FIFTH NATIONAL COMMUNICATION OF THE CZECH REPUBLIC
ON THE UN FRAMEWORK CONVENTION ON CLIMATE CHANGE
INCLUDING
SUPPLEMENTARY INFORMATION PURSUANT TO ARTICLE 7.2 OF THE KYOTO PROTOCOL

Ministry of the Environment of the Czech Republic

Prague 2009

Coordination

Ministry of the Environment of the Czech Republic in cooperation with Integra Consulting Services s.r.o.

Co-authors

Bízek	Vladislav	Technology Centre of the Academy of Sciences of the Czech Republic
Fott	Pavel	Czech Hydrometeorological Institute
Konečná	Kateřina	Ministry of the Environment of the Czech Republic
Kontrošová	Jana	Ministry of the Environment of the Czech Republic
Nondek	Lubomír	Integra Consulting Services s.r.o.
Pretel	Jan	Czech Hydrometeorological Institute
Smutný	Martin	Integra Consulting Services s.r.o.
Spitz	Jiří	ENVIROS, spol. s r.o.
Zámyslický	Pavel	Ministry of the Environment of the Czech Republic

We are grateful to the following persons and institutions for providing data and information:

Baláč	Jan	ČEZ, a.s.
Blažková	Šárka	T.G. Masaryk Water Research Institute
Fridrichová	Renata	T.G. Masaryk Water Research Institute
Halenka	Tomáš	Faculty of Mathematics and Physics of Charles University
Hůla	Josef	Research Institute of Agricultural Engineering
Chmelík	Tomáš	ČEZ, a.s.
Kalvová	Jaroslava	Faculty of Mathematics and Physics of Charles University
Metelka	Ladislav	Czech Hydrometeorological Institute
Míková	Taťána	Czech Hydrometeorological Institute
Řičicová	Pavla	Czech Hydrometeorological Institute
Spitz	Pavel	Research Institute of Ameliorations and Soil Conservation
Vácha	Dušan	Czech Hydrometeorological Institute
Valter	Jaroslav	Czech Hydrometeorological Institute
Valeriánová	Anna	Czech Hydrometeorological Institute
Vyskot	Ilja	Mendel University of Forestry and Agriculture in Brno, Department of Landscape Formation and Protection
Zezulák	Jiří	independent expert

CONTENT

List of Abbreviations

AAU	Assigned Amount Units
AIJ	Activities implemented jointly
AS CR	Academy of Sciences of the Czech Republic
BAT	Best Available Techniques
BOD_5	Biological oxygen demand (5-day)
TRC	Transport Research Centre
CEMC	Czech Environmental Management Centre
CENIA	CENIA, Czech Environmental Information Agency
CF_4	Tetrafluoromethane
CFC	Chlorofluorocarbons
CH_4	Methane
CHMI	Czech Hydrometeorological Institute
CHS	Central heat supply
CITL	Community Independent Transaction Log
CUNC	Czech Union for Nature Conservation
CNG	Compressed natural gas
CO	Carbon monoxide
CO_2	Carbon dioxide
COD_{Cr}	Chemical oxygen demand, dichromate determination
COSMC	Czech Office for Surveying, Mapping and Cadastre
CDA	Czech Development Agency
CSO	Czech Statistical Office
DIS	Dissolved inorganic salts
ECCP	European Climate Change Programme
EE&A	Environmental education and awareness
EEA	European Environment Agency
EEC	Environmental education centers

EKIS	Energy Consultation and Information Centre (Energetické Konzultační a Informační Středisko)
ELI	Efficient Lighting Initiative
EOP	Environment Operational Programme
ERDF	European Regional Development Fund
ERU	Emission Reduction Unit
EU ETS	European Union Emission Trading System
FEP	Framework educational programmes
GAV	Gross Added Value
GCM	Global Climate Models
GDP	Gross domestic product
GEF	Global Environment Facility
GEO	Group on Earth Observations
GHGs	Greenhouse Gases
GIS	Green Investment Scheme
GIS	Geographical Information System
GNI	Gross National Income
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbons (partly fluorinated hydrocarbons)
HFCs	Hydrogenated fluorocarbons
HUW	Hot utility water
IAT	Individual automobile transport
IET	International Emissions Trading
IFC	International Finance Corporation
IPCC	Intergovernmental Panel on Climate Change
IPI	Industrial production index
IPPC	Integrated Pollution Prevention and Control
ITL	International Transaction Log
ITS	Integrated transport system
JI	Joint Implementation

LNG	Liquified natural gas
LPG	Liquified petroleum gas (Propane-butane)
LULUCF	Land Use, Land Use Change and Forestry
M.R.K.E.V	Methodology and implementation of comprehensive environmental education
MoA	Ministry of Agriculture
MAT	Municipal mass transport
MoE	Ministry of the Environment
MERO	Methyl ester of rapeseed oil
MEYS	Ministry of Education, Youth and Sports
MFA	Ministry of Foreign Affairs
MIT	Ministry of Industry and Trade
MRD	Ministry for Regional Development
MSW	Municipal Solid Waste
MT	Ministry of Transport
MU Brno	Masaryk University Brno
N	Nitrogen
N_2O	Nitrous oxide, dinitrogen oxide
NA	not applicable
NAP	National Allocation Plan
NGO	Nongovernmental nonprofit organization
NIPH	National Institute of Public Health
NIR	National Inventory Report
NIS	National Inventory System (greenhouse gases)
NO	Nitrogen oxide
NO_x	Nitrogen oxides
NSRF	National Strategic Reference Framework
ODA	Official Development Assistance
OPEI	Operational Programme Enterprise and Innovations
PCF	Prototype Carbon Fund
PES	primary energy sources

PFC, PFCs	Perfluorocarbons
(S)PM_{10}	Suspended particulate matter under 10 microns in size
(S)$PM_{2.5}$	Suspended particulate matter under 2.5 microns in size
PPP	Purchasing Power Parity
PPS	Purchasing Power Standard
R&D	research and development
RCM	Regional Climate Models
RDF	Refuse-derived fuel
RES	renewable energy sources
SEA	Strategic Environmental Assessment
SEdP	School educational programmes
SEF CR	State Environmental Fund of the Czech Republic
SF_6	Sulphur fluoride
SHMI	Slovak Hydrometeorological Institute
SME	Small and medium-sized enterprises
SMP	Solid municipal waste
SO_2	Sulphur dioxide
SO_x	Sulphur oxides
SP	Solid pollutants
SRES	Special Report on Emission Scenarios (IPCC)
T.G.M.W.R.I.	T. G. Masaryk Water Research Institute
TOP	Transport Operational Programme
TSES	Territorial system of ecological stability
US	undissolved substances (IS - insoluble substances)
v. v. i.	Public research institute
VAT	value added tax
WWTP	waste water treatment plant

1 Summary

This chapter contains a brief summary of the Fifth National Communication of the Czech Republic on compliance with obligations following form the UN Framework Convention on Climate Change (hereinafter the "Convention") and the Kyoto Protocol (hereinafter the "Protocol").

National Conditions

The Czech Republic was established on January 1, 1993 following the splitting of the Czech and Slovak Federative Republic (Czechoslovakia). The Constitution of 1992 established the **basic profile of the structure of the State**, and defines the position and role of the most important bodies of the State authority. The Czech Republic can be considered to be a parliamentary democracy, with separate legislative, executive and judicial powers. The Government provides for executive power and generally consists of representatives of the strongest political parties according to the results of the most recent elections. In this election period, it consists of the Prime Minister, deputy prime ministers and the individual ministers, responsible for the activities of 16 ministries. According to the Constitution, the Czech Republic is divided into regions, which gained a number of powers in 2001 that were formerly held by the Government. They constitute a self-governing intermediate stage between the municipalities and cities and the Government. Their size corresponds to the larger territorial administrative units in the framework of the European Union. Integration relations can be considered to be amongst the most important external relations of the State at the present time. The Czech Republic became a member of OECD in December 1995; in March 1999, it became a member of NATO and, in May 2004, a member of the European Union. The country is a party to most **international conventions related to the environment.**

On December 31, 2008, the Czech Republic had a total of 10.47 million inhabitants and was thus the 15th largest country in Europe in terms of population. With an average population density of 132 inhabitants/km^2, the Czech Republic is one of the more densely populated countries of Europe. The nationality composition of the population is practically homogeneous (94% of the inhabitants are of Czech, Moravian or Silesian nationality, 1.9% constitute a Slovak minority and there are also Polish and German minorities). The originally high birth rate has decreased over the last 50 years. However, the current demographic trends have changed since 2004 – there has been a short-term (2004 – 2008) increase in the birth rate, a positive balance in migration and an increase in the life expectancy. The number of foreigners in the Czech Republic has been constantly increasing since 1989.

Strategic environmental documents were adopted after 1990, including protection of the environment and the principles of sustainable development. The most important of these programmes is the **State Environmental Policy** 2004 – 2010 and the **Strategy of Sustainable Development of the Czech Republic**, which is currently being updated. In May of 2009, the Ministry of the Environment prepared the **Policy of Climate Protection in the Czech Republic** – further discussions on this document will continue in the coming months of 2009.

The **climate** of the country corresponds to the Atlantic-continental area of the temperate climate zone of the northern hemisphere. The average annual temperature varies from 1.0 ^{o}C to 9.4 ^{o}C in dependence on geographic factors. The lowest average temperatures occur in

mountain areas on the northern, eastern and south-western borders of the country. The warmest areas lie at an altitude of about 200 m a.s.l. (lowlands in the southeast of the country and in the area along the Elbe river). Atmospheric precipitation is amongst the most variable climatic elements. Especially the geographic position of the area relative to air currents carrying moisture and the frequency of the occurrence of weather conditions with greater precipitation are decisive for precipitation conditions. Heavy precipitation is connected especially with the occurrence of low pressure areas and fronts over Central Europe.

In 1989, transformation of the centrally planned economy into a **market economy** was commenced in the Czech Republic; this process was completed in connection with accession to the European Union. The rate of growth of the gross domestic product in the Czech Republic in 2000 to 2007 corresponded to two- to three-times the average in the EU 27, EU 15 and OECD countries. In 2005 to 2007, the Czech Republic was amongst the group of countries with the most dynamic rate of GDP growth in Europe, exceeding 6% annually. In relation to the rapid rate of economic growth, the level of GDP per capita in the CR also increased, from 77% in 2000 to 82% in 2007 compared to the average for EU 27. However, the negative consequences of global economic development began to be manifested in the Czech Republic in the second half of 2008 and at the beginning of 2009.

The Czech Republic does not have many **raw material resources**, and this predetermines the potential for economic growth – most mineral materials are imported. The stocks of some mineral resources occurring in the territory of the State have been exhausted to a high degree. Mining of black coal is being cut back for economic reasons. Compared to the level of GDP created, the Czech Republic consumes more primary energy sources (PES) and electricity than necessary (consumed energy is inadequately converted to added value). The **energy and electrical energy intensities** of creation of the GDP in the Czech Republic are substantially higher than the average for the EU countries. The greatest potential for savings lies in energy production, households, the tertiary sector, industry and especially in transport. The overall level of import dependence of the Czech Republic in terms of energy varies around 60% and is increasing as coal is replaced by gas. The country is almost 100% dependent on imports of petroleum, gas and nuclear fuel.

Transport is based on a combination of railway and highway transport. The ratio of public passenger transport in the territories of municipalities to individual automobile transport has changed from approx. 80:20 in the 1980's to the current value of approx. 55:45, which has stabilized. The density of the railway network per unit area of the country is relatively high. However, railway tracks and the highway infrastructure require thorough modernization, which has already been commenced and has been partly completed on some internationally important sections. The increase in the volume of passenger and freight transport and the transition from railway to highway and air transport is continuing. In spite of a gradual improvement in the structure of the vehicle fleet, it continues to be old.

Czech **industry** contributes to the creation of the national GDP more than the EU average (approx. a one-third contribution to GDP) and is exposed to global pressures in a proportionate manner. The Czech economy has continued to open up following accession to the EU and it utilizes the advantages of the common market, but is exposed more to global pressures and must come to terms with the new environmental and labour legislation. The level of competitiveness is low in some branches (leather, textile and clothing industries). On the other hand, some branches have a high level of technology and employee qualification (qualified chemistry, electrotechnical industry, manufacture of means of transport and related branches).

The overall production of **waste** in the Czech Republic decreased consistently between 2002 and 2006, but overall waste production increased again in 2007. There has also been an increase in the amounts of waste from which material is recovered, but a large amount of waste is still disposed of by landfilling, although this amount is decreasing as technologies and also legislative and economic instruments are developed. The considerable portion of biologically decomposable components contained in residual mixed municipal waste, which is disposed of especially by landfilling at managed waste landfills, remains a problem. The percentage of waste that is incinerated and used for energy production remains low. The recovery of hazardous waste has increased since 2002.

Agriculture has a typical Central European character with production of temperate-region foodstuffs and a high intensity of cultivation of the land. The distribution of agricultural production has a zonal character, in which altitude above sea level is more important than latitude. Czech agriculture is capable of meeting domestic requirements for basic agricultural products, with a predominance of plant production over animals. Their production per area of agricultural land is, however, lower than in neighboring countries. The contribution of agriculture to creation of the GDP in the Czech Republic is about average for the EU.

The area of **forest** land is constantly increasing at a slow rate and corresponds to 1/3 of the area of the State. More than 3/4 of forest area consists of narrow-leaved forests and the rest corresponds to broad-leaved species. In recent years, reforestation has been characterized by an attempt to increase the share of broad-leaved species at the expense of coniferous species. The total stand stocks of wood in forests are constantly increasing. From the standpoint of ownership relations, 61.5 % of forest area belongs to the State, 15.9% to towns and municipalities and almost 19 % to private natural persons. In the last few decades, forests have been substantially damaged, especially by industrial emissions. In spite of the substantial reduction in emissions of pollutants into the air (especially SO_2), the condition of forests is improving only very slowly.

Emission inventories

Carbon dioxide (CO_2) is the most important greenhouse gas, contributing 85.9% to overall emissions, followed by methane (CH_4) with 8.0%, dinitrogen oxide (N_2O) with 5.0% and F-gases with 1.1%. There are minimal differences between the individual years. A trend can be observed in the reduction in the share of methane as a consequence of a reduction in fugitive emissions and emissions from the agricultural sector, and an increase in the share of F-gases (HFC, PFC and SF_6) as a result of the process in which they have replaced freons depleting the ozone layer of the Earth (regulated by the Montreal Protocol) in the refrigeration industry and are employed in modern technologies.

The rapid decrease in total greenhouse gas emissions after 1990 was caused by the reduction in production and subsequently also the restructuring of the economy, as one of the consequences of the substantial change in the political system. Conditions have been relatively stable since 1994 and the existing fluctuations can be attributed to various factors (e.g. different winter temperatures, inter-annual changes in GDP and the degree of adoption of measures to reduce greenhouse gas emissions, etc.). The uncertainty in determination of emissions in the individual years is also reflected in the inter-annual changes. The decrease in emissions from the *Energy* sector (stationary combustion) and from the *Agricultural* sector has been substantial, but emissions from *Transport* are continuing to increase.

As total greenhouse gas emissions decreased by 21.6% to 2007 compared to 1990, it can be expected with high probability that the reduction commitment of the Kyoto Protocol will be met for the first review period of 2008 – 2012. Nonetheless, in spite of this reduction of

emissions since 1990, indicators relating aggregated emissions per capita or per one GDP unit remain unfavourable.

Measures to reduce emissions

A number of measures are being implemented in the Czech Republic to reduce greenhouse gas emissions. The survey and classification were prepared in accordance with the methodical instructions for their analysis. These are measures narrowly concentrated on a certain subject area or sector, framework measures or measures of a predominantly adaptation character. However, the targets and impacts of many of the adopted measures are usually much broader, as it is primarily necessary to reduce the negative impacts on the environment as a whole or to improve the unfavourable material and energy intensities of the Czech economy.

The key measures with the greatest expected benefit consist primarily in framework and conceptual measures related to several sectors and also measures of a legislative character. A number of programme measures constitute practical implementation of framework, conceptual and legislative measures. The measures evaluated in the Fifth National Communication consist mainly in those that have come into force since 1995. They encompass utilization of the flexible mechanisms of the Protocol and participation of the Czech Republic in the system of emission trading in the framework of the European Union.

The basis for policy in creation of measures lies in the National Programme to Abate the Climate Change Impacts in the Czech Republic, which was approved by the Government in 2004. It is concerned with defining the main targets and measures in the area of climate change at a national level, so as to ensure meeting the reduction emission targets to the maximum possible degree in the sense of international agreements, to reflect contemporary and future social and economic conditions in the country and to contribute to promotion of sustainable development. Its preparation was based on detailed analysis of national trends in greenhouse gas emissions in the period following 1990, analysis of key emission sources that contribute to a maximal degree to the overall national balance, and also updated projections of emission trends in the time period to the year 2020. Account was also taken of analysis of preliminary adaptation measures in connection with the increased occurrence of extreme weather phenomena in recent years.

The National Programme requires a substantial increase in the share of renewable energy sources in the consumption of primary energy sources and defines conditions for State participation in joint implementation projects, in international emission trading and in participation in trading in emission allowances for greenhouse gases. Prepared measures or measures that came into force in 2005 should contribute to meeting the national quantitative targets that, according to the programme, consist in reduction of specific CO_2 emissions per capita by 30% to 2020 compared to 2000, and reduction of total aggregated CO_2 emissions by 25% to 2020 compared to 2000, with provision for a continuation of this trend to 2030. The share of renewable energy sources in consumption of primary energy sources should increase to 6% by 2010 and to 20% in 2030, and there should be a reduction in the energy intensity of production, distribution and final consumption of energy to a level of 60-70% of current consumption by 2030 and an increase in the share of use of biofuels to 5.75% in 2010. According to the Programme, the use of all alternative fuels in transport should reach a level of 20% in 2020.

The National Programme is also concerned with the aspect of preparation of specific sectoral adaptation measures and places emphasis on their detailed economic evaluation, as a number of adaptation measures can be very interesting economically, especially from the long-term point of view, and can substantially contribute to mitigating the impacts of climate change on a national scale. This area also encompasses intensive promotion of scientific research on

climate change, systematic observation and an improvement in projection and integrated warning systems.

The Programme lays down specific tasks for the individual ministries that are responsible for the key activities of these sectors. Their tasks are also included in the State Energy Conception, approved by the Government in 2004, and the Transport Policy for 2005 – 2013, approved in 2005. Chapter 4 gives a detailed survey of the individual measures.

Emission projections

In accordance with the recommended methodology for their preparation, projections were prepared for the scenario without measures, with measures and with additional measures, corresponding to complete fulfilment of the National Programme of Sound Energy Management and Use of Renewable and Secondary Energy Sources, the introduction of environmental tax reform, implementation of the Directive on Buildings and implementation of the "Industry and Business" and "Infrastructure" operational programmes. This methodology encompasses a series of steps that take into account the latest greenhouse gas inventory, choice of the initial and final year and cross-sectional years for projection, choice of the actual methodology and modelling instruments for preparing the projection, selection and analysis of input data for the projection, establishment of the initial assumptions, definition of scenarios, their calculation, presentation of results and performance of sensitivity analysis under selected assumptions.

In the model calculation of the emission projection from energy-production processes, it was assumed that the Temelín nuclear power plant will be in normal operation throughout the monitored period, that the Dukovany nuclear power plant will be reconstructed in order to prolong its lifetime and will be in normal operation throughout the period of interest, that there will be no limits on petroleum, gas and black coal imports after 2004 and that exports would equal approx. 15 TWh annually until 2010, with a decrease to 10 TWh after 2010.

The results of the prepared projections indicate that a reduction in total greenhouse gas emissions by 26% can be expected in 2010 and by at least 38% in 2020, compared to the level in 1990. A substantial reduction will occur in industry (effect of EU ETS), agriculture and the residential sector (effect of Green Investment Scheme). Projections of transport emissions are dependent on the shares of modes of transport in the total volume of transport, on development of vehicles and fuels and improvement of the infrastructure. Chapter 5 gives a detailed description of the projections.

Estimates of vulnerability, impacts and adaptation measures

Estimates of the impacts of climate change were based on methods of impact evaluation using biophysical, empirical-statistical and process models. Integration of the regional climatic model (RCM) ALADIN – CLIMATE/CZ with the emission scenario A1B for the 1961 – 2050 period with horizontal resolution of 25 km was completed in 2008. The results of the ALADIN-CLIMATE/CZ model indicate that the average temperatures would increase by the end of the third decade of this century in the AB1 scenario compared to the 1961 – 1990 period. The trend in the determined increase in average annual temperatures (0.24 ^{o}C/10 years) corresponds well with global values and the values given for Europe (0.2 ^{o}C/10 years). The average temperatures should increase more rapidly in the autumn and in the winter (maxima in March and September), while the increase in the spring and summer temperatures will be lower (minimum in May). Lower trends in temperature increases in the warm seasons and higher trends in the cold half of the year indicate that the temperature differences between the seasons will decrease. Maximum and minimum temperatures will change similar to changes in the average temperatures. Maximum temperatures will exhibit a trend towards a

clear increase in the winter and summer, while the minimum temperatures will tend to increase especially in the summer and partly also in the autumn and winter.

In a similar way, simulated changes in total precipitation indicate the possibility of a slight increase in annual totals (on an average by approx. 4% compared to 1961 – 1990), higher in the winter and spring (maximum February to April) and lower in the summer and autumn (minimum in July to November). It has been confirmed that, within the framework of the European continent and especially in central Europe, model projections of the precipitation regime are burdened by a much higher level of uncertainty than similar temperature predictions.

Development trends in meteorological characteristics and more frequent occurrence of extreme weather events are already being reflected in changes in the water regime, in agriculture and in forestry and partly also affect the state of health of the population. In the medium term (to around 2030), it can be expected that there will be a further increase, especially in negative impacts on the individual components of the natural environment and it has been relatively newly pointed out that impacts will be felt in the energy sector, potential for recreation and tourism and overall well-being of the population, especially in larger residential agglomerations.

In the medium term, it can be expected that the average flow rates will decrease in many river basins by 15 – 20% ("optimistic" scenario) to 25 – 40% ("pessimistic" scenario), which would lead to quite fundamental changes in the overall hydrological regime. The increased spring flow rates and subsequent additions to groundwater stocks will be gradually shifted to the end of winter and stocks of water will generally decrease. Intense precipitation events that occur during summer thunderstorms will present a greater risk of flash floods even when the long-term total precipitation does not change much. The consequences of changes in the climatic regime substantially affect the volume of storage space in reservoirs that would be necessary to preserve the existing level of water withdrawals.

The temperature and precipitation regime, as well as the atmospheric carbon dioxide concentrations, affect the growth and productivity of agricultural crops. Consequently, the growth conditions of some crops change in response to changing climatic conditions and overall warming. Changes in the vegetation period can also affect the yields of crops, especially those that are less adaptable to changing conditions. The scenarios of further development of the climate predict prolonging of the vegetation period. In the medium term, temperate-zone vegetation can profit by 10 to 15% from the prolonged vegetation period, but can suffer by 10 to 15% because of the loss of water.

Plants and tree species react to climate change mainly through migration but quite negligibly through genetic adaptation. Thus, the expected increase in average temperatures will be manifested in a shift in the range of a great many tree species to higher altitudes. For example, an increase in the average annual temperature by 1 – 2 ^{o}C can lead to a shift in the edge of the forest by 100 to 200 meters above sea level. The effect of dangerous stress by drought will be reflected in forest vegetation. Further habitat factors, such as light, air temperature, availability of nutrients or environmental pollution will act synergically with soil moisture and could affect tolerance to drought. The current less-than-satisfactory condition of tree stands, caused in the past particularly by burdening by high pollutant concentrations in the air, could become even worse with changes in climatic conditions.

Financial sources and technology transfer

The foreign development co-operation of the Czech Republic has exhibited a constant increase in recent years, which is in accordance with the role of this country as an emerging

donor and EU member. A substantial increase in the volume of multilateral assistance occurred in 2004 (in both absolute and relative terms) – this is mainly a consequence of the accession of the Czech Republic to the EU and subsequent inclusion of the relevant share of the volume of assistance provided by the EU as a whole (e.g. EuropeAid and ECHO activities). Several projects were financed in the framework of foreign development assistance in the 2003 – 2009 period, in connection with reduction of greenhouse gas emissions – modernization of energy-production facilities and systems and the use of alternative energy sources, etc.

Research and systematic observation

Research on the climate system is concentrated in a number of institutions, most of which are members of or are represented in the National Climate Program, which is an association of legal persons entrusted with performance of the tasks of the World Climate Research Programme of the World Meteorological Organization (WMO), creation of research teams of scientists in the area of the climate and publication of the results obtained. The research, which is part of the basic tasks of the individual institutions, is financed both from their budgets and also through the Czech grant agencies and the Academy of Sciences of the Czech Republic or grant projects announced by the Ministry of the Environment and the Ministry of Agriculture. Some projects are carried out in the framework of international co-operation and shared financing with foreign partners. Systematic observation of the climate system is performed to a substantial degree by the Czech Hydrometeorological Institute, which acts as the State institute for the fields of protection of air quality, hydrology, water quality, climatology and meteorology with competence to establish and operate the State monitoring and observation network, including international exchange of data according to WMO principles. Other institutions carry out monitoring for their own needs, usually for the limited duration of a certain project.

In addition to participation in the activities of the WMO Organization and UN Environmental Programme (UNEP), the Czech Republic co-operates on a number of international projects concerned with the climate. The most important in this respect is participation in the RC LACE project (the ARPEGE-CLIMAT model). In the past few years, participation of the Czech Republic in international projects concerned with modelling the climate system and estimation of the impacts of climate change has expanded substantially. The Czech Republic regularly provides assistance to developing countries in the area of training courses, and assistance in installation and calibration of instruments (e.g. monitoring of the ozone layer, etc.).

Systematic observations directly connected with the subject of climate change are mostly performed through the Czech Hydrometeorological Institute, which acts as the central State institute for the areas of air purity, hydrology, water quality, climatology and meteorology.

Education and public awareness

The obligation of developing environmental education and awareness (EE&A) is regulated by several laws, the most important of which is Act No. 123/1998 Coll., on the right to information on the environment, and Act No. 561/2004 Coll. – the Act on Schools; The State Environmental Policy 2004 – 2010 and the Strategy of Sustainable Development of the Czech Republic are the basic strategic documents for preparing similar programmes for the individual components of the environment, including the climate. The Action Plan of the EE&A State Programme for 2007 – 2009 was approved in 2006 and the Strategy of Education for Sustainable Development was approved in 2008. Environmental education and awareness are also part of the National Programme of Development of Education in the Czech Republic

(the White Paper). The area of EE&A forms a component of educational programmes in preschool, elementary, secondary and university education.

EE&A activities are financed in the Czech Republic from various important sources, the most significant of which include: the State budget, State funds, local government budgets (regions and municipalities), EU funds, foundations, funds from the business sector and the internal funds of NGOs. Funds from the public administration are expended both in the form of financing of the activities of the bodies of the public administration and the activities of directly subordinate organizations, and also in the form of grants, subsidies and contracts for other entities.

2 National Conditions

2.1 Structure of the State administration

The Czech Republic was established on January 1, 1993 following the splitting up of the Czech and Slovak Federative Republic (Czechoslovakia). The Constitution, which was adopted in 1992, established the basic profile of the structure of the State, which defines the positions and roles of the most important bodies of the State authority. The Czech Republic is a parliamentary democracy, with separate legislative, executive and judicial powers. The State is headed by the President, who is elected by the Parliament for a period of five years. The highest legislative body in the country is the Parliament, consisting of two chambers (Chamber of Deputies and Senate), which approve all the proposed laws and express consent or dissent with important international conventions, agreements, protocols, and various political and strategic documents in the areas of industry, the military, the environment, agriculture, etc. Executive power lies with the Government, which is established on the basis of the results of elections to the Chamber of Deputies. Its members generally consist of the representatives of the strongest political parties in the last elections.

According to the Constitution, the Czech Republic is divided into higher self-governing units (regions), which obtained a number of powers in 2001 that had been formerly held by the Government. Their size corresponds to the larger territorial administrative units in the framework of the European Union with a size of NUTS 3. They are headed by a chief executive officer. The regions constitute a self-governing intermediate stage between the municipalities and cities and the Government. They provide for selected functions and services to citizens in the framework of social-economic and other development (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 directed by elected municipal and city representatives, headed by a mayor.

In the area of protection of the environment, the Ministry of the Environment is the highest executive body of the State administration; at the present time (2008 – 2009), it is divided into five professional sections (Directorate of Economics and Environmental Policies, Directorate of Foreign Relations and Legislation and State Administration, Directorate of Nature and Landscape Protection, Directorate of Technical Protection of Environment and Directorate of Climate and Air Protection). The Ministry also establishes professional institutes (e.g. CENIA - the Czech Environmental Information Agency, the Czech Hydrometeorological Institute, the T.G. Masaryk Water Research Institute, the Agency for Nature Conservation and Landscape Protection of the Czech Republic, the State Environmental Fund of the Czech Republic and the Czech Environmental Inspection).

2.2 International activities

The Czech Republic became a member of OECD in December 1995, a member of NATO in March 1999 and a member of the European Union in May 2004. The country is a party to most international conventions related to the environment (Tab. 2.1). Representatives of the Czech Republic participate in activities in the framework of international organizations (UN, OECD, Council of Europe). The State meets the main duties arising from the adopted international obligations and also participates in a number of foreign projects, which assist in

performing tasks accepted on the basis of international activities. In the sphere of foreign development assistance, aid is provided primarily to less developed countries by sending experts and by promotion of international development programmes (OECD, UN Development Programme – UNDP, etc.).
From 1 January 2009 to 31 June 2009, the Czech Republic held the Presidency of the EU Council (it took over in this position from France and passed it on to Sweden). Climate change, together with energy production, competitiveness and safety are amongst the main priorities set by the Czech Presidency.

Tab. 2.1 International conventions in the area of the environment to which the Czech Republic is a party

Area of the environment	Name of the convention
Climate change	The UN Framework Convention on Climate Change and its Kyoto Protocol
Protection of nature and the landscape	European Landscape Convention Framework Convention on the Protection and Sustainable Development of the Carpathians (Carpathian Convention) Bonn Convention on Conservation of Migratory Species of Wild Animals Convention on Wetlands of International Importance especially as Waterfowl Habitats (Ramsar Convention) The Antarctic Treaty – Czech Antarctic station Convention on Biological Diversity UN Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa
Protection of species	African-Asian Migratory Water Bird Agreement Convention on Conservation of European Wildlife and Natural Habitats (Bern Convention) Convention on International Trade in Endangered Species of Wild Fauna and Flora Agreement on the Conservation of the Populations of European Bats Great Bustard Memorandum of Understanding International Convention for the Regulation of Whaling
Air Protection	Convention on Long-Range Transboundary Air Pollution
Protection of the ozone layer	Vienna Convention on Protection of the Ozone Layer Montreal Protocol on Substances that Deplete the Ozone Layer
Water protection	Convention on the Protection and Use of Transboundary Watercourses and International Lakes
Chemical substances	Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade
Waste	Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal
Industrial accidents	Convention on the Transboundary Effects of Industrial Accidents
Public access to information on the environment	Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (the Aarhus Convention). Protocol on Pollutant Release and Transfer Registers
Environmental Impact Assessment	Convention on Environmental Impact Assessment in a Transboundary Context (Espoo Convention) Protocol on Strategic Environmental Assessment SEA

Source: MoE, MIT

2.3 Population

On December 31, 2008, the Czech Republic had a total of 10.47 million inhabitants and was thus the 15th largest country in Europe in terms of population. With an average population density of 132 inhabitants/km^2, the Czech Republic is one of the more densely populated countries of Europe. The northern part of the country and large industrial agglomerates have higher population densities. The nationality composition of the population corresponds to

94% Czech, Moravian or Silesian nationality, 1.9% Slovak minority and also Polish and German minorities. The originally high birth rate has decreased over the last fifty years. However, the current demographic trends have changed since 2004 – there has been a short-term (2004 – 2008) increase in the birth rate, a positive balance in migration and an increase in life expectancy. The number of foreigners in the Czech Republic has been constantly increasing since 1989. In 2008, over 400 thousand foreigners were legally residing in the Czech Republic (approx. 4% of the population) and the number of immigrants is increasing. The greatest numbers of foreigners residing in the Czech Republic consist in Ukrainians, Slovakians, Vietnamese, Russians and Poles.

2.4 Geographic conditions

Its area (78,867 km^2) places the Czech Republic amongst medium-sized to smaller countries and, following the creation of a number of new European countries, it is the 21st largest State in Europe. Sněžka in Krkonoše (1,603 m a.s.l.) is the highest mountain peak, while the lowest point is at Hřensko, where the Elbe crosses the border into Germany (115 m a.s.l.). From the standpoint of altitude distribution, 5.0% of the total area consists of lowlands or areas below 200 m a.s.l., 74.1% lies at an altitude of 200 – 500 m a.s.l., 19.3% lies at an altitude of 600 – 1,000 m a.s.l. and 1.6% of the area of the country lies at an altitude of over 1,000 m a.s.l. The average altitude is 450 m, which is higher than the average for Europe (315 m). The divide among the main watersheds of Europe passes through the Czech Republic (the North, Baltic and Black Seas). This position on the main European divide is not favourable from the standpoint of water management, as most rivers have their source here. Thus, precipitation becomes the main source of water. The long-term average precipitation equals 693 mm and approximately 30% of this amount flows out of the country in watercourses. The river network in the Czech Republic has a density of 0.96 km/km^2. Vast majority of the territory of Bohemia is drained by the Elbe into the North Sea, major part of Moravia is drained by the Morava River into the Danube and Black Seas, and part of Moravia is drained by the Odra River into the Baltic Sea. The fan-shaped river network in the Odra watershed is characterized by the concentrated confluence of larger rivers in the Ostrava basin with an elevated risk of floods. Compared to the surrounding countries, there are only a very few lakes here (in the Šumava area). Artificial water reservoirs are far more numerous, with more than 24 000 located in the country, the vast majority of which are fishponds. Mineral springs are very common, occurring in about 350 locations.

The current condition of the biosphere is the result of natural development over the last several thousand years. The vegetation in valley floodplains and lowlands corresponds mainly to agricultural land. Lowland meadows cover large areas. Forests are the most important of all plant communities (about 1/3 of the area of the country), and form a microclimate and mezoclimate, absorb more solar radiation, reduce wind speed and affect outflow conditions. Most present-day forest stands were planted artificially and do not correspond to the original species composition of the forests. They consist mostly of single-species stands with a predominance of spruce and pine. The development of the contemporary landscape is affected primarily by secondary ecosystems. Original, natural ecosystems are scarce in the landscape. A large part of the country consists of fields, vineyards, orchards and gardens, used for food production.

The Czech Republic is characterized by scattered settlement structure, based historically on the large number of municipalities (there were 6,249 municipalities as of January 1, 2008) – only a small share of these municipalities can be called towns by international standards. Six cities have more than 100 thousand inhabitants (Prague, Brno, Ostrava, Plzeň, Olomouc and

Liberec) Compared to the other countries of Central Europe, the Czech Republic has a smaller number of medium-sized and especially large cities. Territorial differences in the character of settlements are significantly affected by natural conditions. The areas of the uplands of central, southern and western Bohemia, which do not have very favourable conditions for agriculture, have a dense network of small settlements, while the more fertile lowlands of Bohemia and especially central and southern Moravia have larger rural settlements, frequently with 1-2 thousand inhabitants.

2.5 Protection of the environment

A number of strategic environmental documents were adopted after 1990, encompassing protection of the environment and the principles of sustainable development. The updated State Environmental Policy 2004 – 2010 and the Strategy of Sustainable Development in the Czech Republic, which is currently being updated (2008 – 2009) are the most important of these documents.

The updating of the Czech Republic Strategy for Sustainable Development is intended to specify potential threats (social, economic and environmental) to further development of the Czech Republic and simultaneously find a way (instruments) to avoid these threats with maximum use of synergy amongst the social, environmental and economic areas.

The State Environmental Policy 2004 – 2010 defines the following priority areas:

- nature conservation, protection of the landscape and biological diversity;
- sustainable exploitation of natural resources, protection of waters and protection against floods, optimization of material flows and waste management;
- reducing the burden on the environment from human activities, improving environmental standards for the quality of human life;
- protection of the climate system of the Earth and prevention of long-range transport of air pollution;
- increasing public awareness of environmental issues.

The Policy of Climate Protection in the Czech Republic was prepared by the Ministry of the Environment in May of 2009. Further discussions on this document will continue in the coming months of 2009.

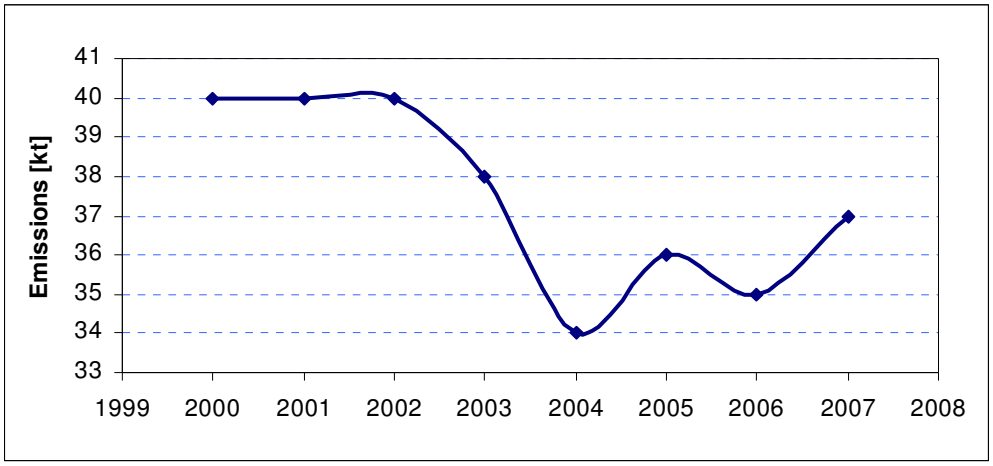
There was a substantial reduction and stabilization in the level of air pollution by SO_x a NO_x in the 1990's (Tab. 2.2). The levels of air pollution by sulphur dioxide and nitrogen dioxide have been relatively low in recent years; in most cases they do not exceed the local pollution limit values and thus also do not exceed the special pollution limit values. The information and warning signals for tropospheric ozone are declared in dependence on meteorological conditions (intensity of solar radiation, air temperature) during the summer months, e.g. signals were announced in 2005 and 2006, but not in 2007. As this pollutant does not have specific emission sources and is formed by chemical reactions of precursors in the atmosphere, announcement of signals is not accompanied by regulation of stationary pollution sources. The target pollution limit value for protection of health for tropospheric ozone is exceeded annually over most of the Czech Republic.

Air pollution by solid pollutants (especially suspended particulates PM_{10} and $PM_{2.5}$) remains one of the main problems in relation to air quality in the Czech Republic. This is primarily because these substances present a serious health risk even at very low concentrations; this is manifested without any apparent lower level for safe concentrations, as has been

demonstrated by a number of studies and the summary report of the National Institute of Public Health (NIPH) for 2007. Since January 1, 2005, valid pollution limits have been introduced for PM_{10} for protection of human health (the 24-hour pollution limits for PM_{10} of 50 $\mu g.m^{-3}$ may be exceeded a maximum of 35 times p.a.; the annual pollution limit equals 40 $\mu g.m^{-3}$). The 24-hour limit is not maintained in practice over a substantial part of the territory of the country and the limits are exceeded for a major part of the year in some areas of the Czech Republic. Simultaneously, the valid pollution limits for PM_{10} are exceeded two- to threefold (i.e. an extreme increase in local pollution levels) primarily as a consequence of poor dispersion conditions.

Of the total of 155 locations where the PM_{10} share was measured in 2007, the 24-hour pollution limit for PM_{10} was exceeded at 54 stations. There was a substantial reduction in the number of locations where the pollution limit was exceeded in 2007 compared to 2006. However, this reduction was substantially affected by the different meteorological and dispersion conditions in 2006 and 2007. Overall PM_{10} emissions exhibited a slight fluctuating decrease in the 2000 – 2006 period.

Fig. 2.1 Trends in overall national PM_{10} emissions (kt p.a.) in 2000 – 2007



Source: CHMI

The areas with the worst air quality include the agglomerations of the large cities (Prague, Plzeň and the Ostrava region) and locations with higher intensity of automobile transport.

The Czech Republic is a Party to the Convention on the Protection of the Ozone Layer (Vienna Convention) and its implementing Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) and the relevant amendments (London, Copenhagen, Montreal and Beijing); the basic obligations have been met, leading to a substantial reduction in the relevant substances.

Tab. 2.2 Trends in emissions of the main pollutants in 2000 -2007 (thousand t. p.a.)

Year	PM	SO_2	NO_X	CO	VOC	CO_2eq
2000	60.7	224.4	292.8	539.4	205.0	147,234
2002	61.8	228.2	288.0	516.7	190.1	149,350
2003	64.1	222.4	290.3	528.8	187.1	145,075
2004	60.7	219.2	288.7	509.2	177.5	147,061
2005	62.3	217.4	291.0	491.2	175.1	146,240
2006	63.1	210.8	280.1	481.3	178.8	149,107
2007	66.7	216.5	283.2	508.3	173.9	150,823

Source: CHMI, CENIA

Similarly as for the air, quite favourable progress has been made in reducing the pollution of surface waters. This is affected primarily by point sources (cities and municipalities, industrial plants and objects with concentrated farm animal production) and also extensive sources (agricultural management in the form of application of industrial fertilizers and chemical preparations, atmospheric depositions and erosion washing-out).

The share of the total population of the Czech Republic residing permanently in houses connected to public sewer systems is constantly increasing, and equaled 80.8% in 2007. A total of 508.1 mil. m^3 of waste water was discharged into public sewer systems in 2008, 95.3% of which passed through waste water treatment plants. The average efficiency of waste water treatment plants (i.e. the ratio of pollution at inflow and outflow) is very high for BOD_5 and US – over 97% of the pollution is removed. In addition, 94% of COD_{Cr} is also eliminated. This is accompanied by 85% removal of phosphorus but only 71% of nitrogenous substances are removed.

Although there was an overall reduction in discharged BOD_5 levels by 94.7%, COD_{Cr} by 88%, US by 90% and DIS by 14.6% in the long term (between 1990 and 2007), the trend since 2003 (2002 was affected by the catastrophic floods) now exhibits only a slow increase in discharge of organic pollutants monitored by the indices of BOD_5 and COD_{Cr} and stagnation in discharged US and DIS.

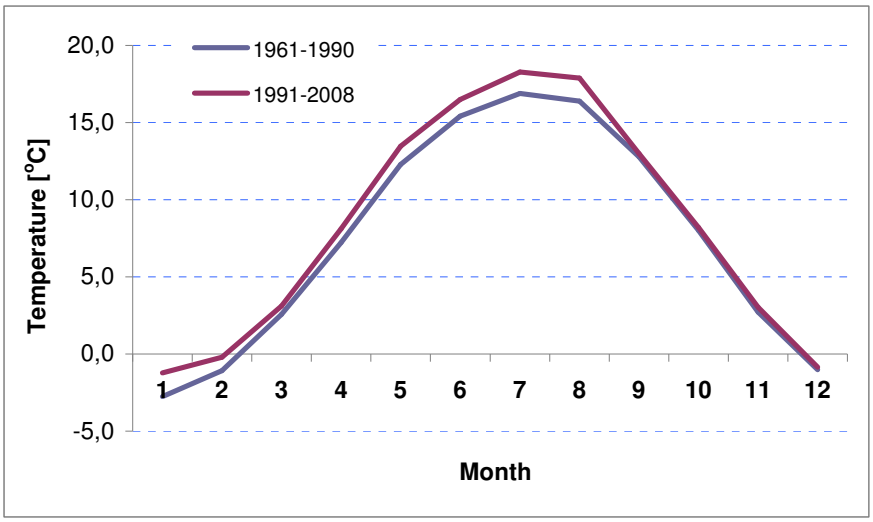
At the present time, the country has four national parks (Krkonoše, Šumava, Podyjí and České Švýcarsko), with the total area of 1,195 km^2, and 25 protected landscape areas (10,867 km^2), covering 15.3% of the total area of the country. After the country entered the EU, the Natura 2000 European system of sites of Community importance and bird areas was introduced. It can be stated that valuable parts of nature have been preserved in the Czech Republic in relatively good condition, providing the possibility of renewal of natural processes. A large part of valuable natural land is protected by a special protection regime pursuant to Act No. 114/1992 Coll., on the protection of nature and the landscape, as amended.

2.6 The Climate

The weather in the Czech Republic corresponds to the Atlantic-continental area of the temperate climate zone of the northern hemisphere. The average annual temperature varies from 1.0 to 9.4 ^oC in dependence on geographic factors. The lowest average temperatures occur in mountain areas on the northern, eastern and south-western borders of the country. The warmest areas lie at an altitude of about 200 m a.s.l. (lowlands in the southeast of the country and in the area along the Elbe). Temperatures of about 7 to 8 ^oC generally predominate in the average annual temperatures and in the average temperatures in the spring and autumn seasons; average summer temperatures are 16 to 17 ^oC and the average winter temperature is -1 ^oC. Prague is a specific area with a thermal island increasing the average

annual temperature by about 1 to 2 °C above the values corresponding to its geographic position.

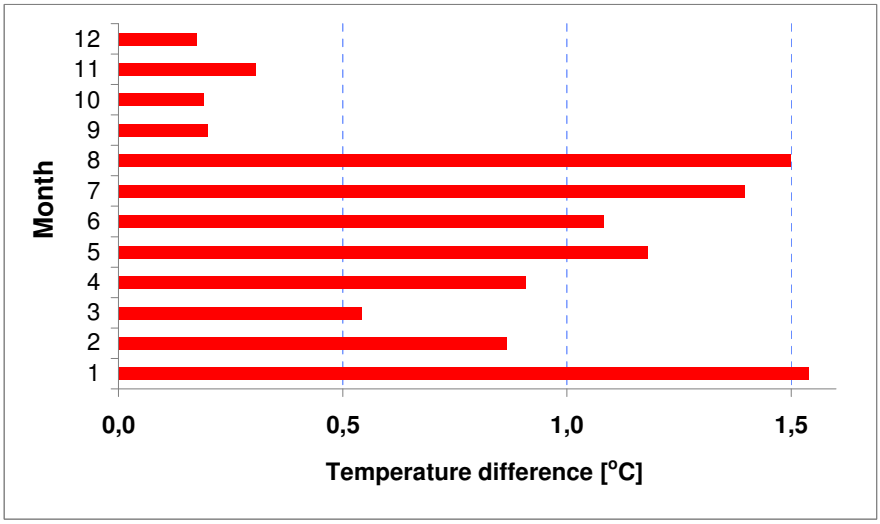
Fig. 2.2 Annual variation in the average air temperatures in the Czech Republic in the 1961 – 1990 and 1991 – 2008 periods



Source: CHMI

The annual air temperature variation has the shape of a simple wave with a minimum in January and maximum in July (Fig. 2.2). Comparison of the temperature trends in 1961 – 1990 and 1991 – 2008 (Fig. 2.3) shows that the average annual temperature increased by 0.8 °C between these two periods, with the greatest temperature increase in January and August (by 1.5 °C) and the smallest in September, October and December (about 0.2 °C).

Fig. 2.3 Average monthly temperature deviation between the 1961 – 1990 and 1991 – 2008 periods

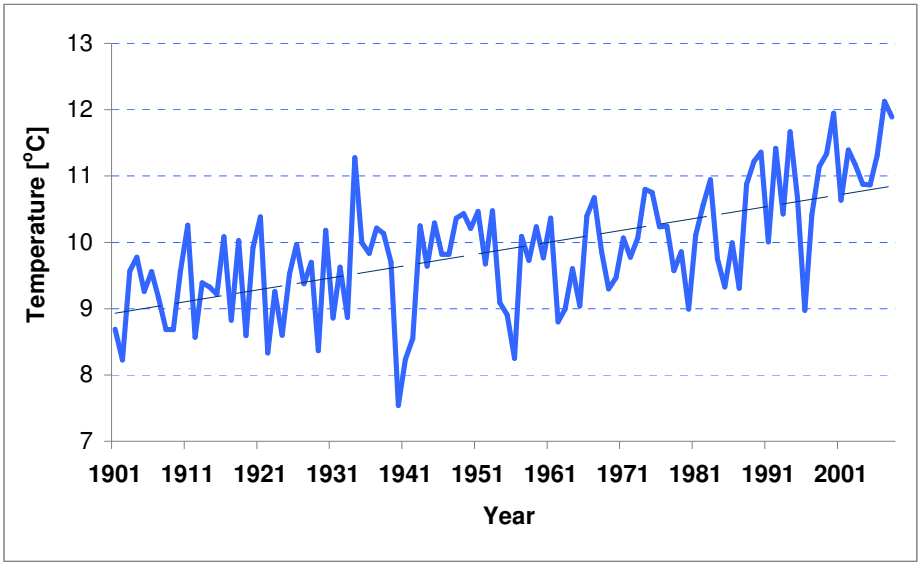


Source: CHMI

The trend in increase in the average annual temperature since 1961 corresponds to 0.33 °C/10 years; the winter and summer trends are higher, corresponding to 0.44 °C/10 years and 43 °C/10 years, while the lowest temperature increase is in the autumn (0.08 °C/10 years).The trends have been increasing over the past 15 years. Fig. 2.4 depicts the trend in average annual temperatures at the Prague Klementinum station since the beginning of the 20th century. The

trend in increasing temperature during this period corresponds to 0.17 °C/10 years, with comparable trends for the summer and winter seasons.

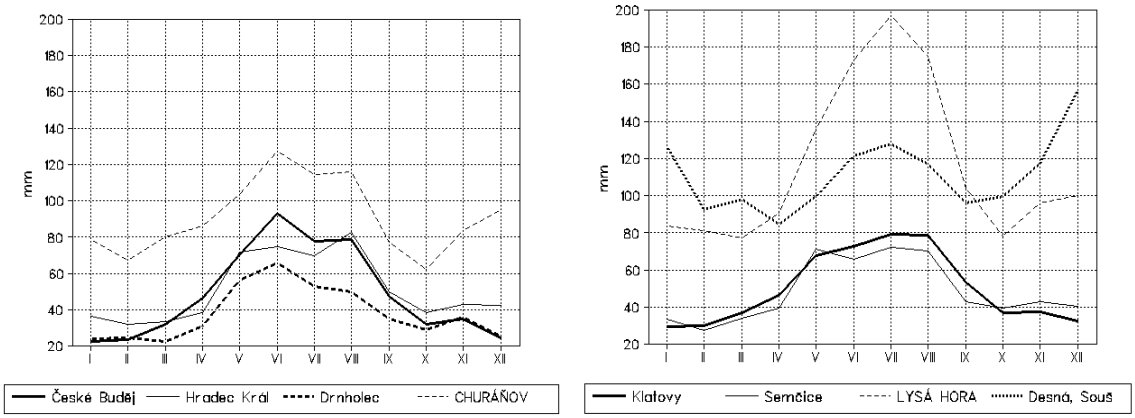
Fig. 2.4 Average annual temperatures in the 1901 – 2008 period at the Prague-Klementinum station



Source: CHMI

Atmospheric precipitation is amongst the most variable climatic elements. Especially the geographic position of the location relative to air currents carrying moisture and the frequency of the occurrence of weather events with greater precipitation are decisive for precipitation events. Heavy precipitation is connected especially with the occurrence of low pressure areas and fronts over Central Europe. Relatively longer periods without precipitation occur especially under the influence of high pressure areas from the Azores in the summer season.

