for Hydrodynamics, the Institute of Landscape Ecology, the Geological Institute), the Departments of the Universities (the Department of Meteorology and Protection of the Environment at the Faculty of Mathematics and Physics of Charles University in Prague, the Department of Geography at the Faculty of Sciences of Masaryk University in Brno, the Institute of Landscape Ecology of the Faculty of Agronomy of Mendel Agricultural and Forestry University in Brno) and the institutes of the sector (the Czech Hydrometeorological Institute, the Water Management Research Institute). Most of these institutes are members of or have representatives in the National Climate Program, which is an association of legal persons authorized, amongst other things, to provide for implementing the tasks of the World Climate Program of WMO in CR, to create research teams of workers in the area of climate change in CR and to publish the results obtained.

The research that is included amongst the basic tasks of the individual institutions is financed from their budgets. Required special studies are financed primarily from the state budget of CR through the Grant Agencies of CR and of the Academy of Sciences CR or grant funds provided by the Ministries of the Environment and Agriculture. Some projects are also carried out in the framework of international cooperation and cooperative financing by foreign partners. For example, in 1993–1995, on the basis of a contract with US EPA, NCP worked on the Territorial Study of Climate Change for CR, whose results continue to be extensively used.

Systematic observation of the climate system is carried out to a decisive extent by the Czech Hydrometeorological Institute (CHMI), which holds the position of the state institute for the areas of protection of air purity, hydrology, water quality, climatology and meteorology, with the competence to establish and operate the state monitoring and observation networks, including international data exchange on the basis of the principles of WMO. Other institutions carry out monitoring only for their own needs, usually for the limited time of duration of a certain project.

The exchange of scientific and technical information between Czech and foreign institutions is in no way regulated and occurs quite freely. Only the basic observation data are provided by CHMI usually for consideration.

In addition to participation in the activities of WMO and UNEP, CR cooperates in a number of international projects concerned with the climate. Participation in the RC LACE project is most important (model ARPEGE-CLIMAT). CR regularly provides assistance to developing countries in the area of training courses, and assistance in installation and calibration of instruments (e.g. for monitoring stratospheric ozone).

8.2 Research

8.2.1 Climate processes and climate systems

In the framework of the long-term basic tasks of research institutions, the following are studied[53]: (i) properties of long observation series with emphasis on variability and trends, including their homogenization, (ii) regional climate variability, (iii) connections between the components of the climate system and estimates of climate changes and (iv) causes of climate changes related to solar activity.

In 1998–2001, work was carried out on grant projects concerned with[54,55,56] (i) study of the impacts of climate changes caused by an increase in the greenhouse effect in CR, (ii) regular monitoring of climate changes and their impacts, (iii) meteorological extremes and their impacts in the Czech lands since the 16th century, (iv) long-term changes in climatic factors in Central Europe and their possible causes and (v) recording of climate changes and tectonic developments in continental sediments of the permotriasian of the sub-Krušné Mt. and inner Sudeten basin.

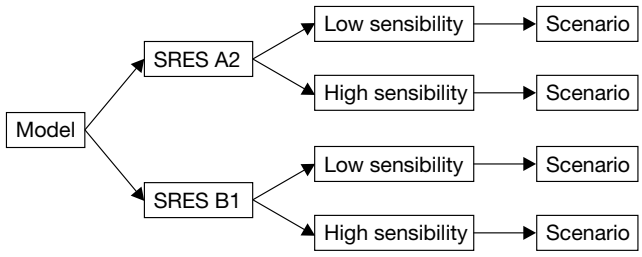
8.2.2 Modelling and prediction of the climate using GCM

The Department of Meteorology and Environmental Protection at the Faculty of Mathematics and Physics of Charles University and the Institute of Physics of the Atmosphere of AS CR, in the framework of their regular work, monitor global trends in the area of GCM and construct regional scenarios of climate change for CR. These scenarios are used by further institutions in CR as inputs for estimates of the impacts of climate change.

The newest scenario of 2000 was constructed in the framework of a project of the Ministry of the Environment according to the IPCC methodology *"Guidelines on the use of scenario data for climate impact and adaptation assessment"* and the methodology *"Using a climate scenario generator for vulnerability and adaptation assessment: MAGIC and SCENGEN"*. The outputs of seven models were archived from the IPCC database; on the basis of the viewpoint of accord of the model outputs with the current state of the climate, two models were chosen from them as most suitable: HadCM2 and ECHAM4. SRES A2 as the pessimistic variant and SRES B1 as the optimistic variant of trends in CO_2 concentrations were employed as the emission scenario. The temperature sensitivity was chosen as a value of 1.5 °C (low sensitivity) and 4.5 °C (high sensitivity).

The scenarios of climate change were calculated for the selected combination: "climate model + time period + emission scenario + temperature sensitivity for the year 2050" and for the following factors: daily air temperature amplitude, average, maximum and minimum daily air temperature, atmospheric precipitation, global radiation, air humidity and wind speed. Four variants were calculated for each model according to the scheme in Fig. 8-1.

Fig. 8-1 Scheme of model use



Simultaneously, a methodology was created for simulation of daily data for an altered climate. For this purpose, the stochastic generator Met&Roll was employed to modify and to better reproduce the day-to-day and year-to-year variability. Air humidity and wind speed were introduced into this generator as new factors.

[53] Research plans of scientific works of AS CR. http:/www.cas.cz/dokumenty/vyzzam.html

[54] List of projects supported by the Grant Agency of CR in 1999, 2000, 2001 http://www.gacr.cz/gacr/Zakl_ramec.html

[55] List of grants awarded by the Grant Agency of AS CR in 1999, 2000, 2001 http://www.gaav. kav.cas.cz

[56] Study of the impact of climate change caused by an increase in the greenhouse effect on the Czech Republic. Individual task 02 of project VaV/740/1/00, National Climate Program, Prague 2000

8.2.3 Study of the impacts of climate change

In the framework of the long-term basic tasks of research institutions, the following were studied: (i) global changes in the environment and their impact on terrestrial ecosystems, biodiversity, and landscape diversity and function on the basis of model stress loading, (ii) environmentally sound management in the cultural landscape, (iii) natural and anthropogenic transition of the landscape, climate and the environment, (iv) precipitation – runoff relations and the regime of surface and ground waters as a consequence of climate change, vegetation cover, effect of geomorphologic factors and anthropogenic activity with special emphasis on extreme runoff conditions and transfer of pollutants and nutrients and (v) development of fossil ecosystems and their reactions to global climate and environmental changes leading to repeated crises and mechanisms of overcoming them.

NCP provided for study of the impacts of climate change on the sectors of agriculture, water sources and forest management (see Chapter 7). This research was carried out using multidisciplinary teams of professionals from the relevant sector and from the field of climatology, created ad hoc for work on the Ministry of the Environment project *"Study of the impacts of climate change"* in 1999–2001.

In addition, in the same period, work was carried out on a number of grant projects concerned with individual aspects of impacts of climate change in various sectors. The most important of these include (i) impacts of climate change on managed ecosystems, (ii) impacts of climate change on the ecosystems of deep layered reservoirs, (iii) the effect of the climate and anthropogenic factors on the living and nonliving environment and (iv) spatial differentiation of reactions of spruce stands to the long-term action of increased CO_2 levels.

8.2.4 Socio-economic analyses

In the framework of the Territorial Study of Climate Change in CR, successful experiments were carried out in modelling of energy management in CR in connection with climate change[57]. Three models were employed: LEAP, EFOM and MARKAL, to determine primary energy sources required to cover the expected demand for energy and for determining emissions of greenhouse gases. These results were used for subsequent projection of emissions of greenhouse gases in CR.

8.3 Systematic Observation

In the framework of the Global Observation System for Climate Changes, the Czech Republic participates only in meteorological atmospheric observations (GCOS) in the GSN network of terrestrial stations through the Milešovka observatory and, in the GAW network, through the Solar and Ozone Observatory in Hradec Králové and the observatory for monitoring the quality of the natural environment at a regional level, located in Košetice[58]. All three observatories comply with the principles of climate monitoring introduced in GCOS/GOOS/GTOS. Detailed data on observatories are given in Tab. 8-1.