Fig. 2.5 Annual variation in total monthly precipitation at selected stations in the Czech Republic in the 1961 – 1990 period



České Budějovice (388 m. a.s.l.), Hradec Králové (278 m. a.s.l.), Drnholec (179 m. a.s.l.), Churáňov (1 118 m. a.s.l.), Klatovy (430 m. a.s.l.), Semčice (234 m. a.s.l.), Lysá hora (1 324 m. a.s.l.), Desná-Souš (772 m. a.s.l.)

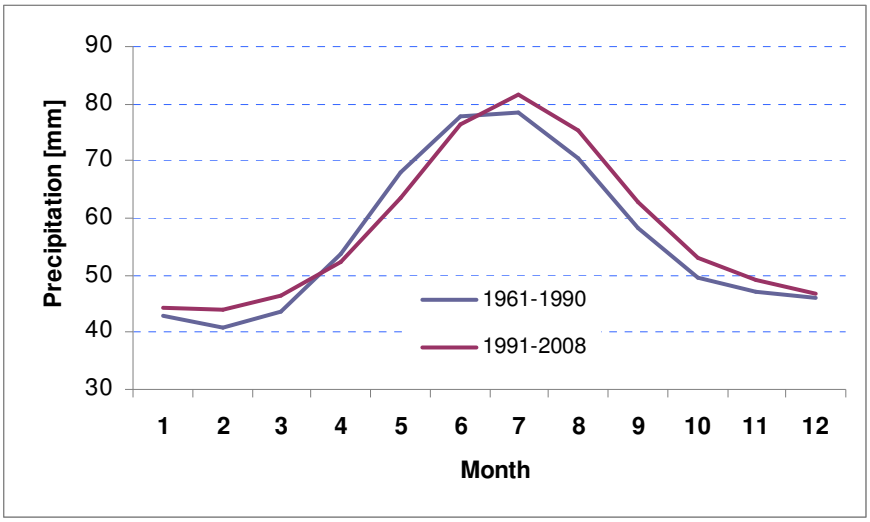
Source: CHMI

The lowest amount of precipitation occurs in the wind shadow of the Krušné hory (mountains), also in a strip along the Ohře river in north-western Bohemia and along the Dyje river in southern Moravia, where the average annual total precipitation equals 450 mm.

Maximum precipitation, with annual totals of over 1,300 mm, occurs in the exposed sides of the Jizerské, Krkonoše and Beskydy mountains (Fig. 2.5).

The overall trend in the precipitation regime in the territory of the Czech Republic can be approximated using the values of the average territorial precipitation, corrected for the height above sea level. Fig. 2.6 depicts the annual variations in 1961 – 1990 and 1991 – 2008. The average annual total precipitation increased in the 1991 – 2008 period by 2.9% compared to the normal values, where a clear increase of more than 5% is apparent in February and March and in the August to October period; the monthly total precipitation in the April to June period was lower by 2 to 6% than in the 1961 – 1990 normal period.

Fig. 2.6 Annual variation in the average territorial precipitation in the Czech Republic in the 1961 – 1990 and 1991 – 2008 periods

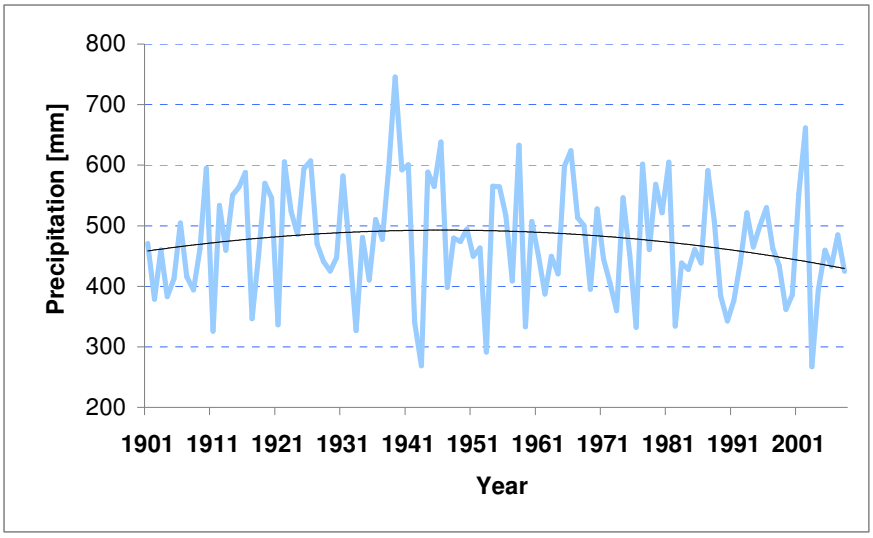


Source: CHMI

The annual variation in precipitation in the shape of a simple wave with maximum in July and minimum in February (Fig. 2.6), which was formerly rather typical for most of this country, still occurs in the variations of the average total monthly precipitation, but is no longer as typical for the individual parts of the country. This reflects the ever-increasing variability of the typical precipitation regime, not only in the territory of the Czech Republic, but also in all of Central Europe. Extreme total precipitation values occur more frequently, reflected in the repeated occurrence of floods, especially after 1995 (e.g. more extensive floods in 1997, 1998, 2002, 2004, 2005 and 2007). Greater occurrences of extreme weather events have been recorded especially in the last ten years.

In the first half of the 20th century, annual total precipitation at the Prague-Klementinum station (Fig. 2.7) exhibited a very slight increase, followed by a slight decrease in the second half (5.6 mm/10 years), caused by the decrease in total precipitation in the warm half of the year – especially in summer and autumn; winter totals increased slightly. The trend in decrease in annual total precipitation corresponds to a decrease in total precipitation by approx. one percent per decade. Differences in the precipitation regime at the Prague-Klementinum station and evaluation based on territorial precipitation confirm their substantial lack of territorial homogeneity.

Fig. 2.7 Total annual precipitation in the 1901 – 2008 period at the Prague-Klementinum station



Source: CHMI

2.7 Economics

In 1989, transformation of the centrally planned economy into a market economy was commenced in the Czech Republic; this process was completed in connection with accession to the European Union. The first half of the 1990s was characterized by a substantial reduction in production, accompanied by a decrease in GDP by more than 20%. The transformation was connected with the privatization process, characterized mainly by a reduction in the State's influence on the economy, by the possibility of input of foreign capital, by improved product quality in an attempt to achieve greater competitiveness on the European and world markets, and by a concurrent reduction in the negative environmental impacts of the economic sphere. The rate of growth of the gross domestic product in the Czech Republic in 2000 to 2007 corresponded to two- to three-times the average in the EU 27, EU 15 and OECD countries. In 2005 to 2007, the Czech Republic was amongst the group of countries with the most dynamic rate of GDP growth in Europe, exceeding 6% annually. Similar conditions prevailed for the demand components of the GDP for investments, household consumption and exports, and for the supply components of the economy related to industry and services. In relation to the rapid rate of economic growth, the level of GDP per capita in the Czech Republic also increased, from 77% compared to the average for EU 27 in 2000 to 82% in 2007.However, consequences of global economic development, such as reduction in the output of the national economy, cut-back in some branches of industry, increase in unemployment levels, etc, began to be manifested in the Czech Republic in the second half of 2008 and at the beginning of 2009.

The Czech economy has continued to open up following accession to the EU in 2004 and it utilizes the advantages of the common market, but is exposed more to global pressures and must come to terms with the new environmental and labour legislation. Global competition represented mainly by the newly emerging Asian markets in China and India, and also the strengthened exchange rate of the Czech koruna against global currencies (USD and EUR) leads to a disadvantage especially for cheap consumer goods, products with low added value and semi-products.

The main supportive forces for economic growth in the Czech Republic in 2004 – 2007 included accession to the EU customs-free zone, high input of direct foreign investments

providing for inflow of capital, know-how and entrance into the sales network of multinational companies. Low and stable inflation, together with low interest rates, stability in the financial sector and an increase in employment rates played an important role in promoting growth, where the economic policy, both monetary and fiscal, was not as restrictive as it had been throughout much of the 1990s.

One of the problems in the economy is its high material and energy intensity – especially in relation to the increasing prices of energy and raw materials in the world markets, and also in connection with the negative impacts of production and transport on the environment and health (and the related economic effects of these impacts), it is necessary to fundamentally reduce the intensity of production in terms of materials and energy.

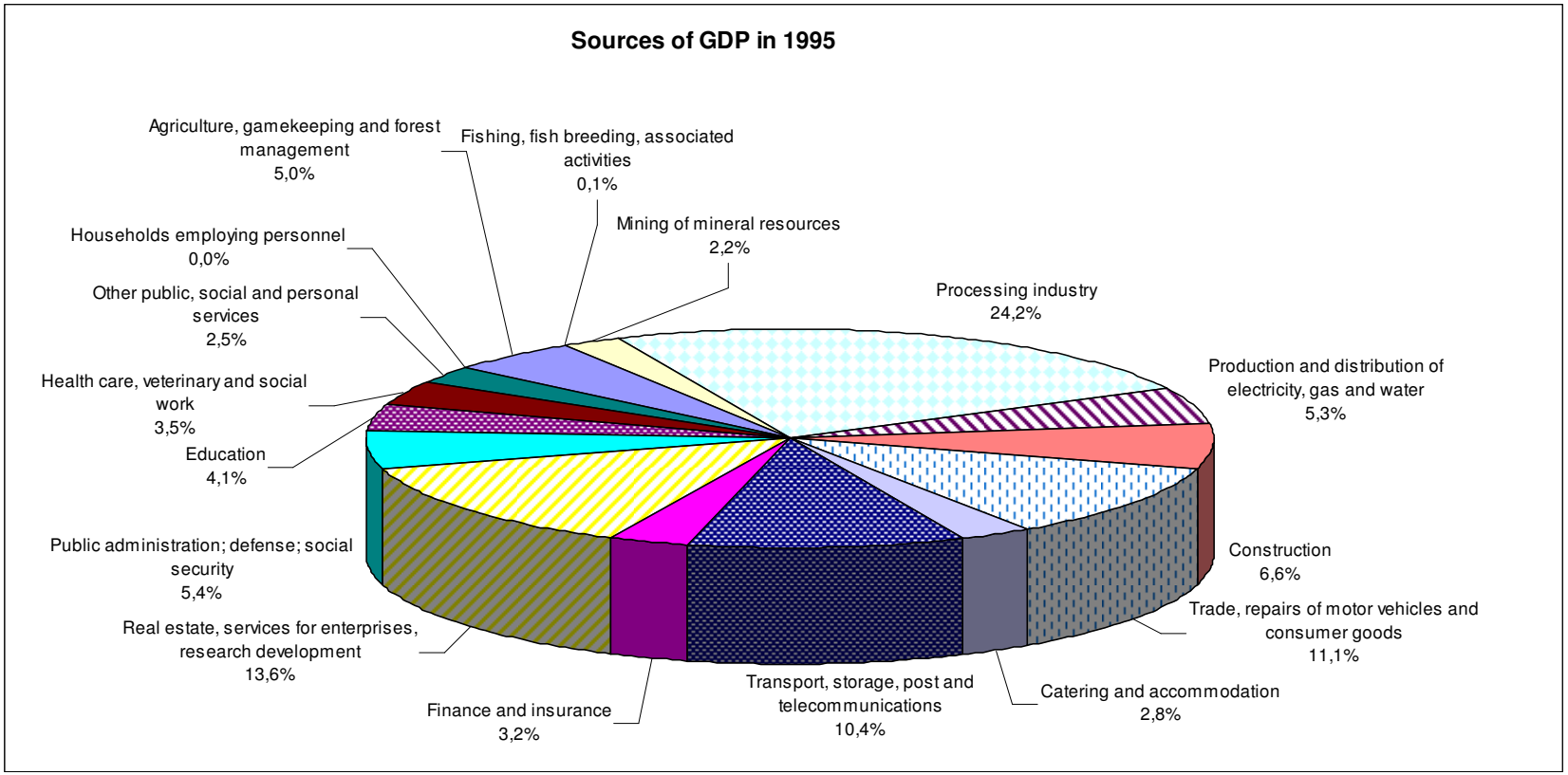
Tab. 2.3 Trends in the number of inhabitants and the main economic indicators in the 1995 – 2007 period

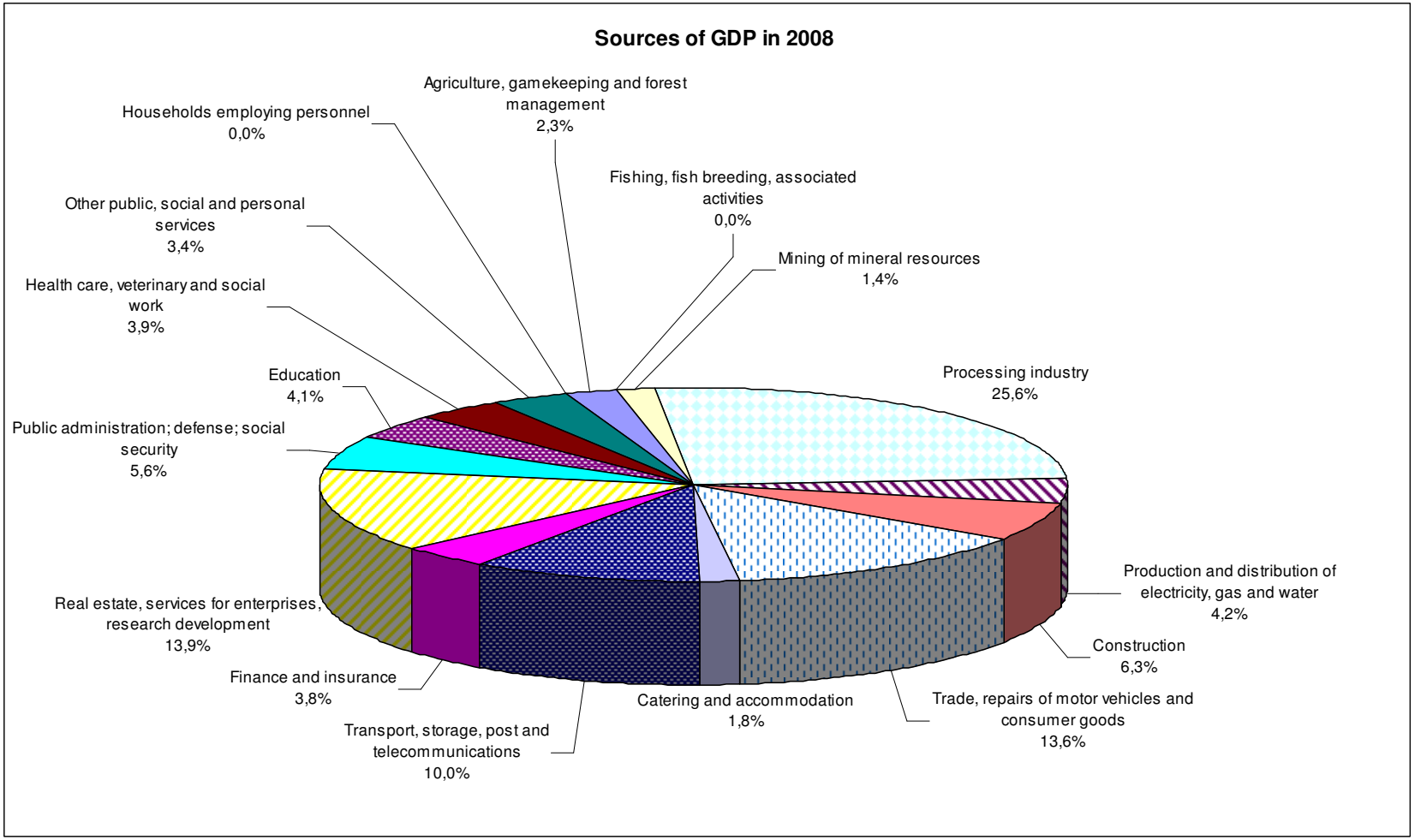
	1995	2000	2001	2002	2003	2004	2005	2006	2007
Number of inhabitants [thousand]	10,331	10,273	10,224	10,201	10,202	10,207	10,234	10,267	10,323
GDP (bil. CZK)	1,466.5	2,189.2	2,352.5	2,464.4	2,577.1	2,814.8	2,983.9	3,215.6	3,551.4
GDP (PPS[a)] per capita)	10,774	13,036	13,891	14,419	15,215	16,257	17,133	18,412	20,286
Average gross monthly wage of employees in the national economy (CZK)	8,010	12,918	13,996	14,999	15,936	17,006	17,827	18,976[b)]	-
Level of inflation (%)	9.1	3.9	4.7	1.8	0.1	2.8	1.9	2.5	2.8
Price indexes in the consumer sphere, total[c)]	252.5	349.9	366.3	372.9	373.3	383.8	391.1	400.9	412.1
Foreign investments in the CR (bil. CZK)	67.9	192.4	214.6	277.7	59.3	127.8	279.2	123.4	185.3
Foreign debts of the CR (bil. CZK)	457.3	817.1	811.3	813.3	894.3	1,011.8	1,142.2	1,193.7	1,348.8
Average annual exchange rate of the CZK vs EUR	34.3	35.6	34.1	30.8	31.8	31.9	29.8	28.3	27.8
Average annual exchange rate of the CZK vs USD	26.54	38.59	38.04	32.74	28.23	25.70	23.95	22.61	20.31
Unemployment level (%)	2.93	8.78	8.90	9.81	10.31	9.47	8.88	7.67	5.98
Balance of foreign investments (bil. CZK)	58.9	–191.9	–244.1	–397.3	–527.5	–825.0	–835.2	–1,081.0	–1,240.3

[a)] PPS (Purchasing Power Standard) – standard purchasing power; average purchasing power; 1 PPS corresponds to an average purchasing power of 1 EUR in the EU 27 countries;
[b)] Preliminary data;
[c)] 1990 = 100 %

Source: CSO

Fig. 2.8 Sources of GDP in current prices in the 1995 and 2008




Sources of GDP in 2008
Agriculture, gamekeeping and forest management 2,3%
Households employing personnel 0,0%
Fishing, fish breeding, associated activities 0,0%
Other public, social and personal services 3,4%
Mining of mineral resources 1,4%
Health care, veterinary and social work 3,9%
Processing industry 25,6%
Education 4,1%
Public administration; defense; social security 5,6%
Production and distribution of electricity, gas and water 4,2%
Real estate, services for enterprises, research development 13,9%
Construction 6,3%
Finance and insurance 3,8%
Catering and accommodation 1,8%
Trade, repairs of motor vehicles and consumer goods 13,6%
Transport, storage, post and telecommunications 10,0%

Source: CSO

2.8 Management of resources

The Czech Republic does not have many raw material resources, and this predetermines the potential for economic growth – most mineral materials are imported. The stocks of some mineral resources occurring in the territory of the State have been substantially exhausted. Mining of black coal is being cut back for economic reasons. Mining of brown coal in surface mines has highly negative environmental impacts. Stocks of energy-production coal in the individual deposits have been estimated at 10 – 50 years. Thus, the use of renewable resources and especially energy savings are significant from the standpoint of sustainable development. Material recycling of industrial and consumer waste and their energy recovery are important. The market in secondary raw materials (aluminum, steel, glass, plastics, etc.) reacts strongly to the prices of primary raw materials and fossil fuels

Mineral materials

The share of extraction of mineral materials in creation of the GDP in 1998 equaled approx. 1.8%, corresponding to a decrease of more than one third between 1990 and 1998. The Czech economy is dependent on the import of a number of mineral materials from abroad, because the stocks of some mineral materials occurring in the territory of the Czech Republic have been substantially exhausted. At the present time, the Czech Republic does not have any important stocks of ores and has only limited stocks of fossil fuels. The country has sufficient stocks of some non-ore and construction materials, with lifetimes estimated at tens to hundreds of years. The Czech Republic has a material base especially for development of traditional branches of industry – glass works (glass sands), ceramics and porcelain (a wide range of ceramic clays, feldspar materials, kaolin) and the paper industry (paper kaolin), see Tab. 2.4. The technical level of production of cement, lime and plaster in the Czech Republic is comparable with that in the developed countries of the EU. The mined-out deposits of natural gas and petroleum could, in the future, be employed under suitable geological conditions as underground storage areas for natural gas.

Energy

The energy and electrical energy intensity of creation of the GDP in the Czech Republic is substantially higher than the average for the EU countries. Especially transport, industry and construction exhibit high energy intensity. The greatest potential for savings lies in energy production, households, the tertiary sector, industry, transport and agriculture.

The overall level of import dependence of the Czech Republic in terms of energy is about 60% and is growing as coal is replaced by gas (Fig. 2.10); this level increased from 58 to 63% between 2000 and 2007. The country is almost 100% dependent on imports of petroleum, gas and nuclear fuel.

The consumption of PES in final energy consumption has increased slightly in recent years as a consequence of changes in the proportions of PES and electricity exports. Demand for sources as a consequence of greater economic growth is partly reduced by the decrease in the energy intensity of the economy. A reduction of the energy intensity to the European average can be expected for the anticipated convergence of the basic macroeconomic indicators to the European standard. Primarily, it is necessary to reduce the large proportion of losses in energy conversions and in final consumption (Fig. 2.10). Losses in energy production processes and distribution equalled 40.3% in 2000 and have increased to 42.9% by 2007.

The production of electricity increased by 20% since 2000, where exports increased faster than domestic consumption. Support was initiated for use of renewable energy sources (RES) – see Fig. 2.12. The share of RES in overall electricity production increased from 3.9% (2000)

to 4.4% in 2007. Energy-production use of biomass increased by 50% over the same period and there was a 150% increase in the exploitation of biogas. The share of combustion sources in the production of electricity decreased from 78.3% (2000) to 67.3% in 2007, particularly thanks to the greater use of nuclear energy.

In spite of the relatively high geological and balance stocks of brown coal, the volumes of extractable stocks in the Czech Republic are low and the life expectancy of the individual open-pit mines varies between 10 and 50 years. Limitation of the extraction of brown energy-production coal is based on the declared environmental mining limits. With maintenance of this fuel base, this will enable renewal of only part of the capacity of the gradually end-of-lifetime production units for electricity and heat. The volume of extractable stocks of black coal in the Czech Republic will be sufficient until 2030 at most. The consumption of black and brown coal in the non-energy-production sectors is decreasing slightly.

The current potential of all RES in the Czech Republic has been estimated at approx. 190 PJ, where the consumption of PES in the Czech Republic varies around about 1,900 PJ. Under the assumption that the consumption of PES does not increase and remains unchanged and the attainable potential of RES is achieved by 2020, their contribution to primary energy sources will equal 10% in 2020. A higher share of RES in overall production/consumption is achievable only for a reduction in overall consumption of PES. In the medium-term future (2020 and later), the potential of renewable energy sources and savings corresponds to up to 30% of total consumption of PES.

The greatest potential for savings lies in energy production, households, the tertiary sector, industry and especially transport. Overall attainable savings for the 2015 – 2020 period vary in the range of 300 – 400 PJ. In dependence on growing requirements on the use of biomass in energy-production, transport (as a fuel component) and as a renewable raw material in industry, it is necessary to exploit the potential of biomass in the short- and medium-term future. Simultaneously, it is necessary to base developments on the principles of sustainable development and good agricultural practice and to thus create conditions for long-term sustainable use of agricultural land, with adequate protection of ecosystems and biodiversity.

Brown coal remains the main source for production of energy, even though the expansion of mining and spatial extent have been limited. If energy consumption continues to grow, the deficit will increase and the stocks of brown coal will be exhausted by 2030. The fundamental question in the energy policy in the Czech Republic remains whether electricity production after 2015 – 2020 will be based on primarily energy sources consisting in brown coal or will be oriented towards other sources (RES and nuclear energy).

As the stocks of black coal are exhausted in the active mines of the Karviná part of the Ostrava-Karviná coal-mining area, it will be necessary to resolve the issue of further supplies of black coal for Czech energy-production and industry in the medium term. So-far unexploited domestic resources are too deep-lying and thus import of cheaper black coal tends to predominate at the present time.

Secondary raw materials and waste

The raw material base in the Czech Republic does not cover all the needs of the domestic processing industry and is thus supplemented by domestic or imported secondary raw materials with an overall volume corresponding to about 15 to 20% of total raw material inputs. For some inputs, the share of consumption of secondary raw materials exceeds 60% (e.g. some nonferrous metals). Recycling of ferrous and nonferrous metals is especially important; the Czech metallurgy industry is highly dependent on this input. Export and import of the most important commodity amongst secondary raw materials, i.e. scrap iron, fluctuates

in dependence on supply and demand amongst metallurgical companies. Separate waste collection remains inadequate and has substantial reserves both in the business and in the civil sphere.

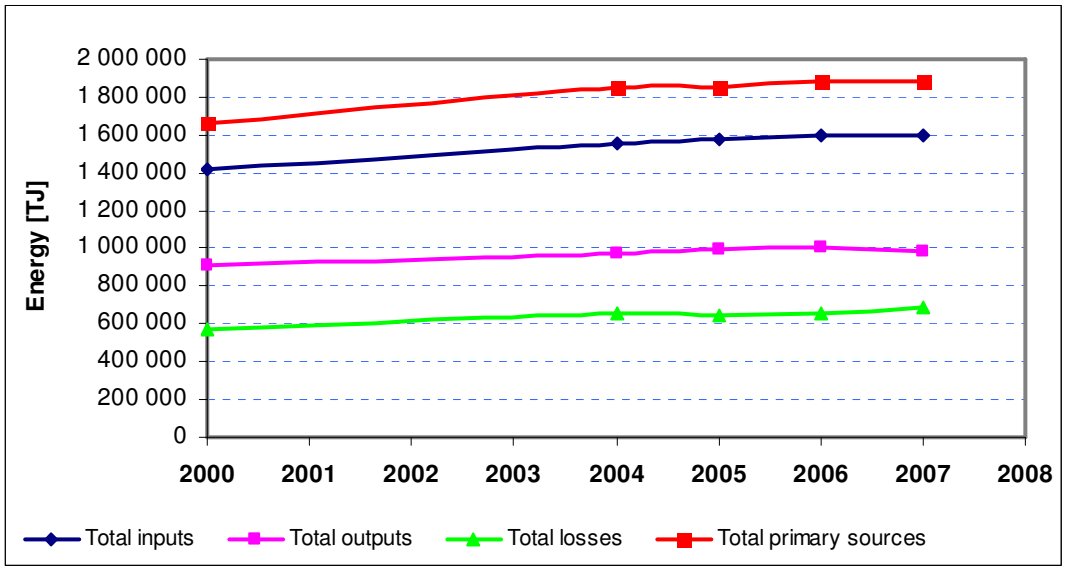
Landfilling of waste remains the most frequent manner of waste disposal. The overall capacity of landfills is adequate for both municipal waste and other kinds of waste. The number of facilities intended for landfilling waste has been decreasing. Incineration of waste is currently limited to three municipal waste incinerators and several smaller incinerators for industrial hazardous waste. The share of biodegradable waste deposited in landfills is decreasing as they are increasingly composted. The energy-production use of biogas (anaerobic fermentation of biomass) and landfill gas has increased in recent years (Fig. 2.12).

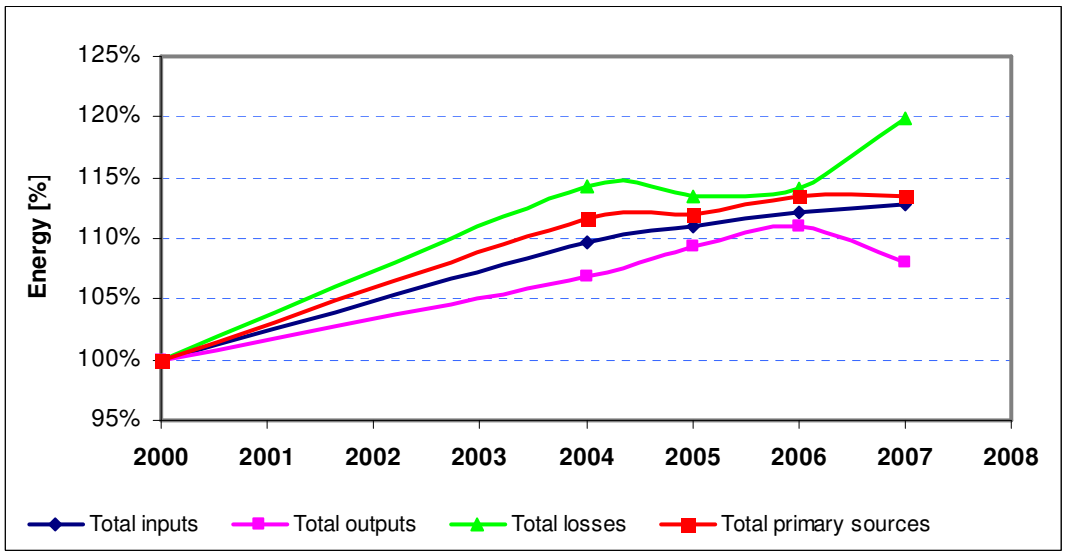
Tab. 2.4 Mining of selected materials (thousand t)

Material	2000	2001	2002	2003	2004	2005	2006	2007
Kaolin	1,242	1,140	1,125	1,286	1,352	1,463	1,420	1,319
Limestone	6,790	6,897	6,586	6,460	6,727	7,021	5,757	6,230

Source: CSO

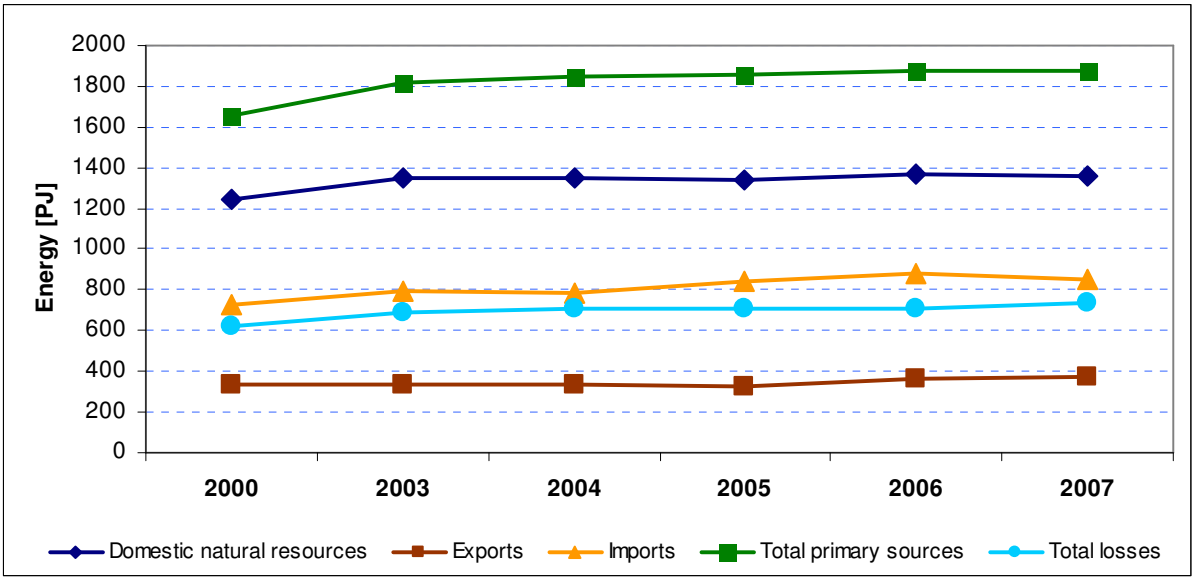
Fig. 2.9 Energy balance (TJ, %)





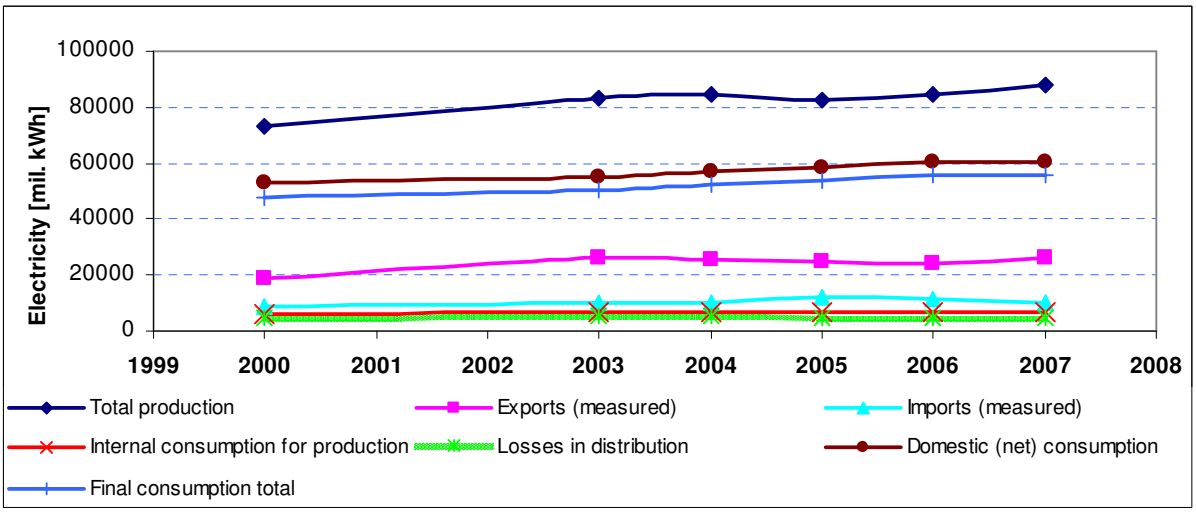
Source: CSO

Fig. 2.10 Total energy balance (PJ) in 2000 and 2007



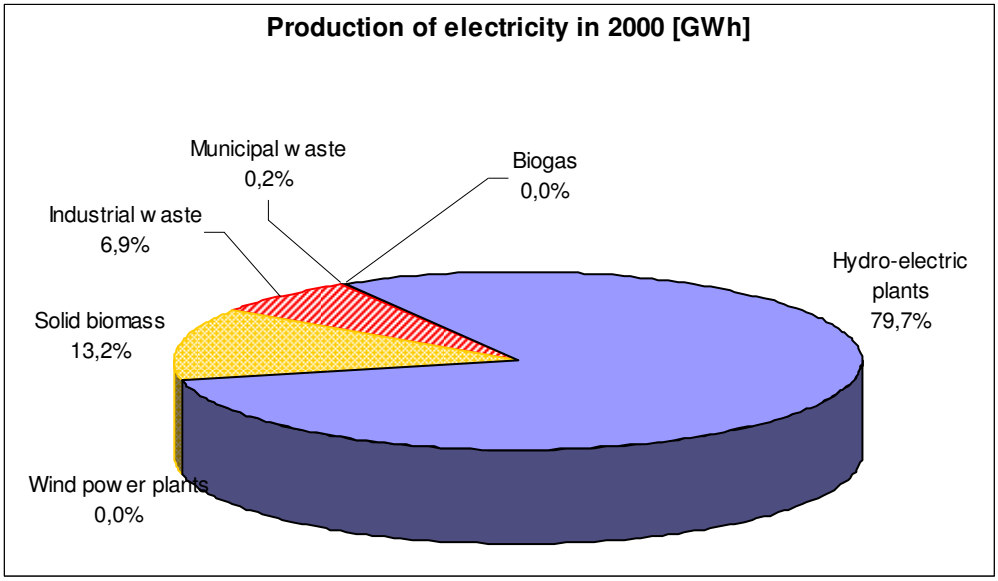
Source: CSO

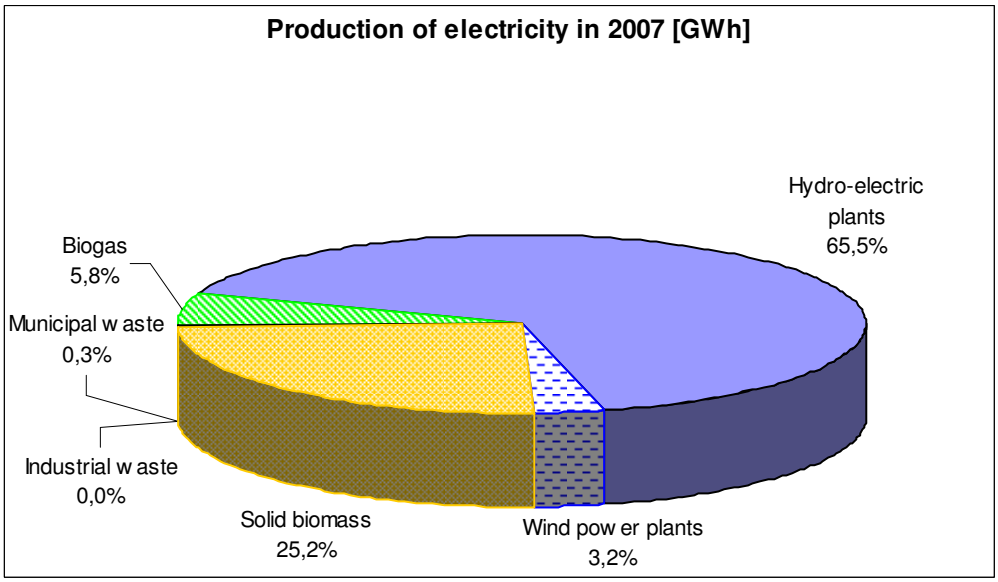
Fig. 2.11 Electricity balance (mil. kWh)

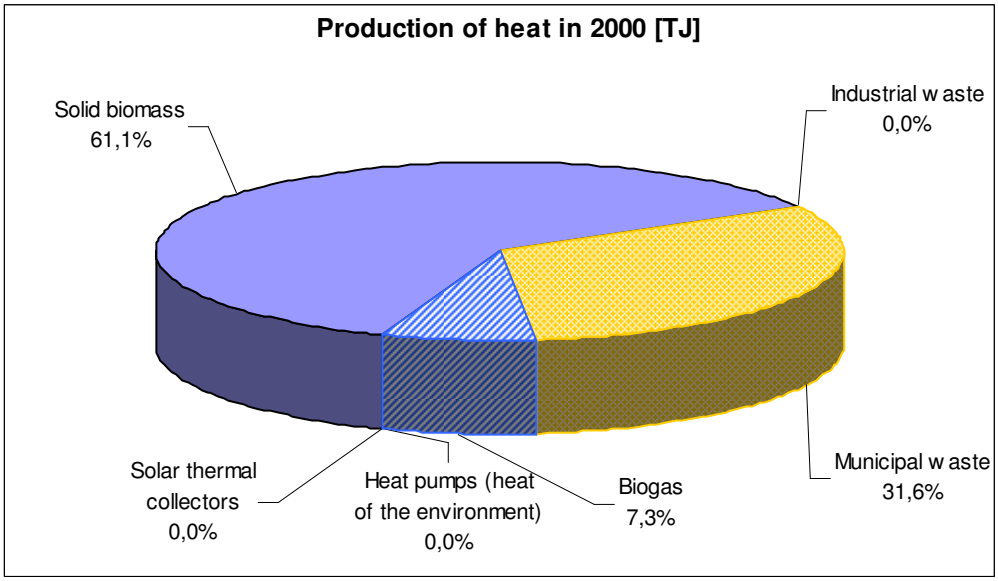


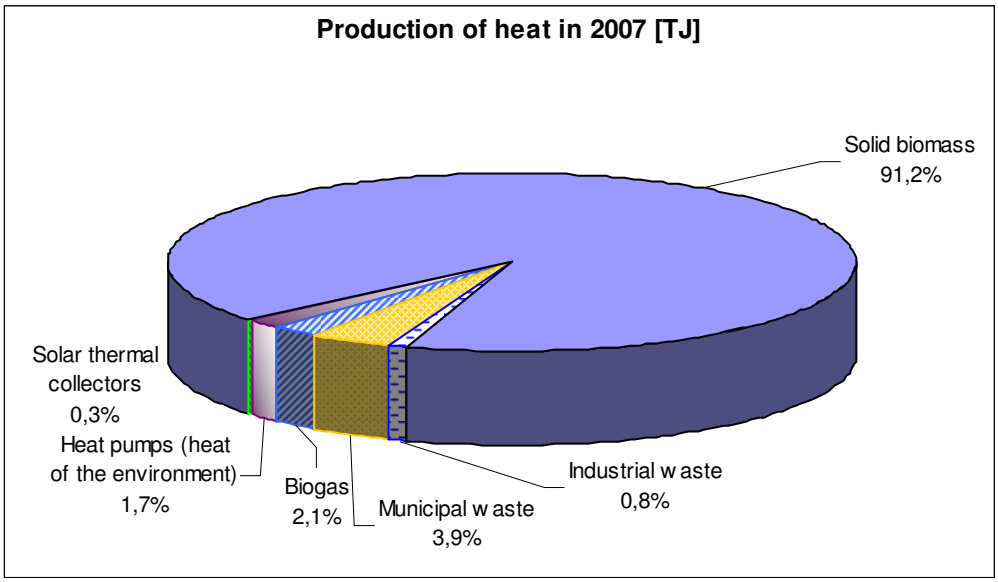
Source: CSO

Fig. 2.12 Production of electricity and heat from renewable energy sources and waste in 2000 and 2007









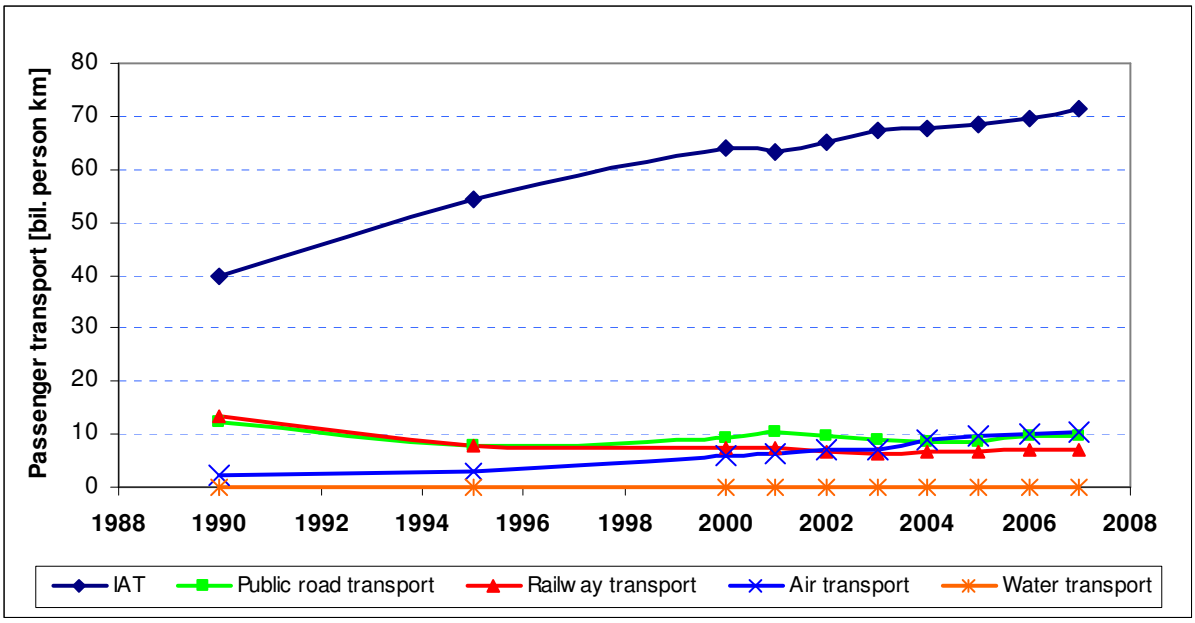
Source: CSO

2.9 Transport

The Czech Republic's central position in Europe makes it a crossroads of transport routes. Transport is based on a combination of railway and road transport. Individual automobile transport is an important transport mode, with division of transport work between public passenger and individual automobile transport (IAT) of approximately 1 : 2. The ratio of public passenger transport in the territories of municipalities to individual automobile transport has changed from a ratio of approx. 80:20 in the 1980's to the current ratio of approx. 55:45, which has stabilized. This situation contributes substantially to deterioration of the state of the environment in areas with a high level of urbanization. The trend in replacement of railway transport by road and air transport is unfavourable (Fig. 2.13, 2.14 and 2.16).

The railway network is relatively dense in terms of the area of the country (12.3 km of track per 100 km^2); however, the railway tracks and other infrastructure require thorough modernization, which has already been commenced and is partly complete in some internationally important sections. The road network (with a density of 71 km/100 km^2 in 2007) also requires modernization and throughways (with a density of 0.84 km/100 km^2 in 2007) need to be constructed.

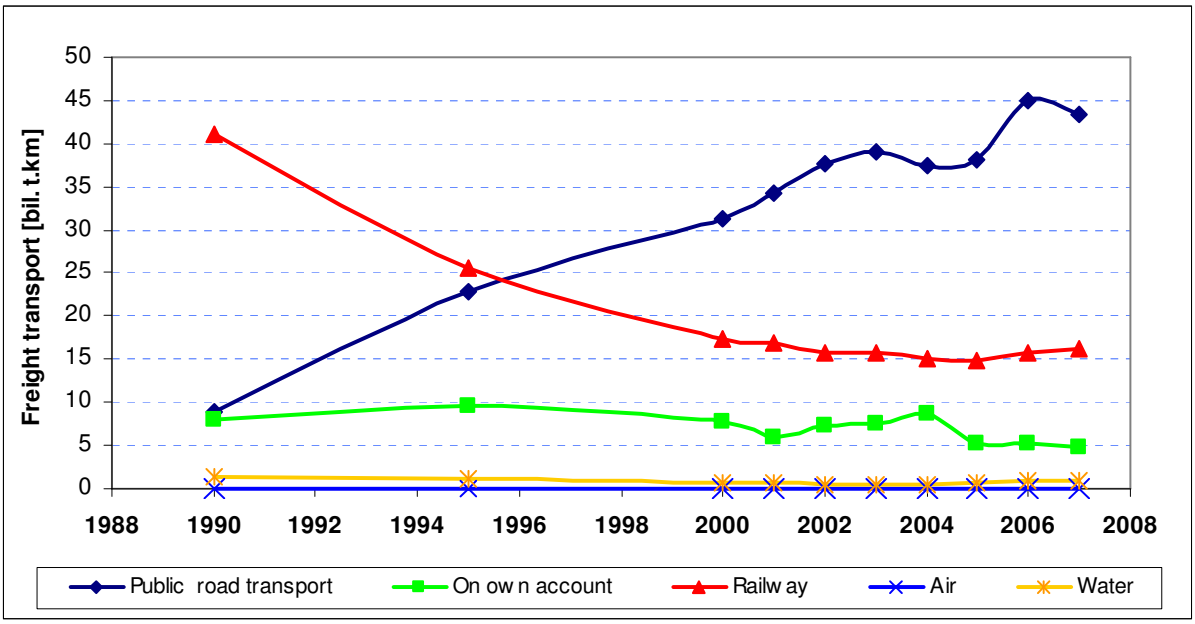
Fig. 2.13 Transport outputs in passenger transport in the 1990 – 2007 period (bil. person km)



Source: TRC

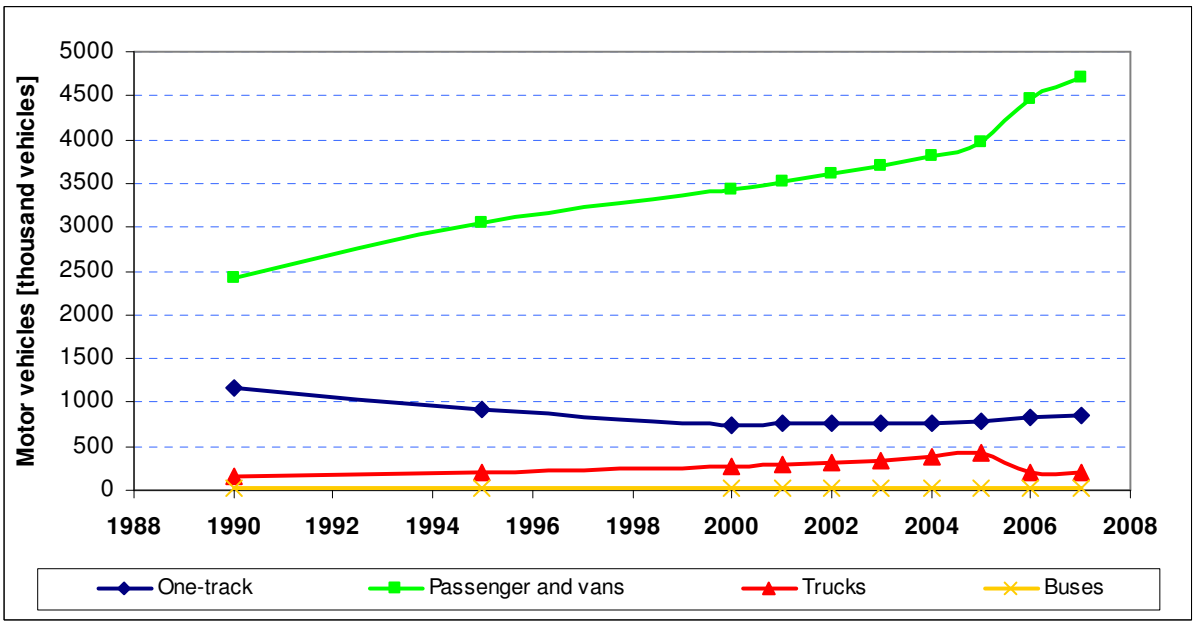
Fig. 2.15 gives a survey of the number of motor vehicles in the Czech Republic in the 1990 – 2007 period. The number of passenger vehicles has almost doubled over the past 15 years and equaled a total of 4.28 mil. vehicles in 2007 – corresponding to 41 vehicles per 100 inhabitants in 2007 (this figure equaled 23 in 1990 and 36 in 2003). In spite of the improvement in the structure of the vehicle fleet (an increasing number of vehicles comply with EURO standards, the number of vehicles equipped with catalytic converters increased from 6.8% in 1993 to 61.4% in 2006), the vehicle fleet in the Czech Republic continues to be very old (the average age of passenger cars in 2007 equaled 13.88 years) and its structure is not yet comparable with that of the vehicle fleet in the EU. However, it can be expected that new vehicles travel much further than old vehicles, improving the real environmental parameters of the vehicle fleet. In 2007, 2.1 % of vehicles were driven by alternative means of propulsion.

Fig. 2.14 Transport outputs in freight transport 1990 - 2007 (bil. t.km)



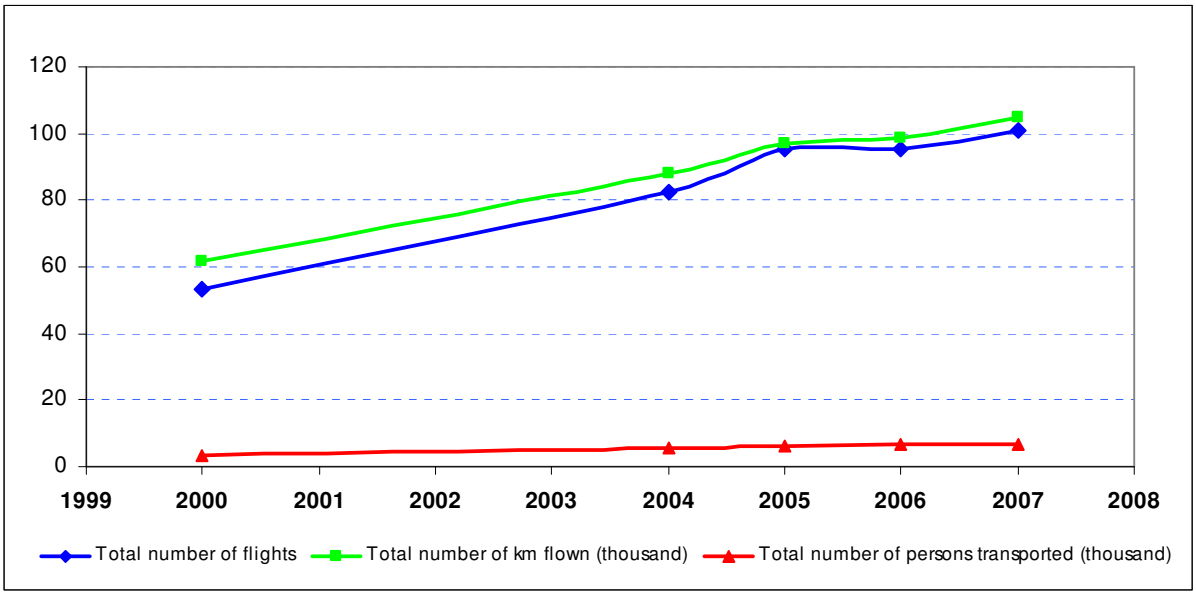
Source: TRC

Fig. 2.15 Number of motor vehicles in the CR 1990 - 2007 (thousand vehicles)



Source: TRC

Fig. 2.16 Output of air transport in the 2000 – 2007 period



Source: CSO

From the standpoint of the conception and strategy in the transport sector, the National Programme to Abate the Climate Change Impacts in the Czech Republic was approved in 2004 and the Transport Policy of the Czech Republic for 2005 – 2013 was approved in 2005. The transport policy deals with current basic conflicts in the area of transport, consisting particularly in the increasing volume of individual automobile transport and inadequate public transport, the incongruity between modernization of transport networks and construction of capacities, especially in road transport, inadequate harmonization of market conditions, reflected in sharp competition between railway and road transport, failure to implement transformation of the railways, etc. The Transport Operational Programme 2007 – 2013 is an important strategic document which was approved in 2007 and is an instrument for drawing finances from the EU funds.

2.10 Industrial production

Czech industry contributes to the creation of the national GDP more than the EU average and is proportionately exposed to global pressures. Industry in the Czech Republic contributes approximately to one third of the GDP compared to approximately one fifth in the EU[1]. For an increase in the GDP per capita (in PPP between 2005 and 2007) by 18.3%, increasing work productivity (approx. 5% annually) and the same level of decreasing energy intensity, revenues in industry increased by 8.1% to 11.6% p.a. Every third worker is employed in an industrial enterprise. More than half of Czech industry exports its products.

A trend was commenced in the 1990's to strengthen those segments that have a favourable position on the global market. The process of restructuring was stimulated both by the different sectoral structure of the input of foreign capital and also by the unequal initial conditions of some sectors in the transformation process and subsequently in investment resources. As mentioned above, the Czech economy has continued to open up following accession to the EU and it utilizes the advantages of the common market, but is exposed more to global pressures and must come to terms with the new environmental and labour legislation. The level of global competitiveness is low in some branches (the leather industry,

[1] see http://www2.czso.cz/csu/redakce.nsf/i/cr:_makroekonomicke_udaje

the textile and clothing industries). On the other hand, some branches have a high level of technology and employee qualification (qualified chemistry, electrotechnical industry, manufacture of means of transport and related branches). The leather industry is also developing, as are the coking industry and petroleum processing. The competitiveness of these branches against "non-OECD" is affected by global fuel and material prices, transport costs, labour costs, etc.

The structure of the Czech economy has been fundamentally formed by the inflow of direct investments into the spheres of industry (machine industry, automobile industry, electronics and electrotechnology, chemistry) and services (especially telecommunications and finance). The tertiary sector makes the greatest contribution to creation of the GDP and employment in the Czech Republic. In spite of the onset of the recession, growth is expected in the service sector; this is not possible in the absence of effective public support directed especially towards small and medium-sized enterprises (SME). In its proportion of high-tech products, the Czech Republic was in 13th place in the EU-25 in 2007 and exhibited one of the greatest growth rates in the past 5 years. Compared to 2000, the volume of export of high-tech products was 2.3 times greater in 2004 and the volume of imports was 1.5 times greater. The favourable development of the MSE sector is insufficient for attaining the EU-15 average.

The volume of industrial production increased during this decade (Fig. 2.17). It is favourable for long-term trends in output volumes of Czech industry that it is based on faster growth in the value of exports than export of material. There has been an increase in the share of exported products from more complicated production processes, such as machinery, electrical instruments and equipment and means of transport. Similar positive changes could also be observed in the 2000 – 2007 period in data on foreign trade structure. A reduction in industrial production occurred in the second half of 2008, caused by a decrease in export as a result primarily of the global recession in the automobile industry. The index of industrial production decreased in the last quarter of 2008 to 86.8% compared to 2007 (production of means of transport and equipment decreased to 78.1% in this period).

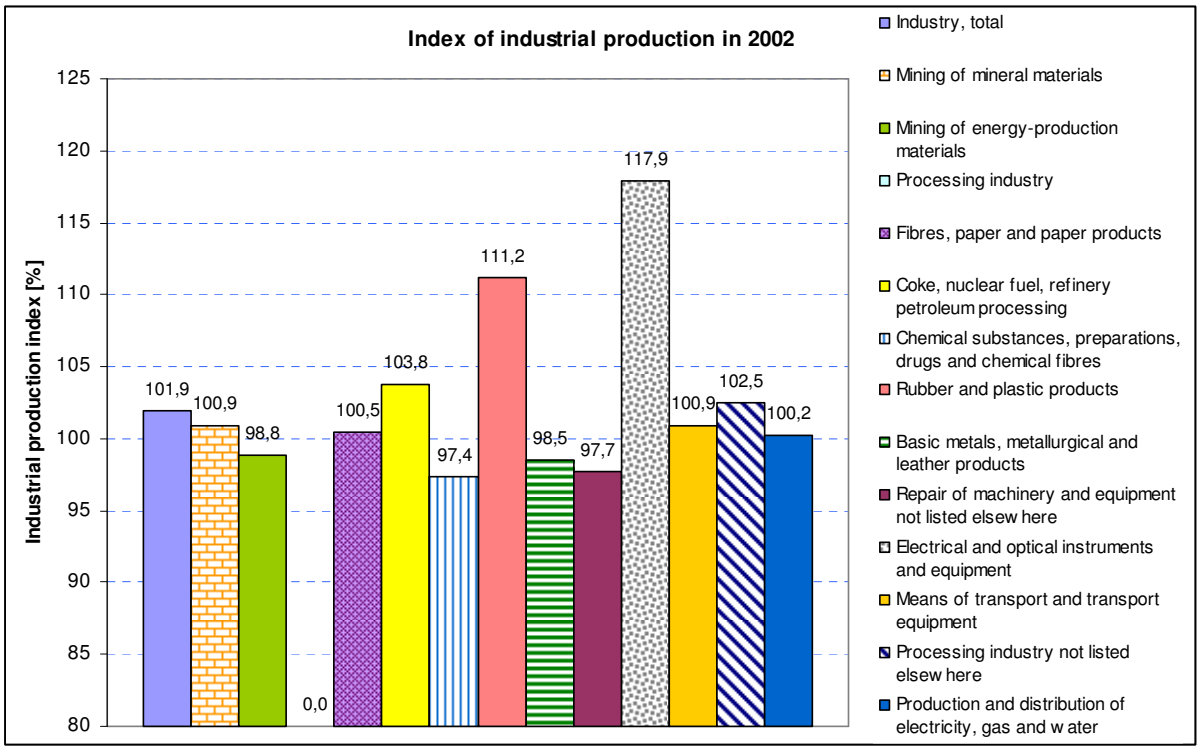
The relatively higher consumption of primary energy sources (PES) per GDP unit in the Czech Republic is a result primarily of the structure of industry, which is different than the usual sectoral structure in the EU-15. Compared with other EU Member States, the difference in consumption of PES per unit GDP after recalculation "to the same structure of industry and purchasing power" is about 20%.

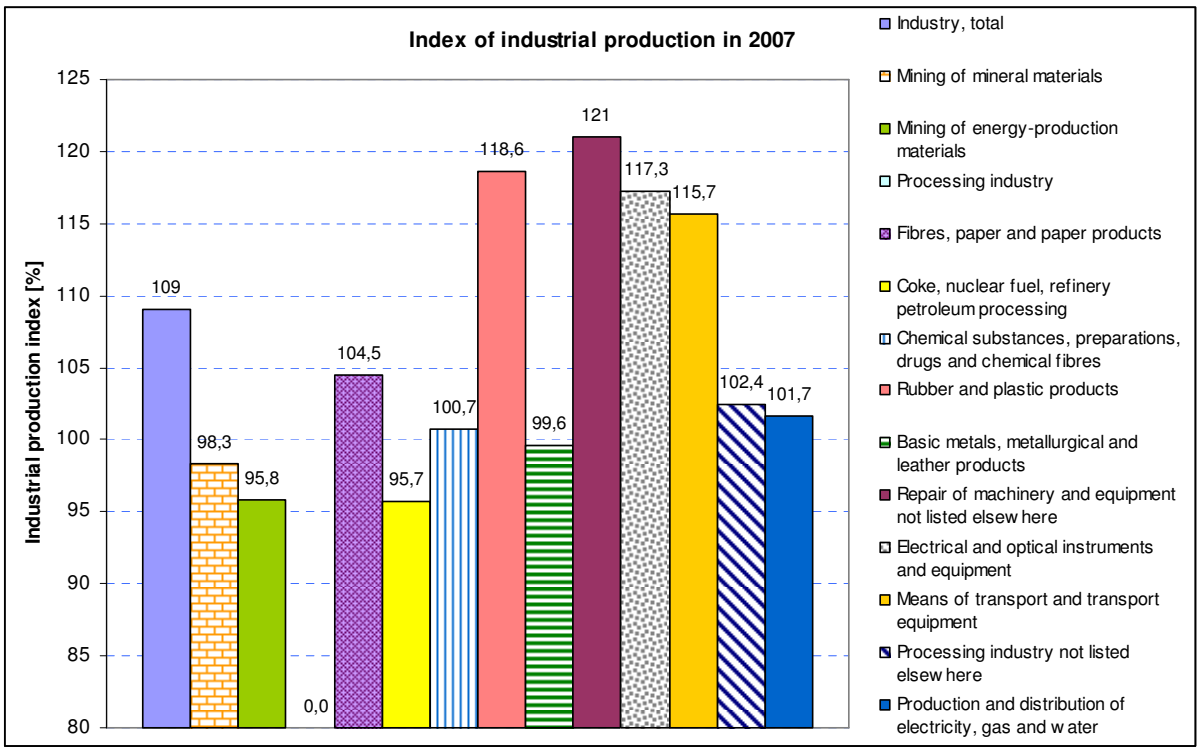
Research, development and innovation

The situation in the area of research and development (R&D) is characterized by a relatively low level of overall expenditures for R&D in total GDP. The developed EU countries spend 2 – 3% of GDP on R&D, while the Czech Republic spent only about 1.5% of GDP on R&D in the 2005 – 2007 period. In the area of research and development, it is necessary to improve cooperation between public and private research institutions and simultaneously to increase the volume and effectiveness of public expenditures for research and development.

Participation by domestic private sources is inadequate and the small share of foreign funds in financing R&D also has negative consequences; in 2005, the latter corresponded to less than 4%, i.e. half the value in the EU-25. Because of its highest share of research capacity, expenditure of the public sector into R&D is concentrated in the Capital City of Prague, while the competitiveness and employment level in a number of regions is weakened by the greater distance from research and development capacities. A platform of support for eco-innovations was established in 2008 in response to the ETAP programme announced by the European Commission.

Fig. 2.17 Index of industrial production according to sector in 2002 and 2007





Source: CSO

2.11 Waste

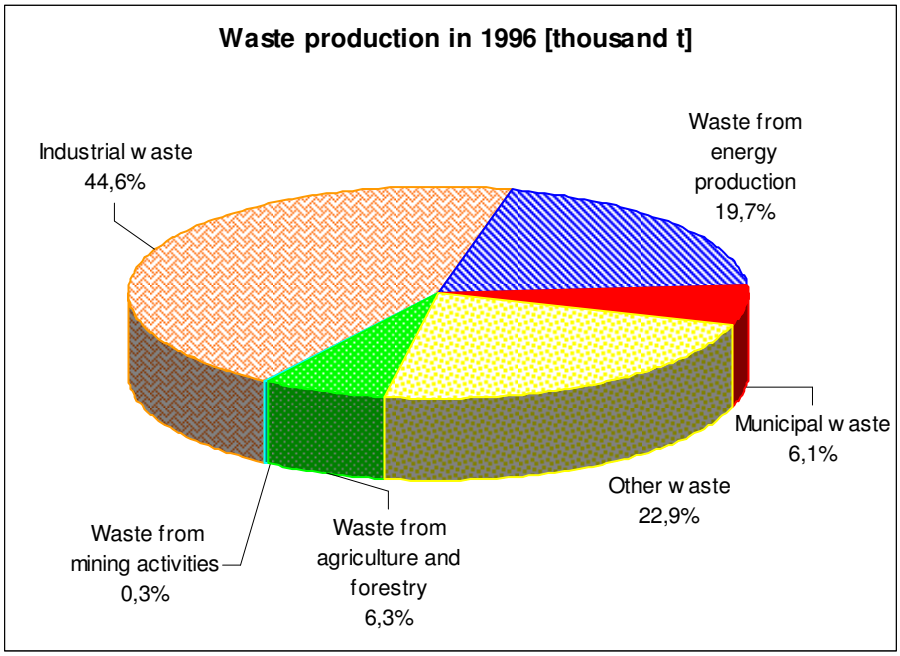
The overall production of waste in the Czech Republic decreased consistently between 2002 and 2006 (with the exception of an increase in 2004), but overall waste production increased again in 2007. A similar trend can be seen in the production of hazardous waste. Construction and demolition waste (approx. 48%) formed the largest part of overall waste production in 2007.

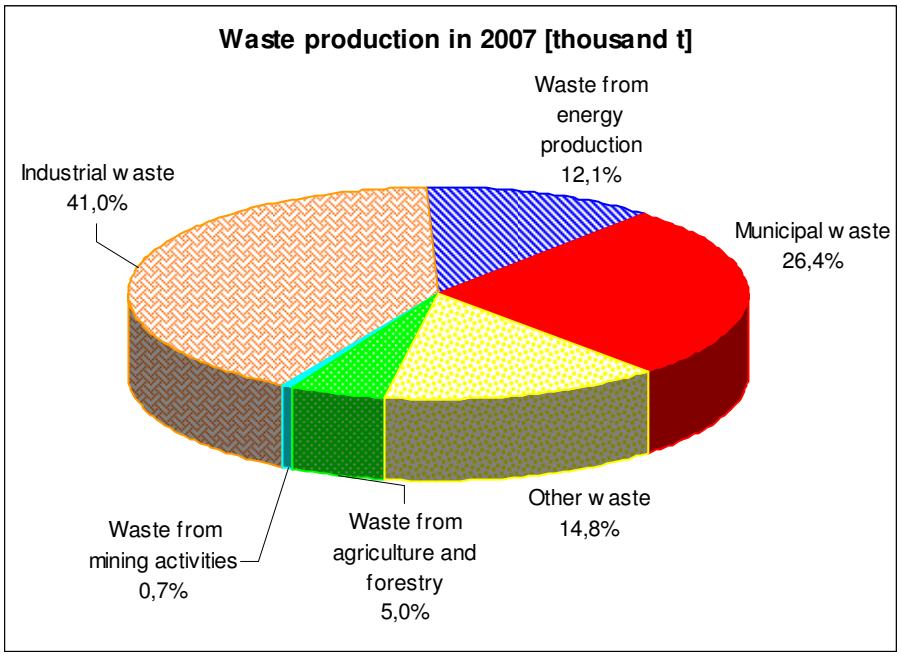
The reduction in the amount of waste produced was a consequence particularly of the reduction in the production in industrial waste as a result of technical developments and increasing pressure on achieving the maximum possible production efficiency, cost minimization and savings of ever-more-expensive primary raw materials. Economic depression and the increasing effectiveness of the sector were another factor reducing the amount of waste from agriculture and forestry.

The reduction in the production of hazardous waste was substantially affected by the improved technical level of production, a change in orientation of industrial activities from heavy industry to production with greater added value, implementation of economic instruments, especially concerning fees, which created scope for development of the waste processing sector towards an increased portion of material recovery of waste and technical modifications eliminating waste or minimizing the hazardous properties of waste.

Fig. 2.18 gives the amounts of waste produced in years 1996 and 2007 from the standpoint of the systematic OECD classification.

Fig. 2.18 Waste production in 1996 and 2007 according to origin (thousand t)





Source: MoE, CENIA

Municipal waste production in the Czech Republic varies around 4.1 mil. tonnes p.a. The greatest amount of municipal waste consists in mixed municipal waste, bio-decomposable fractions (kitchen scraps, grass, leaves, etc.), paper, plastics, glass and a small proportion of hazardous waste. The production of municipal waste is increasing in the long term, with a decrease from 2005, but production steeply increased again in 2007.

The amount of waste used for material recovery is increasing, but a large amount of waste is still disposed of by landfilling. The considerable portion of biologically decomposable components contained in residual mixed municipal waste, which is disposed of especially by landfilling at managed waste landfills, remains a problem.

A total of 23.1 mil. t of all the waste produced was recycled or used as secondary raw material in 2006 (data for 2007 are not yet available). There has also been a reduction in the total amounts of waste disposed of by landfilling; in 2006, 4.228 mil. t were landfilled, i.e. 15.1% of total production (compared to 5.325 mil. t, i.e. 17.9% in 2005). There has been a consistent increase in the amount of separately collected recoverable municipal waste and also hazardous components of municipal waste.

The percentage of waste that is incinerated and used for energy production remains low. In 2006, a total of 648.4 thousand tons of waste were recovered for energy production, corresponding to 2.3% of total waste production (of the production of municipal waste, a total of 9.6% was treated in waste incinerators). A total of 29 hazardous waste incinerators and three municipal waste incinerators (Prague, Brno and Liberec) are in operation in the Czech Republic. In addition to incinerators, waste is also used for energy production in 4 cement plants.

The recovery of hazardous waste has increased since 2002; this corresponded to 36.1% in 2005, increasing in 2006 to 40.5% of total production of hazardous waste. The extent of material recovery of hazardous waste has increased proportionately. In 2006, a total of 5.5% of the total production of hazardous waste was deposited in landfills, 3.8% was disposed of by incineration and 4.4% was used for energy production. The large amount of hazardous waste that is collected annually in hazardous waste storage areas remains a problem.

The current national legislation dealing with the area of waste came into effect in 2001. This consists particularly in Act No. 185/2001 Coll., on waste and Act No. 477/2001 Coll., on packaging, which fully implement the current legislation of the European Communities. Regulation of the Government of the Czech Republic No. 31/2999 Coll., valid from 2003, laid down a list of products and packaging that are subject to the used product collection. These include waste oils, electric batteries, galvanic cells, discharge lamps and fluorescent lamps, tires and also refrigerators.

Tab. 2.5 Management of municipal waste in the Czech Republic in the 2002 – 2007 period (thousand t)

Year	Total management	Recovery	Disposal	Other methods
2002	4,172	427	3,529	216
2003	4,030	546	3,307	177
2004	4,108	590	3,366	152
2005	4,198	732	3,220	246
2006	4,149	611	3,244	293
2007	4,334	734	3,346	254

Source: TGM WRI, CENIA

2.12 Agriculture

Agriculture has a typical Central European character with production of temperate-region foodstuffs and a high intensity of cultivation of the land. The distribution of agricultural production has a zonal character, in which altitude above sea level is more important than latitude. Czech agriculture is capable of meeting domestic requirements for basic agricultural products. Plant production predominates over animal production in the Czech Republic. Production per area of agricultural land is, however, lower than in neighbouring countries. The contribution of agriculture to the GDP in the Czech Republic is about average for the EU.

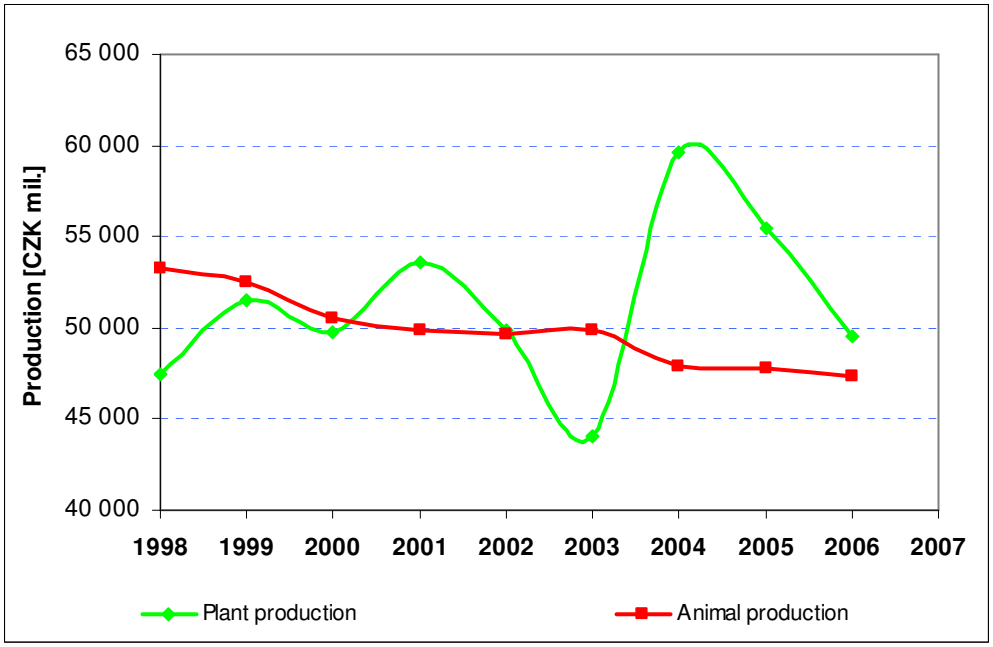
Agricultural land in the Czech Republic, similar to the other EU countries, is giving way to construction – nonetheless, the Czech Republic belongs among EU countries with the largest proportion of cropland in their total area. The main crops on seeded areas consist in cereals and, of them, primarily wheat. These areas have constantly increased in recent years at the expense of feed crops. Areas seeded with rapeseed have grown in the past few years. On the basis of the five-year averages, the harvests of cereals have increased. The greatest harvests are of wheat and barley and, amongst other crops, sugar beet. Yields of the main agricultural crops have gradually increased; nonetheless, the Czech Republic is amongst medium-successful wheat growers. Potatoes are a traditionally successful crop and the Czech Republic is amongst leading producers of rapeseed.

There has been a considerable reduction in the numbers of farm animals despite the development in some neighbouring countries, where their numbers have increased. International comparisons show the number of farm animals as below the EU average. Animal production corresponds to the numbers of cattle; meat production in the Czech Republic is below the EU average. Although the average annual milk yields per cow are increasing, it is not enough to compensate for the decrease in the numbers of cows and milk production is also decreasing.

Plant production in the Czech Republic in 2007 corresponded to CZK 66.5 bil. in current prices and thus constituted 57.6% of the total production of agricultural products. Animal production corresponded to CZK 49.0 bil. (i.e. 42.4%). Plant production has come to predominate over animal production since 2001.

Fig. 2.19 provides a survey of overall agricultural production in 1998 to 2006.

Fig. 2.19 Production of the agricultural sector in constant 2000 prices in the 1998 – 2006 period (CZK mil.)



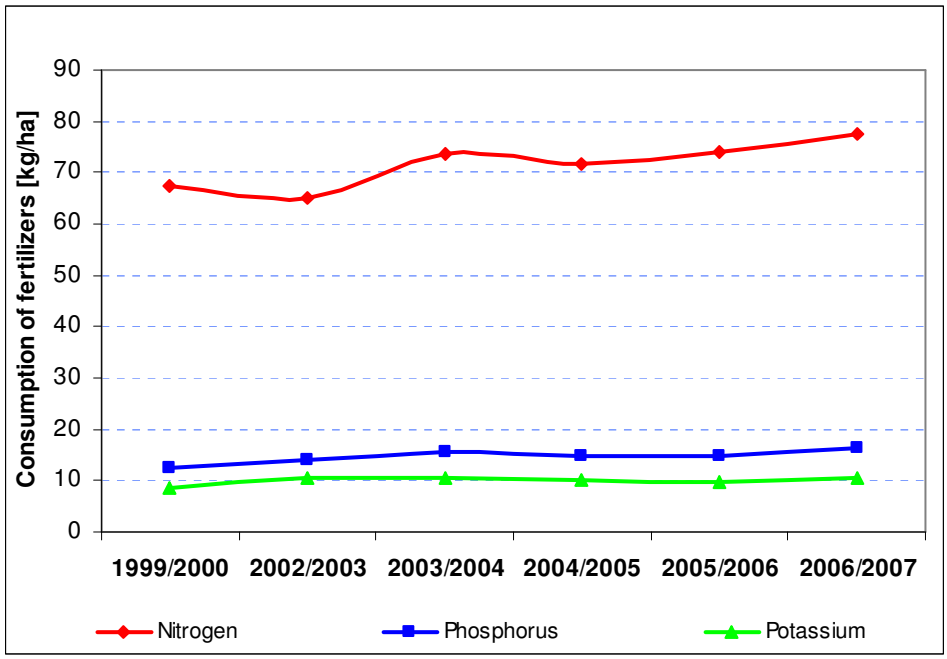
Source: CSO, CENIA

Of the total area of the State (approx. 7.9 mil. ha), 53.9% corresponded to agricultural land in 2007 (54.1% in 2003), corresponding to 0.4 ha per capita. A total of 33 thousand ha of agricultural land were lost between 1993 and 2007 (i.e. a decrease of 0.8%). The increased agricultural production in 2004 – 2007 was accompanied by increased consumption of mineral fertilizers and lime materials (Fig. 2.20).

The development of organic agriculture and the consistent increase in the number of organic farms, vendors of bio-foodstuffs and areas of organically farmed agricultural land are long-term favourable trends. As of December 31, 2007, the area of organically farmed land corresponded to 312,890 ha, i.e. 31,355 ha more than in 2006, i.e. the proportion of agricultural land farmed organically increased to 7.36% (approx. 6% in 2003). There was also an increase in the number of registered enterprises and agricultural land used for integrated production. Compulsory addition of bio-components to automotive fuels was introduced in 2007. The area seeded with rapeseed increased in this connection. There was also a substantial increase in the areas seeded with GM crops. Agriculture contributes to greenhouse gas production; in 2007, emissions of CH_4, N_2O and CO_2 corresponded to a total of approx 6 thousand kt. N_2O emissions in the agricultural sector represent over 70% of total N_2O emissions in the Czech Republic.

After 1990, when agriculture was transformed, there was a very substantial decrease in consumption of mineral fertilizers and lime materials for financial reasons. The application of mineral fertilizers and lime materials increased again in 1994 and has fluctuated slightly since then. At the present time, the application of fertilizers in the Czech Republic corresponds to the EU average.

Fig. 2.20 Trends in the consumption of mineral fertilizers in the 1999 – 2007 period (kg/ha)



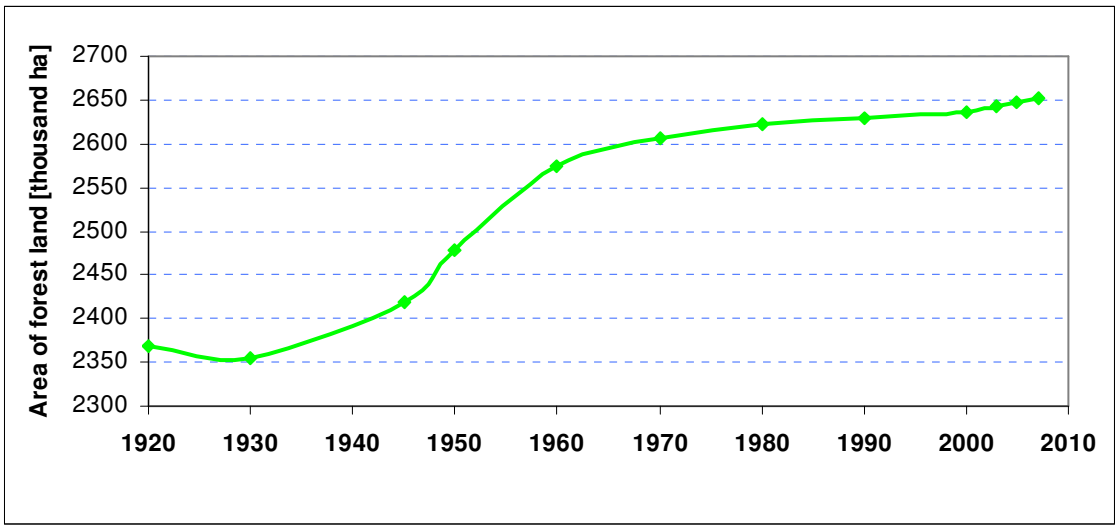
Source: CSO

2.13 Forestry

The Czech Republic is a country with extensive forest coverage. The area of forests has been consistently increasing since the second half of the 20th century, especially as a consequence of long-term afforestation of unproductive agricultural land (the annual increase has been approx. 2000 ha in recent years). The overall area of forests in 2007 equaled 2,651 thousand ha, corresponding to approximately one third of the area of the Czech Republic (33.62% of the total area of the country). The Czech Republic is in 12th place in Europe in the percentage of forest area.

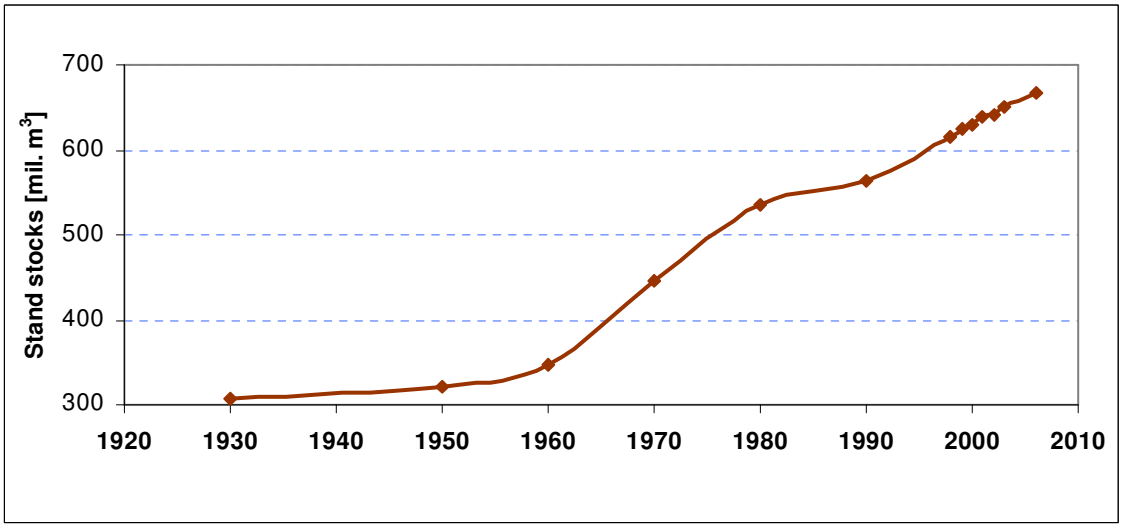
In recent years, afforestation has been characterized by an attempt to increase the share of broad-leaved species at the expense of coniferous species. In 2006, 75.1% of forest stands consisted in coniferous species (compared to 76.5% in 2000), with 23.9% broad-leaved species (compared to 22.3% in 2000). The total stand stocks of wood in the forests of the Czech Republic are constantly increasing and equaled 668 mil. m^3 (Fig. 2.22) in 2006.

Fig. 2.21 Trends in the area of forest land in 1920 – 2007 (thousand ha)



Source: MoA, COSMC

Fig. 2.22 Trends in the total stand stocks of wood in forests in 1930 – 2006 (mil. m^3)



Source: MoA

Tab. 2.6 Trends in some basic characteristics of forest management in 1990 – 2007 (mil. m^3 p.a.)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Total increment	16.3	16.5	16.8	16.8	16.8	17.0	17.2	17.3	17.5	-
Total harvesting	13.3	12.4	14.4	14.4	14.5	15.1	15.6	15.5	17.7	18.5
Ratio of harvesting and increment	0.82	0.75	0.87	0.86	0.86	0.89	0.91	0.90	1.01	-
Random harvesting	9.8	7.9	3.3	3.7	4.2	8.2	5.4	4.5	8.0	14.9
Random harvesting as % of total harvesting	73.7	63.7	22.9	24.0	25.0	48.2	34.4	29.3	45.4	80.5

Source: MoA, CENIA, CSO

Tab. 2.6 gives basic information on forest management. The record values of wood harvesting in 2007 were caused primarily by liquidation of the damage caused by hurricane Kyrill in January of 2007.

From the standpoint of ownership relations, 61.52% of forests belong to the State, 15.85% to towns and municipalities, 18.95% to private natural persons and 3.68% to other owners (data for 2007). Forests in the ownership of the State are managed by Lesy České republiky s.p. (Forests of the Czech Republic) or Vojenské lesy s.p. (Military Forests) and the national park administrations. On the basis of their function, economic (76%), protective (3%) and special purpose (21%) forests can be distinguished. Economic forests lie within the competence of the Ministry of Agriculture and forest units in National Parks and in Protected Landscape Areas lie within the competence of the Ministry of the Environment. In recent years, forest management has contributed between 0.8 and 1.0% to the creation of gross added value.

In the last few decades, forests have been greatly damaged, especially by industrial emissions. In spite of the substantial reduction in emissions of pollutants into the air (especially SO_2), the condition of forests is improving only very slowly. Current damage to forests is caused primarily by long-term accumulative degradation of forest soils as the joint effect of the action of pollution levels and unsuitable and excessively intense forest management. The high concentrations of tropospheric ozone currently also contribute to the damage to forest tree stands.

2.14 Trends in the Main Indicators

The Czech Republic has reduced the absolute volume of total emissions by more than 21% from 190 mil. t (CO_2 equivalent) in 1990 to approx. 150 mil. t in 2007. Thus there has also been a reduction in CO_{2eq} per GDP[2] unit, from 67.25 t CO_{2eq}/mil. CZK GDP in 2000 to approx. 44.46 t CO_{2eq}/mil. CZK GDP in 2007.

Expressed relatively, CO_{2eq} emissions per GDP unit have decreased by approx. 34% since 2000. The decrease in this indicator has maintained a stable trend over the entire monitored period; however, this is mainly a result of the growth of the Czech economy, leading to an increase in GDP in 2000 – 2007 (in constant prices) by approx. 34.6%, rather than of a decrease in total CO_{2eq} emissions, as they have basically remained constant since 1995. This means that decoupling of CO_{2eq} emissions from economic development occurred in the 2000 – 2007 period.

In spite of this favourable development, CO_{2eq} emissions per GDP unit have remained relatively high compared to the other EU-15 countries and most OECD members. Similarly, other new EU Member States' specific greenhouse gas emissions per GDP unit are above the EU-27 average as a consequence of substantial use of fossil fuels and the higher energy intensity of the economy. However, emissions have decreased more slowly in the Czech Republic than in the other new EU Member States. International comparison of CO_2 emissions per capita is not favourable for the Czech Republic (Tab. 2.7) – it has one of the highest emissions per capita in Europe.

Despite all the introduced measures leading to meeting the set targets, current high value of specific CO_{2eq} emissions and the high emission intensity of creation of the gross domestic product in the Czech Republic in comparison with other countries are caused by the composition of primary energy sources with a high share of solid fuels and constant high energy intensity of the economy, although this has undergone a substantial reduction between 2005 and 2007.

[2] *GDP expressed in constant 2000 prices using a GDP deflator (source: CSO)*

Tab. 2.7 International comparison of trends in CO_2 emissions per capita – 2004 (t CO_2 per capita)

Country	1990	1995	2000	2001	2002	2003	2004
EU 27							
Belgium	10.1	10.5	10.0	9.3	8.9	9.9	9.7
Bulgaria	8.5	6.7	5.3	5.6	5.3	5.6	5.5
Czech Republic	.	**11.8**	**11.6**	**11.6**	**11.3**	**11.4**	**11.5**
Denmark	9.7	10.6	8.7	9.0	8.9	10.1	9.8
Estonia	.	12.6	11.7	12.0	11.8	13.6	14.0
Finland	10.3	10.7	10.0	10.9	11.7	13.1	12.6
France[1)]	6.4	6.0	6.0	6.3	6.2	6.1	6.2
Ireland	8.7	9.2	10.9	11.4	11.0	10.5	10.4
Italy[2)]	6.9	7.2	7.4	7.4	7.5	7.7	7.7
Cyprus	6.8	7.0	8.2	8.1	8.1	8.9	8.2
Lithuania	.	4.4	3.4	3.6	3.6	3.7	3.9
Latvia	.	3.8	2.5	2.8	2.7	2.9	3.1
Luxembourg	25.9	20.4	18.9	19.4	21.2	22.1	24.9
Hungary	5.8	5.8	5.3	5.6	5.6	5.8	5.7
Malta	6.2	7.8	5.4	5.3	5.3	6.2	6.1
Germany	12.4	10.2	9.7	10.0	9.7	9.8	9.8
The Netherlands	9.4	9.1	8.9	9.0	9.5	8.8	8.7
Poland	9.1	9.0	7.8	7.9	7.7	8.0	8.0
Portugal	4.2	5.0	5.8	5.7	6.0	5.5	5.6
Austria	7.5	7.2	7.5	8.0	8.1	8.7	8.5
Romania	6.7	5.5	3.9	4.2	4.0	4.2	4.2
Greece	7.1	7.3	8.2	8.4	8.5	8.7	8.7
Slovakia	.	7.6	6.6	6.9	6.9	7.0	6.7
Slovenia	.	7.1	7.3	7.9	8.1	8.1	8.1
United Kingdom	10.1	9.8	9.9	10.0	9.6	9.7	9.8
Spain	5.5	5.9	7.0	6.9	7.3	7.3	7.7
Sweden	5.8	5.3	5.2	5.3	6.1	5.9	5.9
Other countries							
Australia	16.5	17.3	17.6	16.7	16.0	15.9	16.3
China	2.1	2.6	2.6	2.7	2.8	3.3	3.8
India	0.8	1.0	1.1	1.1	1.1	1.1	1.2
Iran	3.9	4.3	5.3	5.5	5.6	5.9	6.3
Iceland	7.9	7.3	7.7	7.4	7.6	7.5	7.6
Israel	7.3	9.7	10.5	10.3	10.8	10.9	10.8
Japan	8.7	9.1	9.5	9.4	9.5	9.6	9.8
Republic of South Africa	9.1	9.1	8.7	8.7	8.4	8.6	9.2
Canada	15.0	17.2	19.1	18.8	19.3	20.1	20.0
Republic of Korea	5.6	8.3	9.2	9.3	9.4	9.6	9.8
Kuwait	20.3	31.6	37.1	34.1	31.9	36.3	38.0
Malaysia	3.1	5.8	5.4	5.7	5.8	6.3	7.0
Norway	7.8	8.5	9.9	11.6	15.8	18.0	19.0
New Zealand	6.6	6.8	8.4	8.7	8.4	8.1	7.8
Saudi Arabia	15.7	13.4	13.1	13.3	13.6	13.6	13.4
Singapore	15.0	13.5	14.1	13.8	13.3	11.3	12.2
United Arab Emirates	29.3	30.3	49.1	43.2	35.4	48.4	37.8
United States of America[3)]	18.8	19.3	20.9	20.4	20.5	20.2	20.4
Switzerland	6.3	5.5	5.4	5.9	5.6	5.5	5.5
Turkey	2.6	2.7	3.3	2.9	3.0	3.1	3.1
Ukraine	.	8.4	6.3	6.4	6.4	7.1	7.0

[1)] *Including Monaco*
[2)] *Including San Marino*
[3)] *Including territories*

Source: UN Statistics Division, CDIAC (Carbon Dioxide Information Analysis Center), 2008

3 Inventories of greenhouse gas emissions, including information on the national inventory system and national registry for emission trading

3.1 Summary tables and the results of the inventories

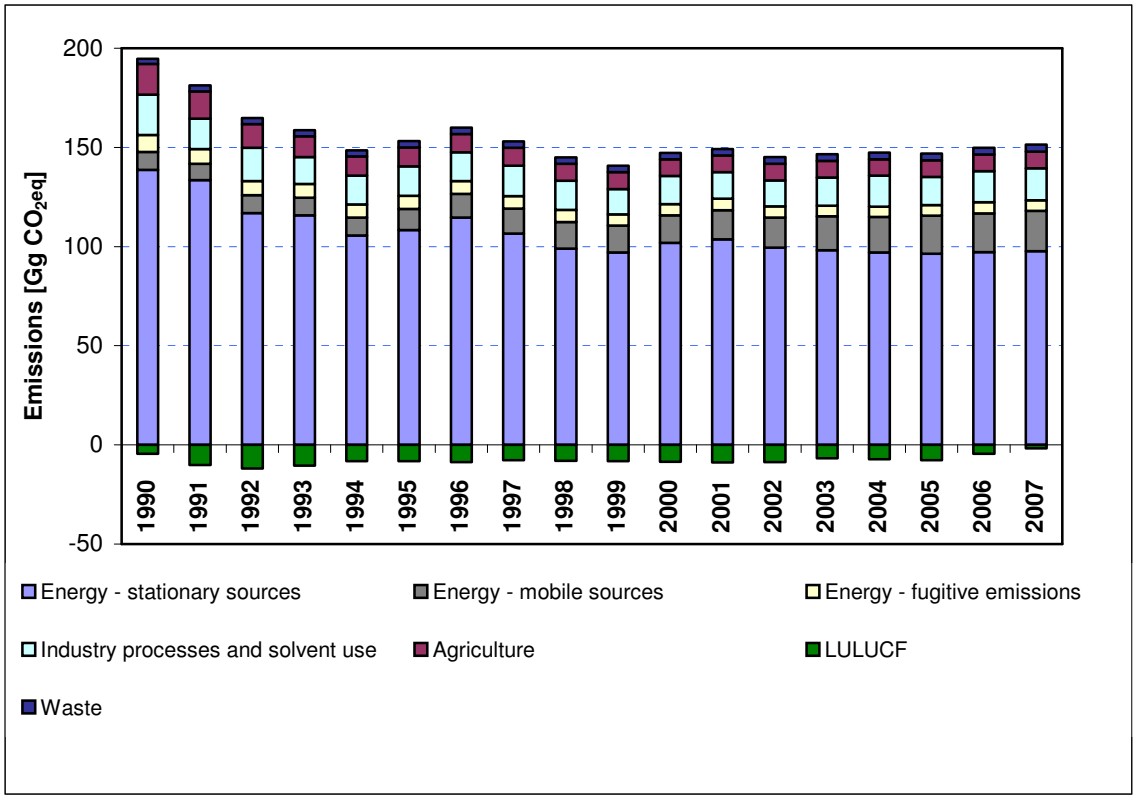
Annex 10.1 gives the summary results of greenhouse gas inventories for the 1990 – 2007 period in basic sectoral classification. These results are taken from the National Inventory Report (NIR), which was submitted to the secretariat of the UN Framework Convention on Climate Change in April of 2009. Annex 10.1 gives four trend tables, of which the first three (Tabs. 10.1 – 10.3) relate to the main greenhouse gases (CO_2, CH_4 and N_2O) and the fourth (Tab. 10.4) is concerned with overall (aggregate) greenhouse gas emissions expressed in CO_2 equivalents. This table gives the emissions from use of F-gases, described in detail in subchapter 3.2.

In accordance with UNFCCC requirements on data outputs, the total emissions in all four tables of Annex 10.1 are given both including emissions and sinks in the Land Use, Land Use Change and Forestry (LULUCF) sector and also without inclusion of this sector. Overall (aggregated) emissions for all the sectors (including LULUCF) decreased by 21.6% from 1990 to 2007; this decrease equaled 22.5% when the LULUCF sector was not included.

The trends in emissions and sinks in the main inventory categories are also depicted in Fig. 3.1. The rapid decrease in total greenhouse gas emissions after 1990 was caused by the reduction in production and subsequently also the restructuring of the economy, as one of the consequences of the substantial changes in the political system. Conditions have been relatively stable since 1994 and the existing fluctuations can be attributed to various factors (e.g. different winter temperatures, inter-annual changes in GDP and the degree of adoption of measures to reduce greenhouse gas emissions, etc.). The uncertainty in determination of emissions in the individual years is also reflected in the inter-annual changes. The decrease in emissions from the *Energy* sector (stationary combustion) and the *Agricultural* sector has been substantial, but emissions from *Transport* are continuing to increase. Fig. 3.2 depicts stable combustion sources in finer sub-sector categorization. It is apparent from this figure that greenhouse gas emissions have decreased in the *Processing industry* and *Other* (housing, institutions and services) sectors, while a reduction has not occurred in the *Energy* sector.

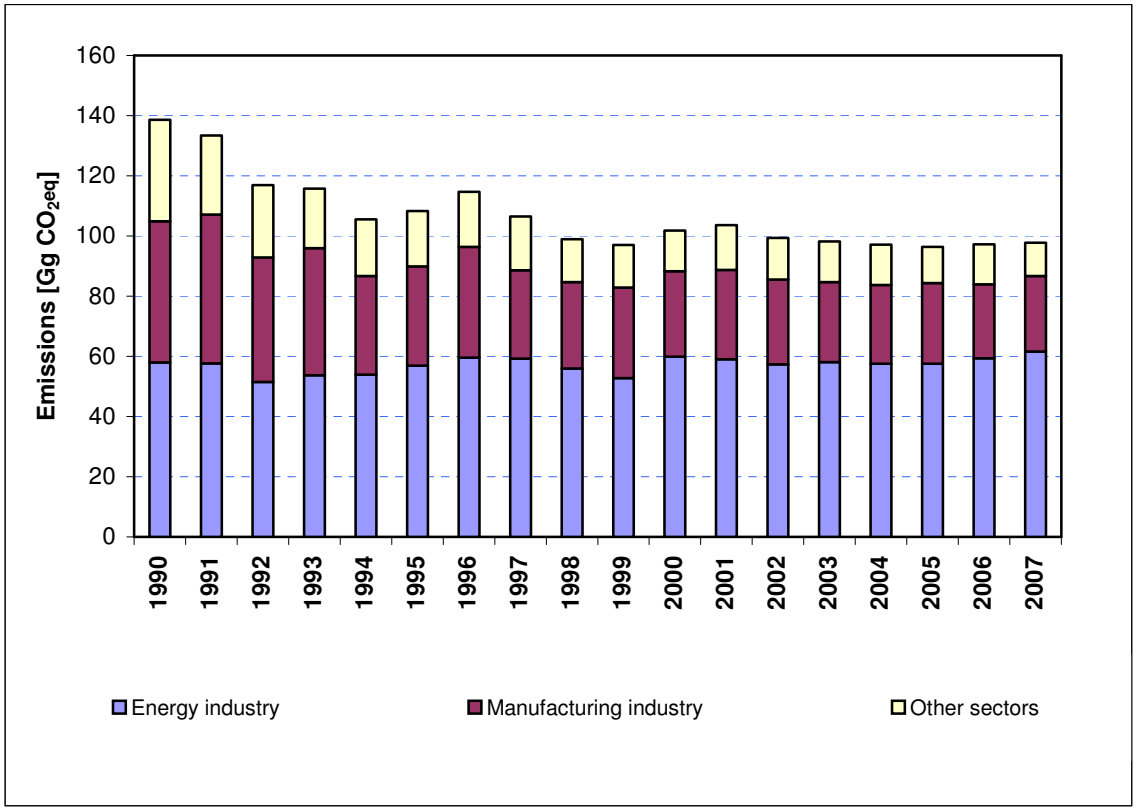
As total greenhouse gas emissions decreased by 21.6% to 2007 compared to 1990 (including LULUCF) or 22.5% (excluding LULUCF), it can be expected that the reduction commitment of the Kyoto Protocol will very likely be met for the first review period of 2008 – 2012 (see also Chapter 5). Nonetheless, in spite of this reduction in emissions since 1990, indicators relating aggregated emissions per capita or GDP unit remain very unfavourable (see Chapter 2.14).

Fig. 3.1 Trends in greenhouse gas emissions in the 1990 – 2007 period in sector categorization (Gg CO_{2eq})



Source: CHMI

Fig. 3.2 Trends in greenhouse gas emissions from stationary combustion sources (Gg CO_{2eq})



Source: CHMI

3.2 Inventories of greenhouse gases

3.2.1 Introduction

Inventories of greenhouse gases for the purposes of the UN Framework Convention on Climate Change monitor emissions and sinks of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), partly or completely fluorinated hydrocarbons (HFCs, PFCs) and sulphur fluoride (SF_6). In addition, *precursors* are registered: volatile organic compounds (NMVOC), carbon monoxide (CO), nitrogen oxides (NO_X) and sulphur dioxide (SO_2). Emphasis is placed on accurate calculations of emissions of greenhouse gases with direct radiation absorption effect (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6). The total impact of emissions of these gases is given as the aggregated emissions, expressed as the equivalent amount of carbon dioxide, taking into account the global warming potential values GWP for a time period of 100 years.
Greenhouse gas inventories are prepared in accordance with the standard IPCC method. A detailed description of the methodology, emission factors employed and activity data is contained in the National Inventory Report, which is updated annually[3].