[57] Tichý, M.: Projection of emissions of greenhouse gases and methods for their mitigation, SEVEn, Prague 1995

[58] Annual Report of the Czech Hydrometeorological Institute 1999, CHMI, Prague 2000

Tab. 8-1 Participation in the global atmospheric observing systems

	GSN	GUAN	GAW	Others
Number of stations under the responsibility	1		2	
Number of stations in operation	1		2	
Number of stations operating to GCOS standards	1		2	
Number of stations be operating in 2005	1		2	
Number of stations providing data to international data centres	1		4	

Source: Czech Hydrometeorological Institute

9. ENVIRONMENTAL EDUCATION AND PUBLIC AWARENESS

9.1 General Policy

The State Environmental Policy is the fundamental, strategic and cross-sectional document for preparing detailed programs in the individual components of the environment, including climate change and for dealing with individual environmental issues. Its up-dated version, approved by the Government of CR on January 10, 2001, includes analysis of the current state and specifically elaborates the individual directions of environmental protection in the years 2001–2005. Amongst topical targets and measures, it implements the creation and use of an interconnected system of environmental education and public awareness disseminated through all the sectors, including the state, public, private and civic institutions and organizations and utilizing their mutual relations on the basis of democratic principles with orientation towards regional differences, potentials and requirements.

The subject of environmental education and public awareness is contained in Act No. 123/1998 Coll., as amended by Act No. 32/2000 Coll., on the right to information on the environment (§ 13). In Resolution of the Government of CR No. 1048/2000, the Government approved the State Program of Environmental Education and Public Awareness in the Czech Republic, which was created at the initiative of the Ministry of the Environment. The draft for the program was prepared jointly by an intersectoral working group established for this purpose at the Ministry of the Environment. One of the key targets of the program is to increase the consciousness and knowledge of the population of the environment, education in sustainable development and public participation in environmental issues.

CR is gradually implementing Agenda 21, whose Chapter 36 is one of the starting points for this program. Another important document in this respect is the Aarhus Convention on access to information, public participation in decision-making and access to justice in environmental matters, which was signed by CR in 1998. The subject of the environment was incorporated into resolution of the Government of CR No. 1/1999 on the Conception of the State Policy in Relation to the Young Generation in CR to the Year 2002. In 1999, an intersectoral agreement was concluded on cooperation in the area of environmental education and public awareness between the Ministry of the Environment and the Ministry of Education, Youth and Physical Education. Both these Ministries consider environmental education and public awareness to be a multidisciplinary instrument providing information, consciousness, knowledge and skills and creating a responsible relationship and behavior of individuals towards the environment.

The State Nature and Landscape Protection Programme of the Czech Republic, approved by Resolution of the Government of CR No. 415/1998, has also become part of the State Environmental Policy of CR. Amongst other things, it contains tasks for administrative nature protection institutions related to environmental education and public awareness and work with the public.

The strategy of development of protected landscape areas is a document under preparation that takes into account also the connections to other conceptual documents, such as the State Environmental Policy (2000), the State program of Protection of Nature and the Landscape in CR (1998) and the State Forest Policy (1996) and also the Strategy of Regional Development in CR (1999), as well as foreign policy and strategy in protection of nature and the landscape in the countries of the European Union, especially in the Federal Republic of Germany and the Netherlands, and also in the United States of America. One of its parts deals with environmental education, and information and work with the public. Resolution of the Government of CR No. 349/2001 has newly been adopted on the System of educating employees in the public administration and on the public administration.

9.2 Educational System

The environmental scientific policy is part of the White Paper – National Program of Development of Education in the Czech Republic. One of the targets of the program is education in protection of the environment in the sense of providing for sustainable development of society. The Act on education, under preparation, whose draft was approved by Resolution of the Government of CR No. 231/2001, lays down the gaining of knowledge of the environment and its protection, based on the principles of sustainable development, as one of the components of general education.

Preschool education

The Framework Program for Preschool Education is a new document implementing the environmental aspect into teaching schedules. The Framework Program was published by the Ministry of Education, Youth and Physical Education in 2001 in accord with § 12 (1) of Act No. 564/1990 Coll., on the state administration and self-governing in education, as amended. The Framework Program is currently provided as recommended material for education in kindergartens, special kindergartens and preparatory classes established for children with social disadvantages. It is expected that the Framework Program will become generally binding by September 1, 2003.

Elementary school education

The Framework Program for Elementary School Education is being prepared in cooperation between the Ministry of Education, Youth and Physical Education and the Pedagogical Research Institute in Prague. The working version of this document is currently being submitted for public discussion; this is now freely available on the Internet. In its final form, it is expected to become an important document guiding education at all types of schools that provide elementary education. Environmental education is an aspect of all parts of the document and is not only a separate subject.

Secondary School Education

The network of higher vocational schools currently includes three schools that are directly concerned with the area of the environment.

University Education

In the 1996/1997 school year, in the framework of the faculties of universities, 40 fields were opened for study in the area of the environment. In the framework of education at universities, projects of environmental education are supported by the Fund for Development of Universities. In recent years, CR has employed EU programs, such as SOKRATES, LEONARDO, etc. for education of university students and employees of the public administration.

Pregraduate education of pedagogues

The Ministry of Education, Youth and Physical Education is responsible for integration of aspects of environmental education and public awareness into pregraduate education of pedagogues. Environmental education takes the form of lectures or obligatory electable workshops and/or exercises and excursions. However, environmental education is newly included for all students in the fields of civic education and also various fields related to ecology, the environment, care for the environment and environmental education are included in teaching in the fields of the nature sciences (biology), chemistry, geography, technical training and family training, and lectures are given at some faculties in pedagogy and occasionally other subjects. Some NGOs have also obtained certificates from the Ministry for education of pedagogical workers.

9.3 Public Information Campaigns

The work of the Ministry of the Environment includes publication, film and promotional activities related, amongst other things, to global environmental issues, including climate change. The Ministry issues a number of publications and periodicals,

both its own and on request by other entities. The basic periodicals of the Ministry of the Environment consist in the Newsletter and the Bulletin, which are published regularly and contain the official wording of all important documents. The public is also informed through the electronic media. The Ministry has its own web site http://www.env.cz and electronic environmental library http://ww.env.cebin.cz. It is also possible to send any questions on the environment to the address **info@env.cz**, to which a qualified answer will be provided by the Ministry of the Environment in the sense of Act No. 123/1998 Coll., on the right to information on the environment, and Act No. 106/1999 Coll., on free access to information. Statistically, about 50 questions are answered each month. Information is provided to journalists and other media through press conferences of the Ministry.

The Ministry of the Environment participates in providing for the celebration of important days related to the environment, provides for awarding of Prizes of the Minister, promotion of Environmentally Friendly Products, publishing of promotional printed materials (posters, folders, brochures), etc. The Ministry holds its own exhibitions or participates in exhibitions and trade shows, both domestic and international, held by other entities (e.g. Pragotherm, Ekostyl, ENVI Brno, etc.) and organizes the EKOFILM film festivals (international film festival on the environment, and the natural and cultural heritage). The videotheque, which it has created since its inception, provides the public with a widely valued service. Films and video programs are most often presented to the public with the assistance of NGOs, Czech Television and some professional institutions or individual professionals concerned with environmental education. These materials are also accessible through a network of video rental outlets and can be ordered through an up-dated catalogue.

Teaching programs

The Ministry of the Environment is one of the first state institutions to introduce information on its educational activities on a web site in accord with the relevant laws. Educational courses are intended primarily for the employees of the sector and are expected to be offered to the general public in the future. Interested persons will be able to apply directly while complying with the set conditions. Training of employees of the state administration in environmental education and public awareness is carried out primarily through regular workshops and printed information (methodical instructions, aids). In training the employees of other organizations, professionals from the Ministry are employed as lecturers in the Institute for Local Administration in Benešov (a country-wide training center, where tests are held of the professional qualifications of employees of the state administration). Similar training is also provided by NGOs such as the Czech Environmental Management Center, the Czech Cleaner Production Center, Agentura Koniklec, etc. Training is concerned with legislation, EMAS, ISO standards, cleaner production, voluntary agreements, waste management, packaging technology, chemical and other hazardous substances, monitoring, modern technology, foreign and domestic know-how, work with the public, codexes and charters in this sphere, etc.