3.2.2 Key categories

Inventories of greenhouse gas emissions are based on a differentiated approach to important and less important emission categories. Important categories contributing more than 95% to overall aggregated emissions are denoted as key categories. This is related to the individual sectors or subsectors of the inventories and the individual greenhouse gases or groups (F-gases). Key categories were identified both on the basis of level assessment (LA) and also on the basis of trend assessment (TA). A total of 25 key categories were identified, of which 18 met the criteria for level assessment. The key categories are listed in Tab. 3.1 together with their contributions to total emissions. The combustion of solid fuels is the most important key category, corresponding to roughly 50% of total, i.e. aggregate greenhouse gas emissions.

Tab. 3.1 Key categories for 2007 evaluated on the basis of level assessment (LA) and trend assessment (TA)

	Key categories	Gas	Share of emissions (%)	Cumulative (%)	Assessment
1	1.A Stationary combustion – solid fuels	CO_2	49.09	49.09	LA,TA
2	1.A.3.b Transport – road transport	CO_2	11.76	60.84	LA,TA
3	1.A Stationary combustion – gaseous fuels	CO_2	10.83	71.68	LA,TA
4	2.C.1 Production of iron and steel	CO_2	5.23	76.91	LA,TA
5	1.A Stationary combustion – liquid fuels	CO_2	3.15	80.06	LA,TA
6	1.B.1a Mining and treatment of coal	CH_4	2.98	83.03	LA,TA
7	4.D.1 Agricultural land – direct emissions	N_2O	1.66	84.69	LA,TA
8	6.A Landfilling of solid waste	CH_4	1.58	86.27	LA,TA
9	4.A. Enteric fermentation	CH_4	1.55	87.81	LA,TA
10	2.A.1 Production of cement	CO_2	1.33	89.15	LA
11	4.D.3 Agricultural land – indirect emissions	N_2O	1.18	90.32	LA,TA
12	2.F.1-6 Use of F-gases – replacement for Freon	F-gases	1.05	91.37	LA,TA
13	5.A.1 Forest area remaining forest area	CO_2	0.88	92.25	LA,TA
14	2.A.3 Use of limestone and dolomite	CO_2	0.72	92.97	LA,TA
15	1.A.5.b Mobile sources in agriculture and forestry	CO_2	0.70	93.67	LA
16	2.A.2 Production of limestone	CO_2	0.52	94.19	LA
17	2.B.2 Production of nitric acid	N_2O	0.50	94.69	LA

[3] The National Inventory Report and sets of data information on inventories for a particular year are available at www.chmi.cz/cc/.

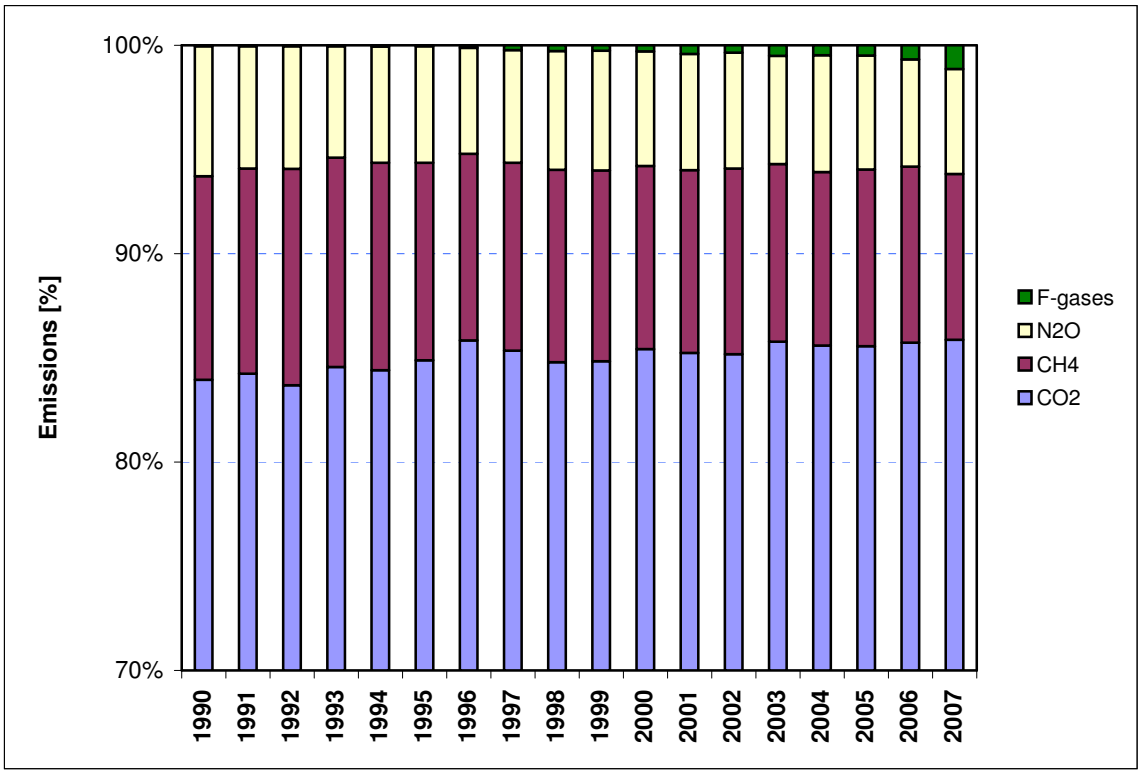
	Key categories	Gas	Share of emissions (%)	Cumulative (%)	Assessment
18	1.A.3.b Transport – Road transport	N_2O	0.47	95.17	LA,TA
19	1.A Stationary combustion – solid fuels	CH_4			TA
20	5.B.1 Agricultural land remaining agricultural land	CO_2			TA
21	6.C Waste incineration	CO_2			TA
22	1.A.3.e Transport – other transport	CO_2			TA
23	1.A Stationary combustion – biomass	CH_4			TA
24	4.B Manure management	CH_4			TA
25	4.D.2 Pastures – manure deposited in pastures	N_2O			TA

Source: CHMI

3.2.3 Emissions of individual greenhouse gases

Fig. 3.3 depicts the shares and trends in the shares of the individual gases or their groups in total greenhouse gas emissions in the individual years. There are minimal differences between the individual years. A trend can be observed in the reduction in the share of methane as a consequence of a reduction in fugitive emissions and emissions from the *Agricultural* sector, together with an increase in the share of F-gases (HFC, PFC and SF_6) as a result of the process in which they have been used in the refrigeration industry as a replacement for freons depleting the ozone layer of the Earth (regulated by the Montreal Protocol) and are employed in modern technologies. Carbon dioxide is the most important greenhouse gas, contributing 85.9% to overall emissions, followed by methane with 8.0%, nitrous oxide with 5.0% and F-gases with 1.1% (figures for 2007, emissions including LULUCF).

Fig. 3.3 Trend in the shares of the individual greenhouse gases in total emissions in 1990-2007 (%)



Source: CHMI

3.2.3.1 Carbon dioxide

Carbon dioxide is the most important greenhouse gas in the national inventory and corresponds to the largest part (85.9% in 2007) of total aggregate emissions. CO_2 emissions come largely from the combustion of fossil fuels and from the decomposition of carbonates in the production of cement, lime, glass and sulphur removal; CO_2 sinks arise from the *Land use, land-use change and forestry (LULUCF)* sector. Solid fuels make the greatest contributions to emissions of carbon dioxide from combustion processes; liquid and gaseous fuels make smaller contributions.

The amounts of carbon dioxide emissions produced by the individual activities are given in the Annex (Tab. 10.1). They decreased by 19.8% between 1990 and 2007 and were derived mainly from the *Processing Industry* and *Other* (households, institutions and services) sectors, falling under the *Energy* sector. The reduction in emissions from combustion in the *Processing industry* sector at the beginning of the 1990s was caused by the cutback and restructuring of some branches of industry; savings and the introduction of new technologies caused a reduction in emissions towards the end of this period. The reduction in emissions in the *Other* sectors can be attributed to sounder utilization of energy (increased energy efficiency, insulation of buildings, etc.). The *Transport* sector exhibits the opposite trend; emissions from this sector have increased more than twofold (2.5 times) since 1990 as a consequence of general trends in transport and especially in individual automobile transport and road freight transport. The trend in the decreasing use of solid fuels and increase in the use of natural gas has had a favourable impact on emission trends. However, there has been a substantial increase in the price of gas in recent years, which could lead to a return to the use of solid fuels in the future.

In accordance with the IPCC methodology, emissions of carbon dioxide from international air and marine transport are not reported as part of national emissions but are reported separately. Similarly, emissions from the combustion of biomass are not included in national emissions, because they would be included twice. These emissions are reported in the sector *Land use, land-use change and forestry (LULUCF).*

3.2.3.2 Methane

Anthropogenic methane emissions are derived mainly from the mining, treatment and distribution of fuels, which is classified as a fugitive source. The breeding of animals, landfilling of waste and waste-water treatment are other important sources of methane emissions. In the case of breeding of animals, this gas is generated in digestive processes (especially in cattle) and in decomposition of excrements of animal origin. In landfilling of waste, decomposition of organic substances under anaerobic conditions leads to the formation of methane and this substance is also formed in the anaerobic treatment of waste waters.

The share of methane in total aggregated emissions of greenhouse gases decreased from 9.8% in 1990 to 8.0% in 2007. The amount of methane emissions produced by the individual activities is given in the Annex (Tab. 10.2). Methane emissions decreased by 36.0% in the 1990 – 2007 period, caused mainly by the cutback in coal mining and reduction in the numbers of farm animals.

3.2.3.3 Nitrous oxide

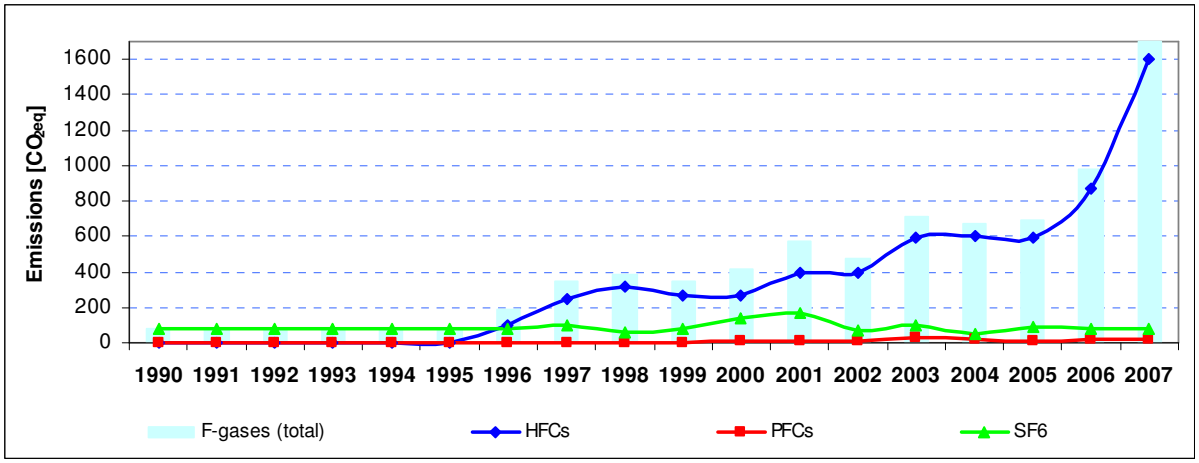
The greatest amounts of emissions of nitrous oxide are derived from agricultural activities, especially denitrification of nitrogen added to the soil in the form of artificial fertilizers or organic material. The production of nitric acid and, to a lesser degree, also *Transport* (automobiles with catalyzers) are also important sources.

The share of nitrous oxide in total aggregated emissions of greenhouse gases decreased from 6.2% in 1990 to 5.0% in 2007. The amount of emissions of this greenhouse gas produced by the individual activities is given in the Annex (Tab. 10.3). There was a reduction in nitrous oxide emissions by 36.9% in the 1990 – 2007 period, particularly as a consequence of the use of artificial fertilizers in agriculture, as a result of the reduction in the numbers of farm animals and, recently, also as a result of targeted introduction of technologies to eliminate nitrous oxide emissions in the production of nitric acid.

3.2.3.4 F-gases

The share of fluorinated gases in total aggregated emissions has increased since 1995, which was established as the reference year for the Kyoto Protocol, from 76 to 1,702 Gg CO_{2eq} in 2007, with a similar increase in the share in total aggregated emissions (0.1% in 1995 to 1.1% in 2007). These substances are not manufactured in the Czech Republic and their total consumption is covered by imports. The increase in emissions is caused by their use as a replacement for substances depleting the ozone layer of the Earth (CFC, HCFC) and by their increased use in modern technologies. They are employed especially in refrigeration technology (esp. HFC's), in electrical technology (esp. SF_6) and in some other fields (e.g. as insulation between window panes, plasmatic etching, filling for fire extinguishers, propellants for aerosols and blowing agents, etc.). Fig. 3.4 presents the amounts of emissions of the individual F-gases in the 1990 – 2007 period.

Fig. 3.4 The results of inventories of F-gases for the 1990 – 2007 period (CO_{2eq})



Source: CHMI

3.3 National system of greenhouse gas inventories

3.3.1 Introduction

According to Article 5 of the Kyoto Protocol, every party had the obligation to create a fully functioning system of greenhouse gas inventories (hereinafter NIS) by the end of 2006; this system must be in accordance with the rules adopted at the Seventh conference of the parties to the UN Framework Convention on Climate Change (Resolution 20/CP.7). The EU Member States were also bound by Decision No 280/2004/EC of the European Parliament and of the Council to create a NIS one year sooner, therefore the system was implemented in the Czech Republic at the end of 2005.

According to Decision 13/CMP.1, adopted at the Conference of Parties to the Kyoto Protocol in 2005, every party had the obligation in 2006 to submit an Initial Report on the Kyoto

Protocol, in which it demonstrated that its national system was fully functional and fulfilled the set conditions. The Czech Initial Report on the Kyoto Protocol, describing NIS, was submitted to the secretariat of the UN Framework Convention on Climate Change in October 2006.

The main functions of NIS include creation and functional operation of the institutional, legislative and procedure arrangement required to perform all the necessary activities connected with greenhouse gas inventories. In the Czech Republic, the Ministry of the Environment (MoE) is responsible for proper functioning of NIS (the *national entity*); it has appointed the Czech Hydrometeorological Institute (CHMI) as the organization responsible for coordination of preparation of inventories and the required data and text outputs. Mr. Pavel Fott continues to be the functional coordinator of NIS in CHMI. (fott@chmi.cz).

3.3.2 Institutional provisions

One of the main pillars of NIS consists in allocation of responsibility to institutions for preparing the inventories in the individual sectors. The main tasks of the NIS coordinator (CHMI) include: management (coordination of cooperation between the individual sectoral workers), general and cross-cutting aspects, including determination of uncertainties, control of outputs QA/QC, reporting and submitting data in the prescribed CRF format (*Common Reporting Format*), preparation of the National Inventory Report (NIR) and cooperation with the relevant bodies of the Framework Convention and the EU.

The sectoral inventories are prepared by specialized institutions – sectoral workers, which are coordinated by CHMI. Responsibility for the individual sectors was allocated to the following workplaces:

- KONEKO marketing performs greenhouse gas inventories in the "Energy" sector with emphasis on combustion of fuels in stationary sources and on fugitive emissions
- The Transport Research Centre (TRC Brno) prepares inventories in the "Energy" sector with emphasis on mobile sources
- In addition to its role as coordinator, CHMI bears responsibility for the greenhouse gas inventory in the "Industrial processes and use of products" sector
- The Institute of Forest Ecosystem Research (IFER) performs inventories of emissions and sinks in the "Agriculture" and "Land use, land use change and forestry" (LULUCF) sectors
- The Environmental Centre of Charles University (EC CU) prepares greenhouse gas inventories in the "Waste" sector

CHMI puts together the official outputs of greenhouse gas inventories (CRF, NIR) and submits them to the Ministry of the Environment for approval. The Ministry of the Environment further provides for contacts with the relevant ministries and state authorities, particularly with the *Czech Statistical Office* (CSO). It also communicates with the European Commission and the UNFCCC Secretariat. The formal aspect of contracts for this institutional arrangement is based on an order sheet of the Ministry of the Environment for CHMI, approved annually by the responsible Deputy Minister of the Environment.

3.3.3 Methodical aspects

The collection of activity data is based on the official, annually published documents of the CSO. In some cases, emissions inventories are also based on supplementary material obtained

from professional trade federations or are obtained directly from industrial enterprises. Emissions from sector 1.A "Energy, combustion of fuels" are based on the official Czech energy balance, prepared by the CSO.

The national greenhouse gas inventory is based on the IPCC methodology (*Revised 1996 IPCC Guidelines, 1997, Good Practice Guidance, 2000 and Good Practice Guidance for LULUCF, 2003*). This methodology emphasizes the transparency, consistency, comparability, completeness and accuracy of the emission inventory, which must not be either over-estimated or under-estimated and where uncertainty should be limited to an acceptable level. Preparation of greenhouse gas inventories encompasses collection of active data, selection of suitable methods and emission factors, determination of uncertainties and performance of QA/QC control mechanisms (*Quality assurance/ Quality control*).

The IPCC methodology introduces "Key categories" for those categories of sources that can substantially affect the uncertainty in the determination of emissions or sinks as levels or trends. A total of 25 key categories were identified in the last greenhouse gas inventory (for 2007). Sophisticated higher level (*Tiers*) methods and territorially specific emission factors are preferred for key categories in the national inventory. However, because of the high expense involved, the recommended emission factors introduced in the IPCC method are still used in a number of cases. The standard recommended emission factors are also employed for non-key categories.

In accordance with the IPCC methodology (*Good Practice Guidance, 2000 and Good Practice Guidance for LULUCF, 2003*) the determined emissions and sinks are recalculated in cases where new, more reliable data occur or when a change is introduced in the methodology, leading to more accurate determination. To ensure consistency, these recalculations are generally performed over the entire time series. Most recalculations of a more fundamental nature were performed prior to submitting the Initial Report of the Czech Republic to the Kyoto Protocol. Recalculations have been performed in the Czech national inventory in recent years only in response to recommendations of the international reviews, organized by the UN Framework Convention on Climate Change. These recalculations usually correct formerly determined values only slightly.

3.3.4 QA/QC control procedures

QA/QC control procedures progress according to a prepared plan. Preparation of this plan reflects the institutional arrangement: each institution prepares its own system of QA/QC procedures, including appointment of a responsible QA/QC expert for each sector. The sectoral QA/QC plan is an integral part of overall QA/QC, prepared by the NIS coordinator. National greenhouse gas inventories are part of the client processes in the Czech Hydrometeorological Institute, prescribed by quality standard ISO 9001 (CHMI received a certificate in 2007). Processes related to national inventories are prepared in the form of development diagrams and include all the main principles that must be maintained in preparation of the inventory, including QA/QC procedures.

QC procedures include routine technical control of the inventory quality to ensure consistency, integrity, accuracy and completeness of the data and to reveal and eliminate all errors and omissions. The QA procedures are applied to all the main procedures performed in the inventory: collection of data, selection of suitable methods and emission factors, calculation of emissions and documentation of procedures. These QC procedures are performed in accordance with the IPCC methodology, specifically with *Good Practice Guidance*, 2000. Some of these procedures are performed by sectoral managers and some are performed by the NIS coordinator. The sectoral managers tend to be concerned with control

of activity data, emission factors and the sector-specific methods used, while the NIS coordinator controls particularly the suitability of selection of the methodologies used, performs analyses of trends and compares data from various potential sources. Both the sectoral managers and the NIS coordinator employ the CRF *Reporter* control instrument.

QA procedures encompass control activities and review by a third party who is not directly connected with preparation of the national inventory of the particular country but is suitably conversant with the subject matter. CHMI traditionally cooperates in QA procedures with Slovak experts from SHMI, who participate in the preparation of the Slovak national inventory. However, control is carried out primarily by the Ministry of the Environment; at least two weeks prior to the official submission, the Czech national outputs are submitted for assessment and approval.

Regular international reviews performed by the authorities of the UN Framework Convention on Climate Change are of great importance for improving the quality of national inventories. Inspection reports identifying inadequacies and containing recommendations for their remediation are thoroughly analyzed by the Czech national team and are utilized to the greatest possible degree in the regular planning of inventories for gradual improvement of the quality of the Czech national greenhouse gas inventories.

3.4 National registry for emission trading

The administrator of the registry, the Operátor trhu s elektřinou, a.s. company, operates the national registry of greenhouse gas emissions allowances trading on the web site https://www.povolenky.cz/. Contact information:

Operátor trhu s elektřinou, a.s.

Sokolovská 192/79, 186 00 Prague 8 – Karlín

Telephone: +420 296 579 166

Fax: +420 296 579 180

e-mail: ote@ote-cr.cz

Useful information is available in the public part of the registry:

- The texts of international agreements
- The corresponding national legislation
- A glossary
- Answers to frequently asked questions (FAQ)
- Documents required to conclude an agreement
- References to other related sites
- Publicly accessible reports of the registry in accordance with Annex No. XVI, par. 4 of Commission Regulation (EC) No 2216/2004, as amended.

In the "Open an account" section, the participant will find all the documents required for concluding an Agreement on establishing and keeping an account in the registry for trading in units of the assigned amount (allowances) of greenhouse gas emissions. These include, in particular, the following documents:

- Basic instructions on the procedure in concluding an agreement

- The application form including annexes
- The wording of a standard agreement
- Business terms and conditions
- Price list

Persons authorized by the holders of accounts only have access to the secured (nonpublic) part of the registry. These persons register using their user name and password.

The Seringas software is used as application software for administration of the registry; this software was developed by the French bank Caisse des Dépôts et Consignations (CDC), which is also the administrator of the registry for France.

In administering the registry, the administrator cooperates with the following organizations:

- The Ministry of the Environment – competent authority
- Logica Czech Republic s.r.o. – technical operator or the information system of the registry
- Dépôts et Consignations (CDC) – provider of the license for the Seringas software

The registry information system conforms with DES. The system was tested for compliance with DES both by the UNFCCC Secretariat in the process of initialization of the procedure prior to connection to ITL and also using a set of testing scenarios performed in cooperation with CITL and ITL. The Czech registry has always passed these tests successfully and has received the necessary certificates.

The application software of the registry contains a number of instruments to minimize discrepancies when performing transactions. The high efficiency of these procedures is based both on the many years of experience gained in operation of the registry (EU ETS was launched in 2005) and also on experience in cooperation of countries using the Seringas joint application software. These include both countries in the EU and countries outside of the European Union.

The production database of the registry is backed up daily and complete weekly back-ups are stored in a safe of a bank outside the location of the production system. The back-up environment is located 15 km away from the production environment and the administrator of the registry has created a plan for renewal of the system following break-down of the production environment. This plan is regularly tested twice per year in cooperation with ITL/CITL.

The registry system is tested on various occasions. The following sets of tests are employed:

- Certification test prior to connection to ITL
- Certification test prior to each introduction of a new version of the registry into the production environment
- Testing of the new version by the license provider (CDC)
- Testing of the new version by the technical operator of the registry information system (Logica)
- Testing of the new version by the administrator of the registry
- Testing of the plan for renewal of the system following break-down of the production environment.

4 Measures to Reduce Greenhouse Gas Emissions

4.1 System of policies and legislation in the area of the climate

GHG emissions decreased in the Czech Republic by more than 20% during the 1990s (reference year 1990), caused by the disintegration of the centrally directed economy and termination of ineffective production in heavy industry. Nonetheless, despite the annual growth of the economy being between 2 – 4% GDP in the second half of the 1990s, GHG emissions have stabilized from the mid-1990s until 2005 at a level of 140 mil. t p.a. Combined with the Kyoto commitment (- 8%), this created a situation where it was not necessary to consider policies and measures targeted towards a further reduction in emissions.

An entirely new situation arose after the accession of the Czech Republic to the EU (May 1, 2004). It was necessary to transpose into the Czech legislation a number of EC instruments affecting GHG emissions or related to support RES, energy savings, the EC single market in energy, etc. In relation to the commitment for the post-Kyoto period (2013 and later), it will be necessary to adopt further measures. Consequently, the National Programme to Abate the Climate Change Impacts in the Czech Republic, which was formulated in 2004, i.e. at the time of accession of the Czech Republic to the EU and in relation to obligations following from the Kyoto Protocol, is currently undergoing a review. The current system of policies and measures is quite inadequate for attaining further emission reductions (e.g. 20 – 30% reduction relative to the reference year of 2005) and will have to be fundamentally altered in the coming years, primarily in relation to future obligations (the post-Kyoto period).

4.1.1 Creation of policies in the area of climate

In the Czech Republic, the Ministry of the Environment is responsible for implementation of the Convention and the Protocol and is simultaneously the supreme control body of the state administration in the area of protection of the environment. The climate change agenda is the responsibility of the Climate Change Department, which also includes the national focal point for the Convention in the Czech Republic. Because of the cross-cutting character of the issue of climate change, which affects a number of professional entities, the sector encompasses the Working Group for Climate Change of the Ministry of the Environment, which is a consulting body for the Minister of the Environment and whose members are representatives of the substantively competent departments. According to the character of the measures, the corresponding sectors (of the environment, industry, transport, agriculture, finances, etc.) are responsible for preparation and implementation of specific measures to reduce greenhouse gas emissions and adaptation measures.

4.1.2 Domestic and regional programmes, legislative instruments, effectiveness and administrative procedures

Because of the size of the Czech Republic, the organization of the public administration and the division of competence between the regions and the central government (ministries) pursuant to Act No. 129/2000 Coll., on the regions, as amended, the regions do not have direct competence in the sphere of protection of the climate system of the Earth. Nonetheless, according to Sections 1 and 14 of Act No. 129/2000 Coll., on the regions, as amended, in the framework of self-government, the regional authorities are responsible for general development of their territory and the needs of their citizens. From this follows the irreplaceable role of the regional authorities in creation of regional development concepts and plans, including water management plans for the areas of the individual river basins and flood

prevention measures, as well as the principles of territorial development utilizing renewable energy sources. The regional authorities also participate in implementation of the programmes listed below for energy savings and use of RES, renewal of the housing fund (central heating systems, renovation of residential apartment districts) and improvement of transport services. The position of the regions in the area of management of solid municipal waste is important as regards regional waste management plans (operation of landfills, composting, energy and material recovery from waste).

The policies that are described in the following text are created and implemented at the central (national) level or at the EC level. Policies and measures in the Czech Republic that have a direct or indirect impact on protecting the climate system of the Earth can be categorized in various ways. In the following text, they are characterized from a temporal standpoint or as measures that are in progress, under preparation or already completed. Policies and measures can be further classified as:

1. measures of a legislative nature,
2. strategic documents (policies) and their implementation plans,
3. programmes,
4. other initiatives and activities.

Measures of a legislative nature play an important role in the Czech Republic, not only imposing a number of obligations on the state administration and also natural and legal persons, but also providing for the preparation and revision of important strategic documents and programmes, such as:

1. the obligation to prepare a National Programme to Abate the Climate Change Impacts in the Czech Republic is established in Act No. 86/2002 Coll., on protection of the air,
2. the conditions for international emission trading and utilization of the revenues obtained are established by Act No. 695/2004 Coll., on the conditions of greenhouse gas emission allowance trading , therefore the “Green Investment Scheme” programme was established on this basis,
3. the coordination and contents of the State Programme in Support of Energy Savings and the Usage of Renewable Energy Sources are stipulated by Act No. 406/2000 Coll., on management of energy.

Thus, since 2000, an interconnected and integrated system of strategic and operational planning has gradually been created, which will be modified in the coming years so that international commitments that will arise for the Czech Republic from the post-Kyoto process and policies adopted by the European Communities (cf. particularly the Climate and Energy Package) could be fulfilled in a suitable manner. Legislative measures also usually stipulate institutional responsibility for coordination and implementation of programmes and impose the obligation to regularly update them.

A broader strategic framework also exists, consisting particularly of the Strategy of Sustainable Development, the National Strategic Reference Framework (NSRF), the Strategy of Economic Growth and the Strategy of Regional Development, i.e. documents that were mostly formulated for the 2007 – 2013 period.

The following text describes the most important policies and measures in this area with direct or demonstrable indirect impact on greenhouse gas emissions. The final tabular survey (see Annex 10.3) of all measures (direct and indirect impact) is divided according to the individual

sectors and gases. This survey is based on the recommended methodology for preparation of the National Communication.

4.2 Legislative instruments

In addition to the above-mentioned Acts No. 86/2002 Coll., on protection of the air, No. 695/2004 Coll., on the conditions of greenhouse gas emission allowance trading, and No. 406/2000 Coll., on management of energy, other legal regulations also exist that are related to the conditions for utilization of RES, application of the best available techniques (BAT) and enterprises in the area of energy. It can be assumed that, as in past years, these laws will continue to be amended, together with their regulations for implementation.

Work was commenced in 2008 on preparation of an amendment to Act No. 185/2001 Coll., on waste, as amended, which includes, amongst other things:

1. restrictions on the landfilling of biodegradable waste and thus also reduced production of landfill methane,
2. promotion of material recycling of waste, which should lead to energy savings,
3. better energy utilization of waste, e.g. through production and use of certified refuse-derived fuels (RDF) or support for new technologies based on environmentally safe energy recovery of part of solid municipal waste (e.g. through gasification and cogeneration).

4.2.1 Act No. 86/2002 Coll., on protection of the air and amending some other laws (the Air Protection Act), as amended

Objective: To create a legal framework for protection of the air and climate system of the Earth and for creation and revision of the National Programme to Abate the Climate Change Impacts in the Czech Republic

Characteristics: Legislative instrument

Period of implementation: 2002 – ongoing (revision)

Time framework: not stipulated

Sector: energy production, industry

In accordance with the law of the European Communities (Directive 2000/76/EC on the incineration of waste, Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants, Regulation (EC) No 2037/2000 on substances that deplete the ozone layer, as amended, and Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases, this law stipulates:

a. the rights and duties of persons in protection of the ambient air against introduction of pollutants through human activities and in handling of controlled substances that deplete the ozone layer of the Earth,
b. the conditions for further reduction of quantities of discharged pollutants having adverse effects on the lives and health of humans and animals, on the environment or on property,
c. instruments for reduction of emitted quantities of substances affecting the climate system of the Earth.

In Section 34, the Act stipulates instruments for protection of the climate system of the Earth. The National Programme to Abate the Climate Change Impacts in the Czech Republic

approved by the Government specifies the national reduction targets for substances affecting the climate system of the Earth and the deadline for achieving these targets.

The operators of very large and large stationary sources shall be obliged to submit to the Ministry, on request, data on emissions of substances affecting the climate system of the Earth and their precursors. The scope and manner of submitting data to the register of substances affecting the climate system is stipulated by a regulation for implementation.

The Act imposes on legal and natural persons the obligation to reduce and prevent air pollution; in relation to CO_2 emissions, legal and natural persons are obliged, where technically feasible and economically acceptable, to use central sources of heat or alternative sources for new structures or for modifications of existing structures. Simultaneously, they shall be obliged to verify the technical and economical feasibility of combined production of heat and energy.

The Act further regulates the conditions for energy recovery of waste and waste oils, introduces categorization of sources and emission limits for the individual categories and pollutants (SO_2, NO_x, PM_{10}, CO, VOC and others) and imposes obligations on the operators of sources in the individual categories.

For the individual categories of sources and pollutants, the Act imposes the obligation to perform monitoring and pay emission fees. The Act also regulates conditions for the use of substances damaging the ozone layer of the Earth. Equipment containing these substances (F-gases) must be subjected to regular inspection and repairs may be made only by an authorized person.

Act No. 482/2008 Coll., amending Act No 86/2002 Coll., on protection of the air and amending some other laws (Act on Protection of the Air), as amended, regulates (Chapter III) protection of the ozone layer of the Earth and the climate system of the Earth in relation to the use of F-gases.

4.2.2 Act No. 695/2004 Coll., on the conditions of greenhouse gas emission allowance trading and amending some laws, as amended (amendment Act No. 212/2006 Coll.. No. 315/2008 Coll.)

Objective: Creation of a legal framework for implementation of EU ETS and international emission trading (IET) according to Art. 17 of the Kyoto Protocol

Characteristics: Legislative instrument

Period of implementation: 2004 – ongoing (revision)

Time framework: not stipulated

Sector: energy production, industry including small and medium-sized enterprises

The Act transposes, into the Czech legislation, Directive 2003/87/EC establishing a scheme for trading in greenhouse gas emission allowances within the Communities. The amendment of 2006 also transposes Directive 2004/101/EC amending Directive 2003/87/EC in respect of the Kyoto Protocol's project mechanisms. In accordance with the EC legislation, the Act lays down:

1. the rights and obligations of the operators of installations and other persons in trading in allowances for greenhouse gas emissions,
2. procedures for issuing permits for discharge of greenhouse gas emissions,

3. procedures for issuing and allocating allowances for greenhouse gas emissions and the conditions for trading therein.

The installations to which the Act is related consist in energy-production installations burning fossil fuels for the purpose of production of heat and electrical energy (the sector of public and corporate energy production) and also technical installations in the sector of petrochemistry, chemistry and metallurgy (including coke production) as well as the production of cement, lime, glass, ceramics, paper and cellulose. The Act establishes a registry for emission trading and stipulates the conditions for allocation of allowances to new installations and the use of emission reduction units and certified emission reduction units from project activities.

The amendment of 2008, introduced by Act No. 315/2008 Coll., defines an allocated allowance unit (AAU) as a property value corresponding to the entitlement of the Czech Republic to release an equivalent of one tonne of CO_2 emissions into the air on the basis of the Kyoto Protocol. In Section 12a, the Act stipulates that AAUs are the property of the Czech Republic, managed by the Ministry of the Environment. The legal regulations related to management of the property of the Czech Republic pursuant to Act No. 219/2000 Coll., on the property of the Czech Republic, are not applicable to management of this property.

AAUs not used by the Czech Republic for fulfilment of its commitment following from the Kyoto Protocol may be sold within the international emission trading scheme (Article 17 of the Kyoto Protocol) or used to promote projects within the joint implementation mechanism (Article 6 of the Kyoto Protocol). Funds obtained by sale of AAUs are an income for the State Environmental Fund of the Czech Republic (SEF CR) and may be used only to promote activities leading to a reduction in greenhouse gas emissions.

4.2.3 Act No. 406/2000 Coll., on energy management, as amended (consolidated version, Act No. 61/2009 Coll.)

Objective: Greater effectiveness of energy management, transposition of the regulations of the European Communities[4].

Characteristics: Legislative instruments, requirements in the area of management of electrical energy and heat, rules for the National Programme to Abate the Climate Change Impacts in the Czech Republic, etc. (coordination MIT)

Period of implementation: 2000 – ongoing (revision)

Time framework: not stipulated

Sector: energy production, industry, services, housing sector

This Act, which has been amended several times since 2000 (original version), stipulates, amongst other things:

a) measures for increasing the economic use of energy and the obligations of natural and legal persons in management of energy,

[4] Council Directive 93/76/EC of 13 September 1993 to limit carbon dioxide emissions by improving energy efficiency, Directive 2002/91/EC of the of the European Parliament and of the Council of 16 December 2002 on the energy performance of buildings, Directive 2005/32/EC of the of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the of the European Parliament and of the Council.

b) rules for the creation of the State Programme in Support of Energy Savings and Usage of Renewable Energy Sources,

c) requirements on ecodesign of energy-using products.

4.2.3.1 State Energy Policy

The State Energy Policy is a strategic document with an outlook of 30 years expressing the objectives of the State in energy management in accordance with the needs of sustainable development. Proposal of State Energy Policy is prepared by The Ministry of Industry and Trade, which submits it to the Government for approval. The Ministry evaluates the implementation of the State Energy Policy at least once every 5 years and informs the Government of the results.

4.2.3.2 State Programme in Support of Energy Savings and the Usage of Renewable Energy Sources

The State Programme in Support of Energy Savings and the Usage of Renewable Energy Sources (hereinafter the "Programme") is an instrument to promote measures to increase the effectiveness of energy use, to reduce energy intensity and promote the use of renewable and secondary energy sources in accordance with the approved State Energy Policy and principles of sustainable development. The Ministry of Industry and Trade prepares the programme for a period of one year and, on the basis of agreement with the Ministry of the Environment, submits it to the Government for approval.

Once annually, the Ministry of Industry and Trade and the Ministry of the Environment evaluate implementation of the Programme and inform the Government of the results. The results of evaluation of the Programme are taken into consideration in the draft Programme for the next period.

Subsidies can be provided from the State budget for implementation of the programme for:

a) energy-saving measures to increase the efficiency of energy use and reduce the energy intensity of buildings,

b) development of the use of combined production of electricity and heat and secondary energy sources,

c) modernization of energy production and distribution installations,

d) modern technology and materials for energy-saving measures,

e) development of the use of renewable and secondary energy sources,

f) development of energy recovery of municipal waste,

g) public awareness, enlightenment, education and consulting in the area of energy management,

h) science, research and development in the area of energy management, energy savings and use of renewable energy sources,

i) preparation of a territorial energy concept and instruments for its implementation,

j) introduction of energy intensity certificates for buildings and performance of energy audits,

k) incentives for medium-sized, small and very small enterprises producing energy-consuming appliances to introduce new procedures leading to fulfilling of requirements on ecodesign.

4.2.3.3 Other Measures

The Act stipulates specific measures leading to energy savings and thus also to a reduction in CO_2 emissions, in particular:

Efficiency of energy use

A producer of electricity or thermal energy is obliged, in newly established installations, to provide for at least the minimum efficiency of energy use stipulated by an implementing legal regulation. This obligation also applies to installations for production of electricity or thermal energy in which a change is introduced in previously completed structures.

Energy intensity of buildings

A builder, building owner or association of owners of units must provide for compliance with the requirements on the energy intensity of buildings and compliance with comparative indicators and also compliance with the requirements stipulated by the relevant technical standards. An implementing legal regulation stipulates the requirements on the energy intensity of buildings, comparison indicators, the method of calculation of the energy intensity of buildings and other details.

Combined production of electricity and heat

When building a new source or modifying an already constructed source, every producer of heat with an installation with total output of the source greater than 5 MWt is obliged to subject the documentation for the structure to an energy audit for the introduction of electricity production.

Energy labels

Domestic producers or importers of mass-produced energy-consuming appliances, a list of which is stipulated by a Decree, are obliged to place energy labels on these appliances prior to placing them on the market. The information on the label must be accurate and in the Czech language.

Energy audit

The Act regulates conditions for the performance of the obligatory energy audit of energy management and of buildings and for the use of the results of the energy audit.

Ecodesign

A producer or importer of energy-consuming appliances stipulated by a regulation for implementation is obliged, prior to placing it on the market or into use, to issue a declaration of conformity, declaring compliance with the requirements on ecodesign of the energy-consuming appliance stipulated in an implementing legal regulation.

4.2.4 Act No. 458/2000 Coll., on the conditions for operating business and on performance of state administration in energy sectors (the Energy Act), as amended

Characteristics: Legislative instrument

Period of implementation: 2000 – ongoing (revision)

Time framework: not stipulated

Sector: energy production, including use of RES

Act No. 458/2000 Coll. transposes Directive/54/EC concerning common rules for the internal market in electricity, Directive 2003/55/EC of the of the European Parliament and of the

Council concerning common rules for the internal market in natural gas, Regulation (EC) No 1228/2003 of the of the European Parliament and of the Council on conditions for access to the network for cross-border exchanges in electricity and Directive 2004/8/EC on the promotion of cogeneration based on a useful heat demand in the internal energy market.

In accordance with the legislation of the European Communities, this law regulates the conditions for operating an enterprise, performance of the state administration and nondiscriminatory regulation in energy branches, consisting in electrical energy production, the gas industry and heat industry, as well as the rights and obligations of natural persons connected therewith. It provides for organization of operating an enterprise in energy branches while retaining the functioning of economic competition, satisfying consumer needs and the interests of license holders and providing for reliable, safe and stable supplies of electricity, gas and heat energy for an acceptable price.

The Act (Section 31) creates a framework for use of renewable energy sources. Renewable sources mean renewable non-fossil natural energy sources, including wind energy, solar energy, geothermal energy, energy of water, energy of soil, energy of the air, energy of biomass, energy of landfill gas, energy of sewage treatment plant gas and energy of biogases. The producers of electricity from renewable energy sources are entitled to preferential connection of their source of electricity to the transmission system or distribution systems;

According to Section 32 of the Act, the objective of combined production of electricity and heat lies in an increase in effectiveness and reduction in the production of greenhouse gases. The producers of heat energy must examine the advantageousness of combined production of heat and electricity according to a special legal regulation. The basic condition for combined production of heat and electricity consists in supply of useful heat for further use.

The criterion for assessment of combined production of electricity and heat consists in savings of primary fuel following from the difference between the overall efficiency of combined production of electricity and heat and the reference value. The overall efficiency of combined production of electricity and heat must conform to the minimum efficiency of energy use and simultaneously the overall efficiency of combined production of electricity and heat must be at least 10% higher than the reference value for classification of the electricity as electricity from combined production of electricity and heat. This condition need not be fulfilled for installations for combined production of electricity and heat to an installed output of 1 MW.

The operator of the distribution or transmission system pays a contribution towards the price of electricity from combined production of electricity and heat or produced from secondary energy sources, provided the producer is directly connected to the transmission system. The Energy Regulatory Office stipulates the amount of the contribution. The Ministry of Industry and Trade issues a certificate of the origin of electricity from combined production of electricity and heat or produced from secondary energy sources, which constitutes an essential precondition for placing electricity from combined production of electricity and heat on the electricity market. Traders in electricity are obliged to preferentially purchase and supply electricity offered by producers of electricity from combined production of electricity and heat or producers of electricity from secondary energy sources.

4.2.5 Act No. 180/2005 Coll., on the promotion of production of electricity from renewable energy sources and on amendment to some laws (Act on Promotion of Use of Renewable Energy Sources)

Objective: Creation of a legal framework for the use of renewable energy sources

Characteristics: Legislative instrument

Period of implementation: 2005 – ongoing (revision)

Time framework: not stipulated

Sector: electrical energy, especially use of RES

The Act transposes Directive 2001/77/EC of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market, with the objective of:

1. promoting the use of renewable energy sources,
2. providing for a constant increase in the contribution of renewable energy sources to the consumption of primary energy sources,
3. creating preconditions for fulfilment of the indicative target for the contribution of electricity produced from renewable sources to the gross consumption of electricity in the Czech Republic equal to 8% by 2010 and create preconditions for further increase in this share after 2010.

The Act stipulates the amount of assistance for the individual categories of installations producing electricity from renewable energy sources and the rights and obligations of entities active in the electricity market derived from renewable energy sources. The Decree implementing the Act stipulates the conditions for support, purchasing and records of the production of electricity from renewable energy sources and the price of this electricity, including "green bonuses".

4.2.6 Act No. 76/2002 Coll., on integrated pollution prevention and control, the integrated pollution register and amending some laws (Act on Integrated Prevention), as amended

Objective: Creation of a legal framework for the application of BAT and emission factors (benchmarks)

Characteristics: Legislative instrument

Period of implementation: 2002 – ongoing (revision)

Time framework: not stipulated

Sector: energy production, industrial technology, waste

The Act transposes into the national legislation Council Directive 96/61/EC concerning integrated pollution prevention and control. It stipulates the obligations of the operators of large stationary installations, a list of which is taken from the above-mentioned EC Directive. In the area of greenhouse gases resulting from the production and use of heat and electrical energy, the Act gives regulators the potential for application of the BAT concept (best available techniques), which should lead to an increase in the energy effectiveness of production. Best available techniques means both the technology employed and the manner in which the particular installation is designed, constructed, operated, maintained and removed from operation. This Act permits the application, e.g., of emission factors based on advanced technology employed in the relevant branches of industry.

4.3 Programme instruments

4.3.1 National Programme to Abate the Climate Change Impacts in the Czech Republic

Objective of the Programme: Updating of the "Strategy of Protection of the Climate System of the Earth in the Czech Republic" and adoption of new reduction targets in the period to 2020, i.e. reduction compared to 2000 by the year 2020:

a) specific CO_2 emissions per inhabitant by 30%,

b) aggregated emissions by 25%.

Characteristics: Cross-cutting and framework strategic document at a national level (coordination MoE)

Period of implementation: 2004 – ongoing

Time framework: 2020

Sector: cross-cutting character

In March of 2004, the Government (see Government Resolution No. 187 of March 3, 2004) adopted a revision of the programme part of the document "Strategy of Protection of the Climate System of the Earth in the Czech Republic", which set new tasks for the individual sectors. The National Programme to Abate the Climate Change Impacts in the Czech Republic replaced the Strategy of Protection of the Climate System of the Earth in the Czech Republic (adopted in Government Resolution No. 480 of May 1999), which had the objective of compliance with the international commitments of the Czech Republic following from the UN Framework Convention on Climate Change and the Kyoto Protocol. This document did not take into account the future accession of the Czech Republic to the European Communities and thus the necessity of harmonizing the national policy and measures with the strategic and legislative framework of the EU. In 1999, when the "Strategy of Protection of the Climate System of the Earth in the Czech Republic" was adopted, the future role of the flexible Kyoto Protocol mechanisms (IET, ETS and JI/CDM) was not yet sufficiently defined.

The National Programme to Abate the Climate Change Impacts in the Czech Republic (hereinafter the "National Programme") is a strategic document of the Government of the Czech Republic. The document coordinates the sectoral and cross-cutting policies at a national level and also takes into consideration the requirements of the European Climate Change Programme (ECCP), which became binding for the Czech Republic on accession to the EU. The individual sectoral ministries were entrusted with implementation of the National Programme.

The National Programme, which was prepared according to the requirements of Council Decision 1999/296/EC, introduces both specific reduction (mitigation) measures to reduce greenhouse gas emissions and also adaptation measures permitting society and ecosystems to adapt to climate change. The document emphasizes that this reduction in emissions will take place in connection with international agreements and with respect to sustainable development in the Czech Republic.

On the basis of Government Resolution No. 395 of April 6, 2005, an evaluation was performed in 2007 of the National Programme from the standpoint of the environmental effects and economic impacts of the adopted measures, i.e. comparison of the initial state of affairs and the reduction in greenhouse gases achieved since adoption of the National Programme. As the National Programme was created in 2003 and climatic negotiations in the Czech Republic and globally have progressed since that time (within the European Union and

at conferences of the parties to the UN Framework Convention on Climate Change and its Kyoto Protocol), this document has been updated on the basis of evaluation of the adopted measures (see the chapter on prepared policies and measures).

The document "Evaluation of the National Programme to Abate the Climate Change Impacts in the Czech Republic" (April 2008), which the Ministry of the Environment submitted to the Government, points out that the positive results are related particularly to an increase in the share of renewable resources in the production of energy. Biomass (79%) and also hydroelectricity plants (11%) corresponded to the largest parts of this production at the end of 2007. A substantial inter-annual increase in the production of electricity was recorded in the area of wind energy (increase between 2004 and 2005 of 117%, increase between 2005 and 2006 of 130%), biogas (increase between 2004 and 2005 of 16%, increase between 2005 and 2006 of 9.3%) and photovoltaic panels (increase between 2004 and 2005 of 56%, increase between 2005 and 2006 of 39%).

The evaluation report emphasizes the inadequacy of the absence of economic analysis of the effectiveness of the measures. The report also points out that the Czech Republic has a long-term record of unfavourable indicators of energy intensity and greenhouse gas emissions per capita. The growth in greenhouse gas emissions in the transport sector is an unfavourable factor; this increase equaled 114% for CO_2 and 121% for N_2O in 2006 compared to 1993. As was pointed out in the "Emission inventory" chapter, this unfavourable trend continued in the following years. Thus reduction measures must be introduced, not only in the transport sector, but especially in the other sectors and areas, where lower marginal abatement costs can be anticipated. It is necessary to continue to improve the awareness of citizens in relation to the political acceptability of the proposed measures.

4.3.2 State Programme in Support of Energy Savings and the Usage of Renewable Energy Sources

Objective: Introduce energy savings, increase energy effectiveness and the use of renewable energy sources

Characteristics: Cross-cutting plan at a national level, sectoral structure (coordination MIT); the target areas are the state administration and local governments, private sector, households and NGO's

Period of implementation: 2004 – ongoing

Time framework: Annual evaluation and determination, including the contents and budgets of the individual parts of the programme (financing from the State budget)

Sector: cross-cutting character

Government Resolution No. 1105/2004 approved the State Programme in Support of Energy Savings and Usage of Renewable Energy Sources (hereinafter the "Programme"). Its scope and financing are specified in Act No. 406/2000 Coll., on management of energy (as amended by Act No. 61/2000 Coll.). The Programme is concerned with decreasing energy consumption and the use of renewable and secondary energy sources, in accordance with economic and social needs, sustainable development and protection of the environment.

Not only the sector of the Ministry of Industry and Trade (coordination of the Programme), but also an additional 10 sectors, particularly the Ministry of Transport, Ministry for Regional Development, Ministry of Agriculture and Ministry of the Environment, participated in implementation of the State Programme in the initial period (2005). Not all the participating sectors were able to calculate the attained effectiveness in units of savings in energy or

reduction in emissions (e.g. support for consulting, research, public awareness). The greatest reductions in emissions were achieved in the sectors of energy production, protection of the environment, renewable energy sources (RES), energy savings in industry and the housing sector, which are further quantified below.

The State Programme is an instrument for meeting the requirements imposed by Directive 2001/77/EC of the European Parliament and of the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market and for compliance with the Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects. Its scope and financing are specified in Act No. 406/2000 Coll., on management of energy (as amended by Act No. 61/2000 Coll.). The Programme is concerned with decreasing energy consumption and the use of renewable and secondary energy sources, in accordance with economic and social needs, sustainable development and protection of the environment.

4.3.2.1 State Programme in Support of Energy Savings and the Usage of Renewable Energy Sources (Ministry of Industry and Trade Subprogrammes)

Characteristics: Cross-cutting programme at a national level (coordination MIT); target areas energy production, industry, buildings and consulting

Period of implementation: 2004 – ongoing

Time framework: Annual evaluation and budget setting (financed from the State budget)

Sector: energy production, industry
This part of the Programme encompasses the subprogrammes of the Ministry of Industry and Trade (MIT) implemented by the Czech Energy Agency and, after its abolishing, directly by the Ministry of Industry and Trade. Overall investments equaled CZK 1,012 mil. (public funds) and CZK 3,548 mil. (private funds). The areas of support changed during the Programme; the Programme covers particularly territorial energy planning, cogeneration and central heating systems, renewable energy sources, building audits, energy savings in industrial processes, monitoring and targeting, consulting (EKIS and regional energy agencies) and education, promotion and pilot projects. Those activities that have direct calculable effects in reducing greenhouse gas emissions are quantified.