Information Centers and Consulting Centers

Czech National Council Act No. 173/1989 Coll., requires that the Ministry of the Environment create an information system on the environment, an integral part of which consists in public information services coordinated by the Ministry. They include services provided to the professional and general public by public general, professional and other specialized libraries, centers of scientific, technical and economic information, archives and other processing or mediating workplaces. This activity is effectively supplemented by printed outputs and presentation of information on the Internet. The Ministry also operates a special web site – the Environmental Library, which contains important and interesting publications issued or supported financially by the Ministry of the Environment. Some of them are also available in English or German, and occasionally also in French.

Participation of the public and NGOs

Environmental education of the public is carried out by institutions of the state administration in the area of the environment (the Ministry of the Environment, District Authorities, Administrations of protected landscape areas and national parks) and some other institutions, e.g. universities, professional scientific institutes, health-care or enlightenment and cultural educational institutions, some tourist centers, etc.

NGOs also play an important role here, especially civic associations or specialized professional federations and societies, and their environmental, agricultural or health-care consulting centers. The activity of some nonprofit organizations (nongovernmental or contributory) is very beneficial, especially that of environmental education centers, which provide services for the public, schools and schooling facilities in the area of environmental education, and possibly other services in the area of extracurricular education, work with parents and children or education and enlightenment of the public. Some important foundations, e.g., the Foundation for Development of a Civic Society, also support environmental education and public awareness.

At the present time, great emphasis is placed on public participation in decision-making in environmental matters and community cooperation and educational programs concerned with a healthy life style. Support for civic participation in environmental issues is also the subject of activities of some NGOs in their basic units concerned, amongst other things, with environmental consulting or NGOs established, amongst other things, as environmental consulting centers (e.g. Veronica, Rosa, Kosenka, Zelený bod Ostrava, etc.). The public also participates in the creation of some important documents, which are placed in their working versions on the web site of the Ministry for public discussion and comments (e.g. the State Program of Environmental Education and Public Awareness in CR, etc.).

Cooperation with NGOs

The Minister of the Environment organizes a meeting of the Green Forum about twice annually. This is a meeting of the Minister and senior employees of the Ministry with NGOs. The Minister and his institution answer a number of questions both at the meeting and also later, in writing. Civic associations and public benefit societies, as NGOs, can obtain state subsidies for their activities through the central bodies of the state administration. The Ministry has contributed to broader informing of the public in this area for a number of years and annually publishes the results of tenders for the individual years in the Bulletin of the Ministry of the Environment and on the Internet (http://www.env.cz), giving a brief survey of the outputs of the projects.

9.4 Related Legislation

Act No. 123/1998 Coll., esp. § 13, on the right to information on the environment deals with the right of the public to timely and complete information on the state of the environment and natural resources, that is available to bodies of the state administration, bodies of territorial self-governing units and the legal persons established, directed or authorized thereby.

Act No. 106/1999 Coll., on free access to information deals with the conditions for free public access to information and lays down the basic conditions under which this information is provided. The requesting party for the purpose of this Act is any natural or legal person who requests information.

Act No. 114/92 Coll., on the protection of nature and the landscape. Some areas of special natural value (about 15 % of the overall area of the country) are designated under special protective regimes pursuant to this Act.

Act No. 100/2001 on environmental impact assessment and amending some related laws (EIA) lays down that the locally competent unit of a civic association or public benefit society or municipality affected by a plan becomes a participant in the related procedure.

9.5 International Activities

The Czech Republic participates in a number of international projects concerned with environmental education and public awareness. These activities are methodically and financially supported directly by the Ministry of the Environment and the Ministry of Education, Youth and Physical Education.

The program Blue from the Sky is the national part of the originally pan-European Air Pollution educational program concerned with monitoring air quality. It has four separate parts. In the Ozone project, children and students study the effect of tropospheric ozone on plants in the spring. In the Lichens project, the occurrence of lichens is studied year-round. During four weeks in the autumn, children measure the acidity of precipitation in the Acid Rain project. In the Energy project, together with children from eight other European countries, they carry out measurements and measures leading to energy savings at their schools in the winter and spring. The GLOBE program is a global program in which CR has participated together with other countries since 1995. For the GLOBE program, scientists have developed a system of demonstrative and simultaneously simple measurements for students, permitting monitoring of trends in global environmental issues. In the framework of the global network of participants in the GLOBE program, students carry out measurements and observations of the quality of the environment in the areas of meteorology, hydrology, biometry, phenology, pedology and remote study of the Earth. They send their observations through the Internet to the NASA center in the USA.

In 1999 the Dutch-Czech "Tulip" project was carried out, concerned with implementation of a complex concept of environmental education at elementary schools, supported financially by the Ministries of the Environment and of Education, Youth and Physical Education. About 50 pilot schools and 9 pedagogical faculties participated in the project together, in particular, with environmental education clubs and centers. The Ministry of the Environment participated in the creation of the *International Visegrad Fund* with official seat in Bratislava in the Slovak Republic; in the first year of its existence in 2001, it announced subjects in the category of *Education*.

APPENDIX I

GHG EMISSION INVENTORIES FOR THE 1990–1999 PERIOD

SUMMARY REPORT FOR NATIONAL GREENHOUSE INVENTORIES, YEAR 1990

SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
			[Gg]			
Total National Emissions[d]	**163 209**	**778**	**26**	**743**	**1 055**	**311**
						435[c]
1 All Energy (Fuel Combustion + Fugitive)	**160 073**	**453**	**20**	**722**	**806**	**121**
A Fuel Combustion[b]	***160 073***	***59***	***20***	***722***	***806***	***112***
1 Energy & Transformation Activities	94 090	7	12	387	47	7
2 Industry (ISIC)	23 104	1	2	87	9	1
3 Transport	7 959	3	1	210	210	52
4 Commercial / Institutional	9 545	8	1	7	169	8
5 Residential	21 455	38	3	19	320	36
6 Agriculture / Forestry	4 948	2	0	12	51	8
B Fugitive Fuel Emissions	***0***	***394***	***0***	***0***	***0***	***10***
1 Coal Mining		362				
2 Oil and Natural Gas Systems		32				10
2 Industrial Processes	**5 417**	**14**	**3**	**22**	**231**	**15**
A Iron and Steel	*3 091[a]*	13		20	231	10
C Inorganic Chemicals	509		3	1		2
D Organic Chemicals		1				3
E Non-Metallic Mineral Products	4 908					
3 Solvent Use	**0**	**0**	**0**	**0**	**0**	**175**
A Paint Application						97
B Degreasing and Dry Cleaning						48
C Chemical Products Manufacture / Processing						31
4 Agriculture	**0**	**204**	**2**	**0**	**0**	**0**
A Enteric Fermentation		156				
B Animal Wastes		48				
C Agricultural Soils			2			
5 Land Use Change & Forestry	**-2 281**	**2**	**0**	**0**	**18**	**0**
A On-site Burning of Cleared Forest		2	0	0	18	
D Managed Forest	-2 281					
6 Waste	**0**	**105**	**0**	**0**	**0**	**0**
A Landfils		81				
B Wastewater		24				

Aggregated emission in Gg CO_2 eq.	CO_2	CH_4	N_2O	F-gas.	Total
Totals including bunkers	163 209	16 348	7 987	-	**187 544**

[a] *CO_2 emissions from Iron and Steel are included to the total in the sector 1A2*

[b] *CO_2 emissions from Fuel Combustion are taken from the IPCC Reference Approach*