4.3.2.2 State Programme in Support of Energy Savings and the Usage of Renewable Energy Sources (Ministry of the Environment Subprogrammes)

Characteristics: Cross-cutting plan at a national level (sector of energy savings and RES, coordination ME)

Period of implementation: 2004 – ongoing

Time framework: Annual evaluation and budget setting (financed from the State budget)

Sector: Energy production (RES), housing sector and services (consulting)
The areas of support in the part managed by the Ministry of the Environment changed during implementation of the Programme; support is provided mainly for subprogrammes of investment support for environmentally sound heating and/or hot-water heating systems for apartments and family homes for natural persons (biomass furnaces, solar systems for heating hot water and additional heating, heat pumps). Overall investments in the evaluated period equaled CZK 1,553 mil. (public funds) and CZK 1,235 mil. (private funds). The programme is implemented by the State Environmental Fund of the Czech Republic.

4.3.2.3 State Programme in Support of Energy Savings and the Usage of Renewable Energy Sources (transport sector, managed by the Ministry of Transport)

Characteristics: Cross-cutting programme at the national level (coordinated by the Ministry of Transport); the target areas include modernization and development of the transport infrastructure, energy savings in the area of powering units, organization of transport and consulting, education and promotion of economic use of energy in the transport sector with emphasis on improvement of the environment. Reduction of transport emissions of CO_2, SO_x and NO_x

Period of implementation: 2004 – ongoing

Time framework: Annual evaluation and budget setting (financed from the State budget)

Sector: transport
The programme was promulgated by Government Regulation No. 63/2002, on the rules for provision of subsidies from the State budget to support economic management and utilization of renewable and secondary sources of energy. The success of the programme is assessed, amongst other things, according to the reduction in the emissions of various pollutants per year. Cofinancing of projects in the range of 30 – 50% is limited by the sum of CZK 1.5 mil.

4.3.3 Programmes financed by European Funds

Reductions in greenhouse gas emissions attained through implementation of sets of Operational Programmes are usually not quantified or are indirect because of the targets of the individual programmes. These programmes (2004 – 2013) are intended to promote the Lisbon Strategy of economic growth and should contribute to economic convergence of the Czech Republic to EU-15.

The National Strategic Reference Framework (NSRF) is the basic programme document of the Czech Republic for utilization of European Union funds in the 2007 – 2013 period. Its conception is based on the obligations of each Member State defined in Council Regulation (EC) No 1083/2006 laying down general provisions on the European Regional Development Fund, the European Social Fund and the Cohesion Fund. The National Development Plan of the Czech Republic, which was taken into cognizance in Resolution of the Government of the Czech Republic No. 175/2006, formed the basis for preparation of the draft NSRF.

The strategy is based on key European (Strategic General Principles of the Communities) and domestic (Strategy of Sustainable Development, Strategy of Economic Growth, Strategy of Regional Development for 2007 – 2013) and other valid sectoral and regional strategies. The NSRF defines a system of operational programmes of policies of economic and social cohesion for 2007 – 2013, through which the individual priority axes will be implemented.

The National Strategic Reference Framework was adopted by the European Commission on July 27, 2007 and the individual operational programmes were approved in the following months.

The National Strategic Reference Framework of the Czech Republic encompasses both global targets and four strategic objectives:

Competitiveness of the Czech economy

Of the total of EUR 26.69 bil. provided by the European Union to the Czech Republic in the 2007 to 2013 period, the amount of EUR 5.11 bil. is earmarked mainly for increasing the competitiveness of the Czech Republic. Funds will be allocated on the basis of the Enterprise and Innovations and the Research and Development for Innovations operational programmes.

The target consists in increasing the competitiveness of the business sector in the Czech Republic through increasing its productivity. Simultaneously, it is necessary to accelerate sustainable economic development through innovations and structural changes.

Open, flexible and cohesive society

Funds for this area will be provided on the basis of three operational programmes: Human Resources and Employment, Education for Competitiveness and Prague – Adaptability. The target of the programme consists in development of a socially cohesive society and contribution to an improvement in the quality of life of the population. Simultaneously, it will be concerned with the creation of a modern educational system, which will contribute to the development of knowledge of the economy and become a source of effectiveness and flexibility of the labour market in the Czech Republic. Of the overall volume of funds provided by the EU to the Czech Republic for the 2007 – 2013 period, the sum of EUR 3.77 bil. is earmarked for the creation of a modern civic society.

Attractive environment

The sum of EUR 10.68 bil. is earmarked for investments into improving the quality of the environment and the accessibility of the transport network in the Czech Republic. The funds will be provided on the basis of the Environment and Transport Operational Programmes. The objective consists in improving the accessibility of the environmental infrastructure, renewal of the quality of the environment and promotion of energy savings. Simultaneously, the accessibility of transport and transport services should be improved with a concurrent decrease in the environmental impact of transport.

Balanced territorial development

Financial assistance will be provided through regional operational programmes and the Prague – Competitiveness Operational Programme, Integrated Operational Programme and Technical Assistance Operational Programme. The objective consists in elimination of economic differences between regions. It is primarily necessary to strengthen economic growth and increase employment. The European Union has provided the Czech Republic with a total of EUR 6.72 bil. for investments into balanced and harmonic development of the entire territory of the Czech Republic in the 2007 – 2013 period.

4.3.3.1 Transport Operational Programme (2007 – 2013)

The Transport Operational Programme (TOP) is concerned with improving the quality of the infrastructure and mutual interconnections of railway, highway and river transport in the framework of the Trans-European Transport Network (TEN-T). The Programme deals with infrastructure of national importance; road infrastructure corresponds to throughways, controlled access roads and 1st class roads. TOP also supports development and modernization of the Prague Metro. The Ministry of Transport – EU Fund Department is the managerial authority for TOP.

The Transport Operational Programme is the largest Czech operational programme. A total of EUR 5.77 bil. is earmarked from EU funds for this programme, corresponding to approx. 21.6% of all EU funds set aside for the Czech Republic. In addition, financing of the programme should be increased by a further EUR 1.01 bil. from Czech public funds. TOP contains priority axes dividing the operational programme into logical units, which are further specified through areas of support, which delimit the types of projects that can be supported within the framework of the relevant priority axis:

1. Modernization of the railway network TEN-T,
2. Construction and modernization of the throughway and road network TEN-T,

3. Modernization of the railway network outside of the TEN-T network,
4. Modernization of 1st class roads outside of TEN-T,
5. Modernization and development of the Prague Metro and systems of traffic control in the Capital City of Prague,
6. Promotion of multi-modal freight transport and development of inland water transport.

All the projects implemented in the individual priority axis prefer mass transport, lead to an increase in the smoothness of road transport and promote environmentally sound alternatives to road automobile transport (boat and rail transport) and thus have indirect favourable impacts on emissions of carbon dioxide, carbon monoxide and nitrogen oxides. On the other hand, they increase the volume of transit transport between Eastern and Central Europe, contributing to an increase in transport emissions.

4.3.3.2 Enterprise and Innovations Operational Programme

The Enterprise and Innovations Operational Programme (EIOP) is concerned with promotion of development of the business environment and support for the transfer of the results of research and development to business practice. The Ministry of Industry and Trade is the managerial body for EIOP.

EIOP is financed from the European Regional Development Fund (ERDF) and is one of the special operational programmes in the Convergence target; from the viewpoint of financing, it is the third largest Czech operational programme: a total of EUR 3.04 bil. from EU funds is earmarked for this programme. In addition, financing of the programme is to be increased by a further EUR 0.54 bil. from Czech public funds. EIOP is divided into 6 priority areas, which are further divided into areas of support.

Priority axes 3 (construction and reconstruction of facilities for the production and distribution of electrical and heat energy produced from renewable energy sources, introduction and modernization of systems of measurement and regulation, modernization, reconstruction and reduction of losses in electricity and heat distribution, etc.) and 6 (development of consulting in the area of eco-technology and environmental management systems) have a direct impact in improving management of energy and use of renewable energy sources. The other axes support the development of production processes with greater added value and thus affect decarbonisation of Czech industry.

4.3.3.3 Environment Operational Programme

The Environment Operational Programme (EOP) contributes to improvement of the condition of the air, water and soil, deals with the issue of waste and industrial pollution and supports care for the landscape and use of renewable energy sources and construction of infrastructure for environmental awareness programmes. The Ministry of the Environment is the competent authority for EOP. The State Environmental Fund of the Czech Republic is a mediating authority. EOP is financed from the European Regional Development Fund (ERDF) and Cohesion Fund (CF).

EOP is the second largest Czech operational programme: a total of EUR 4.92 bil. is earmarked from EU funds for this programme, corresponding to approx. 18.4% of all EU funds set aside for the Czech Republic. In addition, financing of the programme is to be increased by a further EUR 0.87 bil. from Czech public funds. EOP contains several priority axes divided into areas of support and sub-areas of support which delimit the types of projects that can be supported in the framework of the relevant priority axis.

1. Improving the water management infrastructure and reducing the risk of floods
2. Improving the quality of the air and reducing emissions: support is provided for reconstruction and acquisition of combustion sources for reducing consumption and mitigating emissions, acquisition of combustion installations with an Environmentally Sound Product ecolabel, reduction of heat losses in apartment buildings and family homes, measures at sources leading to elimination or reduction of emissions of volatile organic compounds into the air through transition to water-based coatings, installation of catalytic and thermo-oxidation units, etc.
3. Renewable use of energy sources: supported through installation of wind generators, installation of technology to recover waste heat, insulation systems for buildings, construction and reconstruction of central and block furnaces, installation of renewable energy sources, especially for heating and preparation of hot water of the solar system type, biomass furnaces, heat pumps, etc.
4. Improvement of waste management and elimination of environmental burdens from the past: supported through creation of a system of separate waste collection, construction of installations for waste recovery, especially for waste separation, treatment and recycling, reclaiming of old landfills, decontamination of highly contaminated sites, etc.
5. Reducing industrial pollution and reducing environmental risks: support is provided in this axis for improving access to information on the environment and creation of infrastructures for an institutional base for BAT (best available techniques) research.
6. Improvement of the condition of nature and the landscape, including protection of wetlands and forest ecosystems (CO_2 sinks).
7. Development of the infrastructure for environmental education, consulting and public awareness: construction and technical equipment of buildings for the purpose of creating new environmental centres and consulting centres, creation of environmental awareness, information and professional material and educational and methodical instruments.

GHG emissions are directly affected by priority axes 2, 3, 4, 5, 6 and 7, which promote measures increasing the utilization of renewable energy sources, reduction of greenhouse gas emissions from the waste sector, and promoting clean fuels and highly efficient combustion sources.

4.3.4 Emission trading (EU ETS)

Characteristics: Implementation of Directive 2003/87/EC establishing a scheme for trading in greenhouse gas emission allowances within the Communities

Period of implementation: 2005 – ongoing

Time framework: 2012 (end of the first accounting period according to the Kyoto Protocol)

Sector: energy production (public and industrial), industrial technology (refineries, chemistry, metallurgy, coking industry and production of lime, cement, glass, ceramics, paper and cellulose)

The emission trading system was established in the Czech Republic by Act No. 695/2004 Coll., on the conditions of greenhouse gas emission allowance trading and amending some laws, as amended (amendment No. 212/2006 Coll., No. 315/2008 Coll.) The trading system was introduced from January 1, 2005 and a total of 394 installations participated in the trading

in the Czech Republic. The volume of emissions included in the trading system in the Czech Republic corresponds to approx. 60% of total greenhouse gas emissions in the Czech Republic in 2010. Carbon dioxide (CO_2) is the only greenhouse gas included in the trading system.

The creation of an allocation plan forms a basis for emission trading. The National Allocation Plan (hereinafter "NAP") is issued for each trading period and regulates the number of allowances allocated to the individual operators of installations for that period. The NAP was prepared by the Ministry of the Environment in cooperation with the Ministry of Industry and Trade. NAP2 (2008 – 2012) for the Kyoto period was a direct continuation of NAP1 (2005 – 2007), created for the first trading period. Calculation of the allocated amount was based on historical, only partly verifiable emissions for the 2000 – 2004 period (limited quality and availability of data for NAP1) and on fully verifiable emissions for 2005 and 2006 (for NAP2).

The European Commission decided on the total level of allocations for the Czech Republic for NAP2 (2008 – 2012) on March 26, 2007, allocating 86,835,264 allowances to the Czech Republic annually. The original proposal of the Czech Republic corresponded to 101.9 mil. allowances. This overall allocated amount includes a reserve for new participants in the amount of 1.29 mil. allowances and a reserve for joint implementation (JI) projects in the amount of 99,389 allowances.

In order to increase transparency, the method of allocation for the individual installations was simplified compared to the original methodology proposed for NAP1 (2005 – 2007). The sectoral classification and various bonuses were abolished; previously, these had led to discrepancies between reported emissions and the allocated amount.

The emission effectiveness value recalculated by the European Commission was taken as a criterion of effectiveness in reducing emissions. This permits an increase in the allocated number for installations to 50 kt emissions p.a. by 7% annually compared to average emissions for 2005 – 2006 and an increase by 1.279% for installations over 50 kt emissions p.a. compared to average emissions for 2005 – 2006.

The aforementioned allocation is applicable only to those installations whose inter-annual difference did not exceed 20%. Installations with a greater difference were allocated the higher of the emission values for 2005 – 2006. This was intended to achieve non-discriminatory allocation of allowances especially for small and medium-sized installations, for which annual emissions fluctuate in relatively wide ranges. In addition, these small and medium-sized installations utilized the advantages of the emission market only to a limited degree compared to large emission sources.

During the first trading period (2005 – 2007), a total of 410 emissions sources active in the Czech Republic were registered in EU ETS. Of these, 355 (86.6%) were in permanent operation over a three-year period, where their cumulative emissions corresponded to 99.8% of total cumulative emissions. The greatest fluctuations were recorded particularly amongst small and medium-sized sources (< 100 kt CO_2 p.a.). Tab. 4.1 gives the numbers of sources in operation and their cumulative emissions in the individual years.

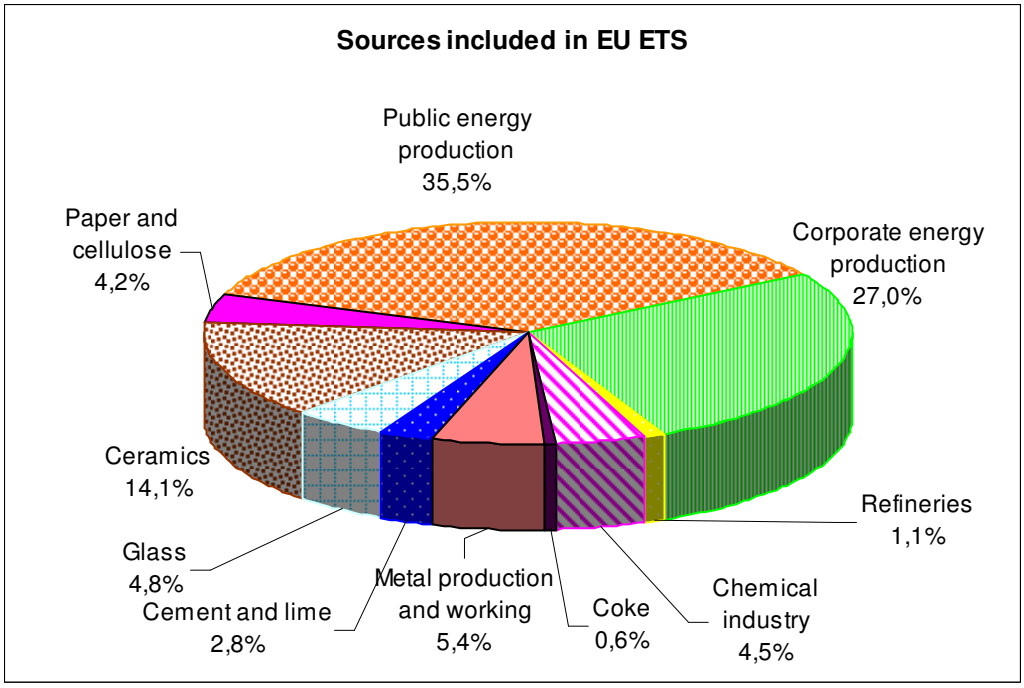
Tab. 4.1 Numbers of sources with reported emissions and total emissions for 2005 - 2007

	Number of installations	Total emissions (mil. t CO_2 p.a.)
2005	384	82.33
2006	379	83.48
2007	374	87.80

Source: MoE

Sources that reported emissions through the whole 2005 – 2007 period were classified according to branches of industry. It is apparent from Fig. 4.1 that the largest amount of emissions (more than 70%) was derived from the production of electricity and heat (public and corporate energy, production of technical steam) and only a smaller part of the emissions were technical (oxidation reactions in petrochemistry and chemistry, calcination of carbonates in production of lime or cement, reduction of ores, direct heating of melting furnaces, etc.).

Fig. 4.1 Categorization of sources included in EU ETS for the entire 2005 – 2007 period according to branch of industry

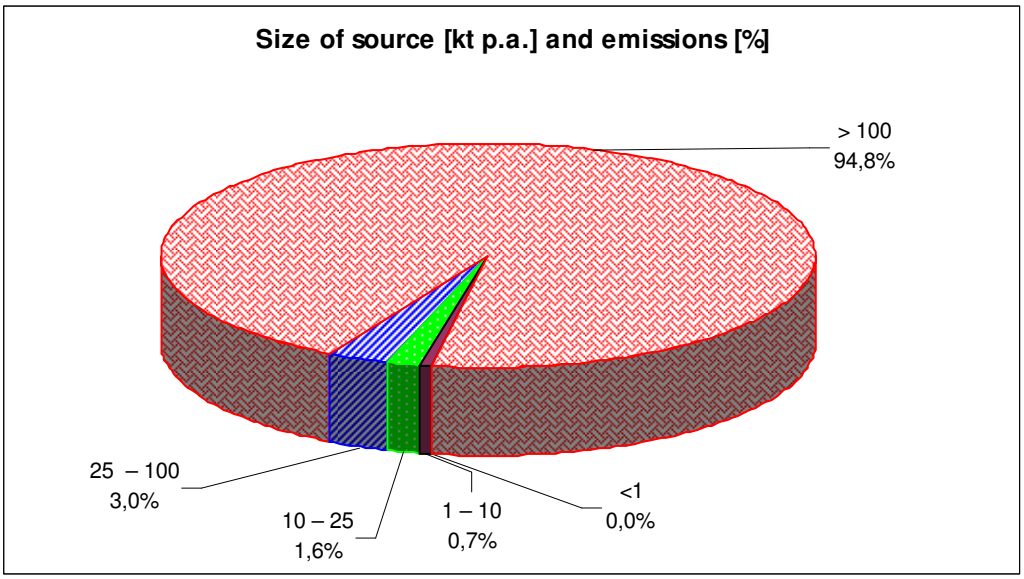


Source: MoE

The mentioned 355 emission sources that were in operation throughout the 2005 – 2007 period have the following classification according to the quantity of annual emissions. The very uneven distribution of emission capacities is apparent from Fig. 4.2, for example sources with emissions to 10 kt p.a., corresponding to 43.4% of the total number, emit only 0.69% of total emissions. This indicates the substantial ineffectiveness of EU ETS in relation to the expended administrative and transaction costs compared with the achieved environmental effect (reduction of emissions).

Although the number of allowances allocated amongst the monitored sources in the 2005 – 2007 period (NAP1) (96,663,495 allowances p.a.) was substantially higher than the reported emissions, the impact of NAP1 on emissions from the above mentioned sources was estimated independently. The effect of EU ETS on reducing industrial emissions is estimated at 3 – 5 mil. t CO_2 for 2005, when the price of allowances was about EUR 20 each. In the subsequent two years, when the price of emissions decreased below EUR 1 each, this effect is estimated at 0.5 – 1 mil. t CO_2 p.a. The main benefit of the first trading period lies primarily in implementation of the administratively complicated system of allocation of allowances, monitoring, verification and reporting of emissions, establishment of individual accounts for transactions and connection of the national system with the global carbon market.

Fig. 4.2 Classification of sources included in EU ETS according to emissions (2007)



Source: MoE

It is apparent from the individual emission reports that operators attempted to replace brown coal by gas or biomass, to use alternative fuels and, in interconnected source systems (power plants and some heating plants), also to utilize the individual capacities in relation to the overall emissions of the system (ordering of sources). Studies concerned with the behaviour of operators during the first 2005 – 2007 period showed that the operators of small sources do not utilize the advantages of trading (lack of know-how and the unit transaction costs are disproportionate to the size of the transaction). The fluctuation in production and thus also the uncertainty in emission projections are much higher for small sources than for sources with a capacity above 100 kt p.a. Consequently, the Czech Republic is considering removing small sources (< 25 kt p.a.) from the EU ETS system after the end of the second trading period (2005 – 2007) and including them in a national programme to reduce emissions.

In 2008, enterprises included in EU ETS discharged 80.399 mil. t CO_2 into the air. That represents a 8.5% reduction in emissions compared to 2007, corresponding to 7.435 mil. t CO_2. In addition to the influence of the price of allowances (EUR 20 ea.), the reduction in emissions can also be affected by the reduction in production in the second half of the year as a consequence of the start of the economic recession (see the National Conditions chapter).

4.4 Other measures

4.4.1 Transport (set of measures)

In 1990, emissions from transport corresponded to only 6.35% of total emissions of carbon dioxide in the Czech Republic. In 2005, this share corresponded to 13.7% (14.1% in 2007). This trend is very unfavourable, but is still lower than the values for the EU-15 countries.

The Transport Policy of the Czech Republic for 2005 - 2013 is the basic document for the transport sector. Its objective consists in unification of the conditions in the transport market and provision for good-quality and environmentally sustainable transport. The Transport Policy creates a framework for implementation of the "Transport" operational programmes (2004 – 2006, 2007 – 2013), see Chapter 4.3.3. The State Environmental Policy 2004 – 2010 also includes a number of environmental requirements on the transport sector, such as support

for the use of alternative fuels, development of environmentally sound transport, introduction of telematic systems preventing traffic jams, development of cycling, inclusion of externalities in transport costs, etc.

4.4.1.1 Passenger vehicles

Valid Decision 1753/2000/EC anticipates a reduction in emissions from passenger automobile transport to a value of 120 g CO_2/km. Valid Directive 1999/94/EC of the European Parliament and of the Council imposes the obligation to provide the end customer with information on fuel consumption and the amount of CO_2 emissions produced by a vehicle. The prepared revision of this Directive will include labelling of vehicles, which will be divided into categories according to production of CO_2 emissions.

4.4.1.2 Alternative fuels

In 2009, there were more than 20 public filling stations for CNG and 600 filling stations for LPG. By 2013, the network of CNG filling stations should cover all the main roads in the Czech Republic; they should number approx. 350 by 2020 and the number of vehicles fuelled by CNG and LPG should increase from 200 thousand to 350 – 500 thousand. These expectations are in accordance with the valid EU legislation and strategy of the European transport policy (10% of vehicles fuelled by alternative fuel by 2020).

Vehicles with alternative propulsion systems (CNG, LPG and also electric motors and hybrid propulsion) are exempt from road taxes; a reduced rate of this tax applies to fuels containing a certain share of biofuels (such as bioethanol E85), depending on the share of the bio-component in the fuel mix.

Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport has been fully implemented in the Czech Republic. The general target lies in attaining a 57.7% share of biofuels and other renewable sources in the total volume of fuels for transport by 2010.

4.4.1.3 Environmentally sound transport

Implementation of measures in the sphere of mass public transport is progressing in the form of support for the purchase of new public transport vehicles from a number of financial sources, such as, e.g. the Programme for Renewal of Mass Transport Vehicles and the Regional Operation Programmes. Transport services being are gradually improved through the introduction of integrated transport systems (ITS), where service is provided on the basis of voluntary agreements by a number of transport companies or one transport company operates several kinds of transport. Establishment of this system encompasses implementation of a uniform tariff policy, mutual interconnection of time schedules, creation of new transfer connections, elimination of parallel lines of several transport companies and adoption of uniform transport conditions. In addition to ITS, specific instruments also include preferential traffic measures, i.e. separate lanes for buses and trolley buses and right-of-way of mass transport vehicles at intersections. In the framework of implementation of the National Cycling Strategy, a network of safe, separate cycling paths is gradually being created, together with facilities for cycling combined with public transport (bike-and-ride systems) and pedestrian zones, as well as the creation of comprehensive integrated transport systems in cities and their surroundings with greater emphasis on track transport; support is provided for combined transport systems in large cities.

4.4.2 Joint Implementation Projects (JI)

Characteristics: Project activities based on Art. 6 Kyoto Protocol coordinated by the ME

Period of implementation: 2004 – ongoing

Time framework: 2012 (end of the first accounting period according to the Kyoto Protocol)

Sectors: industry, energy production (including RES), waste

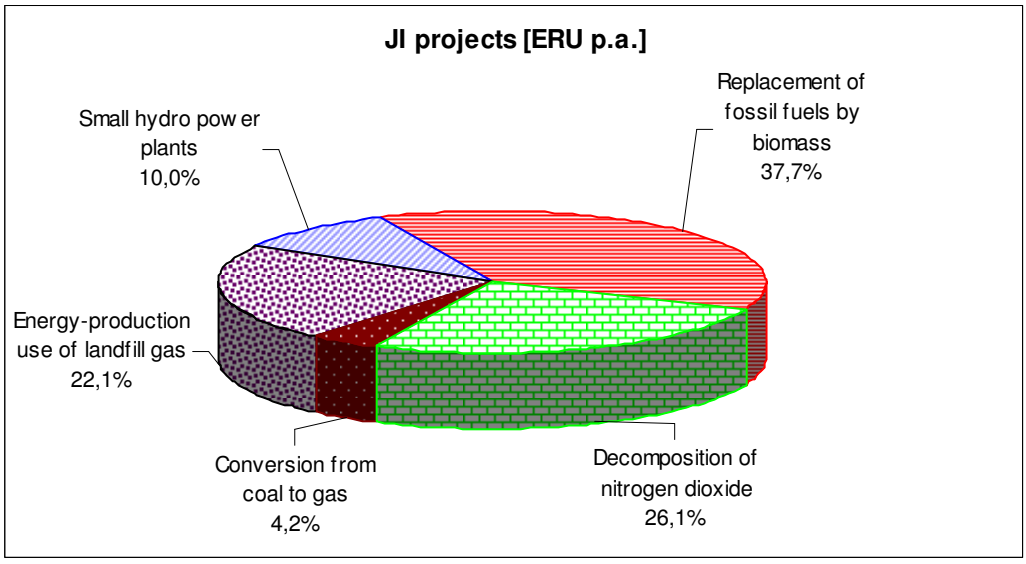
Act No. 695/2004 Coll., on the conditions of greenhouse gas emission allowance trading (amendments No. 212/2006 Coll., No. 315/2008 Coll.) permits the use of extra AAU to support projects according to the joint implementation mechanism (Art. 6 of the Kyoto Protocol).

In Resolution No. 648 of June 30, 2003, the Government of the Czech Republic expressed its consent to negotiation of a Framework Agreement on cooperation in implementation of projects to mitigate greenhouse gas emissions between the Czech Republic and the International Bank for Reconstruction and Development and other investor countries.

A total of 42 JI projects had been approved in the Czech Republic by May 2009 (Fig. 4.3). From the standpoint of the Kyoto Protocol, these emission reductions are implemented during the 2008 – 2012 period, where emission reduction units (ERU) can be transferred to the investor in a project.

A project was implemented to reduce nitrous oxide (N_2O) emissions from the production of nitric acid, with a reduction of 217.5 thousand t CO_{2eq} The overall annual emission reduction attained by the implementation of all JI projects corresponds to approx. 716 thousand t CO_{2eq} p.a. Approximate total emission reduction at the level of 0.7 thousand t CO_{2eq} p.a. can be expected for the Kyoto Protocol control period (2008 – 2012) (see Fig. 4.3).

Fig. 4.3 Overview of JI projects (ERU p.a.)



Source: MoE

4.5 Prepared Measures

4.5.1 Green Investment Scheme (GIS)

Characteristics: Project activities based on Art. 17 Kyoto Protocol coordinated by the MoE

Period of implementation: 2009 – 2012

Time framework: 2012 (end of the first accounting period according to the Kyoto Protocol)

Sectors: housing sector, energy production (RES)

The Czech Republic has an estimated emissions surplus equaling 150 million tons of CO_{2eq}. corresponding to the same number of assigned amount units (or AAU – equivalent to one tonne of CO_2) within the Kyoto Protocol regime for the 2008 – 2012 period, of which approximately 100 million AAUs can be traded in the framework of the international emission trading scheme. Act No. 695/2004 Coll., on the conditions of greenhouse gas emission allowance trading and amending some laws, as amended by Act No. 212/2006 Coll. and No. 315/2008 Coll., which specifies the conditions for management of assigned amount units, forms the legal basis for GIS in the Czech Republic.

These units are the property of the Czech Republic, and are managed by the Ministry of the Environment. AAUs not used by the Czech Republic for fulfilment of its commitment following from the Kyoto Protocol may be sold by the Ministry within the international emission trading scheme pursuant to Article 17 of the Kyoto Protocol or are used by the Ministry to promote projects within the joint implementation mechanism pursuant to Article 6 of the Kyoto Protocol. The funds obtained from sale of assigned amount units are an income for the State Environmental Fund of the Czech Republic. The thus-obtained funds may only be used to promote activities and actions resulting in reduction of greenhouse gas emissions. GIS (the Green Investment Scheme – "Zelená úsporám") and thus advantageously complement support from the Environment Operational Programme (Priority axis 3).

In relation to the volume of expected funds and in relation to the experience and competence of the State Environmental Fund of the Czech Republic and performed analyses of absorption capacities of the considered target areas, GIS in the Czech Republic has the following selected strategic targets:

1. Through IET, utilize the reduction in national greenhouse gas emissions, which is a consequence of the permanent improvement in the energy efficiency of the Czech economy in the 1995 – 2008 period.
2. Invest the funds acquired into measures and Programmes with high reduction potential (maximizing of greening) in accordance with the national sustainable development targets.
3. Provide for the sustainability of projects implemented within GIS and thus achieve a long-term reduction effect extending beyond 2012.
4. Maximize the social, economic and environmental effects of GIS in the Czech Republic, especially increasing the quality of housing, improvement in family budgets particularly for lower income categories, creation of jobs in the sector of small and medium-sized enterprises and reduction of local pollution of the air by SO_2, NO_x and PM_{10}.
5. Minimize administrative and transaction costs for implementation of GIS.

A GIS is concerned with the reduction of energy consumption and CO_2 emissions in the housing sector. In 2006, households consumed 273.8 TJ of energy (corresponding to 76,048 GWh). This consumption includes not only consumption for heating (including losses in furnaces, etc.), but also for preparation of hot utility water for households. The average intensity in 2006 corresponded to 340 kWh/m^2 p.a. If consumption of electricity for heating and other domestic appliances amounting to approx. 10% is subtracted from this quantity

(approx. 2000 kWh p.a. per household), the average energy intensity in 2006 was higher than 300 kWh/m^2 p.a.

Households contributed almost one quarter to energy consumption (23.9% in 2006) and thus the housing sector, together with industry and transportation, belongs amongst the largest emitters of greenhouse gases. The consumption of energy for heating and preparation of hot water is the most important item in the energy balance of households or residential buildings. Most of these buildings do not comply with contemporary energy standards, which is manifested in high energy consumption and CO_2 emissions per unit residential area. As a consequence of the use of small furnaces and especially stoves burning solid fuel (especially brown coal containing sulphur), buildings in categories a) and b) represent an important source of local pollution of the air by dust particles (PM_{10}).

If the current trend is extrapolated to 2020, energy consumption in households will be 11% lower than in 2006 (Tab. 4.2). The technical potential can be expressed as the state when all new and reconstructed buildings would fall in the highest energy intensity category A. The economic potential is considered here to be the state when half of new and reconstructed buildings are in class C and half are in class B.

Tab. 4.2 Potential savings and estimated emission reduction in apartment construction to 2020 (reference year 2006)

Potential	Savings (mil. kWh p.a.)	Savings (TJ p.a.)	Reduction (%)	Reduction in emissions (thousand t CO_2 p.a.)
Business as usual	**8,588**	**30,916**	**11**	**2,800,**
Economic potential	**10,535**	**37,927**	**14**	**3,400**
Technical potential	**14,466**	**52,077**	**19**	**4,700**

Source: MoE

The "Green Investment Scheme" programme was officially announced on Earth Day (April 22, 2009) and preparation of technical and implementation documents, training of employees of the State Environmental Fund of the Czech Republic and promotion of the programme (see www.zelenausporam.cz) took place during the first half of 2009.
The "Green Investment Scheme" programme is divided into three basic areas of support:

A. Energy savings for heating

A.1. Complete insulation of the envelope of buildings, leading to achieving of the low-energy standard,

A.2. Good insulation of selected parts of residential buildings (partial insulation).

B. Support for new construction of passive buildings

C. Use of renewable energy sources for heating and for hot water

C.1. Replacement of sources using solid and liquid fossil fuels or electrical heating by low-emission sources using biomass and effective heat pumps,

C.2. Installation of low-emission sources using biomass and effective heat pumps in new structures,

C.3. Installation of solar-thermal collectors.

D. Subsidy bonus for selected combinations of measures – some combinations of measures are awarded a subsidy bonus

All these activities supported by subsidies from the "Green Investment Scheme" will progress throughout the Czech Republic on the basis of interest on the part of applicants. Subsidies will be provided to the owners of real estate to facilitate purchase of equipment (biomass furnaces, solar collectors, heat pumps, etc.) and implementation of construction work.

4.5.2 Reviewed Policy of Climate Protection in the Czech Republic

Objective: Change in target emissions to 2020 through implementation of the EU Climate and Energy Package. A 27% reduction in emissions is expected by 2020 compared to the reference emissions of 139 mil. t CO_{2eq} (2005).

Characteristics: Cross-sectional and framework strategic document at a national level (coordination MoE)

Period of implementation: draft

Time framework: 2020
Sectors: Cross-cutting character

It is the purpose of the prepared policy to supplement and coordinate the already existing sectoral policies and measures from the standpoint of achieving the national targets in protection of the climate and adaptation to the expected impacts of climate change. The time framework (to 2020) follows from the technical-economic and legislative framework (especially the EU Climate and Energy Package) and the related uncertainty in estimation of costs. These estimates become increasingly uncertain with increasing time framework.

The document states that the proposed target, i.e. reduction of greenhouse gas emissions by 20% between 2005 and 2020, is achievable if all the proposed measures are implemented in the way described in general in the document.

The document proposes modification of existing measures or adoption of new measures in the following areas:

1. Industry and emission trading
    - Reducing emissions in industry
    - Emission trading
2. Energy supply
    - Increasing the efficiency of existing sources
    - Use of renewable energy sources
    - Nuclear energy
3. Final energy consumption – buildings (households, services, construction)
    - Reduction of the energy intensity of buildings,
    - Energy-efficient appliances
    - Use of wood in the construction industry
    - Energy-saving lighting
4. Transport
    - Increasing the energy efficiency of transport
    - Use of alternative fuels and propulsion
    - Support for mass public transport
5. Agriculture
    - Use of biogas

- Afforestation
- Binding carbon in arable land
- Support for environmentally sound farming

6. Other
    - Waste management
    - Programmes of municipalities and cities
    - Science, research and education

The scenario including a new nuclear energy source yields a probable reduction in emissions of approx. 38 mil. t CO_{2eq} This would permit a reduction of approx. 27% in greenhouse gases compared to 139 mil. t CO_{2eq} emitted in 2005.

During 2009, the reviewed Policy of Climate Protection in the Czech Republic will be subjected to strategic environmental impact assessment (SEA) pursuant to Act No. 100/2001 Coll., on environmental impact assessment, as amended. In the framework of this assessment, any negative side effects of implementation of mitigation policies and measures will be assessed pursuant to Art. 4.8 of the Convention and appropriate response measures will be proposed.

4.5.3 Transport

The following measures are being considered in the context of revision of the Policy of Climate Protection (2009) and development of European transport policy:

Objective: Reduction of the linear growth in transport emissions

Characteristics: Programmes and measures based on sectoral policies

Period of implementation: draft

Time framework: 2020

Sectors: Transport, regional development, industry

4.5.3.1 Increasing the energy efficiency of transport

Objective: Provision for an effective reduction in greenhouse gas emissions in automobile transport through support for technical developments and innovations in the area of propulsion units (including hybrid), aerodynamic characteristics, the rolling resistance of tires, braking, etc. Further, attain a substantial proportion of environmentally friendly vehicles in mass transport, the state administration and passenger transport, e.g. the Programme for replacement of the vehicle fleet of the public administration for more "environmentally friendly" vehicles. The target lies in attaining at least a 25% share of these vehicles in the overall vehicle fleet used by governmental bodies by January 1, 2014.

- Updating of the Programme for replacement of the vehicle fleet of the public administration,
- Improvement of the system of preferential treatment of users of vehicles with environmentally friendly propulsion (reduced road tax tariff or complete exemption, variable tariff for power fees or charging for externalities),
- Introduction of a fee for registration of an older vehicle graded according to assignment in EURO emission classes,
- Development of use of vehicles with hybrid propulsion, specifically achieving a 11% share by 2020,

- Development of a system of evaluation of the energy intensity of vehicles (labelling vehicles according to CO_2 emissions) and informing users of the useful characteristics of vehicles. Implementation of emission limits for newly manufactured vehicles and control of the technical and emission parameters of all vehicles (amendment of Act No. 56/2001 Coll., on conditions for the operation of vehicles on roadways and amending Act No. 168/1999 Coll., on insurance for liability for damage caused by the operation of a vehicle and amending some related laws (Act on insurance for liability following from the operation of a vehicle), as amended by Act No. 307/1999 Coll. - the Highway Act).

These innovations and technical development in the area of manufacturing of environmentally sounder vehicles, together with an increase in the share of these vehicles in the vehicle fleet, would enable a reduction of greenhouse gas emissions by 2.1 mil. t by 2020.

4.5.3.2 Alternative fuels and propulsion

Objective: Broader use of alternative fuels in transport. These consist particularly of compressed natural gas (CNG), liquid natural gas (LNG), liquid petroleum gas (LPG), combined (hybrid) propulsion and also biofuels (bioethanol for combustion motors and the methyl ester of rapeseed oil (MERO) for diesel motors and also 2nd generation biofuels).

- Extension of the public network of filling stations for compressed natural gas (CNG), improvement of their accessibility and the effectiveness of the technology employed
- Increasing the attractiveness of purchase of vehicles with alternative propulsion through inclusion in the category with reduced VAT
- Promotion of new fuels and motivation for use of vehicles with alternative fuels, especially by operators of mass transport, in the state administration or other entities using large vehicle fleets
- Promotion of research at a national level in the area of the physical properties of biofuels, their efficiency and effectiveness of production

Intense research on optimizing the physical properties of motor biofuels and production technologies is essential, leading to innovations in the area of adaptation of propulsion units. Replacement of propulsion of motor vehicles based on petroleum products by alternative fuels will probably also continue after 2020.
Assuming a 10% share of alternative fuels in 2020, their type compositions and specific benefits can then be combined to reduce emissions burdening the climate: CNG approx. – 25%, LPG approx. – 12%, a reduction of 50 – 60% can be calculated for pure biofuel, for mixed fuels containing 5% biocomponent (bioethanol or MERO) the savings in CO_{2eq} emissions correspond to only approx. 2%.
On the basis of an expert estimate, the reduction in greenhouse gas emissions from transport through attaining the long-term target of 10% share of alternative fuels to 2020 could correspond to approx. 1.4 mil. t CO_{2eq}.

4.5.3.3 Public passenger and freight transport

Objective: reduce the rapid increase in passenger and freight transport and air transport.

Trends in distribution of transport performances for the individual kinds of transport are unfavourable in the long term, with a predominance of road transport. The demand for transport in cities is currently oriented towards individual automobile transport and practical introduction of a strategy for its regulation and to promote mass, cycling and pedestrian transport is slow. Consequently the prepared Policy of Climate Protection proposes:

- Support for sustainable city mobility (innovative approaches in preference for public mass transport, integrated transport systems, cycling and pedestrian transport, increased quality and attractiveness of services offered).
- Support for the development of systems of combined transport in various sectors of freight transport and logistical solutions.
- Creation of separate subsidy titles for financing the development of alternative means of transport and pilot projects (especially cycling and pedestrian transport).
- Charging for external costs and services in transport, leading to an increase in the attractiveness of alternative transport systems.
- Development of integrated transport systems (ITS) and infrastructures in cities, consistent withdrawal of funds provided in the framework of structural funds and other EU subsidies, legislative support for the establishment and functioning of ITS, extended territorial competence and functioning of ITS, including methodical support for improved management and coordination activities amongst various means of transport.

Air transport will be included in EU ETS from 2012, when the system in tradable emission allowances will be extended to include emissions from all flights with initial or final destination in one of the European Union Member States, without regard to the origin of the airline operator.[5]

Together, these measures could lead to a 5% reduction in CO_{2eq} emissions produced by transport by 2020, i.e. approx. 1 mil. t CO_{2eq}.

4.5.4 Implementation of the Climate and Energy Package

Objective: Change in target emissions to 2020 through implementation of the EU Climate and Energy Package.

Characteristics: Various measures at the EC level

Period of implementation: following adoption of CEP implementation at a national level

Time framework: 2020
Sectors: Cross-cutting character

The Climate and Energy Package is intended to contribute to provision for commitments to 2020 adopted by the European Council in March 2007:

- to reduce greenhouse gas emissions by 20% compared to 1990 (or 30% if the other developed countries adopt similar commitments and if the more economically developed countries contribute proportionately to their historical responsibility and economic capabilities),
- to attain a 20% share of renewable energy sources in the total volume of final energy consumption,

[5] This is intended to stabilize emissions from air transport at the level of average emissions for 2004 – 2006. In the first trading period (Jan. 1, 2012 – Dec. 31, 2012), 97% of these historical emissions will be divided up amongst operators. In the following period (Jan. 1, 2013 – Dec. 31, 2020), the amount of emissions will be reduced to 95%. In both of these periods, the airline operators will be able to request allocation of 85% of the emission allowances free and an auction of allowances in an amount of 15% of the historical emissions will take place in both periods. A special reserve of 3% of historical emissions will be set aside for new operators commencing air operations after 2010 and for existing operators whose inter-annual increase in transported tonne-kilometers exceeds 18%.

- to increase energy efficiency by 20%.

The package includes a change in the European system of emission trading (EU ETS), a decision on shared efforts of Member States to reduce greenhouse gas emissions, a directive on support for the use of renewable energy sources and directive on support for carbon capture and storage (CCS). The package also includes other legislation on CO_2 emissions from passenger cars and the quality of fuel in highway transport.

The following documents form a key part of the Climate and Energy Package[6]:

1. Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/87/EC in order to improve and extend the scheme for greenhouse gas emission allowance trading within the Community (COM(2008)16). The new EU ETS system anticipates gradual elimination of charge-free allocation of allowances to the individual industrial enterprises and the introduction of new rules for auctioning emission allowances after 2013. Electrical energy, which is the most important sector from the standpoint of emissions, will pass to complete auctioning of allowances in 2013 (possible exceptions for some Member States). The purpose of the new Directive is to reduce emissions of greenhouse gases to 2020 throughout the European Union in branches falling under EU ETS by 21% compared to the 2005 level. This will be ensured by the introduction of a uniform EU emission ceiling, which will be decreased by 1.74% annually to 2020. Some new energy-intensive branches of industry (production of ammonia and aluminium) and additional greenhouse gases (e.g. N_2O) were included under EU ETS. Related Directive 2008/101/EC also included international air transport under EU ETS. Small sources with a thermal output of less than 25 MW producing less than 10,000 CO_2 p.a. are to be excluded. The Decision of the European Parliament and of the Council on the endeavour of the Member States to reduce greenhouse gas emissions in order to fulfil the commitments of the Community in the area of reduction of greenhouse gas emissions by the year 2020 (KOM(2008)17). The Decision stipulates the commitments of the individual Member States to reduce greenhouse gas emissions in branches that were not included in EU ETS. The Decision is intended to provide for reduction of greenhouse gas emissions in branches not regulated by EU ETS in a total amount of 10% of EU emissions of 2005 (reference year). Differentiated obligations are set for the individual Member States, from – 20% to + 20%. The Czech Republic will be able to increase its emissions by up to 9% in the areas covered by this Decision.
2. Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (COM(2008)19). The Directive stipulates distribution of the commitment of 20% of renewable energy sources in final consumption to 2020 amongst the Member States. The Czech Republic must achieve a share of at least 13%. By June 2010, every Member State is to prepare an Action Plan for achieving the set national targets and provide for a share of renewable energy sources in transport of at least 10% (including liquid biofuel, electric and hydrogen propulsion). The proposal for the Directive includes guarantees of the origin of the electricity produced from renewable energy sources. It encompasses the obligation of all the Member States to designate one competent authority that will issue, register and cancel guarantees. In the Czech Republic, the company Operátor trhu s elektřinou, a.s. (Operator of the electricity market) should be entrusted with this task. The proposal for a Directive also includes criteria of

[6] The adopted texts have not yet been published in the Official Journal of the European Union and thus only the numbers of the European Commission drafts are given

sustainability from the standpoint of the environment for biofuels and other bioliquids and a system of verification of their maintenance. According to the proposal for a Directive, the saving in greenhouse gas emissions from the use of biofuels and other bioliquids must be at least 35%. The Directive also stipulates the land from which materials may be not obtained for the production of biofuels and other bioliquids (land with high biological diversity, areas designated for the purposes of protection of nature and land with high carbon contents, such as wetlands and continuous forested areas).

3. Proposal for a Directive of the European Parliament and of the Council on the geological storage of carbon dioxide (CCS, see COM(2008)18). The Directive lays down the technical and safety requirements connected with operation and termination of the operation of CCS. The proposals leave to Member States the right to specify the area for the CO_2 storage site; however, it must be a geological formation where there is no significant risk of escape of CO_2 and where the occurrence of significant negative environmental impacts is unlikely. The submitted proposal encounters difficulties since there does not currently exist any technology for geological storage in operation and practical use, particularly in relation to CO_2 storage sites in connection with the method of prevention of release of the stored (or transported) CO_2 back into the atmosphere and the degree to which it will be possible to minimize the energy intensity of this technology.

The European Commission is preparing further steps to meet its commitments, especially in the area of increasing energy efficiency. Within the scope of the Second EU Action Plan for ensuring supplies of energy and solidarity in their use (see COM(2008)781), regulations are proposed that will substantially increase current requirements on energy efficiency, especially in the area of the energy intensity of buildings, stating energy consumption in energy networks, ecodesign and combined production of heat and electricity. In 2010, the Commission will propose a review of the Energy Policy for Europe in an effort to plan the policy agenda for 2030 and outlook for 2050.

The current EU policies also encompass joint steps towards adaptation to the ongoing and expected climate changes. The currently valid Community legislation (in the area of waters, agriculture, biodiversity and the land use) is related to adaptation measures. The White Paper Adapting to climate change: Towards a European framework for action (COM(2009)147) lays down the procedure for creation of a common integrated framework for adaptation measures at the EU level. The Climate and Energy Package was accepted politically by the Government of the Czech Republic in December 2008 and was actually approved in April 2009.

4.6 Measures completed in the 2003 – 2007 period

Tab. 4.3 lists measures that were completed in the 2003 – 2007 period (including quantification of benefits). This encompasses particularly the framework Strategy of Protection of the Climate System of the Earth in the Czech Republic, which was prepared after COP 3 (Kyoto) and the National Programme of Sound Energy Management and Use of Renewable and Secondary Energy Sources. Both documents have undergone review or have been replaced by up-dated cross-cutting documents of a similar character (see the previous chapters). Emission trading EU ETS in the 2005 – 2007 three-year test period was also completed, as were the operational programmes for the 2004 – 2007 period. The AIJ (activities implemented jointly) phase was completed and the JI phase of projects was commenced (see above).

Tab. 4.3 Survey of measures completed in 2003 - 2007

Name of measure	Category/Sector	Description	Emission reduction	Gases	Responsibility	Commenced/ Completed
Strategy of Protection of the Climate System of the Earth in the Czech Republic	Strategy / cross-cutting document	The objective of the Strategy of Protection of the Climate System of the Earth in the Czech Republic (Government Resolution No. 480 of May 1999) consisted in compliance with the international commitments of the Czech Republic following from the UN Framework Convention on Climate Change and the Kyoto Protocol	Coordination of sectoral activities, cannot be quantified	All	Government, individual sectors	1999 – 2004
The National Programme of Sound Energy Management and Use of Renewable and Secondary Energy Sources	Framework programme / cross-cutting document	The Programme was approved in Government Resolution No. 1079 of 2001 (support for Act No. 406/2000 Coll., on management of energy) and is concerned with decreasing energy consumption and the use of renewable and secondary energy sources, in accordance with economic and social needs, sustainable development and protection of the environment. Act No. 406/2000 Coll. was amended in 2007 by omitting the National Programme for the 2006 – 2009 period and replacing it by the State Programme in Support of Energy Savings and the Usage of Renewable Energy Sources. Sources of support come from the budgets of the MIT, MoA and MoT (support for regional and urban transport), SEF CR (support for energy savings and RES) and the State Fund for Development of Housing. It is based on the State Energy Policy and the State Environmental Policy (2004). The programme was directed towards the following target groups: the state administration and self-government, the business sphere, households and NGO's. The recommended measures are based particularly on the State Energy Policy and the State Environmental Policy. The programme is a framework document for the State Programme in Support of Energy Savings and the Usage of Renewable Energy Sources (see below).	Reduction of GHGs cannot be quantified (cross-cutting nature of the programme)	All	MIT (Part A) and ME (Part B)	2000 – 2006 2006 – 2007
GEF efficient lighting initiative	Programme / Particularly the public sector	The Efficient Lighting Initiative (ELI) was a three-year programme prepared by the International Financial Corporation (IFC) and financed by the Global Environmental Facility (GEF).	Cumulative reductions from 200 – 2003 of approx. 0.8	CO_2	IFC/GEF	2000 – 2003

		The objective was to reduce greenhouse gas emissions by the introduction of energy-saving technologies to newly emerging markets (public sector, households). An investment and consulting system, whose implementation began in the spring of 2000, with a total ELI budget for the Czech Republic of USD 1.25 mil. The programme in the Czech Republic was concerned mainly with the public sector, households and public street lighting. Instruments – information, education, support for preparation of projects, mediation of financing, support for businesses. The budget was used in the individual programme activities so as to stimulate local private and public sources for increasing the effects of the programme. The savings were reinvested in better economy of public lighting. The benefit of the programme also lies in reduction of emissions of pollutants.	mil. t O_2			
Operational Programmes	Investment subsidies / multisectoral	The Industry and Enterprise Operational Programme and the Infrastructure Operational Programme were important for greenhouse gas emissions. In two priority axes, the Industry and Enterprise Operational Programme was concerned with increasing the energy effectiveness of production and energy consumption in industry and increasing the share of renewable energy sources. The Infrastructure Operational Programme was concerned, amongst other things, with reduction of the amount of emitted pollutants, improvement of pollution levels in the affected locations, improvement of the state of health of the population and condition of vegetation; reduction of greenhouse gas emissions tended to be a side effect.	The annual reduction in emissions from 2010 can be estimated at 325 thousand t CO_2.	CO_2	Government, individual sectors	2004 – 2007
MIT Decree No. 291/2001 Coll., laying down the details of the efficiency of energy use in energy consumption in buildings	Legislative / buildings	Energy intensity of buildings, replaced by MIT Decree No. 147/2007 Coll., on the energy intensity of buildings. MIT Decree No. 291/2001 Coll. stipulated the thermal technical and energy properties of construction structures and buildings, therefore compliance with the Decree was considered to constitute compliance with the general technical requirements on construction.	Not quantified		Owners, operators of buildings	2001 – 2007
Emission trading	EU ETS 1,	Emissions sources (approx. 4000 installations) have allocated	It can be estimated	CO_2	Installation	2005 – 2007

Phase 1	Tradable allowances /industry	tradable allowances. The system of trading in allowances in the Czech Republic was commenced on the basis of Directive 2003/87/EC transposed into the Czech legislation through Act No. 695/2004 Coll., on the conditions of greenhouse gas emission allowances tradings. The National Action Plan for the 2005 – 2007 period was also prepared during 2005 and came into affect following approval as Government Resolution No. 315/2005 Coll. The register for transfer of allowances was started up on October 13, 2005 and Czech installations became a regular part of EU ETS. The number of installations (approx. 400) changes with time.	that the effect of EU ETS on decreasing CO_2 emissions compared to the projection for 2005 and 2006 lies in the range of 3 – 5 mil. t CO_2.		operators	
Activities implemented jointly	Projects implemented by PCF and especially OECD / esp. energy and industry sectors	Five AIJ projects were implemented in the Czech Republic in 1996 - 1999	Not quantified			1996 – 1999

Source: ENVIROS, s.r.o., MoE

5 Projections of greenhouse gas emissions

5.1 Scenario for emission projections

In accordance with the methodical instruction for preparation of projections[7], projections were prepared for following scenarios:

- without measures;
- with measures, i.e. with implemented measures, which came into force in the 1995 – 2005 period;
- with additional measures, i.e. with measures that are currently prepared or under preparation[8].

Additional measures included in preparation of projections are:

- The Green Investment Scheme,
- Measures adopted on the basis of the EU Climate and Energy Package, e.g. continuation of EU ETS with full or partial auctioning of emission allowances,
- Measures introduced on the basis of the prepared Regulation of the of the European Parliament and of the Council, laying down emission standards for new passenger cars (COM(2007)0856).

5.2 Methodology employed

The methodology employed for preparation of emission projections is in accordance with the methodology employed for preparation of projections for the Third and Fourth National Communications which, amongst other things, permits them to be compared. The methodology includes following set of steps:

(i) inventory of greenhouse gases

(ii) selection of base and final year and cross-cutting years for creating projections,

(iii) selection of the actual methodology and model instruments for preparing the projection,

(iv) collection and analysis of input data for the projection,

(v) establishment of initial assumptions,

(vi) definition of scenarios,

(vii) calculation of scenarios and presentation of their results,

(viii) performance of sensitivity analysis on selected assumptions.

The results of the individual steps are described in the following chapters.

---

[7] UNFCCC Reporting Guidelines on National Communication, FCCC/CP/1999/7, part II

[8] see "Updating of forecasts of greenhouse gases and summary of policies and measures in the Czech Republic", ENVIROS, s.r.o., February 2009.

5.2.1 Inventory of greenhouse gas emissions

Inventories of greenhouse gas emissions are prepared by the Czech Hydrometeorological Institute; the last summary inventory is available for 2007. Summary data from this inventory are given in Chapter 3 of this document. Total greenhouse gas emissions recalculated to CO_2eq for 2007 were calculated as 149,103 thousand t (including sinks).

The results of greenhouse gas inventories indicate that CO_2 emissions, produced by the combustion of fossil fuels (90.8%), make the largest contribution to greenhouse gas emissions (85.9%). The largest amount comes from the energy production sector (52.7%), followed by industry including corporate energy production (21.4%), households, agriculture and the tertiary sector (9%). Transport currently contributes 15.9% and exceeded the share from households, agriculture and the tertiary sector last year.

5.2.2 Base year and cross-cutting period of the projections

2007 was the base year. Information on macroeconomic development, the energy balance, balance of resources and energy consumption and the national emission inventory was available for that year for work on the projections. Data for 2005 were also used for calibration of the model. The year 2020 was selected as the final year for projections of greenhouse gas emissions, in accordance with the required methodology for preparing this document. The years 2005, 2010, 2015 and 2020 were selected as cross-cutting years for preparing the projections.

5.2.3 Model instruments and procedures

The EFOM/ENV energy production linear optimization model was used for projections of CO_2, CH_4 a N_2O emissions from combustion processes. The following activities were included in calculation of emission projections for the individual greenhouse gases:

- **carbon dioxide** - combustion of fuels in fuel conversion processes (public and factory energy production), combustion of fuels for final consumption (industrial processes, transport, households, agriculture and the sector of public and commercial services), fuel improvement processes (refineries, post-mining treatment of coal and coking) and removal of SO_2 from combustion products using limestone,
- **methane** – coal mining and its post-mining treatment; mining, storage, transport and distribution of natural gas and mining, storage, transport and refining of petroleum,
- **nitrous oxide** – combustion of fuels in stationary and mobile sources.

A combined procedure with the EFOM/ENV model and a table processor was used for projections of trends in greenhouse gas emissions from industrial processes. The projection was concerned only with activities and emissions with a major contribution to greenhouse gas emissions. Other emissions and activities with a minor contribution to greenhouse gas emissions were derived on the basis of an increase in GDP in the processing industry, amongst other things, because of the lack of information on potential future trends (e.g. production of steel, coke, polymers, nitric acid, etc.).

The main component of emissions from industrial processes, i.e. the metallurgy of ferrous metals, is dealt with directly in the EFOM/ENV optimization model. Projections in the sector of production of nonmetallic materials were made only for carbon dioxide emissions from the production of cement, corresponding to approx. 90% of emissions. It is expected that the emissions from the production of glass, which is the second most important source of carbon dioxide emissions from this sector, will remain in a constant ratio to those from cement

production. The emission factor taken from the IPCC methodology was employed in the projection for cement production, i.e. 0.4985 t CO_2/t cement.

5.2.4 Collection and analysis of input data for the projections

The following documents were employed as basic data sources for preparing projections of greenhouse gas emissions:

Statistical data:

1. Inventory of greenhouse gas emissions in the Czech Republic in 2007, Czech Hydrometeorological Institute, Prague, February 2009
2. Energy balance of the Czech Republic in 2004, 2005, 2006, Czech Statistical Office, Prague, 2008
3. Balance of energy-production processes for improved fuels in 2006, Czech Statistical Office, Prague, 2008
4. Annual national accounts 2001 – 2007; Czech Statistical Office – internet database
5. Individual documents of the Ministry of Industry and Trade, Ministry of the Environment, Ministry of Transport, Ministry of Agriculture, Ministry of Education, Youth and Sports, Ministry of Culture, Czech Energy Agency, State Environmental Fund of the Czech Republic, Czech Statistical Office and the CzechInvest agency

Projection data:

1. Communication of the European Commission COM (2008) 744 „Second Strategic Energy Review – AN EU Security and Solidarity Action Plan – Europe's current and future energy position – Demand – resources – investments" of November 13, 2008
2. Documents from the Ministry of Industry and Trade, Ministry of the Environment, Ministry of Transport, Ministry of Agriculture, Ministry of Education, Youth and Sports, Ministry of Culture, Czech Energy Agency and the State Environmental Fund of the Czech Republic
3. Documents from EGÚ Brno, a. s., VUPEK Economy, s. r. o.

A database on input data for creation of the projections was drawn up using these sources.

5.2.5 Initial assumptions and scenarios

5.2.5.1 Political and legal environment

From the standpoint of the political and legal environment, the following basic conditions are considered for trends in energy production and industrial processes emitting GHGs:

- Through accession to the EU, the Czech Republic accepted commitments in the area of protection of the environment and climate that are part of community law (e.g. Directive 2001/80/EC on large combustion plants, Directive 96/61/EC concerning integrated pollution prevention and control, Directive 2001/81/EC on national emission ceilings, Directive 2003/96/EC on the environmental taxes and Directive 2003/30/EC on the promotion of the use of biofuels).
- Emission allowance trading, which is part of EU ETS, was introduced in the Czech Republic. This system will be further developed, particularly in relation to allocation of allowances as the principle of charge-free allocation of allowances on the basis of

historical emissions (grandfathering) will be gradually abandoned in favour of purchasing allowances at auctions.

- The Czech Republic is bound by a number of international agreements in the area of protection of the climate and the environment (Kyoto Protocol, Second Protocol on Sulphur, Göteborg Protocol).
- The energy market was opened in accordance with Act No. 458/2000 Coll. (the market in electricity was fully opened on January 1, 2006 and in gas on January 1, 2007) and the prices of coal, gas and electrical energy are converging towards the prices on the European energy market.

5.2.5.2 Technical developments

Substantial developments are expected in the development of technology for obtaining, converting, transport and use of energy sources in the 2010 – 2020 period. In the area of utilization of solid fuels for the production of electrical energy, use will be concentrated on sources with super-critical steam parameters and on fluid technologies, connected with much higher effectiveness and, in the area of combined production of electrical energy and heat, improvements will be made in technology permitting the construction of sources that are as close as possible to heat consumers. In the long term, consideration is being given to a potential increase in small sources based on microturbines and fuel cells.

However, it is not very likely that a new nuclear source will be brought into operation in the Czech Republic before 2020. The development of nuclear energy is still limited by the unresolved problem of management of spent nuclear fuel, which is currently stored in the premises of the two nuclear power plants. As there is no energy policy (the last version was formulated in 2004), the future of nuclear energy in the Czech Republic remains a matter for discussion.

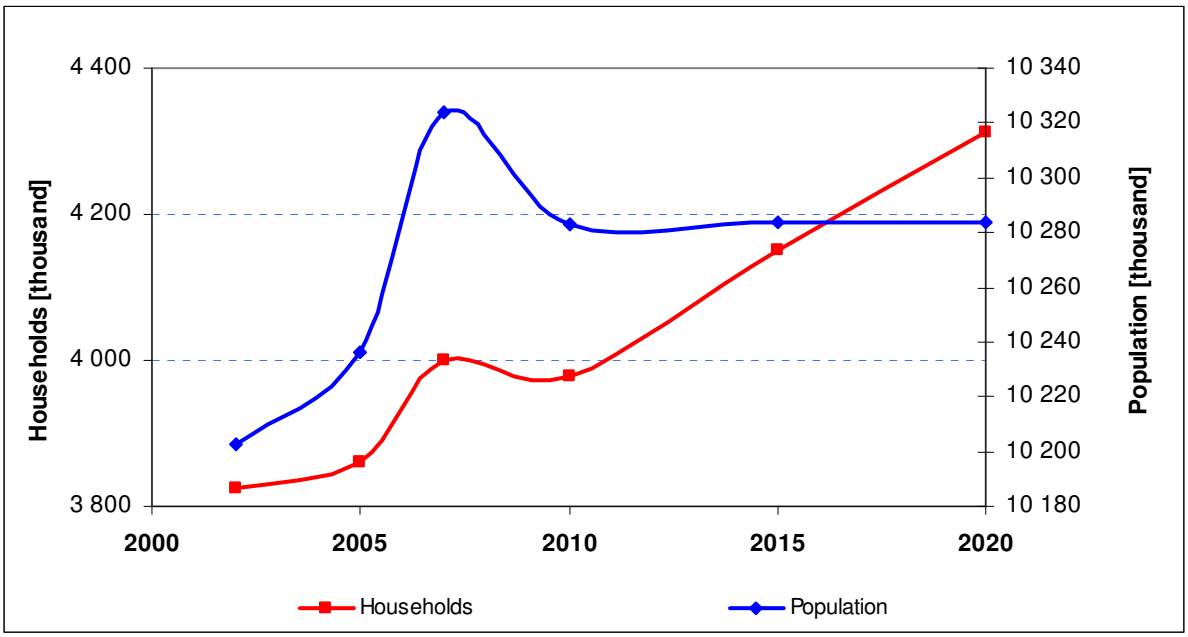
For motor fuels, in addition to a further reduction in specific consumption, it is expected that the use of alternative fuels will be gradually introduced, which will, amongst other things, be facilitated by the use of renewable energy sources (biofuels). The main trend will lie not only in a further reduction in specific investment costs, but also in criteria for protection of the land and biodiversity and a demonstrable benefit in reducing GHGs.

5.2.5.3 Scenario of demographic trends

Predictions of the number of inhabitants are based on information from the Czech Statistical Office (CSO)[9]; the number of households, which is also required for calculation of energy demand, was estimated. CSO prepared population projections in three variants; the mean variant was used here.

[9] Population forecast for the CR to 2050, CSO, Prague 2004, publication 4025-04

Fig. 5.1 Demographic projection (thousand)

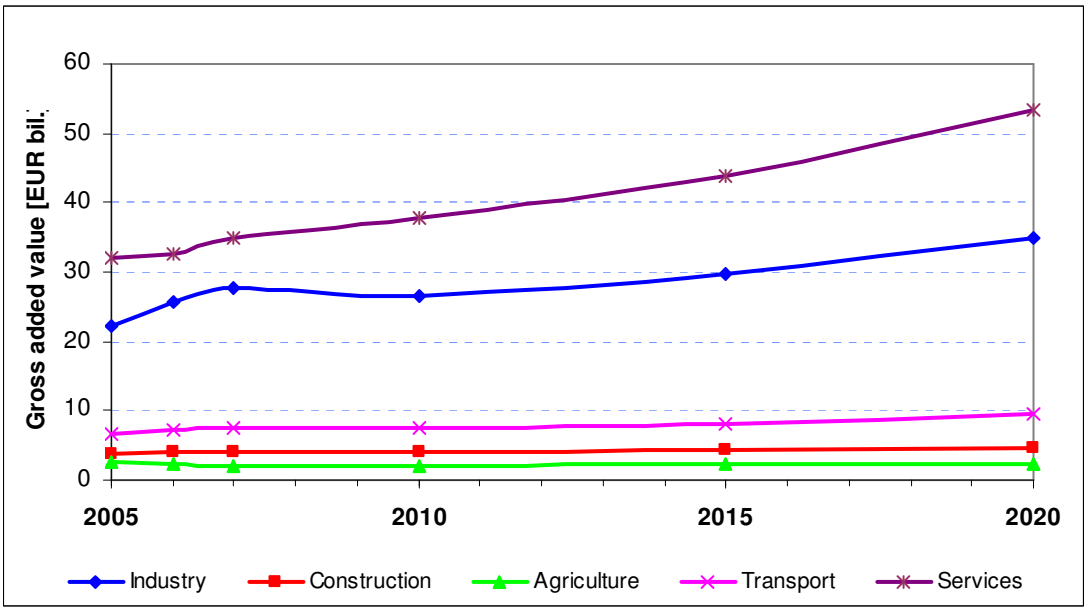


Source: CSO, ENVIROS, s. r. o.

5.2.5.4 Scenario of economic development

An official projection of long-term trends in GDP is not available for the outlook to the year 2020. In addition, under the conditions in the current economic crisis, it is very difficult to predict the trends in the national economy and its individual sectors. The scenarios of trends in the GDP used in this projection are based on the results of the R&D project 2A-2TP1/095 "Sustainable Development in Energy Production", carried out in the framework of the Sustained Prosperity programme. In the framework of this project, a question survey was performed in February of 2009 to determine experts' opinions on the impacts of the global economic crisis on trends in the Czech economy, the individual sectors and energy production. The projections for the GDP and GAV (gross added value) employed for the individual sectors are thus based on the results of this survey.

Fig. 5.2 Projection of trends in gross added value (constant prices[10] of 2000) in EUR bil.



Source: ENVIROS, s. r. o.

5.2.5.5 Scenario of trends in global prices of fuel and energy

Petroleum, natural gas and black coal are commonly traded energy commodities on the global market. Price trend scenarios are also regularly prepared for these three basic energy commodities. Recently, electrical energy has been increasingly traded; however, because of the regional character of trade, no scenarios have been published for price trends.

The prices of fuels on the global market were taken from the communication of the European Commission[11] of November 13, 2008. The data correspond to the "moderate" scenario of price trends.

Tab. 5.1 Global prices of fuels (constant prices[12] of 2005)

€/GJ	2005	2010	2015	2020
Petroleum	7.32	7.32	7.78	8.21
Natural gas	4.65	5.58	5.83	6.18
Black coal	1.99	2.12	1.92	1.98

Source: Second Strategic Energy Review COM (2008) 744

The main assumptions employed in creation of the scenarios are as follows:

- a sudden change occurred in the trend in petroleum prices and the predictions of the long-term trends in the prices of petroleum and natural gas are very different;
- because of the ever-increasing demand (especially in the developing world), the price of natural gas will continue to be based on the price of petroleum (the range and speed of price changes will be lower than for petroleum prices);

[10] Exchange rate 35.61 CZK/€ – average for 2000

[11] COM (2008) 744 "Second Strategic Energy Review – AN EU Security and Solidarity Action Plan – Europe's current and future energy position – Demand – resources – investments"

[12] Exchange rate 1.25 CZK/€ – average for 2005

- the import price of black coal is based on the optimistic assumption of an excess on the European market;
- there is a certain risk of an increase in the price of black coal as a consequence of an increase in the demand in the rapidly developing countries of Asia;
- domestic black coal prices will be further increased by transport costs to the state borders (estimated at CZK 10 /GJ);
- new energy sources will have to meet strict environmental limits and the price of electrical energy will have to cover variable and fixed costs and will thus be substantially higher than the present value;
- after 2010, the increase in the price of electrical energy will be derived from the increase in the price of natural gas as a decisive new fuel for production of electrical energy in Europe.

5.2.5.6 Scenario of trends in domestic prices and availability of fuel and energy

The prices of imported primary energy sources will be based on the above-listed average import prices into the EU. The prices of domestic energy sources is based on the costs of their acquisition and will also be affected by the position of the given fuel in the market compared to competitive energy sources. Solid fuels, especially brown coal, will continue to be a decisive domestic primary energy source to 2020.

The purchase prices of electrical energy from renewable energy sources and from sources with combined production of electricity are currently stipulated by a Decree of the Energy Regulation Authority[13]. The current legislation[14] guarantees favourable purchase prices for a period of 15 years from bringing the source into operation. The Energy Regulatory Office can reduce these prices by up to 5% annually compared to the previous year. The projections assume maintenance of current purchase prices for the entire period.

The purchase prices of electricity from combined production of electricity and heat offered to producers for the individual production plants with total installed output of up to 1 MWe and supplied to the distribution system is CZK 240/MWh and, for production plants with installed output of 1 – 5 MWe, CZK 150 MWh.

5.2.5.7 Scenario of the availability of domestic coal

Solid fuels, especially brown coal, will continue to be a decisive domestic primary energy source in the near future. These sources will depend on the binding nature of territorial environmental limits on brown coal mining. Tab. 5.2 gives trends in the capacities of mining and costs of mining. It is not expected that environmental limits for mining brown coal will be relaxed at the ČSA mine.

[13] ERA Price Decision No. 10/2004, stipulating the prices of electricity and related services

[14] Act No. 180/2005 Coll., on the promotion of production of electricity and from renewable energy sources and on amendment to some laws (Act on Promotion of Use of Renewable Sources)

Tab. 5.2 Projections of domestic coal mining

Category of coal	Maximum mining (units)	2005	2010	2015	2020
Black, cokable	PJ	217	201	178	219
	thousand t	7,526	6,900	6,139	7,525
Black, energy production	PJ	146	122	111	64
	thousand t	6,168	5,100	4,561	2,675
Brown (SD – Libouš)	PJ	**147**	**158**	**139**	**120**
	thousand t	**13,208**	**14,500**	**13,500**	**12,000**
Brown (SD – Bílina)	PJ	117	132	130	130
	thousand t	**8,641**	**9,300**	**9,250**	**9,250**
Brown (MUS – Hrabák)	PJ	109	108	75	75
	thousand t	10,475	**10,000**	**7,000**	**7,000**
Brown (MUS – ČSA)	PJ	90,9	88,1	45,3	46,3
	thousand t	**5,166**	**4,950**	**2,500**	**2,500**
Brown (SU – Jiří)	PJ	103	88	88	88
	thousand t	**8,176**	**7,000**	**7,000**	**7,000**
Brown (SU – Družba)	PJ	26.9	25.2	25.2	25.2
	thousand t	**2,131**	**2,000**	**2,000**	**2,000**
Lignite	PJ	4	4		
	thousand t	450	450		

Source: VUPEK-ECONOMY, spol. s r. o.

5.2.5.8 Energy production scenario

The following initial assumptions were employed for model calculation of greenhouse gas emissions from energy-production processes:

(i) The Temelín nuclear power plant will remain in normal operation for the whole monitored period (2000 – 2020).

(ii) The Dukovany nuclear power plant will be reconstructed to prolong its lifetime and will be in normal operation for the whole monitored period.

(iii) No new nuclear power plant will be brought into operation by 2020.

(iv) Territorial environmental limits on mining of brown coal will be retained at the ČSA mine and partly relaxed at the Bílina mine.

(v) No limits will be introduced on the import of petroleum, gas and black coal.

(vi) For electricity, the maximum possible export will be 20 TWh in 2010, 6 TWh in 2015 and massive exports of electricity are not expected after 2015. It is also expected that there will be no significant imports of electricity.

5.3 Sectoral projections

To prepare projections of greenhouse gas emissions and in accordance with the IPCC methodology for greenhouse gas inventories, greenhouse gas emissions were classified into groups according to their origin:

(i) Emissions of greenhouse gases from combustion processes and fugitive emissions (Sector 1A and 1B)

(ii) Greenhouse gas emissions from industrial processes (Sector 2)

(iii) Emissions from the use of solvents (Sector 3)

(iv) Emissions from agricultural production (Sector 4)

(v) Forest management (Sector 5)

(vi) Waste (Sector 6)

Projections (CO_2, N_2O and CH_4, NO_x, CO, NMVOC and SO_2) were calculated according to the above mentioned groups; summary projections were made for HFC, PCF and SF_6 emissions. The methodical procedures and model instruments according to these groups are described in the following text.

5.3.1 Emissions of greenhouse gases from combustion processes and fugitive emissions (Sector 1A and 1B)

The EFOM/ENV energy production linear optimization model was used for projections of CO_2, CH_4 and N_2O emissions from combustion processes. The calculation includes the following processes for the individual gases:

CO_2 emissions

- emissions from combustion of fuel in fuel conversion processes (public and corporate energy production),
- emissions from combustion of fuel for final consumption (industrial processes, transport, households, agriculture and the sector of public and commercial services),
- emissions from fuel improvement processes (refineries, post-mining treatment of coal and coking),
- emissions from processes of removal of SO_2 from combustion products using limestone.

CH_4 emissions

- emissions from mining and post-mining treatment of coal,
- emissions from extraction, storage, transit transport and distribution of natural gas,
- emissions from extraction, storage, transport and refining of petroleum.

N_2O emissions

- emissions from combustion of fuels (in stationary and mobile sources).

The parameters of trends in the energy sector are a result of calculation using the EFOM/ENV optimization model. The balance holds for the scenario with measures.

Tab. 5.3 Domestic consumption of primary energy sources – WM scenario

(PJ)	2005	2010	2015	2020
Coal	827	764	631	570
Petroleum	393	366	346	349
Gas	324	351	386	406
Electricity	–46	–26	–15	4
Nuclear energy	279	318	318	318
RES	72	108	137	173
Total	1,850	1,880	1,802	1,820

Source: CSO, ENVIROS, s. r. o.

Tab. 5.4 Structure of electricity production – WM scenario

(TWh)	2005	2010	2015	2020
Coal	48.2	44.9	40.9	37.7
Petroleum	1.0	0.6	0.6	0.4
Gas	3.8	5.1	4.4	5.0
Nuclear energy	25.8	29.3	29.3	29.3
RES	3.1	4.1	5.9	7.9
Total	81.8	84.0	81.0	80.3

Source: CSO. ENVIROS. s. r. o.

Tab. 5.5 Final consumption of fuel and energy – WM scenario

(PJ)	2005	2010	2015	2020
Coal	134	125	100	81
Petroleum	322	304	293	300
Gas	295	312	336	347
Electricity	189	212	215	228
Heat	154	141	132	132
RES	50	76	94	116
Total	1,145	1,170	1,169	1,204

Source: CSO. ENVIROS. s. r. o.

Tab. 5.6 Final electricity consumption – WM scenario

(TWh)	2005	2010	2015	2020
Industry	21.5	25.6	27.3	28.8
Agriculture	1.1	1.0	0.9	1.0
Transport	2.7	3.4	3.7	4.2
Services	12.6	12.6	12.5	12.1
Households	14.5	16.3	15.3	17.4
Total	52.4	58.8	59.7	63.4

Source: CSO, ENVIROS, s. r. o.

The average value according to EUROSTAT of 3,570 day-degrees was used for heating. For cooling of buildings, no uniform method of calculation exists and information on day-degrees for cooling is not available. The scenarios with additional measures or without measures were calculated by adding or subtracting emissions from the individual measures.

5.3.2 Greenhouse gas emissions from industrial processes (Sector 2)

A model based on a table processor was used to projection greenhouse gas emissions from industrial processes. The projections were concerned with activities and emissions currently reported in the National Emission Inventory for 2007.

Documents from industrial federations submitted for preparation of the second stage of NAP and also the results of the survey prepared in the framework of the "Sustainable Development in Energy Production" project were used to predict production of the individual materials. The emission coefficients were taken from the National Emission Inventory for 2007.

Emissions from combustion processes in industry were calculated using the EFOM/ENV model, based on demand derived from the sectoral GDP projections. Tab. 5.7 gives final fuel consumption in industry for the WM scenario.

Tab. 5.7 Final consumption of fuel and energy in the industrial sectors – WM scenario

(PJ)	2005	2010	2015	2020
Coal	86.2	83.9	76.2	68.5
Petroleum	71.8	60.1	40.9	47.6
Gas	142.7	151.7	164.5	179.4
Electricity	77.3	92.1	98.2	103.8
Heat	84.3	71.1	67.0	66.3
RES	26.5	34.0	37.4	36.2
Total	488.7	492.8	484.2	501.9

Source: CSO, ENVIROS, s. r. o.

Emissions from industrial processes were determined from the projections for energy-intensive materials and products on the basis of information obtained from industrial federations. Tab. 5.8 gives a survey of emission projections.

Tab. 5.8 Projections of the production of selected energy-intensive materials (thousand t)

Material	2006	2007	2010	2015	2020
Clinker	3,288	3,837	3,583	3,637	3,962
Lime	1,034	1,083	1,069	1,189	1,215
Glass	1,750	1,688	1,745	1,721	1,743
Bricks and ceramics	1,528	1,860	1,470	1,464	1,479
Ammonia	242	227	276	266	264
Ethylene	462	409	500	483	479
Nitric acid	543	554	491	474	470
Pig iron	5,192	5,282	5,512	5,500	5,459
Steel	7,053	6,211	5,971	6,032	6,163
Coke	3,428	3,258	2,940	2,484	1,937

Source: Industrial federations, ENVIROS, s. r. o.

5.3.3 Emissions from the use and production of solvents and selected chemicals (Sector 3)

Two substantial changes occurred in the past in processing and use of solvents – an increase in the chemical industry and a decrease in the use of coatings as a consequence of the transition to water-based coating materials. The slight decrease in emissions from coatings is the only predictable tendency.

Tab. 5.9 Projections of GHG emissions from the production and use of solvents and paints.

	2005	2006	2007	2010	2015	2020
A. Paint application	39.4	37.5	37.7	35.5	34.0	32.5
B. Degreasing and chemical cleaning	17.6	17.6	17.0	17.6	17.6	17.6
C. Chemical products, manufacture and processing	13.0	14.1	14.1	13.0	13.0	13.0
D. Other						
1. Use of N_2O for anaesthesia	0.346	0.346	0.346	0.346	0.346	0.346
2. N_2O from fire extinguishers						
3. N_2O from aerosol cans	0.346	0.346	0.346	0.346	0.346	0.346
4. Other use of N_2O						
Other use of solvents (SNAP 0604)	25.2	25.8	25.963	25.8	25.8	25.8

Source: CRF tables 2005 – 2007, ENVIROS, s. r. o.

5.3.4 Emissions from agricultural production (Sector 4)

The projection of greenhouse gas emissions includes the following activities:

CH_4 emissions

- enteric fermentation,
- manure management.

N_2O emissions

- direct emissions from agricultural land,
- indirect emissions from agricultural activities.

Emissions from combustion processes in agriculture were determined using the EFOM/ENV model, based on the following projections of final energy production in the agriculture sector.

Tab. 5.10 Final energy consumption in the agriculture sector – WM scenario

(PJ)	2005	2010	2015	2020
Coal	0.9	0.8	0.4	0.0
Petroleum	11.8	7.0	7.2	9.7
Gas	2.6	2.6	2.6	2.5
Electricity	4.1	3.5	3.3	3.5
Heat	1.5	1.5	1.2	1.5
RES	0.4	3.0	4.3	2.6
Total	21.3	18.5	19.1	19.8

Source: ENVIROS, s. r. o.

CH_4 and N_2O emissions from plant and animal production were calculated from projections of the number of farm animals and use of agricultural land, as given in Tabs. 5.11 and 5.12. The emission coefficients recommended by IPCC were used.

Tab. 5.11 Projections of the numbers of farm animals (thousand head)

	1995	2005	2007	2010	2015	2020
Cattle	2,030	1,374	1,402	1,405	1,420	1,430
Pigs	3,867	2,840	2,443	2,755	2,640	2,520
Sheep	165	148	184	210	230	250
Goats	45	14	16	20	24	28
Horses	18	23	24	25	27	29
Poultry	26,688	25,736	27,314	23,700	21,700	19,800

Source: MoA, CSO

Tab. 5.12 Projections of data for management of the land

Input data	1995	2006	2010	2015	2020
Application of nitrogenous fertilizers (t N)	229,334	215,131	218,521	209,918	201,315
Production of cereals (t)	6,601,700	6,386,078	7,148,997	7,038,455	6,922,199
Production of pulses (tons)	144,100	87,510	84,456	79,831	77,380

Source: IFER – Institute of Forest Ecosystem Research, s.r.o.

Measures to reduce the amount of greenhouse gas emissions in agriculture consist mainly in lower application of nitrogenous fertilizers, cultivation of interim crops, development of organic farming, introduction of modern technologies, controlled fermentation of plant waste, etc. Reduction of the application of fertilizers and reduction of wash-out from fields are amongst the declared targets of contemporary policy. Thus, it can be expected that the current trend in reduction of greenhouse gases in agriculture will continue, but at a slower rate than to date (substantial decrease in the 1990 – 1994 period). The potential of the introduced

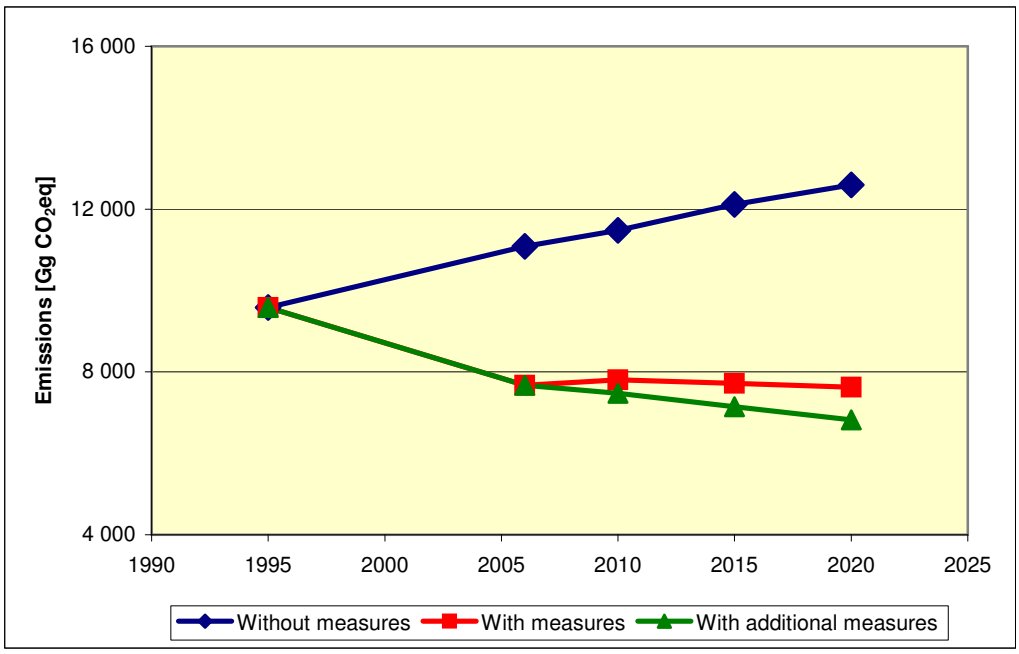
additional measures anticipates only a slight decrease in emissions to 2020, by 10% compared to 2006.

Tab. 5.13 Projections of total emissions from agriculture (in Gg CO_2eq)

	1995	2006	2010	2015	2020
Without measures	9,580	11,087	11,482	12,115	12,593
With measures	9,580	7,670	7,809	7,722	7,628
With additional measures	9,580	7,670	7,477	7,149	6,821

Source: ENVIROS s.r.o.

Fig. 5.3 Projections of total emissions in the Agriculture sector according to three scenarios



Source: ENVIROS s.r.o.

It is apparent from Tab. 5.13 and Fig. 5.3 that a substantial reduction effect of additional measures implemented in 1995 on the total emissions produced in the Agriculture sector is expected in 2020.

5.3.5 Land use, land use changes and forestry (Sector 5)

The forests in the Czech Republic are mostly managed for economic purposes and, with the exception of negligible areas, do not consist of "primary" forest. Consequently, the forests in the Czech Republic are classified in the category of "economically managed temperate forests" according to the "Good Practice Guide" (2003, Chapter 3). According to the Marrakesh Convention, forest land is defined as land with woody vegetation, where tree crowns growing to a height of at least 2 m at maturity cover at least 20% of an area with a size of at least 0.05 ha. The definition does not include permanent clearings entered in the land registry as forests (these are included in the category of other land). The definition of forest land thus corresponds to the provision of Act No. 289/1993 Coll., on forests, as amended, and Ministry of Agriculture Decree No. 84/1996 Coll., on forest management planning. Decisive tendencies in use of the land are:

- an increase in forest land
  - by conversion of meadows into forests

- by conversion of other land into forests

- an increase in meadows through conversion of cultivated land into meadows
- reduction of cultivated land
- increase in the other categories of land (mainly by construction)

Tab. 5.14 gives the anticipated trend in the areas of land.

Tab. 5.14 Projections of changes in land use

(thousand ha)	2005	2006	2007	2010	2015	2020
Forest land remaining forest land	2,554	2,555	2,560	2,565	2,573	2,581
Land converted to forest land	37	38	38	37	34	31
Cropland remaining cropland	3,236	3,230	3,224	3,204	3,177	3,150
Land converted to cropland	50	49	47	36	27	20
Grassland remaining grassland	851	856	857	857	863	869
Land converted to grassland	225	222	219	239	242	237
Wetlands remaining wetlands	148	149	150	153	158	163
Land converted to wetlands	13	13	13	11	9	7
Settlements remaining settlements	585	589	594	608	642	678
Land converted to settlements	81	79	77	70	56	44
Other land remaining other land	107	107	107	107	107	107
Land converted to other land	0	0	0	0	0	0

Source: MoA, CRF tables 2005 – 2007, ENVIROS, s. r. o.

The following projections apply to N_2O emissions from conversion of land to cropland (see Tab. 5.15).

Tab. 5.15 Projections of conversion of land to cropland for calculation of N_2O emissions

(thousand ha)	2005	2006	2007	2010	2015	2020
Conversion of land to cropland	38.0	37.1	36.1	33.9	30.4	27.8

Source: CRF tables 2005 – 2007, ENVIROS, s. r. o.

Liming of the land decreased for a long time but has again increased slightly over the past three years. Projections anticipate a further slight decrease, as emissions of substances causing acid rain decrease. Tab. 5.16 gives the anticipated trend in the liming of land.

Tab. 5.16 Projections of liming of land

(t of lime)	1990	1995	2000	2005	2006	2007	2010	2015	2020
Cropland	2,517,500	235,964	198,092	135,697	151,853	165,496	136,994	117,713	101,145
Meadows and pastures	132,500	12,419	10,426	5,495	6,178	8,710	5,715	4,872	4,154

Source: CRF tables 2005 – 2007, ENVIROS, s. r. o.

Burning of biomass in situ has increased in recent years, mainly as a consequence of the more frequent occurrence of calamities (bark beetles, blow-downs). There is has been a slight decrease in the number of forest fires. Tab. 5.17 gives the anticipated trend in the burning of biomass in situ.

Tab. 5.17 Projections of burning of biomass in situ.

(10^3 t)	2005	2006	2007	2010	2015	2020
Controlled burning	559	662	1,017	632	683	726
Uncontrolled burning	13.5	24.3	22.9	22.7	21.2	19.8

Source: CRF tables 2005 – 2007, ENVIROS, s. r. o.

5.3.6 Emissions from waste (Sector 6)

The projection includes the following activities:

- CO_2 emissions
- incineration of waste

CH_4 emissions

- landfilling of waste
- collection and treatment of municipal and industrial waste waters

N_2O emissions

- collection and treatment of municipal and industrial waste waters

Three scenarios (WOM – without measures, WM – with measures, WAM – with additional measures) were prepared, for which demographic forecasts and sectoral GDP forecasts were used. Additional measures (WAM scenario) are proposed in the prepared amendment to the Act on Waste. Adopted measures encompass the 2004 – 2008 period, when measures mentioned in a number of EU Directives were implemented (landfills, waste incineration, recycling, packaging and packaging waste, biodegradable waste, WWTP) and included in the WM scenario. Technical developments were also taken into consideration. Activity data recommended by the methodologies prepared or recommended by IPCC were used. Detailed calculations are given in the study "Projections of emissions from the "Waste" sector", ENVIROS, s. r. o., 2009. The resultant emissions are determined by a number of independent factors.

The total amount of waste

Dematerialization of the economy, transfer of production to third countries and recycling lead to a reduction in waste production with increasing GDP. Consequently, projections of this input variable are very uncertain.

Waste management technology

Landfilling is and always has been the most frequently used technology in the Czech Republic. Almost 80% of all solid municipal waste was landfilled in 2007 (most recent available data) (CENIA, Czech Environmental Information Agency, 2008). This percentage will decrease over time and adopted measures (promotion of incineration and composting) will have a substantial impact on the total amount of emissions.

Waste composition

The overall composition of municipal solid waste (MSW) is very important. The biodegradable part of MSW affects the amount of methane produced by MSW landfills. Fossil carbon affects the amount of carbon dioxide from incineration of MSW. In addition, measures for a change in technology interact with measures changing the waste composition (reducing the amount of biodegradable waste in MSW, separate collection, etc.). If the waste contains a large amount of biodegradable waste, the unit emissions from the landfill will be high. On the other hand, if the waste contains fossil carbon, emissions from the landfill will be low, but those from waste incineration will be high.

Emission mitigation technology

The methane formed need not necessarily act as a greenhouse gas. Methane generated in landfills and waste treatment technology can be collected and either used for energy production or can be disposed of by flaring or targeted bio-oxidation. The assumptions

mentioned in NIR, 2008, based on the existing technical standards, hold for waste waters (the anaerobic part of processes disposes of methane, the aerobic does not dispose of it). It is not clear how the efficiency of landfill degassing systems can be defined. Quantification of contemporary emissions (2007) is based on statistical data from MIT, giving the collection value as approx. 14% of the expected methane production.

Considerations of future developments assume that the effectiveness and coverage of landfills by collection systems will substantially improve. Oonk and Boom (1993) and Scheehle and Kruger (2006) evaluated technology installed at landfills and compared it according to the extracted methane. They found that the installed capacity was 30 – 70% effective.

5.3.6.1 Scenario without measures (WOM)

Waste production is constant and currently remains high. Dematerialization, contemporary economic instruments and separation of selected components from MSW and their recycling are adequate to stop the increase in landfilling of MSW. Most waste is deposited in landfills, provided for by the construction of additional capacities. New landfills are degassed but the effectiveness of the collection systems remains at the 2004 level. Waste composition does not change with time and the emission factors are identical with the recommended IPCC values (2006). Communal waste waters are treated by a combination of aerobic and anaerobic technologies. Industrial waste waters are treated by a combination of aerobic and anaerobic technologies. Their production is dependent on trends in GDP. Production of dinitrogen oxide corresponds to the availability of proteins in food and the size of the population.

5.3.6.2 Scenario with measures (WM)

Production of municipal waste (MSW) was constant over the monitored period. Dematerialization, contemporary economic instruments and separation of selected components from MSW and their recycling are adequate to stop the increase in MSW. Most waste is deposited in landfills, provided for by the construction of additional capacities. New landfills are degassed and the effectiveness of the collection systems is at a medium level. The composition of landfilled waste changes with time, with a decreasing share of biodegradable waste and plastics. Communal waste waters are treated by a combination of aerobic and anaerobic technologies. Their production depends on the size of the population. Industrial waste waters are treated by a combination of aerobic and anaerobic technologies. Their production increases with increasing GDP. Production of nitrous oxide corresponds to the availability of proteins in food and the size of the population.

5.3.6.3 Scenario with additional measures (WAM)

Production of municipal waste (MSW) decreased over the monitored period. Dematerialization, economic instruments and increased separation of selected components from MSW and their recycling and material and energy recovery lead to a reduction in landfilling. Most waste continues to be deposited in landfills, but its relative volume is gradually decreasing from the current 80% to 50%. New landfills are degassed and the effectiveness of the collection systems is at a high level (BAT). The composition of landfilled waste changes with time, with a decreasing share of biodegradable waste and plastics. Communal waste waters are treated by a combination of aerobic and anaerobic technologies. Their production depends on the size of the population. Industrial waste waters are treated by a combination of aerobic and anaerobic technologies. Their production increases with increasing GDP. Production of nitrous oxide corresponds to the availability of proteins in food and the size of the population.

Tab. 5.18, 5.19 and 5.20 give the calculations of partial and total emissions related to the three scenarios described above. The GWP values recommended by IPCC were used for aggregation and conversion to CO_{2eq} (21 for methane, 310 for nitrous oxide).

Tab. 5.18 Total emissions for WOM scenario, Gg CO_{2eq}

	2005	2007	2010	2015	2020
Landfilling	2,345	2,440	2,562	2,730	2,835
Municipal water	446	450	444	444	444
Industrial water	265	285	286	313	340
Incineration	363	417	412	412	412
Total	3,419	3,592	3,704	3,899	4,031

Source: ENVIROS s.r.o.

Tab. 5.19 Total emissions for WM scenario, Gg CO_{2eq}

	2005	2007	2010	2015	2020
Landfilling	2,345	2,417	2,499	2,604	2,625
Municipal water	446	450	456	437	389
Industrial water	265	265	286	313	326
Incineration	363	417	412	406	400
Total	3,419	3,550	3,652	3,760	3,739

Source: ENVIROS s.r.o.

Tab. 5.20 Total emissions for WAM scenario, Gg CO_{2eq}

	2005	2007	2010	2015	2020
Landfilling	2,345	2,417	2,394	2,331	2,205
Municipal water	446	450	456	437	384
Industrial water	265	265	286	313	309
Incineration	363	417	418	424	430
Total	3,419	3,550	3,553	3,505	3,328

Source: ENVIROS s.r.o.

5.3.7 HFC, PCF and SF_6 emissions

Insufficient data are available for forecasting the production and consumption of fluorinated gases, the forecast was therefore made by an expert estimate.

Tab. 5.21 Projection of the production and use of fluorinated gases (t)

	2005	2006	2007	2010	2015	2020
HFC-23	1.2900	0.3230	0.2772	0.2855	0.2998	0.3148
HFC-32	15.4400	23.0300	47.1200	48.5300	50.9600	53.5100
HFC-41						
HFC-43-10mee						
HFC-125	47.6000	88.2000	138.6000	142.8000	149.9000	157.4000
HFC-134						
HFC-134a	210.3000	250.0000	576.1000	593.3000	623.0000	654.2000
HFC-152a	0.1485	0.1815	0.5675	0.5845	0.6138	0.6444
HFC-143						
HFC-143a	35.6000	69.3000	107.1000	110.3000	115.9000	121.6000
HFC-227ea	0.3583	0.5989	0.3684	0.3795	0.3984	0.4183
HFC-236fa	4.0875	2.6400	4.2138	4.3402	4.5572	4.7850
HFC-245ca	0.1000	0.0203	0.0193	0.0199	0.0209	0.0220

	2005	2006	2007	2010	2015	2020
Unspecified mixture of HFCs (1)						
Total HFCs						
CF4		1.1172	0.7372	0.7593	0.7973	0.8371
C2F6	0.4389	1.0180	1.0542	1.0858	1.1401	1.1971
C3F8	0.8625	0.8480	0.8100	0.8343	0.8760	0.9198
C4F10						
c-C4F8						
C5F12						
C6F14						
Unspecified mixture of PFCs (1)						
Total PFCs						
SF_6	3.5934	3.4756	3.1737	3.2689	3.4323	3.6039

Source: CRF tables 2005 – 2007, ENVIROS, s. r. o.

5.3.8 CO, NO_X, SO_2 and NMVOC emissions

For complex information on potential emission trends, a framework projection of emissions of indirect greenhouse gases to 2020 is given. The projections were calculated by the EFOM/ENV model (energy branches) with calculation using a table calculator (other branches). The projections reflect changes in the emission limits in the sense of the Act on Protection of the Air.

Tab. 5.22 Framework projections of indirect greenhouse gases (thousand t p.a.)

	2005	2007	2010	2015	2020	Emission ceiling for 2010 according to the Treaty on Accession to EU
CO	505	754	550 – 554	430 – 437	333 – 352	-
NO_x	320	323	286	262 – 264	224 – 228	286
SO_2	225	252	213 – 226	179 – 190	136 – 143	265
NMVOC	205	177	199 – 201	178 – 182	162 – 168	220

Source: CHMI, ENVIROS, s. r. o.

It follows from model calculations for nitrogen oxide emissions that the relevant emission ceiling of 286 kt can be achieved in 2010 only at the cost of a radical replacement of the vehicle fleet in transport and agriculture.

5.3.9 Transport sector

Emissions from transport are again calculated using the EFOM/ENV model. The calculation is based on the following predictions of transport performances.

Tab. 5.23 Expected transport performances for passenger and freight transport

	2005	2006	2007	2010	2015	2020
Passenger transport (bil. person km)	109	111	113	121	136	154
Passenger vehicles (mil. vehicle km)	36,200	36,731	37,462	40,185	45,167	51,145
Freight transport (bil. tkm)	61.4	69.3	67.5	71.3	81.7	93.2

Source: Ministry of Transport, Transport Research Centre, ENVIROS, s. r. o.

A model calculation was used to determine the following projections for final energy consumption in transport for the scenario with measures (Tab. 5.24).

Tab. 5.24 Projections of final consumption of fuel and energy in transport – WM scenario (PJ)

	2005	2010	2015	2020
Petroleum products	220.5	226.3	234.8	233.0
Bio fuel	0.0	11.7	18.5	40.6
Electricity	9.6	12.2	13.2	15.0
CNG	2.2	7.4	14.6	24.1
Total	**236.1**	**263.7**	**287.4**	**321.1**

Source: ENVIROS, s. r. o.

5.3.10 Buildings

The emission projection for residential buildings is based on the expected change in the number of housing units and their size.

Tab. 5.25 Projection of the number and average area of housing units

	2005	2006	2007	2010	2015	2020
Number of housing units (thousand)	4,365	4,405	4,452	4,582	4,702	4,773
Average area per housing unit (m^2)	95.2	95.2	95.3	96	98	100

Source: CSO, EGÚ Brno, ENVIROS, s. r. o.

The indicator of the areas of places of operation is not monitored for the service sector. Consequently, the calculation was based on the projection of the added value in the sector.

5.4 Overall projection

Fig. 5.4 depicts the trend in greenhouse gas emissions in the 1990 – 2020 period. Values from the national greenhouse gas inventory are used for the 1990 – 2007 period; the values for 2007 – 2020 come from our own projections:

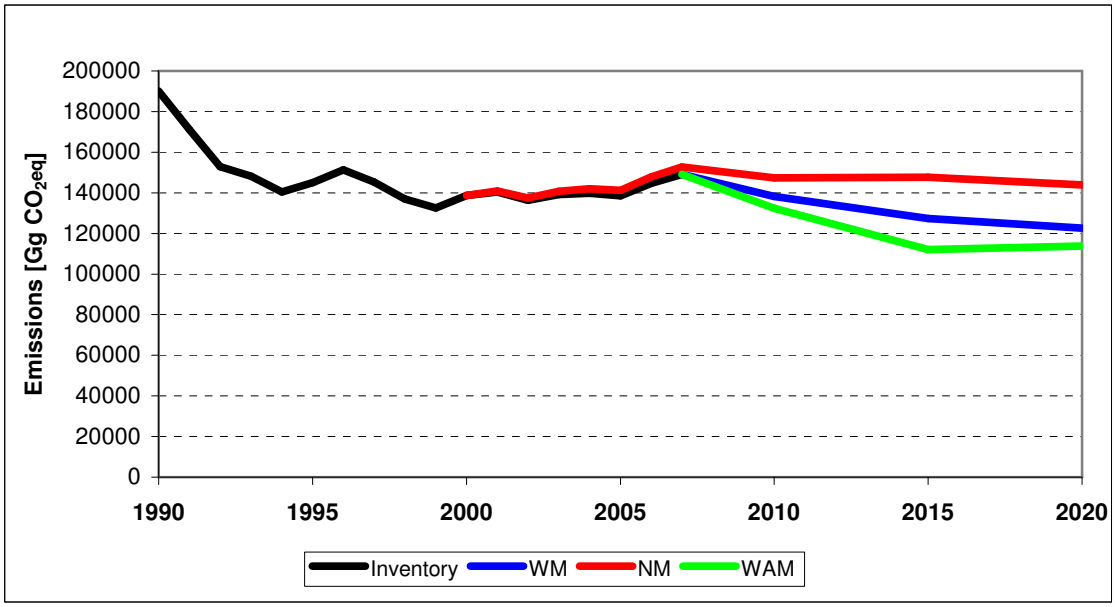
(i) Projection without measures (WOM),

(ii) Projection with measures (WM),

(iii) Projection with additional measures (WAM).

These projections differ in the number of measures for reducing greenhouse gas emissions and the level of their implementation.

Fig. 5.4 Projections of greenhouse gas emissions in CO_{2eq}



Source: CRF tables 2005 – 2007, ENVIROS, s. r. o.

Tabs. 5.26, 5.27 and 5.28 give more detailed results of the calculations for the three mentioned projections.