[c] *Czech official value for UN ECE*

[d] *including bunkers*

SUMMARY REPORT FOR NATIONAL GREENHOUSE INVENTORIES, YEAR 1991

SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
			[Gg]			
Total National Emissions[d]	**148 115**	**711**	**23**	**726**	**1 101**	**243**
						398[c]
1 All Energy (Fuel Combustion + Fugitive)	**148 807**	**406**	**19**	**707**	**866**	**103**
A Fuel Combustion[b]	***148 807***	***50***	***19***	***707***	***866***	***94***
1 Energy & Transformation Activities	89 976	7	12	371	67	6
2 Industry (ISIC)	23 250	1	2	88	14	1
3 Transport	6 869	2	1	210	210	45
4 Commercial / Institutional	7 356	6	1	8	166	6
5 Residential	18 993	32	2	19	356	30
6 Agriculture / Forestry	3 559	2	0	11	54	6
B Fugitive Fuel Emissions	***0***	***356***	***0***	***0***	***0***	***9***
1 Coal Mining		321				
2 Oil and Natural Gas Systems		35				9
2 Industrial Processes	**4 335**	**12**	**3**	**19**	**220**	**13**
A Iron and Steel	*2 735[a]*	12		18	220	9
C Inorganic Chemicals	489		3	1		2
D Organic Chemicals		1				2
E Non-Metallic Mineral Products	3 846					
3 Solvent Use	**0**	**0**	**0**	**0**	**0**	**128**
A Paint Application						55
B Degreasing and Dry Cleaning						43
C Chemical Products Manufacture / Processing						30
4 Agriculture	**0**	**186**	**2**	**0**	**0**	**0**
A Enteric Fermentation		138				
B Animal Wastes		48				
C Agricultural Soils			2			
5 Land Use Change & Forestry	**-5 027**	**2**	**0**	**0**	**15**	**0**
A On-site Burning of Cleared Forest		2	0	0	15	
D Managed Forest	-5 027					
6 Waste	**0**	**105**	**0**	**0**	**0**	**0**
A Landfils		81				
B Wastewater		24				

Aggregated emission in Gg CO_2 eq.	CO_2	CH_4	N_2O	F-gas.	Total
Totals including bunkers	148 115	14 926	7 264	-	**170 304**

[a] *CO_2 emissions from Iron and Steel are included to the total in the sector 1A2*

[b] *CO_2 emissions from Fuel Combustion are taken from the IPCC Reference Approach*

[c] *Czech official value for UN ECE*

[d] *including bunkers*

SUMMARY REPORT FOR NATIONAL GREENHOUSE INVENTORIES, YEAR 1992

SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
			[Gg]			
Total National Emissions[d]	**134 179**	**668**	**23**	**699**	**1 045**	**234**
						359[c]
1 All Energy (Fuel Combustion + Fugitive)	**135 629**	**383**	**17**	**682**	**835**	**102**
A Fuel Combustion[b]	***135 629***	***41***	***17***	***682***	***835***	***92***
1 Energy & Transformation Activities	84 461	7	11	355	129	6
2 Industry (ISIC)	20 340	1	2	77	25	1
3 Transport	8 143	3	1	210	210	53
4 Commercial / Institutional	6 240	4	1	9	91	4
5 Residential	15 411	25	2	19	356	24
6 Agriculture / Forestry	2 206	1	0	11	24	4
B Fugitive Fuel Emissions	***0***	***342***	***0***	***0***	***0***	***10***
1 Coal Mining		306				
2 Oil and Natural Gas Systems		36				10
2 Industrial Processes	**4 591**	**11**	**4**	**17**	**197**	**12**
A Iron and Steel	*2 432[a]*	11		16	197	8
C Inorganic Chemicals	471		4	1		2
D Organic Chemicals		1				2
E Non-Metallic Mineral Products	4 120					
3 Solvent Use	**0**	**0**	**0**	**0**	**0**	**120**
A Paint Application						41
B Degreasing and Dry Cleaning						39
C Chemical Products Manufacture / Processing						40
4 Agriculture	**0**	**169**	**2**	**0**	**0**	**0**
A Enteric Fermentation		122				
B Animal Wastes		47				
C Agricultural Soils			2			
5 Land Use Change & Forestry	**-6 041**	**2**	**0**	**0**	**13**	**0**
A On-site Burning of Cleared Forest		2	0	0	13	
D Managed Forest	-6 041					
6 Waste	**0**	**104**	**0**	**0**	**0**	**0**
A Landfils		81				
B Wastewater		22				

Aggregated emission in Gg CO_2- eq.	**CO_2**	**CH_4**	**N_2O**	**F-gas.**	**Total**
Totals including bunkers	134 179	14 025	6 978	-	**155 182**

[a] *CO_2 emissions from Iron and Steel are included to the total in the sector 1A2*

[b] *CO_2 emissions from Fuel Combustion are taken from the IPCC Reference Approach*

[c] *Czech official value for UN ECE*

[d] *including bunkers*

SUMMARY REPORT FOR NATIONAL GREENHOUSE INVENTORIES, YEAR 1993

SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
			[Gg]			
Total National Emissions[d]	**129 208**	**633**	**21**	**574**	**967**	**229**
						338[c]
1 All Energy (Fuel Combustion + Fugitive)	**130 661**	**373**	**17**	**559**	**775**	**102**
A Fuel Combustion[b]	***130 661***	***39***	***17***	***559***	***775***	***91***
1 Energy & Transformation Activities	83 746	7	11	267	85	6
2 Industry (ISIC)	16 985	1	2	48	13	1
3 Transport	8 314	3	1	210	210	55
4 Commercial / Institutional	5 907	4	1	9	73	4
5 Residential	15 325	25	2	16	373	23
6 Agriculture / Forestry	1 716	1	0	9	20	3
B Fugitive Fuel Emissions	***0***	***333***	***0***	***0***	***0***	***11***
1 Coal Mining		298				
2 Oil and Natural Gas Systems		35				11
2 Industrial Processes	**4 190**	**10**	**3**	**16**	**178**	**11**
A Iron and Steel	*2 238[a]*	10		15	178	7
C Inorganic Chemicals	518		3	1		2
D Organic Chemicals		1				2
E Non-Metallic Mineral Products	3 673					
3 Solvent Use	**0**	**0**	**0**	**0**	**0**	**116**
A Paint Application						31
B Degreasing and Dry Cleaning						36
C Chemical Products Manufacture / Processing						49
4 Agriculture	**0**	**148**	**2**	**0**	**0**	**0**
A Enteric Fermentation		106				
B Animal Wastes		41				
C Agricultural Soils			2			
5 Land Use Change & Forestry	**-5 643**	**2**	**0**	**0**	**14**	**0**
A On-site Burning of Cleared Forest		2	0	0	14	
D Managed Forest	-5 643					
6 Waste	**0**	**100**	**0**	**0**	**0**	**0**
A Landfils		81				
B Wastewater		19				

Aggregated emission in Gg CO_2 eq.	CO_2	CH_4	N_2O	F-gas.	Total
Totals including bunkers	129 208	13 287	6 573	-	**149 068**

[a] *CO_2 emissions from Iron and Steel are included to the total in the sector 1A2*

[b] *CO_2 emissions from Fuel Combustion are taken from the IPCC Reference Approach*

[c] *Czech official value for UN ECE*

[d] *including bunkers*

SUMMARY REPORT FOR NATIONAL GREENHOUSE INVENTORIES, YEAR 1994

SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
			[Gg]			
Total National Emissions[d]	**123 802**	**613**	**22**	**435**	**1 042**	**263**
						310[c]
1 All Energy (Fuel Combustion + Fugitive)	**123 631**	**361**	**17**	**427**	**811**	**118**
A Fuel Combustion[b]	***123 631***	***44***	***17***	***427***	***811***	***105***
1 Energy & Transformation Activities	61 373	5	9	131	51	9
2 Industry (ISIC)	33 368	3	5	68	25	4
3 Transport	8 260	1	1	199	285	25
4 Commercial / Institutional	5 100	4	1	6	53	7
5 Residential	13 639	29	2	16	373	54
6 Agriculture / Forestry	1 895	3	0	7	24	5
B Fugitive Fuel Emissions	***0***	***317***	***0***	***0***	***0***	***13***
1 Coal Mining		282				
2 Oil and Natural Gas Systems		35				13
2 Industrial Processes	**4 114**	**12**	**3**	**8**	**215**	**11**
A Iron and Steel	*2 531[a]*	11		7	215	7
C Inorganic Chemicals	518		3	1		2
D Organic Chemicals		1				2
E Non-Metallic Mineral Products	3 596					
3 Solvent Use	**0**	**0**	**0**	**0**	**0**	**133**
A Paint Application						44
B Degreasing and Dry Cleaning						36
C Chemical Products Manufacture / Processing						53
4 Agriculture	**0**	**139**	**2**	**0**	**0**	**0**
A Enteric Fermentation		100				
B Animal Wastes		39				
C Agricultural Soils			2			
5 Land Use Change & Forestry	**-3 943**	**2**	**0**	**0**	**16**	**0**
A On-site Burning of Cleared Forest		2	0	0	16	
D Managed Forest	-3 943					
6 Waste	**0**	**101**	**0**	**0**	**0**	**0**
A Landfils		81				
B Wastewater		19				

Aggregated emission in Gg CO_2 eq.	CO_2	CH_4	N_2O	F-gas.	Total
Totals including bunkers	123 802	12 882	6 679	-	**143 364**

[a] CO_2 emissions from Iron and Steel are included to the total in the sector 1A2

[b] CO_2 emissions from Fuel Combustion are taken from the IPCC Reference Approach

[c] Czech official value for UN ECE

[d] including bunkers

SUMMARY REPORT FOR NATIONAL GREENHOUSE INVENTORIES, YEAR 1995

SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
			[Gg]			
Total National Emissions[d]	**123 362**	**599**	**22**	**415**	**874**	**241**
						286[c]
1 All Energy (Fuel Combustion + Fugitive)	**124 647**	**347**	**16**	**406**	**644**	**95**
A Fuel Combustion[b]	***124 647***	***32***	***16***	***406***	***644***	***82***
1 Energy & Transformation Activities	66 574	5	9	128	59	9
2 Industry (ISIC)	30 124	2	4	56	24	3
3 Transport	8 912	1	1	193	266	24
4 Commercial / Institutional	4 942	4	1	6	57	8
5 Residential	12 551	17	1	16	226	33
6 Agriculture / Forestry	1 546	2	0	7	13	5
B Fugitive Fuel Emissions	***0***	***315***	***0***	***0***	***0***	***13***
1 Coal Mining		277				
2 Oil and Natural Gas Systems		38				13
2 Industrial Processes	**4 170**	**12**	**3**	**9**	**215**	**12**
A Iron and Steel	*2 541[a]*	11		7	215	7
C Inorganic Chemicals	540		3	1		2
D Organic Chemicals		1				3
E Non-Metallic Mineral Products	3 630					
3 Solvent Use	**0**	**0**	**0**	**0**	**0**	**134**
A Paint Application						41
B Degreasing and Dry Cleaning						37
C Chemical Products Manufacture / Processing						55
4 Agriculture	**0**	**139**	**2**	**0**	**0**	**0**
A Enteric Fermentation		99				
B Animal Wastes		40				
C Agricultural Soils			2			
5 Land Use Change & Forestry	**-5 454**	**2**	**0**	**0**	**14**	**0**
A On-site Burning of Cleared Forest		2	0	0	14	
D Managed Forest	-5 454					
6 Waste	**0**	**101**	**0**	**0**	**0**	**0**
A Landfils		81				
B Wastewater		19				

Emissions of HFCs, PFCs and SF_6	HFCs	PFCs	SF_6	Total
in Gg CO_2 eq.	2	0	167	**169**

Aggregated emission in Gg CO_2 eq.	CO_2	CH_4	N_2O	F-gas.	Total
Totals including bunkers	123 362	12 589	6 698	169	**142 819**

[a] CO_2 emissions from Iron and Steel are included to the total in the sector 1A2

[b] CO_2 emissions from Fuel Combustion are taken from the IPCC Reference Approach

[c] Czech official value for UN ECE

[d] including bunkers

SUMMARY REPORT FOR NATIONAL GREENHOUSE INVENTORIES, YEAR 1996

GHG SOURCE AND SINKS CATEGORIES	NATIONAL EMISSIONS, Gg						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals	**128 344**	**573**	**29**	**433**	**906**	**282**	**946**
1 Energy	**129 885**	**335**	**4**	**413**	**672**	**140**	**932**
A Fuel Combustion – Reference Approach	***129 809***						
– Sectorial Approach	129 516	***34***	***4***	***413***	***668***	***134***	***928***
1 Energy Industries	57 818	3	1	111	59	5	503
2 Manufact. Industries & Constr.	43 867	1	0	53	24	2	310
3 Transport	9 896	4	2	188	251	67	7
4 Other Sectors	17 936	27	1	61	334	60	107
B Fugitive Emissions from Fuels	***76***	***301***	***0***	***0***	***4***	***5***	***5***
1 Solid Fuels	76	268					
2 Oil and Natural Gas	0	32	0	0	4	5	5
2 Industrial Processes	**2 479**	**5**	**3**	**19**	**214**	**24**	**14**
A Mineral Products	2 479	0	0	5	7	5	3
B Chemical Industry		0	3	10	10	7	2
C Metal Production		4	0	4	195	6	8
D Other Production (Food + Paper)		0	0	1	1	7	2
3 Solvent and Other Product Use	**109**		**1**			**118**	
4 Agriculture		**134**	**21**				
A Enteric Fermentation		98					
B Manure Management		36					
D Agricultural Soils and Other N_2O emiss.			21				
5 Land-Use Change & Forestry	**-4 486**	**2**	**0**	**0**	**20**	**0**	
6 Waste	**357**	**97**	**0**				
A Solid Waste Disposal on Land		81	0				
B Wastewater Handling		16					
C Waste Incineration	357						
Memo Items:							
International Bunkers	**459**	**0**	**0**	**3**	**8**	**3**	**0**
Aviation	459	0	0	3	8	3	0
Totals including bunkers	***128 803***	***573***	***29***	*436*	*915*	*286*	*946*

Emissions of HFCs, PFCs and SF_6	**HFCs**	**PFCs**	**SF_6**	**Total**
in Gg CO_2 eq.	134	4	183	**321**

Aggregated emission in Gg CO_2 eq.	**CO_2**	**CH_4**	**N_2O**	**F-gas.**	**Total**
National Totals (excluding bunkers)	128 344	12 031	9 117	321	**149 814**
Totals including bunkers	128 803	12 034	9 117	321	**150 276**

CO_2 emissions from Iron and Steel are included to the total in the sector 1A2
CO_2 emissions from Fuel Combustion are based on the IPCC Reference Approach

SUMMARY REPORT FOR NATIONAL GREENHOUSE INVENTORIES, YEAR 1997

GHG SOURCE AND SINKS CATEGORIES	NATIONAL EMISSIONS, Gg						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals	**130 035**	**562**	**29**	**422**	**899**	**274**	**701**
1 Energy	**131 715**	**330**	**4**	**406**	**677**	**146**	**689**
A Fuel Combustion – Reference Approach	***131 474***						
– Sectorial Approach	133 925	***31***	***4***	***406***	***673***	***141***	***684***
1 Energy Industries	59 180	2	1	81	53	4	212
2 Manufact. Industries & Constr.	43 341	2	0	64	34	3	352
3 Transport	11 392	4	2	197	299	80	7
4 Other Sectors	20 013	23	1	64	287	54	112
B Fugitive Emissions from Fuels	***241***	***298***	***0***	***0***	***4***	***5***	***5***
1 Solid Fuels	241	263					
2 Oil and Natural Gas	0	35	0	0	4	5	5
2 Industrial Processes	**2 498**	**4**	**4**	**16**	**202**	**15**	**12**
A Mineral Products	2 498	0	0	3	10	1	3
B Chemical Industry		0	4	8	9	3	3
C Metal Production		4	0	4	182	3	6
D Other Production (Food + Paper)		0	0	1	0	8	0
3 Solvent and Other Product Use	**104**		**1**			**113**	
4 Agriculture		**129**	**19**				
A Enteric Fermentation		93					
B Manure Management		36					
D Agricultural Soils and Other N_2O emiss.			19				
5 Land-Use Change & Forestry	**-4 639**	**2**	**0**	**0**	**20**	**0**	
6 Waste	**357**	**97**	**1**				
A Solid Waste Disposal on Land		81	0				
B Wastewater Handling		16	1				
C Waste Incineration	357						
Memo Items:							
International Bunkers	**407**	**0**	**0**	**2**	**7**	**3**	**0**
Aviation	407	0	0	2	7	3	0
Totals including bunkers	***130 442***	***562***	***29***	*425*	*906*	*277*	*701*

Emissions of HFCs, PFCs and SF_6	HFCs	PFCs	SF_6	Total
in Gg CO_2 eq.	296	7	323	**626**

Aggregated emission in Gg CO_2 eq.	CO_2	CH_4	N_2O	F-gas.	Total
National Totals (excluding bunkers)	130 035	11 808	8 883	626	**151 351**
Totals including bunkers	130 442	11 810	8 883	626	**151 761**