Tab. 5.26 Calculation of projection of greenhouse gas emissions – projection with measures

	2005	2006	2007	2010	2015	2020
	INV	INV	INV			
Total emissions (Gg)						
CO_2	119,407	124,409	128,031	117,894	108,096	104,292
CH_4	557.712	573.711	565.533	540.142	490.397	446.334
N_2O	24.249	23.852	24.177	23.431	22.903	22.411
Total emissions, Gg CO_{2eq}						
CO_2	119,407	124,409	128,031	117,894	108,096	104,292
CH_4	11,712	12,048	11,876	11,343	10,298	9,373
N_2O	7,517	7,394	7,495	7,264	7,100	6,947
HFCs, PFCs, SF_6	690	978	1,702	1,753	1,840	1,932
Total, Gg CO_{2eq}	139,326	144,829	149,103	138,253	127,334	122,544

Source: ENVIROS s.r.o.

Tab. 5.27 Calculation of projection of greenhouse gas emissions – projection without measures

	2005	2006	2007	2010	2015	2020
	INV	INV				
Total emissions (Gg)						
CO_2	119,407	124,409	128,379	124,020	124,491	121,151
CH_4	557.712	573.711	648.449	591.640	561.489	517.880
N_2O	24.249	23.852	29.326	29.602	30.993	31.860
Total emissions, Gg CO_{2eq}						
CO_2	119,407	124,409	128,379	124,020	124,491	121,151
CH_4	11,712	12,048	13,617	12,424	11,791	10,875
N_2O	7,517	7,394	9,091	9,177	9,608	9,877

	2005	2006	2007	2010	2015	2020
	INV	INV				
Total emissions (Gg)						
HFCs, PFCs, SF_6	690	978	1,702	1,753	1,840	1,932
Total, Gg CO_2eq	139,326	144,829	152,789	147,373	147,730	143,836

Source: ENVIROS, s.r.o.

Tab. 5.28 Calculation of projection of greenhouse gas emissions – projection with additional measures

	2005	2006	2007	2010	2015	2020
	INV	INV	INV			
Total emissions (Gg)						
CO_2	119,407	124,409	128,031	113,026	94,600	97,012
CH_4	557.712	573.711	565.533	503.443	422.914	397.007
N_2O	24.249	23.852	24.177	22.573	21.671	20.893
Total emissions, Gg CO_2eq						
CO_2	119,407	124,409	128,031	113,026	94,600	97,012
CH_4	11,712	12,048	11,876	10,572	8,881	8,337
N_2O	7,517	7,394	7,495	6,998	6,718	6,477
HFCs, PFCs, SF_6	690	978	1,702	1,753	1,840	1,932
Total, Gg CO_2eq	139,326	144,829	149,103	132,348	112,039	113,758

Source: ENVIROS s.r.o.

5.4.1 Sensitivity analysis to a change in economic growth

Creating a projection of GDP is accompanied by a high degree of uncertainty because of the current economic crisis. Economic development is a dominant factor affecting the results of the projection. Various scenarios can be imagined, from rapid recovery of the economy from the crisis to another decline and economic recession lasting several years. Under these conditions, it makes sense to analyze the sensitivity of the projection particularly to economic development, as the effect of other factors will be substantially smaller.

In relation to the dominant position of CO_2 emissions from combustion processes in total greenhouse gas emissions in the Czech Republic, the sensitivity analysis concentrated on this crucial part of the projection.

Two alternative scenarios of growth of the gross domestic product – low and high – were created for this sensitivity analysis. Tab. 5.29 and 5.30 give the structure of creation of GDP for the two scenarios. The results of the survey performed in the R&D project "Sustainable development in energy production" were again used to create this scenario.

Tab. 5.29 Projection of trends in GDP in the low scenario (constant 2000 prices, bil. EUR)

	2005	2006	2007	2010	2015	2020
Industry	22.2	25.7	27.6	25.8	27.4	31.2
Construction	3.8	3.9	3.9	3.8	4.0	4.3
Agriculture	2.5	2.4	2.1	2.0	2.1	2.2
Transport	6.5	7.1	7.6	7.5	7.7	8.6
Services	32.1	32.5	35.0	36.8	41.0	48.3
Total	67.1	71.6	76.2	75.9	82.2	94.7

Source: ENVIROS s.r.o.

Tab. 5.30 Projection of trends in GDP in the high scenario (constant 2000 prices, bil. EUR)

	2005	2006	2007	2010	2015	2020
Industry	22.2	25.7	27.6	27.3	32.3	38.7
Construction	3.8	3.9	3.9	4.0	4.4	5.0
Agriculture	2.5	2.4	2.1	2.2	2.4	2.6
Transport	6.5	7.1	7.6	7.8	8.6	10.2
Services	32.1	32.5	35.0	38.8	46.7	58.5
Total	67.1	71.6	76.2	80.1	94.3	115.0

Source: ENVIROS s.r.o.

Sensitivity analysis of sectoral emissions (energy production, industrial emissions, transport, others sectors, fugitive emissions) in relation to the rate of economic growth (national level) permits the following conclusions:

(i) As could be expected, total emissions grow with growing GDP and decrease with decreasing GDP. The growth in emissions in the higher scenario is smaller than the decrease in the lower scenario. This indicates that, with higher GDP, funds will be available for innovations and new technology.

(ii) The same that is true for total emissions also applies to emissions from the processing industry. In this branch, higher GDP will again result in more investments into protection of the climate.

(iii) The opposite tendency can be observed in the transport sector. As GDP increases, the standard of living of the population also improves and its mobility increases faster, therefore the growth in emissions in the high scenario is greater than the decrease in the low scenario.

(iv) The structure of the production park in the energy production sector does not differ much in the individual scenarios. Differences in emissions in this sector thus depend mainly on greater demand for electricity and heat. The difference between the high and reference scenarios is lower than the difference between the reference and low scenarios, caused mainly by demand in industry.

(v) The impact on emissions from the other sectors (tertiary, households, agriculture) is not great. This is a result to a considerable degree of the large share of energy consumed in heating, which is not very dependent on GDP. Thus, even in the low scenario, emissions in 2020 are lower than in the reference scenario, reflecting the substantial slowing down of the current rate of insulating of buildings.

(vi) Changes in the demand for electricity and heat also affect fugitive emissions, especially those connected with black coal mining. They are higher in 2015 in the high scenario than in the other two scenarios. This difference disappears in 2020 as a consequence of the gradual termination of mining of domestic black coal.

5.5 Mechanisms pursuant to Articles 6, 12 and 17 of the Kyoto Protocol

Act No. 695/2004 Coll., on the conditions of greenhouse gas emission allowance trading (amendments No. 212/2006 Coll., No. 315/2008 Coll.) permits the use of extra AAU to support projects according to the joint implementation mechanism (Art. 6 of the Kyoto Protocol).

In Resolution No. 648 of June 30, 2003, the Government of the Czech Republic expressed its consent to negotiation of a Framework Agreement on cooperation in implementation of

projects to mitigate greenhouse gas emissions between the Czech Republic and the International Bank for Reconstruction and Development and other investor countries.

A total of 42 JI projects had been approved in the Czech Republic by May 2009. From the standpoint of the Kyoto Protocol, these emission reductions are being implemented during the 2008 – 2012 period, where emission reduction units (ERU) can be transferred to the investor in a project.

A project was implemented to reduce nitrous oxide (N_2O) emissions from the production of nitric acid, with a reduction of 217.5 thousand t. CO_{2eq}. The overall annual emission reduction attained by the implementation of all JI projects corresponds to approx. 716 thousand t CO_{2eq} p.a. Approximate total emission reduction at the level of 3.5 thousand t CO_{2eq} can be expected for the Kyoto Protocol control period (2008 – 2012).

From the standpoint of overall reductions in emissions in the 2008 – 2012 period (see Annex 10.1), the contribution of JI projects is estimated at 3.5 – 4% of total emission reductions and the contribution of the GIS Programme (“the Green Investment Scheme” programme) corresponds to 2.5 – 3% of overall emission reductions. It is thus apparent that the Czech Republic utilizes flexible mechanisms only as a supplementary instrument to national measures, which also include the current EU ETS regime. It is estimated that EU ETS contributes 26.0% to overall reduction in emissions in 2008 – 2012. As emission allowances were allocated on the basis of the National Allocation Plan, this is an instrument at the national level.

Until 2009, the Government had not supported any CDM projects. However, large Czech enterprises can enter these projects at their own initiative. For example, the Czech electricity producer, the ČEZ Group, invests in the development of renewable energy sources, energy savings and projects implemented in Central and Eastern Europe and in the Balkans. In addition, ČEZ is looking for projects, e.g., in China and Southeast Asia. The basic precondition for choice of projects consists in accordance with the requirements of UNFCCC and KP. For example, ČEZ has concluded an agreement on purchase of emission credits with Chinese developers of wind and water power plants in the Hebei and Sichuan provinces and with a company distributing mine methane for cooking in 50 000 households in the city of Fengcheng in South of China. ČEZ purchases credits in Europe from Hungarian companies burning landfill methane and is considering participation in other projects for elimination of greenhouse gases. Through Multilateral Carbon Credit Fund (MCCF), which is administered by the European Bank for Renewal and Development (EGRD) and the European Investment bank (EIB), ČEZ is considering purchasing credits from projects for the use of renewable energy sources in the Balkans, in the Caucasus region and in the Russian Federation.

6 Estimates of vulnerability, impacts of climate change and adaptation measures

6.1 Expected impacts of climate change

6.1.1 Observed trends

The position of the European continent is the main cause of the highly regional variability in its climate. Over the past century, the average temperature in Europe has increased by 1.2 °C, of which the increase over the past 25 years was 0.45 °C, almost half as much again as the global average. While the trend in increase over the past half century was approximately 0.1 °C/decade, this has increased to twice as much over the past decade[15]. Because of this regional variability in the climate, there are substantial differences between the individual parts of the continent.

Tab. 6.1 Trends in changes in territorial temperatures for the Czech Republic since 1961 (°C/decade)

Trends over the past ...	Spring	Summer	Autumn	Winter	Year
48 years	0.37	0.43	0.08	0.44	0.33
25 years	0.50	0.66	0.23	0.58	0.48
15 years	0.48	0.57	0.53	0.72	0.48

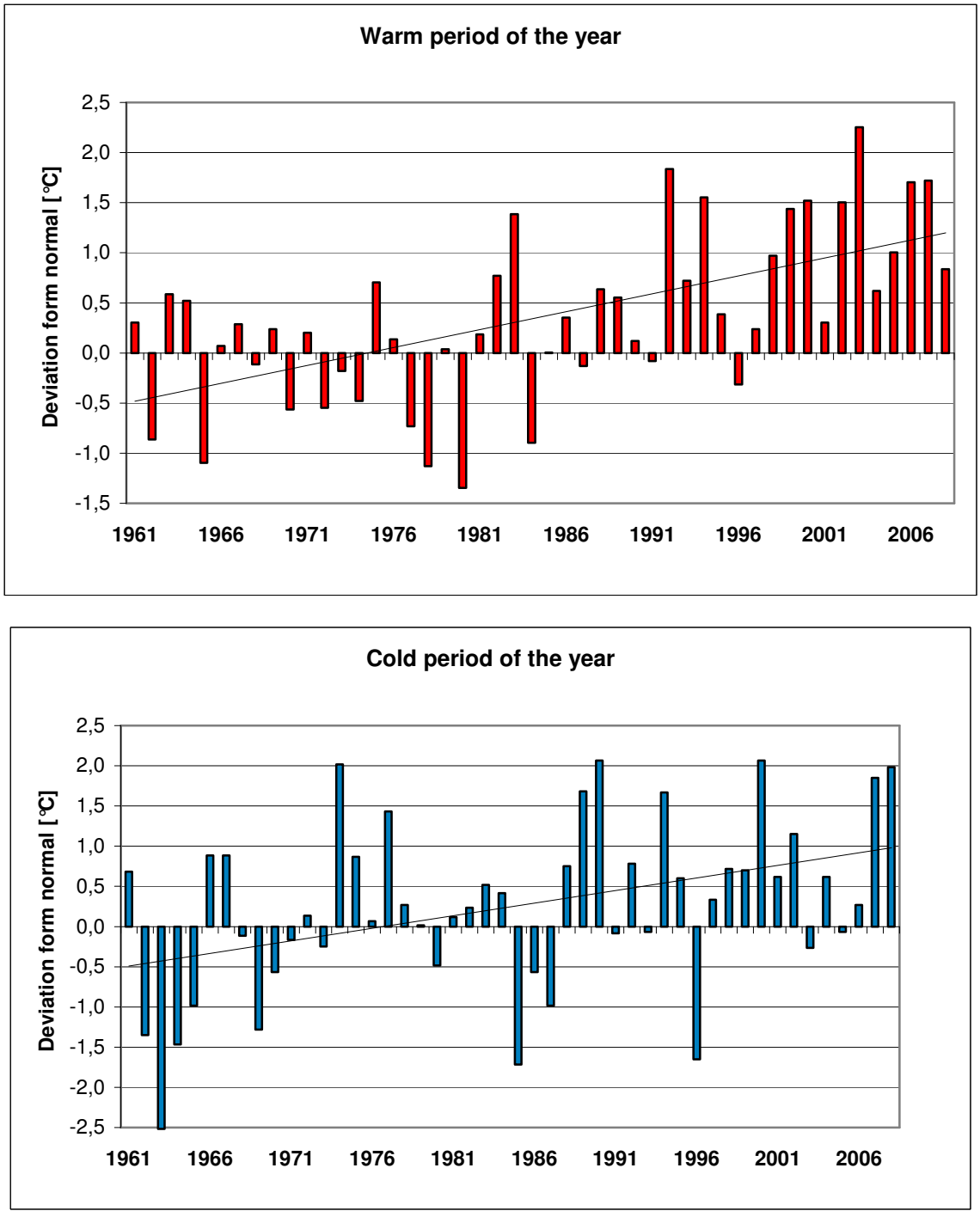
Source: CHMI

Trends in changes in the temperature are also apparent in the Czech Republic and can be illustrated on the data from most climatological stations, as well as on the values of the linear trends of the average territorial temperatures and precipitation, corresponding to the corrected values, based on general processing of data from the entire national network of stations and taking into account the positions of the individual stations (thus-processed data is available from 1961)[16]. The territorial temperature values confirm the constantly growing trend in the increase in average temperatures, which is more marked in the winter and summer (Fig. 6.1). The differences between the western and the eastern halves of the country are statistically insignificant and vary within the limits of precision of the estimates.

[15] Impacts of Europe's changing climate - 2008 indicator-based assessment, EEA/JRC/WHO Report, 4, 2008, ISSN 1725-9177, 246 pp.

[16] Pretel J. (2009), Current trends in the climate and outlooks, Ochrana přírody (in press)

Fig. 6.1 Trend in deviations in territorial temperatures in the Czech Republic from normal in 1961 - 2006



Source: CHMI

Deviations in the average annual and seasonal temperatures compared to the 1961 – 1990 normal values have exhibited positive values over the entire past twenty-year period (with the exception of 1996), which have been especially marked in the warm half of the year (April to September) – Fig. 6.1. The changes in average temperature values are associated with extreme values – the numbers of tropical summer days and tropical nights have increased substantially in recent years, while the numbers of frost and ice days have decreased (Tab. 6.2).

Tab. 6.2 Linear trends in changes in temperature, total precipitation and extreme temperatures in Prague in the past 50 years

Trends over the past ...	Extreme temperatures[17] *(number of days/decade)*				
	Tropical night	Tropical day	Summer day	Frost day	Ice day
50 years	0.9	1.4	2.9	–1.6	0.1
25 years	2.1	3.9	6.6	–1.6	0.1
15 years	8.3	17.4	12.7	–6.5	–1.3

Source: CHMI

Temperature changes over the past few years are also manifested in trends in total precipitation, corresponding to decreases in all the seasons of the year, with the exception of the winter, which are more marked in the spring and summer (Tab. 6.3). While the temperature trends are more or less homogeneous throughout the country, trends in precipitation exhibit certain differences. In the eastern part of the country, reductions in summer precipitation are more marked and are also the cause of the overall decrease in annual totals; in the western part, the increase in winter precipitation is more marked, leading to a slight increase in annual total values. The determined differences correspond to the geographic trend in changes in precipitation in Europe in the 1961 – 2006 period. Nonetheless, in comparison with the seasonal normal values, these changes correspond to a maximum of one percent of the total precipitation per decade.

Tab. 6.3 Trends in changes in territorial total precipitation in the Czech Republic since 1961 (% of the normal value/decade)

Trends over the past ...	Spring	Summer	Autumn	Winter	Year
48 years	–2	1	3	3	1
25 years	2	2	6	0	3
15 years	–10	–8	–7	16	–4

Source: CHMI

The changes in the zonal and meridional components of the air flow are, with a few exceptions, statistically insignificant and spatially very variable and thus changes in the atmospheric circulation in the Czech Republic cannot be unambiguously monitored. However, in recent years, it seems that the systematically positive trend in the North Atlantic oscillation over the past decades and consequent increase in wind speeds that have been apparent in western Europe in the past few years are already becoming manifested in this country.

Trends in the relative humidity, cloud cover, hours of sunshine, and depth and duration of the snow cover are mutually consistent and correspond well to trends in the temperature and its amplitudes. Winter, spring and summer are characterized by an increase in the number of hours of sunshine, decreasing cloud cover and decreases in the relative humidity. In contrast, in the autumn, when the temperature and daily amplitude decrease, we can observe a reduction in the number of hours of sunshine and an increase in cloud cover and relative humidity. The average number of days with snow cover at positions up to 600 m a.s.l. has decreased over the past twenty years by an average of approx. 15% compared to the usual number of days in the middle of last century (shortening of the season by 12 days); this decrease was approximately half as great at higher altitudes. The maximum snow cover has decreased by 25% at lower altitudes and by up to 30% at higher altitudes. Total amounts of new snow in the winter exhibit similar trends.

[17] *tropical night - $T_{min} < 20$ oC, tropical day - $T_{max} > 30$ oC, summer day - $T_{max} > 25$ oC, frost day - $T_{min} < 0$ oC, ice day - $T_{max} < 0$ oC; T_{max} – maximum daily value, T_{min} – minimum daily value*

6.1.2 Construction of scenarios

Integration of the regional climate model (RCM) ALADIN – CLIMATE/CZ[18] with emission scenario A1B for the 1961 – 2050 period, with horizontal resolution of 25 km, was completed in 2008. The outputs of the ALADIN – CLIMATE/CZ model in the form of series for the 1961 – 1990 period with a time resolution of 6 hours were first converted to daily data. The average daily and also maximum and minimum air temperatures and total daily precipitation were calculated. Subsequently, the obtained fields were validated by comparison with the set of measured values. The results for the individual seasons are illustrated in Fig. 6.2 (seasonal average daily air temperatures) and Fig. 6.3 (seasonal total precipitation).

During the construction of the scenario of changes in the air temperature and atmospheric precipitation, emphasis was placed on three thirty-year time intervals: 2010 – 2039, 2040 – 2069 and 2070 – 2099 and, for the time being, SRES scenario A1B (simulations for other SRES scenarios will be gradually performed). The basis for the scenario consists in RCM ALADIN – CLIMATE/CZ outputs with a resolution of 25 km, corrected for errors in the model, which were identified when comparing the model simulation for the reference period.

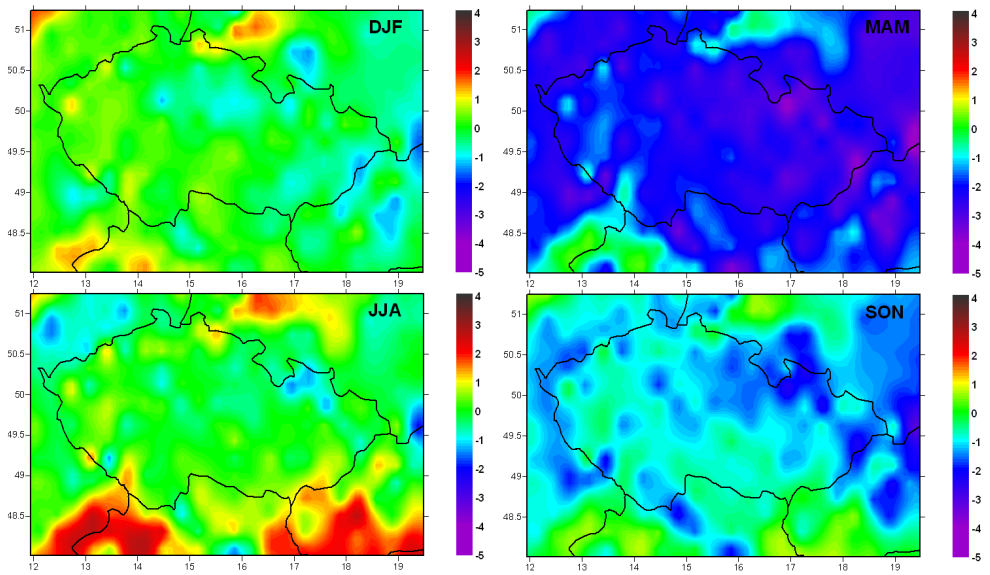
The global climate models (GCM) was used for uncertainty analyses for the 2010 – 2039 and 2040 – 2069 periods. The range of changes in thirty-year average temperatures and total precipitation in the country is characterized by the upper and lower quartiles of the set of changes, calculated by a group of selected GCM; the average change is the multi-model median. In addition to RCM ALADIN – CLIMATE/CZ outputs, the scenario will also include additional time series, which will reflect the "average" change that can be expected in the region of the Czech Republic on the basis of GCM outputs and the interval within which the results of 50% of the monitored GCM lie. A simple additive (for temperatures) and multiplicative (for precipitation) procedure recommended by IPCC[19] was used to obtain these time series. In addition to GCM, the estimate of the uncertainty for the 2070 – 2100 period will also be based on inclusion of the outputs of the ALADIN – CLIMATE/CZ model in the context of further RCM, primarily in the models of the PRUDENCE[20] project.

[18] Farda, A., Skalák, P., Štěpánek, P. (2008), High resolution experiments with the regional climate model ALADIN-Climate/CZ, Geophysical Research Abstracts, Vol. 10, EGU2008-A-08210

[19] IPCC-TGICA (2007) General Guidelines on the Use of Scenario Data for Climate Impact and Adaptation Assessment. Version 2. Prepared by T.R. Carter on behalf of the Intergovernmental Panel on Climate Change, Task Group on Data and Scenario Support for Impact and Climate Assessment, 66 pp.

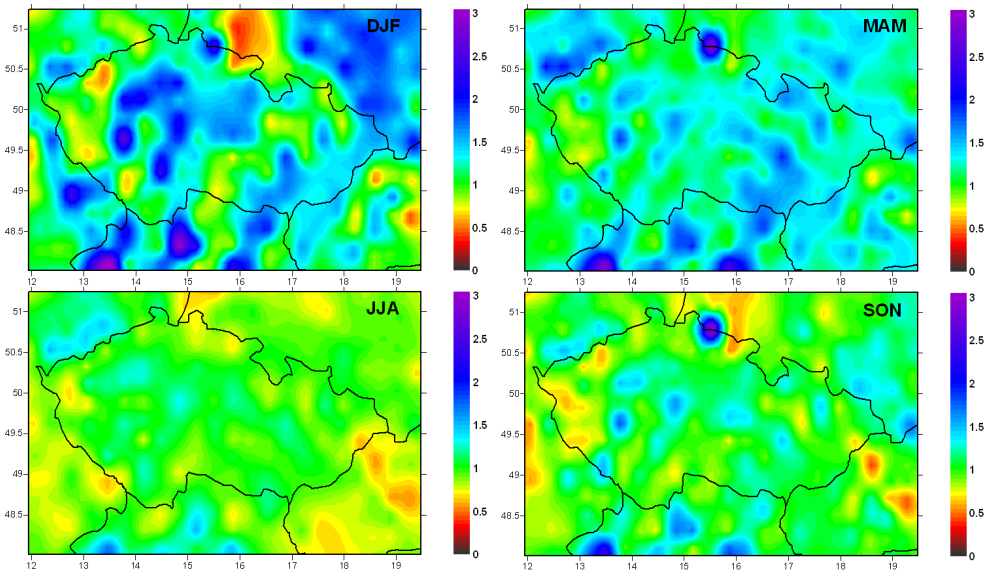
[20] http://prudence.dmi.dk/

Fig. 6.2 Difference between average daily temperatures (°C) simulated by the ALADIN model and temperatures observed for the 1961 – 1990 period during the winter (DJF), spring (MAM), summer (JJA) and autumn (SON)



Source: CHMI

Fig. 6.3 Ratio of the total precipitations simulated by the ALADIN model for the 1961 – 1990 period and precipitation observed for the 1961 – 1990 period during the winter (DJF), spring (MAM), summer (JJA) and autumn (SON)



Source: ČHMI

6.1.3 Expected outlook for the climate in the 2010 – 2039 period

The prognosis for the climate in the territory of the Czech Republic is currently being updated on the basis of refinement of regional scenarios being prepared in the framework of project of the Ministry of the Environment SP/1a6/108/07[21] with emphasis on the 2010 – 2039 period. The results of the ALADIN CLIMATE CZ simulation model indicate that, to the end of the

[21] Pretel, J. (coord.), (2008), Refinement of current estimates of the impacts of climate change in the sectors of water management, agriculture and forestry and proposals for adaptation measures, Research report of the project SP/1a6/108/07 for 2008, ME, Prague.

third decade of this century, in scenario A1B[22], the average temperatures will increase compared to the 1961 – 1990 period by the values according to Tab. 6.4, which also gives the expected range of values (median Q50, lower and upper quartile, Q25 and Q75). The trend in the determined increase in average annual temperatures (0.24 °C/10 years) corresponds well with global values and values given for Europe[23] (0.2 °C/10 years).

Tab. 6.4 Model changes in average temperatures to 2030 (°C)

	Spring	Summer	Autumn	Winter	Year
Q50	1.1	1.0	1.3	1.4	1.2
Q25	*0.7*	*0.8*	*1.1*	*0.9*	*0.9*
Q75	*1.5*	*1.5*	*1.6*	*1.8*	*1.6*

Source: CHMI

The average temperatures should increase more rapidly in the autumn and in the winter (maxima in March and September), while the increase in the spring and summer temperatures will be lower (minimum in May). Lower trends in increases in the temperature in the warm seasons and higher trends in the cold half of the year indicate that the temperature differences between the seasons will become less distinct. Maximum and minimum temperatures will change similar to changes in the average temperatures. Maximum temperatures will exhibit a trend towards a clear increase in the winter and summer; the minimum temperatures will tend to increase especially in the summer and partly also in the autumn and winter.

In a similar way, simulated changes in total precipitation (Tab. 6.5) indicate the possibility of a slight increase in annual totals (on an average by approx. 4% compared to 1961 – 1990), higher in the winter and spring (maximum from February to April), lower in the summer and autumn (minima from July to November). The difference between the values for the two quartiles in the individual months (4 to 17%) indicates substantial variability in average total precipitation. The value of quartile Q25 in the period from May to October (possible reduction in total precipitation by 2 to 8%), together with increased evaporation in these months, indicates the risk of an increase in water deficit in soils.

Tab. 6.5 Model changes in total precipitation for 2030 (% of normal values in 1961 – 1990)

	Spring	Summer	Autumn	Winter	Year
Q50	7	3	1	4	4
Q25	*–1*	*–4*	*–5*	*–1*	*–3*
Q75	*12*	*8*	*8*	*7*	*9*

Source: CHMI

If the model temperature trends are compared with current trends, it is likely that temperatures will tend to vary at the level of the upper quartile Q75 by the end of the third decade of this century. Acceptable correlation of results can be determined from the standpoint of seasonal changes and a truly rapid increase in average winter and autumn temperatures. Similar comparison of the model total precipitation indicates that the correspondence of the simulation with the results of current observations is much lower for precipitation. It can more likely be expected that total precipitation will vary around the level of the lower quartile Q25; nonetheless, the probability of an increase in total winter precipitation is high. Figs. 6.4 and

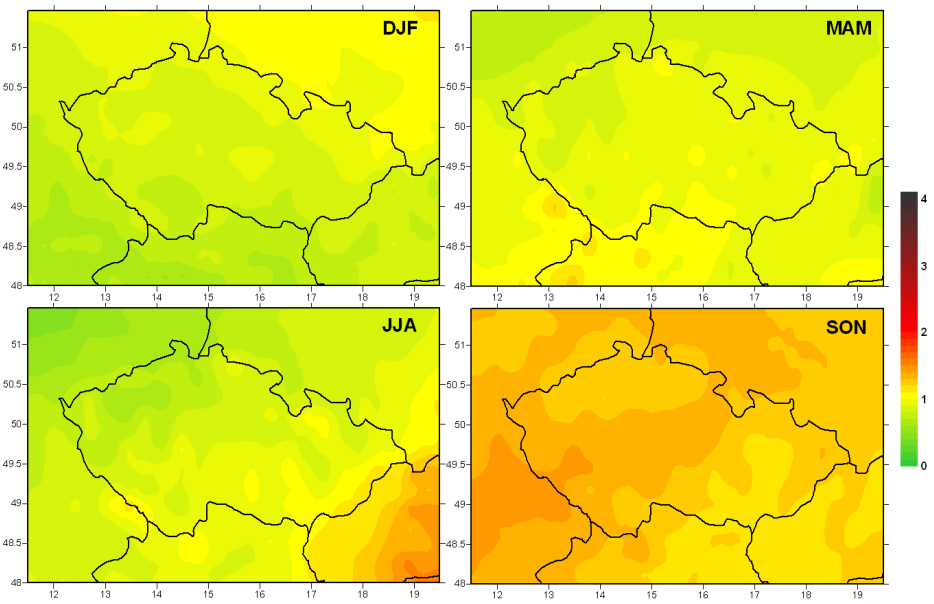
[22] Nakicenović, N. et al. (ed.), (2000), Special Report on Emission Scenarios, Cambidge University Press, ISSN 0-521-80493-0, 959 pp.

[23] Solomon, S. et al. (ed.), (2007), Climate Change 2007: The Physical Science Basis, Cambidge University Press, ISSN 978-0-521-88009-1, 996 pp.

6.5 depict the spatial distribution of the expected changes in the seasonal average temperatures and precipitation to 2039.

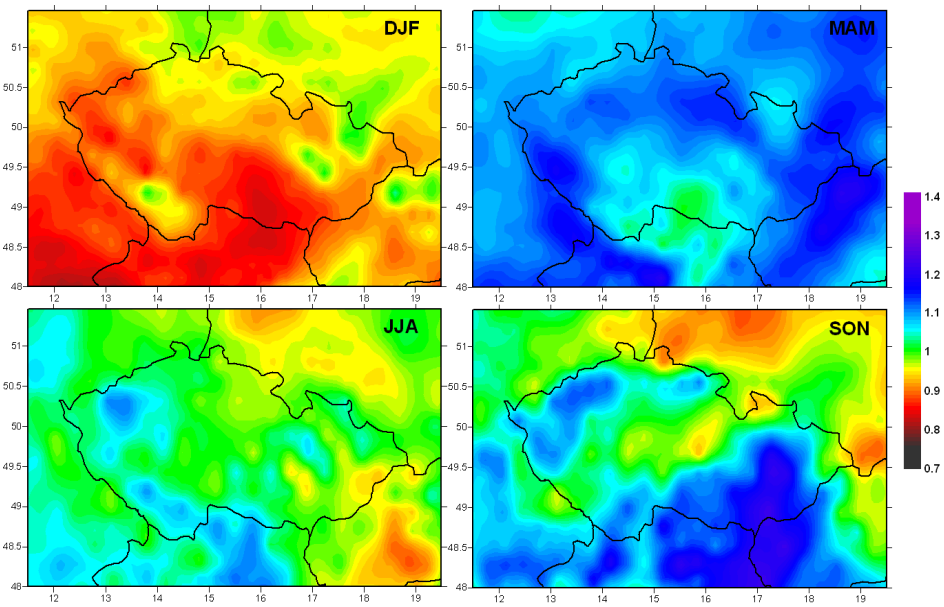
It has been confirmed that, within the territory of the European continent and especially in Central Europe, model projections of the precipitation regime are burdened by a much higher level of uncertainty than similar temperature projections. This is demonstrated in the effect of the relatively complicated orography of the continent, which currently does not permit sufficiently detailed modelling of precipitation processes, as well as of the predominant impacts of climate change in Europe – increased temporal and spatial variability in precipitation.

Fig. 6.4 Difference between average daily temperatures (°C) simulated by the ALADIN model for the 2010 – 2039 period and the values for 1961 – 1990 during the winter (DJF), spring (MAM), summer (JJA) and autumn (SON)



Source: CHMI

Fig. 6.5 Ratio of seasonal precipitation simulated by the ALADIN model for the 2010 – 2039 period and the values for 1961 – 1990 during the winter (DJF), spring (MAM), summer (JJA) and autumn (SON)



Source: CHMI

6.2 Vulnerability estimates

Development trends in meteorological characteristics and more frequent occurrence of extreme meteorological events are already being reflected in changes in the water regime, in agriculture and forestry and partly also affect the state of health of the population. In the medium term (around 2030, see the scenario for the 2010 – 2039 period), it can be expected that there will be a further increase, especially in detrimental impacts on the individual components of the natural environment, and it has been relatively newly pointed out that impacts will be felt in the energy sector, potential for recreation and tourism and overall well-being of the population, especially in larger residential agglomerations.

6.2.1 Water regime

Under the conditions in Central Europe and this country, the water regime is clearly most affected by the ongoing changes in all sectors of human activity. Climate change affects the quantity and quality of the condition of water sources. The basic variables include particularly the intensity and frequency of the occurrence of floods and inundations alternating with dry periods, and also the availability of water and its consumption.

An increase in flow rates signals an increase in the risk of floods and inundations, while a decrease indicates a shift towards risks of the occurrence of dry periods. It is currently rather difficult to exactly estimate the direct consequences of climate change on changes in the water regime, as actual condition is very closely connected both with changes in temperature and in particular with changes in the overall precipitation regime and is a significant regional variable.

In the medium term, it can be expected that the average flow rates will decrease in many river basins by 15 – 20% (“optimistic” scenario) to 25 – 40% (“pessimistic” scenario), which would lead to fundamental changes in the overall hydrological regime. Similar relative decreases can be expected for minimum flow rates and minimum outflow of ground waters. As a consequence of higher winter temperatures, the annual outflows will also change due to a reduction (in some places very substantial) in stocks of water from snow and an increase in territorial evaporation. The increased spring flow rates and subsequent additions to groundwater stocks will be gradually shifted to the end of winter and stocks of water will generally decrease. In the spring to autumn period, when a large part of the precipitation will be converted to territorial evaporation as a consequence of elevated temperatures, outflows will generally decrease and this reduction can be prolonged by one or two months compared to current conditions.

Analyses of the impacts of climate change on the storage function of reservoirs point to an increasing risk of a substantial reduction in this function, manifested in altered ability to compensate and provide for withdrawals. The degree of expected reduction is substantially affected by the scenario of further development and can vary in a wide range from several percent to as much as half of current values. Water courses characterized by substantial accumulation space in the form of groundwater stocks or artificial reservoirs are generally more resistant to the climate change impacts. The effect of changes on the hydrodynamics and selected water quality parameters in reservoirs will be demonstrated in increased lowering of water levels in the summer and autumn, shortening of the winter stratification period and of the interval of coverage of the reservoir by ice and increased summer surface temperatures.

Decrease in flow rates will be demonstrated in changes in the quality of surface waters through an increase in the water temperature and its subsequent eutrophication. This will augment the water deficits in the summer and autumn months, even in relatively wetter

regions. Increased winter run-off and the risk of increased occurrence of spring floods and inundation situations can be expected in parallel with reduced creation of stocks of water from snow cover.

Intense precipitation episodes that occur during summer thunderstorms will present a greater risk of flash floods even when the long-term total precipitation does not change much. The consequences of changes in the climatic regime substantially affect the size of the storage spaces in reservoirs that would be necessary to preserve the existing level of water withdrawals. Larger reservoirs are less sensitive to changes than reservoirs with smaller volumes, in which a seasonal cycle of filling and emptying prevails. Even a relatively insignificant reduction in precipitation, combined with warming, can lead to a substantial reduction in guaranteed water withdrawals.

6.2.2 Agriculture

The temperature and precipitation regime, as well as the atmospheric carbon dioxide concentrations, affect the growth and productivity of agricultural crops. Consequently, the growth conditions of some crops change in response to changing climatic conditions and overall warming. Changes in the vegetation period can also affect the composition of plants, especially those that adapt worse to changing conditions. The scenarios of further development of the climate predict prolonging of the vegetation period. In the medium term, temperate-zone vegetation can profit by 10 to 15% from the prolonged vegetation period, but can suffer by 10 to 15% because of the loss of water.

The anticipated further increase in average temperatures will lead to the expected increase in the sum of active and effective temperatures and number of summer and tropical days, while the number of frost and ice days will decrease. The frost-free period will be prolonged by 15 – 20 days in the medium term and the beginning of the vegetation period at lower altitudes will move to the beginning of March and the end will shift to the end of October. More obvious changes can be expected at lower altitudes, where the length of the vegetation period could be prolonged by as much as 20 days, permitting earlier emergence of seedlings and onset of further phenophases, while the time of ripening or harvesting could move forward by as much as 10 days. However, acceleration of vegetation in the spring is accompanied by the danger of damage to plants by late frosts. The temperature increase should create sufficient temperature security for growing thermophilic species; nonetheless, extremely high temperatures can increase the danger of occurrence of temperature stress.

In the absence of a substantial increase in precipitation and with the expected increase in evapotranspiration, there will be a much greater danger of drought in a number of the most productive areas of the country, where the humidity index values will decrease. The change in the current precipitation regime and more frequent occurrence of downpours could lead to an increased risk of water erosion of the soil, which currently affects more than half of domestic agricultural land. The permeability of the soil was substantially reduced in the recent past (particularly through the use of heavy farming equipment), so that the rate of infiltration of precipitation is decreased and the tendency towards run-off is exacerbated, causing water erosion.

6.2.3 Forest management

Plants and tree species react to climate change mainly through migration, while genetic adaptation negligible. Thus, the expected increase in average temperatures will be manifested in a shift in the occurrence of many tree species to higher altitudes. For example, an increase in the average annual temperature by 1 – 2 ^{o}C can lead to a shift in the tree line by 100 to 200

meters above sea level. The effect of dangerous stress by drought will be reflected on forest vegetation. Further habitat factors, such as light, air temperature, availability of nutrients or environmental pollution will act synergically with soil moisture and could reduce tolerance to drought.

The current less-than-satisfactory state of tree stands, caused in the past particularly by burdening by high pollutant concentrations in the air, could become even worse with changes in climatic conditions. There is a risk of potential decomposition of unstable young and adult spruce single-species forests in unsuitable sites and increased abiotic damage under extreme weather conditions, accompanied by the spreading of pathogens.

The increased concentration of carbon dioxide in the atmosphere is demonstrated in promotion of the growth of plants and production of biomass; nonetheless, the long-term effect can lead, especially for spruce, to the occurrence of acclimation depression of photosynthetic activity. The resultant effect of increasing concentrations can thus vary between zero effect on accretion, through increased growth of roots and new shoots, to changes in the growth of new shoots and roots in favour of one or the other.

The decline of forest stands is a consequence of the mutual action of biotic and abiotic stress factors, which fundamentally affect the physiological function of the tree species and thus their state of health, including their susceptibility to fungal diseases and insect pests. Thus, it is necessary to expect a greater frequency of occurrence of pests, especially bark beetles, leaf-eating insects and sap-sucking insects. Species that have not yet been recorded in this country could spread. The stress burden will probably lead to an increased proportion of dry wood and thus greater occurrence of fungal diseases.

6.2.4 Human health

Climate change can affect human health through a wide range of direct and indirect effects. The direct effects on human health are a consequence of temperature changes (especially extreme heat waves), increased frequency and intensity of the occurrence of extreme weather conditions and increasing penetration of the short-wave part of the ultraviolet spectrum to the surface of the Earth. Those components of the environment that were modified by climate change (air pollution, changes in the occurrence of infectious diseases, food production, social and economic changes, etc.) have indirect effects.

The negative impacts on health are manifested particularly in heat stress and probably also in worsening air quality. Increased weather extremes (floods, inundations, gales, storms), accompanied by subsequent direct and indirect consequences, can be manifested on human health and general sense of well-being. It cannot be excluded that other health problems will occur, which are currently not anticipated on the basis of present knowledge.

Substantial impacts of climate change have been found for zoonoses, with effects on both the animal host and the vehicle of the infection. This can lead to substantially increased occurrence of tick-borne encephalitis and Lyme's borreliosis and increased occurrence of diseases transmitted by vectors in connection with increased average air temperatures. Infections transmitted by ticks will spread to areas where they did not formerly occur, including areas at higher altitudes. The increase in temperature will aggravate the risk of gradual spreading of different species of ticks and blood-sucking insects, acting as transmitters of infections. Repeated introduction of Mediterranean ticks by the dogs of tourists and spreading of the vehicles of Leishmaniasis, which has already been found in Southern Germany, have been observed.

Another of the consequences of elevated temperatures consists in greater occurrence of pollen grains and fungus spores in the air; the number of pollen grains increases exponentially with maximum daily temperatures, while the number of fungus spores increases with increasing daily minimal temperatures. The amount of tree pollen is affected by the daily relative humidity (the number of pollen grains increases at lower humidity). The anticipated increase in winter temperatures could lead to earlier beginning of the pollen season of spring tree species. Pollen grains can react with pollutants in the air (e.g. ozone) and can cause immunologically-determined reactions, most frequently manifested by allergic hay fever, conjunctivitis, skin inflammation and respiratory problems.

6.2.5 Biodiversity

The on-going and anticipated climate change affects biological diversity from individual genes to the entire landscape. The most vulnerable ecosystems in this country include alpine ecosystems and ecosystems consisting of residues of the original grasslands. Changes are manifested most in ecosystems above the shifting upper boundary of forests, where the vulnerability is exacerbated by their relatively small area. Species of wild plants and animals that are closely connected with a specific habitat (glacial cirques, peat bogs, parts of mountains above the upper boundary of the forest), e.g. the boreal owl, *Aegolius funereus*, will be most endangered in this country. On the other hand, the typical thermophilic species of European bee-eater, *Merops apiaster*, will spread to a larger area of the country. Approximately one tenth of monitored plant species will be in danger of extinction by the end of the century, while one fifth of plant species can rapidly and effectively adapt to a changing climate.

The natural reaction of plants and animals will consist in moving to areas where they will encounter more favourable conditions for their existence (higher altitudes, more northerly sites), where they are capable of adapting to the new conditions. If they do not find suitable conditions, they can be faced with extinction. Climate change will enable the spreading of invasive non-indigenous species, i.e. species whose intentional planting or inadvertent introduction and subsequent spreading endangers biological diversity, biotopes or even entire ecosystems. Consequently even successful species will be forced to face so-far unknown competitors, natural enemies, parasites and organisms transmitting diseases.

Potential negative impacts on biological diversity also include new interventions of humans into nature and the landscape. A typical example is the construction of dams, on the one hand intended to prevent potential lack of water but, on the other hand, sometimes constituting a substantial danger for biodiversity through a change in the water regime in the particular area. Subsidized cultivation of crops processed to first-generation biofuels and extensive afforestation (especially in farmed landscape) can destroy valuable residues of the original environment or can promote the spreading of invasive non-indigenous plants species, including tree species.

6.2.6 Energy production and industry

Energy production will continue to be dependent on the availability of water required for cooling in thermal power plants and for its cooling properties, and also as a source for the production of electricity in hydro-electric plants and for cultivation of biomass as energy-production crops. Changes at the level of water sources can be manifested in the future in the manner and availability of production of electrical energy in small hydro-electric plants or could even endanger the reliability of energy supplies from large hydro-electric plants.

Increased occurrence of some more extreme weather conditions can affect the infrastructure connected with the production and supplies of energy (strong wind, floods, icing, wet snow, etc.). In the future, temperature changes will also affect changes in the seasonal demands for energy supplies; reduced energy demand can be expected in the winter (heating) and, on the other hand, increased energy demand can be anticipated in the summer (air conditioning, refrigeration). The scenarios of further anticipated developments are not very favourable for energy supplies from water sources, as dry periods can be expected in the summer, accompanied by high temperatures and greater evaporation.

6.2.7 Potential for tourism and recreation

Changes in the distribution of precipitation, increased variability and extremes of temperature and humidity and other changes in meteorological factors, together with feed-back, will influence the landscape and its natural units. A number of tourist and recreational activities are directly dependent on the weather. There has been a trend in shortening of the winter skiing season in recent years, and this can be expected to continue in the future. Artificial snow production on ski slopes and cross-country ski tracks, which could prolong the season, will be increasingly complicated by lack of water sources and energy barriers (especially increasing prices).

The expected increase in summer temperatures could increase interest in summer recreation around natural and artificial water reservoirs, but prolonged high temperatures will cause substantial heating of water volumes with subsequent reduction in water quality, accompanied by the growth of blue-green algae. This is a high-risk factor that could even prevent the use of water bodies. Therefore, it can be expected that the recreation season will tend to shift to the spring or autumn months, which will have more acceptable temperatures.

6.2.8 Urban agglomerations

Changes in the climate conditions will also have complex effects on large urban agglomerations, where more than two thirds of the population currently reside. Thus, from the viewpoint of minimizing impacts, it is desirable that greater attention be paid in the future to urban agglomerations and municipal units, reflected in new approaches to land-use planning with incorporation of adaptation measures taking into consideration the impacts of climate change. The observed and expected trends in the main manifestations of climate change can form a general guideline for establishing general priorities in monitoring the impacts that are specific for urban agglomerations and for subsequent preparation of adaptation land-use plans or strategies, where priorities can change slightly in dependence on the area and position of the agglomeration (Tab. 6.6).

Tab. 6.6 General priorities for evaluation of the impacts of climate change on urban agglomerations

High priority	increase in extremely high temperatures, increase in the number of summer and tropical days
	increased frequency of the occurrence of strong precipitation (>10 mm/day)
	increased thermal index values, increase risk of thermal stress for human beings
	increased risk of floods and inundations
	decreased stocks of groundwater
	decreased quality of drinking and utility water
	increase in energy consumption
Medium priority	increased frequency of the occurrence of extreme precipitation (>30 mm/day)
	increased risk of soil erosion
	increased risk of the occurrence or viral diseases and infectious diseases
	increased frequency of the occurrence of dry periods
	decreased water balance
	decreased volume of surface waters
	risk of water stress for vegetation

Low priority	increase in minimum daily temperatures and numbers of ice and frost days
	reduction in snow cover
	increased risk of temperature stress for vegetation
	increased risk of the occurrence of infections and pests on vegetation
	migration of flora and fauna species
	migration of populations

Source: CHMI

6.3 Adaptation Measures

Adaptation measures consist in a set of potential adaptations of the most vulnerable components of a natural or anthropogenic system to an actual or expected climate change and its impact. In an attempt to prevent the most negative impacts of changes, it is necessary that adaptation measures be gradually shifted from the position of reactive (measures for liquidation of the immediate consequences of natural or other extraordinary situations or catastrophes) to the position of proactive. Measures can be adopted not only at the national level (mostly when cooperation of a number of sectors is required), but also at the level of the private sector, individuals or groups of inhabitants and municipalities or cities.

Adaptation measures are frequently connected with financial requirements for preparation and introduction. However, costs can be balanced by the reduction in the amount of damage that the unfavourable impacts of the changes cause or could cause. Consequently, it is necessary to analyze their effectiveness and feasibility prior to introduction. In general, measures that take into account regional and local conditions tend to be the simplest, cheapest and usually also most effective. For this reason, it is desirable that the regional administrative authorities and local self-governing bodies participate in their preparation. The State should concentrate particularly on defining general conditions for their introduction.

Current knowledge of sectoral impacts of climate change suggests that the water management sector is the most vulnerable. The on-going changes in the hydrological regime are subsequently reflected in the agricultural and forestry sectors and are thus a basic driving force affecting changes in these sectors.

This part was prepared on the basis of research work and also the following strategic material: The National Programme to Abate the Climate Change Impacts in the Czech Republic[24], the Plan for the Main River Basins[25], the National Forestry Programme for the Period to 2013[26], the Strategy for Protection of Biological Diversity[27] and the working concepts of the prepared documents of the Policy of Climate Protection in the Czech Republic, Policy of Territorial Development in the Czech Republic, Strategy of the Ministry of the Environment for adaptation measures in the landscape in connection with climate changes, etc.

A summary overview of the vulnerability of the individual areas and the relevant adaptation measures are given in Tab. 6.7 at the end of this section.

6.3.1 Water Management

The basic means of protection against extreme hydrological phenomena lies in retention of water in the landscape through optimizing its structure and utilization of effective and close-to-natural technical preventative measures. In order to comply with these conditions, it is

[24] http://www.mzp.cz/cz/narodni_program_zmirneni_dopadu

[25] http://www.mze.cz/Index.aspx?ch=79&typ=2&ids=2474&val=2474

[26] http://www.mze.cz/Index.aspx?ids=573&ch=77&typ=1&val=42330

[27] http://chm.nature.cz/cooperation/fol362718

particularly necessary that regional and local self-governing authorities participate in long-term forecasts of water requirements and prepare draft legislative measures, required to achieve connectedness and elaboration of plans for water basin areas, accompanied by comprehensive land-use measures. It is desirable that these authorities implement a conception for management of precipitation water, enabling its retention, seepage and direct use (especially in urban areas) and provide for renewal of the function of existing water reservoirs by removal of sediments, as well as providing for protection of sites suitable for artificial accumulation of surface water.

6.3.1.1 Implemented measures

Increasing the safety of water works

Revision of the manipulation or operating regulations of all 346 water works in categories I to III was performed and the results were discussed by the competent water-law authorities in order to increase the safety of water works against overflowing, improve the effectiveness of their management under non-stationary conditions and for decision-making processes in dangerous or uncertain situations. Similarly, a study was performed of their technical condition from the viewpoint of possible future defects, proposals were prepared of necessary measures with stipulation of priorities and a general estimate was made of the costs connected with implementation over a period of 10 years.

Flood protection measures

The most important measure from the standpoint of flood protection is the Prevention of Floods programme of the Ministry of Agriculture (Government Resolution No. 382/2000), which is intended to improve protection of the most endangered areas against floods. A higher degree of protection can be achieved through measures of investment and non-investment character (construction and renewal of polders, reservoirs and dykes, increasing the flow capacity of the channels of water courses, delimitation of inundation zones, analysis of outflow conditions and delimitation of the extent of the territory endangered by floods).

Reducing water losses

The rules for provision of support for the subsidy titles of the Ministry of Agriculture in the area of water mains and sewers are concerned to reduce losses in drinking water mains, reducing demands on consumption of drinking water and minimization of pollution of water courses through discharge of waste waters below individual agglomerations. The amendment to Act No. 274/2001 Coll., on water mains and sewers for public use, of 2006 introduced, for the owners of water mains and sewers, the obligation to prepare and implement Plans of financing renewal of water mains and sewers for at least 10 years.