CO_2 emissions from Iron and Steel are included to the total in the sector 1A2
CO_2 emissions from Fuel Combustion are based on the IPCC Reference Approach

SUMMARY REPORT FOR NATIONAL GREENHOUSE INVENTORIES, YEAR 1998

GHG SOURCE AND SINKS CATEGORIES	NATIONAL EMISSIONS, Gg						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals	**124 511**	**529**	**27**	**414**	**787**	**267**	**443**
1 Energy	**124 903**	**304**	**4**	**398**	**584**	**141**	**429**
A Fuel Combustion – Reference Approach	*122 663*						
– Sectorial Approach	***124 486***	***23***	***4***	***397***	***584***	***139***	***425***
1 Energy Industries	58 706	2	2	76	52	4	186
2 Manufact. Industries & Constr.	35 376	1	1	52	27	2	159
3 Transport	10 779	2	1	192	273	73	5
4 Other Sectors	19 624	17	0	78	231	59	75
B Fugitive Emissions from Fuels	***417***	***281***	***0***	***0***	***1***	***2***	***5***
1 Solid Fuels	417	253					
2 Oil and Natural Gas	0	28	0	0	1	2	5
2 Industrial Processes	**2 661**	**4**	**4**	**16**	**184**	**10**	**14**
A Mineral Products	2 661	0	0	3	10	1	3
B Chemical Industry		0	4	7	9	1	2
C Metal Production		4	0	5	164	2	8
D Other Production (Food + Paper)		0	0	1	0	7	0
3 Solvent and Other Product Use	**347**		**1**			**116**	
4 Agriculture		**121**	**17**				
A Enteric Fermentation		86					
B Manure Management		35					
D Agricultural Soils and Other N_2O emiss.			17				
5 Land-Use Change & Forestry	**-3 757**	**2**	**0**	**0**	**20**	**0**	
6 Waste	**357**	**98**	**1**				
A Solid Waste Disposal on Land		82	0				
B Wastewater Handling		17	1				
C Waste Incineration	357						
Memo Items:							
International Bunkers	**225**	**0**	**0**	**1**	**4**	**2**	**0**
Aviation	225	0	0	1	4	2	0
Totals including bunkers	***124 735***	***529***	***27***	*415*	*792*	*269*	*443*

Emissions of HFCs, PFCs and SF_6	HFCs	PFCs	SF_6	Total
in Gg CO_2 eq.	382	9	131,7	**523**

Aggregated emission in Gg CO_2 eq.	CO_2	CH_4	N_2O	F-gas.	Total
National Totals (excluding bunkers)	124 511	11 117	8 390	523	**144 540**
Totals including bunkers	124 735	11 118	8 395	523	**144 771**

CO_2 emissions from Iron and Steel are included to the total in the sector 1A2
CO_2 emissions from Fuel Combustion are based on the IPCC Sectoral Approach

SUMMARY REPORT FOR NATIONAL GREENHOUSE INVENTORIES, YEAR 1999

GHG SOURCE AND SINKS CATEGORIES	NATIONAL EMISSIONS, Gg						
	CO_2	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total National Emissions and Removals	**117 692**	**517**	**26**	**390**	**709**	**244**	**269**
1 Energy	**118 038**	**279**	**4**	**365**	**544**	**123**	**258**
A Fuel Combustion – Reference Approach	*115 136*						
– Sectorial Approach	***117 501***	***21***	***4***	***364***	***543***	***122***	***253***
1 Energy Industries	53 848	2	2	62	7	4	83
2 Manufact. Industries & Constr.	34 156	1	1	48	10	2	94
3 Transport	12 016	2	2	194	291	76	5
4 Other Sectors	17 481	16	0	60	235	40	71
B Fugitive Emissions from Fuels	***537***	***258***	***0***	***0***	***1***	***1***	***5***
1 Solid Fuels	537	229					
2 Oil and Natural Gas	0	29	0	0	1	1	5
2 Industrial Processes	**2 362**	**4**	**3**	**25**	**142**	**8**	**11**
A Mineral Products	2 362	0	0	12	7	3	4
B Chemical Industry		0	3	7	3	0	2
C Metal Production		4	0	5	130	1	5
D Other Production (Food + Paper)		0	0	1	1	5	0
3 Solvent and Other Product Use	**336**		**1**			**113**	
4 Agriculture		**121**	**17**				
A Enteric Fermentation		85					
B Manure Management		35					
D Agricultural Soils and Other N_2O emiss.			17				
5 Land-Use Change & Forestry	**-3 401**	**3**	**0**	**0**	**23**	**0**	
6 Waste	***357***	**111**	**1**				
A Solid Waste Disposal on Land		82					
B Wastewater Handling		29	1				
C Waste Incineration	357						
Memo Items:							
International Bunkers	**539**	**0**	**0**	**3**	**10**	**4**	**0**
Aviation	539	0	0	3	10	4	0
Totals including bunkers	***118 231***	***517***	***26***	*393*	*719*	*248*	*269*

Emissions of HFCs, PFCs and SF_6	**HFCs**	**PFCs**	**SF_6**	**Total**
in Gg CO_2 eq.	412	3	111	**526**

Aggregated emission in Gg CO_2 eq.	**CO_2**	**CH_4**	**N_2O**	**F-gas.**	**Total**
National Totals (excluding bunkers)	117 692	10 849	8 111	526	**137 178**
Totals including bunkers	118 231	10 852	8 116	526	**137 725**

CO_2 emissions from Iron and Steel are included to the total in the sector 1A2
CO_2 emissions from Fuel Combustion are based on the IPCC Sectoral Approach

APPENDIX II

GHG EMISSION PROJECTIONS
FOR THE YEARS 2000, 2005, 2010 AND 2020

CO_2 EMISSION PROJECTIONS – HIGH SCENARIO

GHG SOURCE AND SINKS CATEGORIES	1999	2000	2005	2010	2015	2020
	[Gg]					
Total National Emissions and Removals	**117 692**	**121 680**	**121 105**	**121 801**	**127 310**	**127 137**
1 Energy	**118 038**	**122 100**	**121 067**	**121 471**	**126 559**	**125 987**
A Fuel Combustion	*115 136*					
– Sectorial Approach	***117 501***	***121 491***	***120 524***	***120 936***	***126 071***	***125 602***
1 Energy Industries	53 848	61 360	61 261	60 090	57 194	50 365
2 Manufact. Industries & Constr.	34 156	35 110	33 896	36 111	42 132	49 012
3 Transport	12 016	11 659	12 257	12 322	13 905	13 432
4 Other Sectors	17 481	13 361	13 110	12 413	12 840	12 793
B Fugitive Emissions from Fuels	***537***	***609***	***543***	***535***	***488***	***385***
1 Solid Fuels	537	609	543	535	488	385
2 Oil and Natural Gas	0	0	0	0	0	0
2 Industrial Processes	**2 362**	**2 288**	**2 696**	**2 941**	**3 103**	**3 245**
A Mineral Products	2 362	2 288	2 696	2 941	3 103	3 245
B Chemical Industry						
C Metal Production						
D Other Production (Food + Paper)						
3 Solvent and Other Product Use	**336**	**336**	**336**	**336**	**336**	**336**
4 Agriculture						
A Enteric Fermentation						
B Manure Management						
D Agricultural Soils and Other N_2O emiss.						
5 Land-Use Change & Forestry	**-3 401**	**-3 401**	**-3 487**	**-3 575**	**-3 665**	**-3 758**
6 Waste	**357**	**357**	**493**	**628**	**977**	**1 326**
A Solid Waste Disposal on Land						
B Wastewater Handling						
C Waste Incineration	357	357	493	628	977	1 326
Memo Items:						
International Bunkers	**539**	**498**	**523**	**549**	**576**	**605**
Aviation	539	498	523	549	576	605

CO_2 emissions from Iron and Steel are included to the total in the sector 1A2

CO_2 emissions from Fuel Combustion are based on the IPCC Sectoral Approach

CO_2 EMISSION PROJECTIONS – REFERENCE SCENARIO

GHG SOURCE AND SINKS CATEGORIES	1999	2000	2005	2010	2015	2020
	[Gg]					
Total National Emissions and Removals	**117 692**	**121 680**	**106 601**	**109 064**	**105 749**	**103 344**
1 Energy	**118 038**	**122 100**	**106 875**	**109 055**	**105 420**	**102 691**
A Fuel Combustion	*115 136*					
– Sectorial Approach	***117 501***	***121 491***	***106 397***	***108 520***	***104 932***	***102 276***
1 Energy Industries	53 848	61 360	51 573	57 257	52 763	49 279
2 Manufact. Industries & Constr.	34 156	35 110	29 580	27 183	28 816	31 232
3 Transport	12 016	11 659	11 585	11 372	12 128	11 052
4 Other Sectors	17 481	13 361	13 659	12 708	11 226	10 713
B Fugitive Emissions from Fuels	***537***	***609***	***478***	***535***	***488***	***415***
1 Solid Fuels	537	609	478	535	488	415
2 Oil and Natural Gas	0	0	0	0	0	0
2 Industrial Processes	**2 362**	**2 288**	**2 411**	**2 670**	**2 767**	**2 868**
A Mineral Products	2 362	2 288	2 411	2 670	2 767	2 868
B Chemical Industry						
C Metal Production						
D Other Production (Food + Paper)						
3 Solvent and Other Product Use	**336**	**336**	**336**	**336**	**336**	**336**
4 Agriculture						
A Enteric Fermentation						
B Manure Management						
D Agricultural Soils and Other N_2O emiss.						
5 Land-Use Change & Forestry	**-3 401**	**-3 401**	**-3 444**	**-3 487**	**-3 531**	**-3 575**
6 Waste	**357**	**357**	**424**	**490**	**757**	**1 024**
A Solid Waste Disposal on Land						
B Wastewater Handling						
C Waste Incineration	357	357	424	490	757	1 024
Memo Items:						
International Bunkers	**539**	**498**	**523**	**549**	**576**	**605**
Aviation	539	498	523	549	576	605

CO_2 emissions from Iron and Steel are included to the total in the sector 1A2
CO_2 emissions from Fuel Combustion are based on the IPCC Sectoral Approach

CH_4 EMISSION PROJECTIONS – HIGH SCENARIO

GHG SOURCE AND SINKS CATEGORIES	1999	2000	2005	2010	2015	2020
	[Gg]					
Total National Emissions and Removals	**516.599**	**521.830**	**521.409**	**488.411**	**449.679**	**415.344**
1 Energy	**278.684**	**283.916**	**283.198**	**247.234**	**230.261**	**207.411**
A Fuel Combustion						
– Sectorial Approach	***20.954***	***17.207***	***15.893***	***12.385***	***12.435***	***12.017***
1 Energy Industries	1.658	1.972	1.984	1.979	1.904	1.752
2 Manufact. Industries & Constr.	1.280	1.292	1.487	1.592	1.857	2.153
3 Transport	1.898	2.020	1.895	1.909	2.013	2.041
4 Other Sectors	16.118	11.923	10.527	6.906	6.661	6.071
B Fugitive Emissions from Fuels	***257.731***	***266.709***	***267.305***	***234.849***	***217.827***	***195.394***
1 Solid Fuels	228.960	238.768	232.469	196.542	174.204	146.158
2 Oil and Natural Gas	28.770	27.941	34.836	38.306	43.622	49.236
2 Industrial Processes	**3.919**	**3.919**	**3.919**	**3.919**	**3.919**	**3.919**
A Mineral Products	0.000	0.000	0.000	0.000	0.000	0.000
B Chemical Industry	0.399	0.399	0.399	0.399	0.399	0.399
C Metal Production	3.520	3.520	3.520	3.520	3.520	3.520
D Other Production (Food + Paper)	0.000	0.000	0.000	0.000	0.000	0.000
3 Solvent and Other Product Use						
4 Agriculture	**120.502**	**120.502**	**121.962**	**126.027**	**128.293**	**130.526**
A Enteric Fermentation	85.164	85.164	86.196	89.069	90.670	92.248
B Manure Management	35.338	35.338	35.766	36.958	37.623	38.277
D Agricultural Soils and Other N_2O emiss.						
5 Land-Use Change & Forestry	**2.579**	**2.579**	**2.579**	**2.579**	**2.579**	**2.579**
6 Waste	**110.915**	**110.915**	**109.752**	**108.653**	**84.627**	**70.910**
A Solid Waste Disposal on Land	81.560	81.560	79.030	76.499	50.975	35.690
B Wastewater Handling	29.355	29.355	30.722	32.154	33.652	35.220
C Waste Incineration						
Memo Items:						
International Bunkers	**0.160**	**0.147**	**0.154**	**0.162**	**0.170**	**0.179**
Aviation	0.160	0.147	0.154	0.162	0.170	0.179

CO_2 emissions from Iron and Steel are included to the total in the sector 1A2

CO_2 emissions from Fuel Combustion are based on the IPCC Sectoral Approach

CH_4 EMISSION PROJECTIONS – REFERENCE SCENARIO

GHG SOURCE AND SINKS CATEGORIES	1999	2000	2005	2010	2015	2020
	[Gg]					
Total National Emissions and Removals	**516.599**	**521.830**	**505.366**	**469.369**	**410.097**	**390.830**
1 Energy	**278.684**	**283.916**	**274.981**	**229.558**	**192.802**	**185.827**
A Fuel Combustion						
– Sectorial Approach	***20.954***	***17.207***	***16.658***	***13.030***	***10.387***	***10.609***
1 Energy Industries	1.658	1.972	1.729	1.885	1.757	1.662
2 Manufact. Industries & Constr.	1.280	1.292	1.329	1.244	1.287	1.443
3 Transport	1.898	2.020	1.635	1.609	1.604	1.577
4 Other Sectors	16.118	11.923	11.966	8.292	5.740	5.927
B Fugitive Emissions from Fuels	***257.731***	***266.709***	***258.323***	***216.528***	***182.414***	***175.218***
1 Solid Fuels	228.960	238.768	229.129	185.943	148.075	141.182
2 Oil and Natural Gas	28.770	27.941	29.194	30.585	34.339	34.036
2 Industrial Processes	**3.919**	**3.919**	**3.919**	**3.919**	**3.919**	**3.919**
A Mineral Products	0.000	0.000	0.000	0.000	0.000	0.000
B Chemical Industry	0.399	0.399	0.399	0.399	0.399	0.399
C Metal Production	3.520	3.520	3.520	3.520	3.520	3.520
D Other Production (Food + Paper)	0.000	0.000	0.000	0.000	0.000	0.000
3 Solvent and Other Product Use						
4 Agriculture	**120.502**	**120.502**	**114.796**	**126.027**	**128.293**	**130.526**
A Enteric Fermentation	85.164	85.164	79.030	89.069	90.670	92.248
B Manure Management	35.338	35.338	35.766	36.958	37.623	38.277
D Agricultural Soils and Other N_2O emiss.						
5 Land-Use Change & Forestry	**2.579**	**2.579**	**2.579**	**2.579**	**2.579**	**2.579**
6 Waste	**110.915**	**110.915**	**109.092**	**107.286**	**82.505**	**67.980**
A Solid Waste Disposal on Land	81.560	81.560	79.030	76.499	50.975	35.690
B Wastewater Handling	29.355	29.355	30.063	30.787	31.530	32.290
C Waste Incineration						
Memo Items:						
International Bunkers	**0.160**	**0.147**	**0.154**	**0.162**	**0.170**	**0.179**
Aviation	0.160	0.147	0.154	0.162	0.170	0.179

CO_2 emissions from Iron and Steel are included to the total in the sector 1A2
CO_2 emissions from Fuel Combustion are based on the IPCC Sectoral Approach

N_2O EMISSION PROJECTIONS – HIGH SCENARIO

GHG SOURCE AND SINKS CATEGORIES	1999	2000	2005	2010	2015	2020
			[Gg]			
Total National Emissions and Removals	**26.166**	**26.290**	**26.339**	**26.316**	**26.412**	**26.382**
1 Energy	**4.464**	**4.588**	**4.630**	**4.612**	**4.712**	**4.686**
A Fuel Combustion						
– Sectorial Approach	***4.464***	***4.588***	***4.630***	***4.612***	***4.712***	***4.686***
1 Energy Industries	1.950	2.173	2.160	2.160	2.068	1.871
2 Manufact. Industries & Constr.	0.600	0.636	0.707	0.732	0.839	0.995
3 Transport	1.579	1.570	1.577	1.589	1.675	1.699
4 Other Sectors	0.335	0.209	0.186	0.131	0.129	0.121
B Fugitive Emissions from Fuels	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***
1 Solid Fuels						
2 Oil and Natural Gas	0.000	0.000	0.000	0.000	0.000	0.000
2 Industrial Processes	**3.221**	**3.221**	**3.221**	**3.221**	**3.221**	**3.221**
A Mineral Products	0.000	0.000	0.000	0.000	0.000	0.000
B Chemical Industry	3.221	3.221	3.221	3.221	3.221	3.221
C Metal Production	0.000	0.000	0.000	0.000	0.000	0.000
D Other Production (Food + Paper)	0.000	0.000	0.000	0.000	0.000	0.000
3 Solvent and Other Product Use	0.692	0.692	0.692	0.692	0.692	0.692
4 Agriculture	**17.140**	**17.140**	**17.147**	**17.143**	**17.139**	**17.135**
A Enteric Fermentation						
B Manure Management						
D Agricultural Soils and Other N_2O emiss.	17.140	17.140	17.147	17.143	17.139	17.135
5 Land-Use Change & Forestry	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**
6 Waste	**0.647**	**0.647**	**0.647**	**0.647**	**0.647**	**0.647**
A Solid Waste Disposal on Land						
B Wastewater Handling	0.647	0.647	0.647	0.647	0.647	0.647
C Waste Incineration						
Memo Items:						
International Bunkers	**0.015**	**0.014**	**0.014**	**0.015**	**0.016**	**0.017**
Aviation	0.015	0.014	0.014	0.015	0.016	0.017

CO_2 emissions from Iron and Steel are included to the total in the sector 1A2
CO_2 emissions from Fuel Combustion are based on the IPCC Sectoral Approach

N_2O EMISSION PROJECTIONS – REFERENCE SCENARIO

GHG SOURCE AND SINKS CATEGORIES	1999	2000	2005	2010	2015	2020
	[Gg]					
Total National Emissions and Removals	**26.166**	**26.290**	**25.788**	**25.858**	**25.680**	**25.653**
1 Energy	**4.464**	**4.588**	**4.080**	**4.153**	**3.979**	**3.956**
A Fuel Combustion						
– Sectorial Approach	***4.464***	***4.588***	***4.080***	***4.153***	***3.979***	***3.956***
1 Energy Industries	1.950	2.173	1.871	2.075	1.952	1.799
2 Manufact. Industries & Constr.	0.600	0.636	0.641	0.592	0.588	0.734
3 Transport	1.579	1.570	1.361	1.339	1.335	1.312
4 Other Sectors	0.335	0.209	0.208	0.147	0.104	0.111
B Fugitive Emissions from Fuels	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***
1 Solid Fuels						
2 Oil and Natural Gas	0.000					
2 Industrial Processes	**3.221**	**3.221**	**3.221**	**3.221**	**3.221**	**3.221**
A Mineral Products	0.000	0.000	0.000	0.000	0.000	0.000
B Chemical Industry	3.221	3.221	3.221	3.221	3.221	3.221
C Metal Production	0.000	0.000	0.000	0.000	0.000	0.000
D Other Production (Food + Paper)	0.000	0.000	0.000	0.000	0.000	0.000
3 Solvent and Other Product Use	0.692	0.692	0.692	0.692	0.692	0.692
4 Agriculture	**17.140**	**17.140**	**17.147**	**17.143**	**17.139**	**17.135**
A Enteric Fermentation						
B Manure Management						
D Agricultural Soils and Other N_2O emiss.	17.140	17.140	17.147	17.143	17.139	17.135
5 Land-Use Change & Forestry	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**	**0.002**
6 Waste	**0.647**	**0.647**	**0.647**	**0.647**	**0.647**	**0.647**
A Solid Waste Disposal on Land						
B Wastewater Handling	0.647	0.647	0.647	0.647	0.647	0.647
C Waste Incineration						
Memo Items:						
International Bunkers	**0.015**	**0.014**	**0.014**	**0.015**	**0.016**	**0.017**
Aviation	0.015	0.014	0.014	0.015	0.016	0.017

CO_2 emissions from Iron and Steel are included to the total in the sector 1A2
CO_2 emissions from Fuel Combustion are based on the IPCC Sectoral Approach

HFCs, PFCs, SF_6 EMISSION PROJECTIONS – HIGH SCENARIO

Emission (Gg CO_2 eq.)	1999	2000	2005	2010	2015	2020
HFCs	**411.89**	420	553	650	780	910
PFCs	**2.70**	4	11	18	21	26
SF_6	**110.85**	120	170	215	240	287
Total	**525.44**	**544**	**734**	**883**	**1 041**	**1 223**

HFCs, PFCs, SF_6 EMISSION PROJECTIONS – REFERENCE SCENARIO

Emission (Gg CO_2 eq.)	1999	2000	2005	2010	2015	2020
HFCs	**411.89**	420	520	585	650	780
PFCs	**2.70**	4	7	14	18	21
SF_6	**110.85**	120	145	194	228	264
Total	**525.44**	**544**	**672**	**793**	**896**	**1 065**

GREENHOUSE GASES EMISSION PROJECTIONS – HIGH SCENARIO

Emissions (Gg)	1999	2000	2005	2010	2015	2020
CO_2	**118 231**	122 178	121 628	122 350	127 886	127 742
CH_4	**516.758**	522	522	489	450	416
N_2O	**26.181**	26	26	26	26	26
Emission (Gg CO_2 eq.)						
CO_2	**118 231**	122 178	121 628	122 350	127 886	127 742
CH_4	**10 852**	10 962	10 953	10 260	9 447	8 726
N_2O	**8 116**	8 154	8 170	8 163	8 193	8 184
HFCs, PFCs, SF_6	**525**	544	734	883	1 041	1 223
Total	**137 724**	**141 837**	**141 484**	**141 656**	**146 567**	**145 875**

GREENHOUSE GASES EMISSION PROJECTIONS – REFERENCE SCENARIO

Emission (Gg)	1999	2000	2005	2010	2015	2020
CO_2	**118 231**	122 178	107 124	109 613	106 326	103 949
CH_4	**516.758**	522	506	470	410	391
N_2O	**26.181**	26	26	26	26	26
Emission (Gg CO_2 eq.)						
CO_2	**118 231**	122 178	107 124	109 613	106 326	103 949
CH_4	**10 852**	10 962	10 616	9 860	8 616	8 211
N_2O	**8 116**	8 154	7 999	8 021	7 966	7 958
HFCs, PFCs, SF_6	**525**	544	672	793	896	1 065
Total	**137 724**	**141 837**	**126 411**	**128 287**	**123 803**	**121 183**

EVALUATION OF EFFECT OF POLICIES AND MEASURES ON GHG EMISSIONS

Reference Scenario

GHG (Gg CO_2 eq.)	1990	1995	1996	1997	1998	1999	2000	2005	2010	2015	2020
Inventory	187 544	142 713	150 362	151 551	144 772	137 724					
With measures							141 837	126 411	128 287	123 803	121 183
Without measures		142 713	151 162	153 151	148 771	144 123	149 835	135 325	138 420	135 530	133 086
With additional measures							141 837	119 958	121 873	117 389	114 769

High Scenario

GHG (Gg CO_2 eq.)	1990	1995	1996	1997	1998	1999	2000	2005	2010	2015	2020
Inventory	187 544	142 713	150 362	151 551	144 772	137 724					
With measures							141 837	141 484	141 656	146 567	145 875
Without measures		142 713	151 162	153 151	148 771	144 123	149 835	151 081	152 644	159 428	159 200
With additional measures							141 837	135 031	135 242	140 153	139 461

"With measures" scenario comparison

GHG (Gg CO_2 eq.)	1990	1995	1996	1997	1998	1999	2000	2005	2010	2015	2020
Inventory	187 544	142 713	150 362	151 551	144 772	137 724					
High scenario with measures							141 837	141 484	141 656	146 567	145 875
Reference scenario with measures							141 837	126 411	128 287	123 803	121 183

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