River System Restoration Programme

The programme (Ministry of the Environment Directive No. 5/2006) is intended to create conditions for the renewal of the natural environment and sources exploited by humans and to consistently increase the water retention ability of the landscape. It contributes to mitigation of the negative impacts of climate change through renewal of the natural function of water courses, including dead arms and spring areas, renewal of floodplains and bank vegetation, establishment and restoration of elements of the system of ecological stability bound to the water regime, elimination of lateral obstacles on water courses, renewal of the retention ability of the landscape (construction of fishponds, polders, etc.) and renewal of the natural function of water courses.

The Landscape Programme

In the framework of the programme commenced in 2006 (Ministry of the Environment Directive No. 5/2006), support is provided for projects for protection of the landscape against erosion, concerned with elimination and stabilization of the manifestations of sheet and rill erosion outside of the channels of water courses, creation of biological anti-erosion measures and implementation of defined and approved elements of the territorial system of ecological stability (TSES).

6.3.1.2 Planned measures

Flood Prevention Programme II

The programme (Ministry of Agriculture Decree No. 560/2006 Coll.), which is intended to continue the process of prevention and protection of persons and property against floods, has been approved for the period of 2007 – 2012. It is concerned with support for flood-prevention measures with retention, flood-prevention measures along water courses, increasing the safety of water works, delimitation of inundation areas and study of out-flow conditions. It is intended to promote the creation of new retention areas on water courses, reconstruction and modifications at existing water reservoirs with retention effect to increase the level of protection against floods.

Plan for the main river basins

The plan was prepared by the Ministry of Agriculture in cooperation with the Ministry of the Environment and was approved by the Government in 2007 (Government Resolution No. 562/2007). It is a strategic planning document in the area of waters, based on the Framework Directive on waters (2000/60/EC), other related European legislation and international agreements, and conventions and obligations of the Czech Republic in the area of waters. The plan for the main river basins introduces full support for implementation of the adaptation measures stipulated in the National Programme to Abate the Climate Change Impacts in the Czech Republic (Government Resolution No. 187/2004 Coll.) and concerned particularly with increasing the retention of water in the landscape and improving the structure of the landscape. It requires strengthening of the position of the water law authorities in the sense of supervision over achieving objectives and principles of increasing the retention of water in the landscape with regard to approved plans in the river basin areas, also encompassing preparation of a conception of management of rain water in urban areas.

Environment Operational Programme[28]

The programme based on European funds (Cohesion Fund and European Regional Development Fund) for the 2007 – 2013 is concerned, amongst other things, with cofinancing projects concerned with improving the water management infrastructure and reducing the risk of floods (reducing water pollution, improving drinking water quality, reducing the risk of floods) and improving the condition of nature and the landscape (optimization of the water regime in the landscape, anti-erosion measures and measures to reduce the negative consequences of surface run-off of water).

Programme of renewal of the natural functions of the landscape

In the framework of the newly approved subprogramme of the Environment Operational Programme, support will be provided for adaptation measures contributing to improving the natural function of water courses, improving the natural retention capacity of the landscape

[28] www.opzp.cz

and establishment and restoration of elements of the system of ecological stability bound to the water regime.

6.3.2 Agriculture

In addition to its productive function, agriculture fulfils an important role in creation of the landscape. The proposed adaptation measures are thus based on existing knowledge and analysis of regional and local natural conditions. In connection with protection against the impacts of climate change in the agricultural sector, it is necessary to strengthen measures to protect the soil against erosion and measures that promote retention of water in the agricultural landscape.

6.3.2.1 Implemented measures

Land-use planning

Land-use planning creates conditions for rational management by property owners. Properties are thus classified in terms of space and function and provision is made for access to them. An integral part of all land-use planning also consists in a plan for joint facilities, encompassing, amongst other things, water management and anti-erosion measures (to protect the land fund and improve the water regime in the landscape) and measures to protect and create the environment and measures to increase the ecological stability of the territory (territorial systems of ecological stability and other green areas). Thus, land-use planning substantially reduces the impacts of extreme meteorological situations, prevents erosion of the soil and helps prevent floods.

Agro-environmental measures

The measures were proposed in accordance with Council Regulation (EC) No 1257/1999 and Commission Regulation (EC) No 817/2004, as well as Government Regulation No. 242/2004 Coll., on performance of agro-environmental measures, as amended. Originally the measures were created for the purpose of elimination or mitigation of the negative environmental impacts of agricultural production; at the present time, on the basis of professional recommendations and a Pan-European consensus, most of them are adopted as an important part of adaptation measures to climate change (especially organic farming, grassing over of cropland, creation of grass strips on sloped land and cultivation of intermediate crops).

Development of Rural Areas and Multi-functional Agriculture Operational Programme[29]

Projects falling in this programme, which is the responsibility of the Ministry of Agriculture, encompass particularly renewal and reconstruction of fishponds and agricultural water reservoirs not used to breed fish and structures for irrigation and drainage of properties.

6.3.2.2 Planned measures

From the standpoint of adaptation measures, the following measures will be particularly relevant in the coming years:

Selection of new and existing varieties suitable for the vegetative conditions

The measure requires obtaining suitable genetic material (protection of domestic genetic sources and import from suitable areas). The key direction of improvement will consist in achieving greater resistance of varieties to drought, as it can be expected that the increase in

[29] http://www.strukturalni-fondy.cz/oprvmz

temperature in the driest areas will lead to substantially greater evaporation and an overall distinct expansion in areas with negative water balance. Although it is not anticipated that the expected range of temperature and precipitation changes would lead to fundamental changes in the species composition of current field crops, it can be expected that current cultivars will be shifted to higher altitudes. At lower altitudes, it will be necessary to obtain varieties with greater resistance to dryness, as climate change will entail, amongst other things, greater variability in temperature in the winter and early spring and thus a greater risk of winter kill of crops.

Creation, renewal and maintenance of irrigation systems

In the framework of agrotechnical procedures, it is necessary to concentrate on technology saving water and reducing loss of soil moisture, as water will gradually become a crucial factor in economical cultivation of crops. The problem of irrigation systems does not lie in the cost aspect, but mainly in the availability of irrigation water. It is necessary to cooperate with hydrologists in selecting locations where their construction has been shown to be effective.

Provision for soil stability from the standpoint of the danger of erosion

Water erosion can be caused not only by the frequency of the occurrence of erosion by dangerous rainfall, but also by seasonal changes in the variation of extreme precipitation. Ant-erosion measures will include, e.g. grassing over of cropland, cultivation of intermediate crops and the establishment of grass strips on sloped land. The effect of wind erosion will probably increase substantially, especially in the warm and dry areas of Southern Moravia. In this respect, correction must be made of proposals for anti-erosion protection and its individual elements. Proposals for anti-erosion measures with long lifetime and high costs (terraces, windbreaks, anti-erosion reservoirs, etc.) must take into account the impacts of potential climate change. The use of anti-erosion measures must correspond to the spatial and functional arrangement of the landscape with a positive effect on its ecological stability and must thus be part of all landscape measures.

Reduction of the occurrence of thermophilic diseases and pests

In cooperation with more southern countries (e.g., Austria, Hungary), it is necessary to monitor the occurrence and spreading of thermophilic diseases and pests and, through joint research with the State Plant Medicinal Administration, it is necessary to perform case studies on selected harmful species from the standpoint of their ecological niches, increased number of generations and occurrence of new invasive pathogens.

Modification of the regions of production areas

Altered climatic and habitat conditions for cultivation of field crops and especially the ever more frequent occurrence of extreme weather conditions make it necessary to modify the current classification into regions. The extreme situations over the past 15 years have been a decisive negative factor in the quantity of production for a number of agricultural enterprises. New classification into regions will form a basis for re-evaluation of subsidy policy of support for farmers and primary producers.

Creation of a system of integrated agro-meteorological monitoring and warning

This is an important adaptation measure on which a number of developed countries have agreed. Its outputs must be directed towards flexible consulting in agricultural primary production. So far, insufficient attention has been devoted to this key aspect.

6.3.3 Forestry

In the forestry sector, it is necessary to concentrate mainly on stabilization. This is closely related to the interconnection of adaptation and mitigation measures, as measures directed towards prevention of general collapse of forest ecosystems as a consequence of climate change are simultaneously measures that stabilize stocks of carbon in forests and thus act against acceleration of climate changes. The optimum model from the standpoint of climate change, while respecting the precautionary principle, seems to consist in a structurally varied forest, managed by close to nature practices, preferring habitat-suitable tree species with high and stable production of wood material, managed mainly utilizing natural processes with minimization of energy inputs.

6.3.3.1 Implemented measures

Increasing the adaptation potential of forests through species, genetic and age diversification of tree stands

The aspect of species diversity is connected particularly with reduction of spruce stands and increasing the share of broad-leaved and fir trees. The number of broad-leaved trees in the natural composition of forests should be approximately three times their current quantity. The natural conditions in this country provide sufficient scope for implementation of this measure. Spatial diversity means provision for adequate girth and height differentiation of the forest and is related to age and species diversity. Trees of various ages fill the space of a forest stand at various levels, mixing tree species with various requirements on light and temperature and with various natural root depths facilitate more effective utilization of the above-ground and soil space for the formation of biomass capturing carbon, and trees of various sizes are exposed to different risk factors. Forest differentiation thus reduces the risk of extensive decomposition of the forest and substantially contributes to stabilization of carbon stocks. The principle of increasing the adaptation potential of forests by increasing the species diversity of forest tree species in an attempt to approach natural forest composition and maintain the gene pool of original forest tree species was already included in the Principles of Forestry Policy (Government Resolution No. 249/21994) and the Forest Act No. 289/1995 Coll. also respects these principles. At the present time, the Ministry of the Environment is preparing a methodical instruction for the management of richly structured forests in national parks.

Implementation of sounder management methods and elimination of pressure from game

Sounder management methods reduce the use of clear-cutting and prefer noncompartmentalized or undergrowth forms of management and natural renewal, contributing to increasing the species, spatial and genetic diversity of forest ecosystems. This is related to the aspect of disproportionately high numbers of game (especially bisculate) in forests in this country, which do not permit natural renewal with a suitable species composition and cause further damage. High numbers of game are a demonstrable limiting factor for effective introduction of adaptation measures in relation to climate change.

Reduction of the risk of increased populations of insect pests, vascular mycosis and especially root rot

Measures to monitor elimination or reduction of the risk of an increase in populations of insect pests encompass monitoring of the state of health of forests and the dynamics of insect pest populations using satellite imaging, recognizance flights, pheromone traps, sticky strips, etc. In addition to the use of traditional methods for liquidation of insect pests, chemical means with minimum impact on the other components of nature are also used in calamity situations in exceptional cases and to a minimum degree (where possible biological means are

preferred). Forest fertilization and liming to reduce the acidity of the soil caused by prolonged high emissions of especially sulphur dioxide have been used for a number of years as measures to maintain or improve the state of health of forests and increase their stability in areas where forests are affected most by industrial pollutants. However, practice at the present time has shown that measures based on biological approaches are more effective and economically preferable.

6.3.3.2 Planned measures

Additional measures were proposed in the up-dated version of the National Forestry Programme for the period to 2013 (Government Resolution No. 1221/2008) within the framework of mitigation of the impacts of climate change; these are concerned with:

- promotion of species and ecotypes of more resistant forest tree species maintaining high, stable production of wood material,
- promotion of ecologically advantageous afforestation of agricultural land, particularly by stands of fast-growing tree species,
- prolonging the legal deadlines for afforestation and provision for tree stands in connection with the natural renewal of the forest,
- reducing degradation of the soil and increasing the amount of carbon bound in the soil, and
- directing subsidy rules towards support for adaptation measures reducing the impacts of climate change.

These principles will be gradually implemented in the Environment Operational Programme (2007 – 2013), the Rural Development Programme (2007 – 2013) and the Programme of Renewal of the Natural Function of the Landscape, which is expected to be commenced in 2009.

6.3.4 Health care

The health-care sector, the main task of which consists in caring for the health of society, plays an important role in the aspect of adaptation measures from the viewpoint of prevention and preparation for climate change.

6.3.4.1 Implemented measures

System of warning forecasts of the level of tick activity

This system was prepared as the result of research on the effect of the climate on tick activity and was put into routine operation in June of 2007. Information is regularly placed on the web sites of the Czech Hydrometeorological Institute, State Health Institute and Ministry of Health. This is an important preventative measure as vaccination levels against the tick-borne encephalitis virus remain low in the Czech Republic.

Educational programmes

Regular and compulsory education of public health service employees in the area of the environment is provided.

Enlightenment programmes

Advice and information are provided to the public for specific situations in an attempt to affect the behaviour of the population in advance as part of the work of medical facilities and as part of the Health 21 Programme (Government Resolution No. 1046/2002).

6.3.4.2 Planned measures

Within the framework of its programmes and in cooperation with the State Health Institute, the Ministry of Health is implementing further measures to mitigate the consequences of climate change, concerned with more intense monitoring of zoonoses and other damage to health, for which a clearly increasing tendency is manifested, together with comprehensive research on the cycle of infection in the zoonotic sphere, with emphasis on a change in vectors and definition and refinement of high-risk areas, seasons of the year and groups of the population affected by risk factors of infectious and non-infectious origin.

6.3.5 Nature and the landscape

Current results indicate that natural and artificial ecosystems with high species diversity and healthy ecosystems will most probably be capable of adapting to on-going and anticipated climate change. As it can be expected that the existing environment in a number of specially protected areas will not correspond to the habitat requirements of all the species for which they were originally established, a change in the climate will require a much more dynamic approach to the concept of protection on the part of authorities in relation to nature and the landscape. In connection with the expected shift of the areas of occurrence of many species of flora and fauna, it is necessary to extend the existing system of specially protected territories, including the EC Natura 2004[30] system of protected areas, to encompass as many bio-climatically different areas as possible. In the absence of care for the landscape even outside of specially protected areas and without monitoring of selected components of biodiversity, many species of flora and fauna will not be capable of reacting to climate change in time. These principles will be gradually implemented, e.g., in the Environment Operational Programme (2007 – 2013), the Landscape Programme and the Programme of Renewal of the Natural Function of the Landscape, which is expected to be commenced in 2009.

A number of measures that are mentioned in par. 6.3.1 to 6.3.3 in relation to water management, agriculture and forestry will also have direct impacts on nature and the landscape as a whole.

6.3.6 The urbanized landscape

From the viewpoint of landscape measures, it is considered important in the urbanized landscape to implement to a far greater degree measures based on the principle of increased green areas of various sizes according to the specific location and necessary function. A further target consists, on the other hand, in incorporation of natural and close-to-natural elements directly into built-up areas or at least in their immediate vicinity – water features, meadows, etc.

6.3.6.1 Implemented measures

In the part concerned with promotion of regeneration of the urban landscape, the Environment Operational Programme (2007 – 2013) is concerned with renewal of close-to-natural green areas in the urban environment, including city and municipal wooded parks, school gardens and enclosed landscape areas, parks, tree alleys and important groups of trees within settlements and renewal of green areas in the framework of creation of green rings around settlements. The operational programme is also concerned with planting green areas on properties smaller than 10 ha, established in former military training areas, areas burdened by

[30] http://www.nature.cz/natura2000-design3/hp.php

or with the consequences of geological prospecting, etc. and construction or modification of water features in built-up areas and around settlements.

6.3.6.2 Planned measures

The necessary measures can be fully supported and do not so far have any apparent inadequacies that would be discovered in practice. However, it will be necessary to ensure at least limited support for these measures from national sources after completion of the operational programme after 2013.

6.3.7 Biodiversity

Almost all the measures mentioned for the other areas (par. 6.3.1 to 6.3.3, 6.3.5, 6.3.6) have a significant effect on maintenance or augmentation of biological diversity. Therefore, here we will mention only programmes with priority emphasis on measures to promote biodiversity and concerned with functional interconnection of the landscape with natural or close-to-natural features.

6.3.7.1 Implemented measures

Implementation of rescue programmes and programmes of care for specially protected species

Measures in the Programme of Renewal of the Natural Function of the Landscape (newly approved subprogramme of the Environment Operational Programme) are concerned particularly with maintenance of and increasing the number of species, rescuing ecosystems and creation of suitable conditions for their further existence, protection of biodiversity in situ, and also minimization and prevention of damage caused to highly and critically endangered specially protected species of fauna, improving the adaptation abilities of ecosystems and species to increasing fragmentation of the landscape and care for handicapped fauna.

Prevention of introduction, regulation and liquidation of populations of invasive species

Measures in the framework of the Programme of Renewal of the Natural Function of the Landscape to promote adaptation measures in aquatic, forest and nonforest ecosystems of an investment character that are further directed towards implementation of the elements of a network of ecological stability TSES and renewal of the landscape structure.

6.3.7.2 Planned measures

The necessary measures can be fully supported and do not so far have any apparent inadequacies that would be discovered in practice. Financially, it will be necessary to provide for regular long-term monitoring, performed by observing various measurable variables of the environment. The main sense of monitoring consists in recording conditions compared to a preset standard with a certain probability.

6.3.8 Public sector

Most human activities will very likely be affected by climate change and therefore it is necessary to adapt to the individual changes. This must be based on reformulating land-use and construction plans to take into account climate change. In relation to the growing prices of petroleum and energy, it is necessary to begin constructing environmentally sound structures with low energy consumption, preferably from environmentally sound and resistant construction materials. The occurrence and number of extreme weather events will undoubtedly increase in the future and therefore it is necessary to elaborate risk management

and prepare suitable adaptation measures in the individual sectors at national, regional and especially local level. Governmental authorities, especially the Ministry of the Environment, are entrusted with ensuring that the public has access to the relevant information and are required to concentrate on public awareness of environmental problems. The public and its attitude to this issue undoubtedly remains a decisive factor from the standpoint of adaptation to climate change.

Tab. 6.7 Summary overview of the vulnerability of individual areas and relevant adaptation measures

Vulnerable areas	Examples, commentary, adaptation measures
Water regime	Vulnerability: reduction of average and minimum flow rates and minimum outflow rates or groundwater, changes in the annual variation on flow rates, reduction in the supply function of water reservoirs, worsening of surface water quality (eutrophication), worsening and lengthening of water deficits in the summer and winter months, increased frequency of flash floods, reduction in guaranteed water withdrawals. Adaptation: increased safety of water works, flood prevention measures, reduction of water losses, restoration of river systems, landscape programme.
Agriculture	Vulnerability: shift and prolonging of the vegetation period, acceleration of vegetation in the spring with greater risk of damage to plants by late frosts, loss of moisture, increased water erosion of farm land. Adaptation: land-use planning, agro-environmental measures, renewal and reconstruction of fish ponds and agricultural water reservoirs, irrigation and drainage of agricultural properties.
Forest management	Vulnerability: risk of decomposition of unstable maturing and mature stands of unsuitable spruce single-species stands, increased biotic damage under extreme weather conditions, increased susceptibility to fungal diseases and insect pests. Adaptation: increased diversification potential of forests through species, genetic and age diversification of stands, use of sounder means of management and elimination of pressure from game, reduction of the risk of increased populations of insect pests, vascular mycoses and root rot.
Human health	Vulnerability: heat stress, reduced air quality, extreme weather conditions, increased occurrence of some infections (tick-borne encephalitis, Lyme's borreliosis, Leishmaniasis). Adaptation: introduction of a system of warning forecasts of the level of tick activity, regular compulsory education of public health workers in environmental issues, public awareness programmes.
Biodiversity	Vulnerability: endangering of species of flora and fauna bound to specific habitats (glacial cirques, parts of mountains above the tree line, etc.), increased spreading of invasive nonindigenous species, human activity connected with climate change and necessary adaptations (construction of dams, cultivation of plants for production of biofuels). Adaptation: regeneration of the urban landscape, renewal of green areas in settlements and creation of "green rings" around settlements, rescue programmes for specially protected species of fauna and flora, prevention of introduction, regulation and liquidation of populations of invasive species.
Energy production and industry	Vulnerability: poor availability of water required for cooling thermal power plants, availability of some forms of production of electrical energy (e.g. hydro power plants), impacts of extreme weather conditions on energy-production infrastructure, changes in demand for energy (reduced in the winter, increased in the summer – air conditioning). Adaptation: under preparation.
Tourism and recreation potential	Vulnerability: shortening of the winter skiing season, lack of sources of water for production of artificial snow (and increase in its energy intensity), reduction in the quality of bathing water (occurrence of blue-green algae). Adaptation: under preparation.
Urban agglomerations	Vulnerability: danger of inundations and floods, reduced quality of drinking and utility water. Adaptation: under preparation.

Source: CHMI

7 Funding and transfer of technology

As the Czech Republic is not a country listed in Annex II of the Convention, it is not obliged in the sense of Article 12.3 of the Convention to adopt measures and fulfil obligations following from Articles 4.3, 4.4 and 4.5 of the Convention and especially to create further sources of funding.

7.1 Foreign Development Assistance

In the first few years after the change of the political regime in 1989, Czechoslovakia and subsequently the Czech Republic were characterized by very limited contacts with the developing world at most levels of mutual relations. These began to develop again in the second half of the 1990's, when renewal of development assistance was a necessary precondition for accession of the Czech Republic to OECD in 1995.

The second half of the 1990's were characterized by substantial territorial and sectoral fragmentation of Czech foreign development assistance, where larger projects were implemented in more than 40 countries. The conception of foreign development assistance by the Czech Republic in the 2002 – 2007 period stipulated 20 priority countries and emphasized the need for institutional reform of the system of foreign development assistance provision.

Pursuant to Government Resolution No. 248/2003 on the medium-term outlook for the financing of the Czech Republic's foreign development assistance, which substantially amended the "Principles for provision of foreign development assistance", approved in 1995, foreign development assistance is subject to an annual programme that, together with the draft budget, was submitted by the Minister of Foreign Affairs for the following budgetary year. Government Resolution No. 302/2004 newly adopted the Principles of foreign development cooperation following the Czech Republic's accession to the EU, according to which the Minister of Foreign Affairs, as the coordinator of foreign assistance, was requested to submit a plan of foreign development cooperation for the following year together with the prospective budget for the following two years. This document also narrowed the list of priority countries – Angola, Bosnia and Herzegovina, Yemen, Moldavia, Mongolia, Serbia and Montenegro, Vietnam and Zambia were defined as long-term priority countries; Afghanistan and Iraq were designated as medium-term priorities.

This material also introduced a uniform method for calculation and reporting Czech foreign development assistance. Development assistance is reported on an international scale using the indicator of the share of the volume of assistance to developing countries (*Official Development Assistance*) in the GDP.

In 2007, the Government decided to reform foreign development assistance in Resolution of the Government of the Czech Republic No. 1070 of September 19, 2007 on transformation of the system of foreign development assistance of the Czech Republic. The reform is based on the creation of the Czech Development Agency directed by the Ministry of Foreign Affairs and its gradual takeover of foreign development assistance activities from the individual sectoral ministries (by the end of 2010).

The foreign development assistance of the Czech Republic has exhibited a constant increase in recent years that is in accordance with the role of this country as an emerging donor and an EU member. This increase is a consequence of both the increasing volume of funds

designated for development assistance and also of the better statistical reporting of the Ministry of Foreign Affairs. On an international scale, reporting is collected at the OECD Development Assistance Committee, whose members are all developed donors and whose methodology is generally accepted. The Czech Republic has had the statute of an observer on this committee since 1996. A substantial increase in the volume of multilateral assistance occurred in 2004 (in both absolute and relative terms) – this is mainly a consequence of the accession of the Czech Republic to the EU and subsequent inclusion of the relevant share of the volume of assistance provided by the EU as a whole (e.g. EuropeAid and ECHO activities).

Tab. 7.1 Survey of the main recipients of Czech assistance in 2003 – 2006 (mil. USD)

Order	2003		2004		2005		2006	
	Country	USD	Country	USD	Country	USD	Country	USD
1.	Iraq	39.96	Iraq	13.66	Iraq	8.13	Iraq	11.80
2.	Afghanistan	6.12	SCG	6.88	SCG	6.89	Serbia	6.00
3.	SCG[1)]	4.15	Afghanistan	6.08	Ukraine	4.62	Afghanistan	4.20
4.	BIH[2)]	3.93	Ukraine	4.58	Pakistan	3.70	Indonesia	3.28
5.	Vietnam	2.04	Russia	3.96	Mongolia	3.04	Mongolia	2.72
6.	Mongolia	1.68	Vietnam	3.05	Afghanistan	1.96	Ukraine	2.69
7.	Russia	1.64	China	2.94	Vietnam	1.42	BIH	2.13
8.	Moldavia	1.62	Mongolia	2.88	BIH	1.34	Vietnam	1.91
9.	China	1.31	Georgia	1.36	India	1.31	Belarus	1.71
10.	Ukraine	1.07	Kyrgyzstan	1.14	China	1.30	Egypt	1.35

1) SCG = Serbia and Montenegro
2) BIH = Bosnia and Herzegovina

Source: MFA

The total amount of finances provided for ODA in 2005 equaled CZK 3.24 bil. and, in 2006, CZK 3.64 bil., where the share of the contributions for multilateral development assistance predominated (56%) over bilateral contributions (48.3% in 2006). In 2006, the ODA/GDP ratio equaled 0.120% (Tab. 7.2).

Tab. 7.2 Development of the structure of Czech foreign development assistance in 2003 – 2006 (mil. CZK/USD)

	2003		2004		2005		2006	
	CZK	USD	CZK	USD	CZK	USD	CZK	USD
ODA Total	2,556.0	90.55	2,780.1	108.17	3,236.0	135.13	3,636.9	160.86
Bilateral ODA	2,268.3	80.36	1,631.5	63.48	1,541.9	64.39	1,756.7	77.70
Assistance in the area of infrastructure	214.2	7.59	352.1	13.70	164.0	6.85	175.9	7.78
Special programmes (peace-building and renewal)	1,252.7	44.38	377.0	14.67	227.7	9.51	282.8	12.51
Technical assistance [1)]	282.0	9.99	281.4	10.95	363.8	15.19	442.0	19.55
Humanitarian aid	30.2	1.07	51.1	1.99	247.6	10.34	216.6	9.58
Assistance to refugees in the donor country	162.6	5.76	180.7	7.03	206.9	8.64	178.8	7.91
Reducing debts	247.8	8.78	275.8	10.73	229.9	9.60	333.0	14.73
Administrative costs and enlightenment	78.8	2.79	113.3	4.41	102.0	4.26	127.5	5.64
Multilateral ODA	287.6	10.19	1,148.6	44.69	1,694.0	70.74	1,880.2	83.16
Share of bilateral ODA (%)	88.7%		58.7%		47.7%		48.3%	
Ratio ODA/GDP	0.101%		0.106%		0.114%		0.120%	
GNP	2,532,400	89,716	2,611,500	101,611	2,839,100	118,558	3,027,390	133,902
Deflator GDP (2005=100 %)	96.2		99.8		100.0		101.7	
CZK/USD exchange rate	28.227		25.701		23.95		22.61	

	2003		2004		2005		2006	
	CZK	**USD**	**CZK**	**USD**	**CZK**	**USD**	**CZK**	**USD**
ODA in constant 2005 prices	2,651.4	103.16	2,780.1	108.17	3,229.2	135.13	3,576.1	149.33
Sub-Saharan Africa	61.5	2.18	97.1	3.78	95.55	3.99	129.78	5.74
Southern and Central Asia	232.6	8.24	259.1	10.08	237.79	9.93	192.40	8.51
Other Asia and the Pacific	167.7	5.94	262.4	10.21	167.87	7.01	206.19	9.12
Middle East and North Africa	1,174.2	41.60	398.6	15.51	229.65	9.59	403.34	17.84
Latin America and the Caribbean	52.2	1.85	67.3	2.62	51.49	2.15	57.88	2.56
Europe	332.2	11.77	271.4	10.56	407.10	17.00	430.48	19.04
Unspecified[2)]	247.8	8.78	275.5	10.72	352.50	14.72	336.65	14.89
Total	2,268.3	80.36	1,631.5	63.48	1,541.95	64.39	1,756.72	77.70
Least developed countries (LDC)	228.9	8.11	242.4	9.43	123.09	5.14	224.73	9.94
Poorly developed countries	227.8	8.07	332.6	12.94	290.24	12.12	202.35	8.95
Countries with low mean income	1,536.7	54.44	744.0	28.95	733.98	30.65	817.54	36.16
Countries with high mean income	12.7	0.45	14.1	0.55	22.75	0.95	44.09	1.95
Countries with high income	0.0	0.00	0.0	0.00	0.00	0.00	0.00	0.00
Unspecified[2)]	262.2	9.29	298.4	11.61	371.90	15.53	468.01	20.70
Total	2,268.3	80.36	1,631.5	63.48	1,541.95	64.39	1,756.72	77.70
Education, health and the population	827.9	29.33	233.6	9.09	169.54	7.08	210.26	9.30
Other social infrastructure	114.0	4.04	401.7	15.63	348.43	14.55	451.73	19.98
Economic infrastructure	146.5	5.19	114.6	4.46	32.09	1.34	40.02	1.77
Manufacturing industry	81.0	2.87	90.5	3.52	86.21	3.60	100.61	4.45
Multi-sectoral aid	579.5	20.53	170.1	6.62	133.62	5.58	115.53	5.11
Programme assistance	4.2	0.15	0.0	0.00	4.07	0.17	0.00	0.00
Reducing debts	247.8	8.78	275.8	10.73	229.89	9.60	333.03	14.73
Humanitarian aid	188.6	6.68	231.8	9.02	450.44	18.81	395.43	17.49
Unspecified[3)]	78.8	2.79	113.3	4.41	87.65	3.66	110.11	4.87
Total	2,268.3	80.36	1,631.5	63.48	1,541.95	64.39	1,756.72	77.70
UN	149.9	5.31	141.9	5.52	106.56	4.45	118.47	5.24
European Communities	0.0	0.00	862.8	33.57	1,478.01	61.72	1,554.14	68.74
World Bank group	68.9	2.44	63.7	2.48	58.91	2.46	84.11	3.72
Regional development banks	0.0	0.00	0.0	0.00	0.00	0.00	0.00	0.00
Other	68.9	2.44	80.2	3.12	50.53	2.11	123.45	5.46
Total	287.6	10.19	1,148.6	44.69	1,694.01	70.74	1,880.16	83.16

[1)] also includes scholarships
[2)] also includes reducing debts
[3)] also includes administrative costs

Source: MFA

In addition to mandatory contributions, following from membership in international organizations (e.g. in the framework of the UN system, the World Bank group and the International Monetary Fund, etc.), the Czech Republic also provides contributions on a voluntary basis through various bodies, particularly as special-purpose contributions.

In 2005 a total of CZK 1.88 bil. was expended from the State budget for payments to the UN and other international organizations, which are included in ODA according to the OECD methodology.

7.2 Activities related to transfer of technology

Developed countries that are parties to the Convention included in Annex II have pledged to take all practicable steps to promote, facilitate and finance the access to environmentally sound technologies and know-how by the other parties to the Convention, especially developing country parties pursuant to the provisions of Art. 4.5 of the Convention and also according to the similar commitment pursuant to Art. 10(c) of the Kyoto Protocol. As a

country with economy in transition, the Czech Republic utilized international assistance to gain know-how and modern technology. Because of the high level of damage to the environment that occurred in the period of a centrally directed economy, the transfer of environmental technology was especially necessary.

Until 2000, because of the necessity of complying with the requirements of the new legal regulations on protection of the environment, first-generation technologies clearly predominated (dust removal, sulfur removal and denitrification of power plants and large heating plants, construction of large waste water treatment plants, construction or reconstruction of waste landfills). After 2000, the share of second-generation technologies increased, to a substantial degree as a result of the investment cycle of existing technological units and investments into newly constructed technological units. Act No. 76/2002 Coll., on integrated pollution prevention and control, as amended, also contributed greatly to extending applications of environmental technologies. In this respect, the existing technologies were assessed from the viewpoint of the best available techniques in more than a thousand of the most important industrial and agricultural enterprises and environmental requirements were stipulated for the equipment of new buildings.

The largest share of total investments in 1993 to 2006 (approx. 80%) was expended for the items "protection of the climate and the air" and "waste water management", with the vast majority of investments into first-generation technology (end-of-the-pipe equipment), which is of a systematic nature for waste waters and appeared for the air mainly in the period prior to 2000. The extensive programme of conversion to gas in cities and municipalities is an example of significant investment into second-generation environmental technology for protection of the air in the period until 2000. The operational programmes financed from the EC cohesion and structural funds were a further important stimulus for transfer of technology. Their impacts on increasing the energy and material efficiency of industrial production, modernization of conventional energy production, use of RES and promotion of energy savings were documented in Chapter 4.

The Environmental Technologies Action Plan in the Czech Republic (ETAP CR), which was approved in 2006, is the principal national document in the area of environmental technologies. The Environmental Technologies Action Plan in the Czech Republic was prepared on the basis of the Communication of the European Commission "Report on the implementation of the Environmental Technologies in 2004" of January 27, 2005, which recommended that Member States adopt national programmes to implement the Environmental Technologies Action Plan. Updating of ETAP CR was commenced in 2008 and is still progressing in 2009. The objective of the updated programme is to stimulate further development and broader introduction of environmental technologies and to promote the development and commercial use of innovative technologies concerned with promoting economic growth with simultaneous limitation of pressure on natural resources and improvement of the quality of life ("eco-innovation").

The system priorities of the updated programme are:

- Promotion of environmental technologies and eco-innovations on the part of demand (creation of a market to which the private sphere will react with a suitable supply in its own economic interests).
- Promotion of second-generation environmental technologies and eco-innovations on the part of supply (creation of a supply of technically feasible and simultaneously economically effective technical procedures for effective use of natural resources and prevention and control of the formation of pollution and other negative impacts on human health and the components of the environment).

Simultaneously, the Czech Republic is participating in assistance to developing countries (see Chap. 7.3.1), where it utilizes its fresh experience as a recipient of modern technologies and know-how (amongst other things as a host country for JI projects). In the working version of the currently prepared Policy of Climate Protection (see Chap. 4.5.2), a substantial part of this document is devoted to increasing development assistance in the area of mitigation and adaptation policies and measures in the context of the economic capabilities of the Czech Republic.

7.3 Information pursuant to Article 10 of the Kyoto Protocol

A survey of information based on Art. 10 of the Kyoto Protocol, set forth in the framework of the 5th National Communication, is given in Annex 10.2 (Tab. 10.5).

7.3.1 Foreign projects related to climate change

Finances were provided in the framework of foreign development assistance in the 2003 – 2009 period for several projects related to the reduction of greenhouse gas emissions – modernization of energy-production facilities and systems, use of alternative energy sources, etc. – or adaptation to climate change. Table 7.3 gives a survey.

Tab. 7.3 Survey of bilateral projects of foreign development assistance related to climate change in the 2003 – 2009 period

Responsible ministry	Project name	Region/country	Total budget of the project (CZK thous)	Implementation
MIT	Introduction of a system of utilization of renewable energy sources through construction of mini-hydropower plants	Philippines	29,000	2003 – 2005
MIT	Modernization of powering and control of power plant block No. 4, establishment of a technical training centre at the University in Ulan Bator	Mongolia	28,000	2003 – 2005
MoE	Creation of capacities of environmental management systems (EMS)	Macedonia (FYROM) Bosnia and Herzegovina, Serbia, Ukraine	7,000	2003 – 2005
MoE	Programme of management and renewal of water courses in the Kali Progo/Sapi and Tondano watersheds	Indonesia	1,980	2003 – 2005
MoE	Application of preventative procedures in selected enterprises, connected with transfer of Czech technology and know-how	Kazakhstan	5,000	2003 – 2005
MoE	Assessment of natural risks from the river basins of the Chira and Piura rivers in the north-western part of Peru	Peru	8,000	2003 – 2006
MoE	Monitoring alpine glacial lakes and protection of the population against the catastrophic consequences of floods	Kyrgyzstan	9,150	2004 – 2006
MoE	Maintenance of ozone layer monitoring networks in developing countries	Countries of Africa, South America, Asia and the former SSSR	1,520	2004 – 2006
MoE	Elimination of substances damaging the ozone layer of the Earth	Ukraine	7,318	2004 – 2006
MoE	Solar energy for schools in Kenya	Kenya	6,691	2004 – 2006
MoE	Renewable energy sources for a remote village community	Angola	1,348	2005 – 2006

Responsible ministry	Project name	Region/country	Total budget of the project (CZK thous)	Implementation
MoE	Improvement of the environment in Moldavia through the use of Czech environmental technologies produced in joint Czech-Moldavian companies	Moldavia	12,000	2005 – 2008
MoE	Renewable energy sources for a remote village community	Angola	1,068	2005 – 2006
MoE	Transfer of experience with modern environmental technologies in utilizing renewable energy sources and increasing energy production efficiency in the Shumadija area and city of Kragujevac	Serbia	2,946	2006 – 2007
MoE	Construction of an effective system of remote heating intended to eliminate energy-intense and environmentally completely unsuitable local heating sources in the city of Valjevo	Serbia	18,062	2006 – 2008
MoE	Monitoring surface waters and protection against floods in the river basin of the Reut river	Moldavia	6,078	2006 – 2008
MoT	Cooperation in the area of environmentally acceptable urban mass transport	Serbia and Montenegro	30,000	2006 – 2010
MIT	Modernization and increasing the efficiency of the Al Hiswa power plant	Yemen	58,550	2006 – 2010
MIT	Greening of management of petroleum and chemical substances and hazardous waste	Serbia and Montenegro	29,400	2006 – 2010
MIT	Area of alternative energy sources	Vietnam	24,500	2006 – 2010
MoE	Research and study of geomorphological and hydrogeological conditions in the river basin of the Piura river to reduce environmental factors limiting the social and economic development of this region in Peru	Peru	11,098	2007 – 2010
MoE	Regional geological study to define and forecast natural dangers in the central part of Central America	Nicaragua, Costa Rica, Salvador	17,210	2007 – 2009
MoE	Analysis of the risks and mitigation of the consequences of breakage of dams on alpine lakes	Kyrgyzstan	15,236	2007 – 2010
MIT	Implementation of new technologies contributing to improving the environment in the petroleum industry – Kuçovë region	Albania	35,000	2008 – 2010

Source: MoE, CDA

Examples of projects concerned with mitigation measures include projects under the auspices of the Ministry of the Environment implemented in Serbia in 2006 – 2007 and 2006 – 2008.

The main development intention of the project "Transfer of experience with modern environmental technologies in utilizing renewable energy sources and increasing energy production efficiency in the Shumadija area and city of Kragujevac" consisted in contribution to reduction of the detrimental environmental impact of energy management. In 2006, the introductory part of the project was implemented, including input analysis, concerned with assessing the energy supply to the region and potential energy savings and RES in the region, and also including performance of patrol energy audits at 16 selected sites. On the basis of input analyses and feedback obtained during working meetings and seminars with the representatives of the region, an Action Plan of measures was prepared in 2007, leading to greater use of RES and increasing energy efficiency. In the framework of experience with modern environmental technologies while utilizing RES and increasing energy efficiency, the representatives of the region were trained in means of implementing the conclusions of the Action Plan, modern energy management and means of financing energy projects. In addition, a catalogue of modern environmental technologies using RES and increasing energy

efficiency and potential suppliers of technologies and energy services in the region and in the Czech Republic was prepared and distributed.

The project “Construction of an effective system of remote heating intended to eliminate energy-intense and environmentally completely unsuitable local heating sources in the city of Valjevo” was concerned with providing for long-term effectiveness and stability in supply of the inhabitants of the city of Valjevo, with the objective of increasing the energy efficiency of remote heating / heat distribution and thus attaining minimization of heat energy losses during transfer from production to the end user. The project was implemented in the area of the Kolubara residential area in Pantičeva street and the surrounding roads through construction of a modern heat distribution system, including measuring and regulation technologies in accordance with European standards and regulations. Simultaneously, this project assisted in replacement of small, unsuitable local heating sources through heat supplies from a central heating supply (CHS). Reconstruction of the hot-water network was designed so as to create conditions for connection of further customers (residential and commercial buildings) to the CHS. In 2006 – 2007, excavation work was performed, with disassembly of old heat distribution lines, including removal of the original concrete shafts for the pipeline in the Kolubara residential area. Material was supplied, along with installation work (i.e. installation of new heat distribution lines made of preinsulated pipe, introduction of measuring and regulation technology), operating tests and landscaping. Simultaneously, the house transformer stations were replaced by the recipient.

8 Research and systematic observation

This chapter summarizes information on the structure of research in the area of climate change and its basic results in the period since the Fourth National Communication of the Czech Republic to the UN Framework Convention on Climate Change[31]. It also provides basic information on the ongoing systematic observation and archiving of climatological data.

This research is intended particularly to improve knowledge of the causes, effects, magnitudes and temporal factors of climate changes and their sectoral, economic or social consequences. Attention is also devoted to international cooperation and exchange of scientific and technical and also socio-economic information.

8.1 General organization of research and systematic observations

Research on aspects connected with the current state and developments of the climate system is concentrated particularly in the following institutions:

- The National Climate Program of the Czech Republic
- The National Committee for IGBP
- The Committee on the Environment of the Academy of Sciences of the Czech Republic
- The National Forestry Committee
- Institutes of the Academy of Sciences of the Czech Republic (Institute of Atmospheric Physics ASCR, v.v.i.; Geophysical Institute AS CR v.v.i.; The Institute of Hydrodynamics of the ASCR, v.v.i.; Institute of Systems Biology and Ecology, v.v.i.; Institute of Geology ASCR, v.v.i.).
- University departments (Faculty of Mathematics and Physics, Charles University in Prague; Faculty of Science, Masaryk University; Faculty of Science, Charles University in Prague; University of South Bohemia in České Budějovice; the Mendel University of Agriculture and Forestry in Brno)
- Sectoral institutes (Czech Hydrometeorological Institute, the T.G. Masaryk Water Research Institute, v.v.i.) and other research institutes (Crop Research Institute, v.v.i., Research Institute of Agricultural Engineering, v.v.i., Research Institute of Ameliorations and Soil Conservation v.v.i., etc.).

Some of these institutes are members of or are represented in the National Climate Programme of the Czech Republic[32], which is an association of legal persons entrusted, amongst other things, with performance at a national level of the tasks of the World Climate Research Programme of the World Meteorological Organization (WMO), creation of research teams of scientists in the area of the climate in the Czech Republic and publication of the results obtained.

[31] This chapter does not contain the results that were the subject of research completed prior to 2004 incl. and which were contained in the Fourth National Communication of the Czech Republic to the UN Framework Convention on Climate Change.

[32] http://www.chmi.cz/nkp/nkp.html

The research, which is part of the basic tasks of the individual institutions, is financed both from their budgets and also through the Czech grant agencies and the Academy of Sciences of the Czech Republic or grant projects announced by the Ministry of the Environment and Ministry of Agriculture (Chapter 8.2). Some projects are carried out in the framework of international cooperation and co-financed by foreign partners (Chapter 8.3).

Systematic observation of the climate system is carried out mostly by the Czech Hydrometeorological Institute (CHMI) which performs the function of a State institute for the area of air quality protection, hydrology, water quality, climatology and meteorology, with a competence to establish and operate State monitoring and observation networks, including international data exchange pursuant to the WMO principles. Other institutions carry out monitoring for their own needs, usually for a limited period of a certain project.

Exchange of scientific and technical information between Czech and foreign institutions is not regulated in any way and occurs quite freely; CHMI provides basic data, usually for a fee according to the valid tariff.

In addition to participation in the activities of the WMO and UN Environmental Programme (UNEP), the Czech Republic cooperates on a number of international projects concerned with the climate. The most important in this respect is participation in the RC LACE project (the ARPEGE-CLIMAT model). Recently, participation of the Czech Republic in international projects concerned with modelling the climate system and estimation of the impacts of climate change has expanded substantially. The Czech Republic regularly provides assistance to developing countries in the area of training courses, and assistance in installation and calibration of instruments (e.g. monitoring of the ozone layer, etc.) – for details, see Chapter 8.3.

8.2 Research

8.2.1 Information on the most important national research projects

8.2.1.1 Refinement of current estimates of the impacts of climate change in the sectors of water management, agriculture and forestry and proposals for adaptation measures

The project of the Ministry of the Environment is coordinated by the Czech Hydrometeorological Institute, cooperating institutes include the T.G. Masaryk Water Research Institute, v.v.i.[33], Faculty of Mathematics and Physics, Charles University in Prague[34], Institute of Systems Biology and Ecology, v.v.i.[35] and the Crop Research Institute, v.v.i.[36]

The project, with a research period of 2007 – 2011, which is divided into six individual subprojects, consists, amongst other things, in:

- Refinement and updating of the scenario of development of the climate in the territory of the country to the end of the 21st century with emphasis on the period around 2030,
- Comprehensive evaluation of the possibility of drawing up a long-term scenario of climatological anomalies with emphasis on anomalies in temperature and precipitation

[33] www.vuv.cz

[34] www.mff.cuni.cz

[35] www.usbe.cas.cz

[36] www.vurv.cz

and refinement of estimates of the variability and frequency of the occurrence of extreme weather and hydrological events,

- Refinement of the expected impacts of climate change in the sectors of water management, agriculture and forestry,
- Support for measures to deal with climate changes and reduce the risk of their impacts and assessment of formerly proposed framework sectoral adaptation measures, possibly with specification or supplementing.

The overall objective of the project consists in support for implementation of the National Programme to Abate the Climate Change Impacts in the Czech Republic of 2004 and promotion of the prepared Policy of Climate Protection in the Czech Republic.

In the framework of the project, regional climate models with high resolution were used to update and refine the regional scenario of climate changes with monthly and daily steps for the time periods of 2010 – 2039, 2040 – 2069 and 2070 – 2100, changes in the occurrence of extreme phenomena were estimated and the possibility of drawing up long-term scenarios of climatological anomalies with emphasis on anomalies in temperatures and precipitations was evaluated. The basis for the scenarios consists in RCM ALADIN – CLIMATE/CZ outputs with a resolution of 25 km, corrected for errors in the model, which were identified when comparing the model simulation for the reference period. Some of the results obtained to date are presented in Chapters 6.2 and 6.3.

Updated scenarios were used to refine the existing estimates of the impacts of climate changes on the hydrological balance and water sources. The impacts on water withdrawals from water courses, from reservoirs and groundwaters were also assessed. The impacts on water supplies are modeled for the selected river basins using the procedures of water management methods, including stochastic generation of series and hydrodynamic models of groundwater flow. Estimates are also made of the impacts of climate changes on the maximum and minimum flow-rate regimes. The laws governing the time distribution of precipitation in the framework of precipitation episodes are monitored, an algorithm is created for random selection of the distribution for modelling river basins, statistical evaluation is performed of simulated series in relation to the annual variation in outflows and the flood regime and other status variables in the model are evaluated.

The results to date indicate, for example, that the average annual temperatures increased in the 1980 – 2007 period; together with the reduction in the average humidity, this led to greater potential evapotranspiration in part of the country. There was a slight increase in total precipitation in most river basins in this period, where the gradient of increase was mostly comparable with or greater than the gradient of increase in potential evapotranspiration. A growing trend between the height of precipitation and height of outflow was apparent over practically the whole country (in a wide range of values from close to zero to values exceeding 70 mm p.a. over 10 years). The difference between precipitation and outflow on a long-term scale corresponds to territorial evaporation which is, however, affected more by precipitation than temperature over most of the country. The increase in the difference corresponds not only to the increase in air temperature, but also to the increasing time gradient of precipitation.

For selected climatic scenarios, trends in the newly determined flow rate characteristics will be subsequently assessed and procedures will be proposed for evaluation of the surface water quantitative regime and determination of the hydrological characteristics under the conditions of a nonstationary hydrological regime and climate changes.

Agricultural production in the Czech Republic is greatly limited by natural conditions. The main source of inter-annual variability in the yields of farm crops lies in the effect of the weather in interaction with soil and agrotechnical factors. Consequently, analysis is performed within the relevant subproject of the impacts of potential climate change on the processes affecting both agricultural production and also the volume of water in the landscape, the retention capacity of the soil, the dynamics of water balance, soil moisture, substances released into the air and soil, etc. It is necessary to define these impacts for the purposes of land-use planning and biotechnical interventions in the landscape, which substantially affect protection of the soil against water and wind erosion, increased evapotranspiration and thus prevention of soil degradation.

Previous regression analyses evaluating the effect of meteorological and site conditions on the yields of selected crops indicate that the observed annual variability in the yields or quality of crops is the result of interactions between weather conditions and other factors, particularly nutrient stocks. The strongest relationship of weather indices to cereal yields can be found for temperature conditions in the April to June period and, for precipitation, over the vegetation and shorter periods.

The smallest differences in long-term moisture conditions between the individual altitude zones occur at the beginning of the vegetation period for all groups of soil types. This is generally caused by the great predominance of precipitation over evapotranspiration and the small variability of the former compared to the vegetation period. The greatest long-term acute deficit of soil moisture occurs at the end of the vegetation period for all groups of soil types. The least favourable situation in long-term moisture conditions in the vegetation period occurs in the lowest altitude zone to 200 m. a.s.l.; in contrast, the most favourable situation occurs in the highest vertical zone above 800 m.a.s.l. For most of the monitored parameters, significant differences occur amongst the various regions of the country; the least favourable situation is encountered in southern Moravia and around the Ohře River, while the best conditions were encountered around the Labe (Elbe) River and especially in central Moravia.

Evaluation of current conditions in stands of forest tree species is concerned primarily with monitoring the sensitivity of Norway spruce and red beech (*Fagus sylvatica*) to climate change, the reaction of stands with a predominance of Norway spruce to stress and determination of their regeneration potential. Evaluation was also carried out of the risk of occurrence of fungal pathogens and insect pests and their effect on the production and quality of wood mass and reduction of the value of the function of the forest for society as a whole. The subproject is also concerned with estimation of environmental risks entailed in disturbing the development of existing forest ecosystems with a predominance of spruce and indicative estimates of the potential economic losses in the production and quality of wood mass and detriment to the environment as a consequence of reduction of the value of the function of the forest for society as a whole for various scenarios of climate change.

In the final phase of the work, a summary will be made of the proposed sectoral adaptation measures (water management, agriculture and forestry) and their potential interconnection. The main output will consist particularly in recommendations for the government and local self-governing bodies in preparing adaptation measures and their management.

8.2.1.2 Climate atlas and regionalization of outputs of models of general atmospheric circulation for the territory of the Czech Republic

The R&D Project 740/2/03 of the Ministry of the Environment was carried out by the National Climate Program of the Czech Republic in 2003 – 2007 and was intended to

elaborate the climatography of the Czech Republic for the 1961 – 1990 standard climatology period.

The climate atlas of the Czech Republic was issued in printed form in March 2007 together with an electronic version on an accompanying CD. The publication contains more than 300 maps supplemented with graphs, tables, photographs and text in Czech and English. It is divided into 11 chapters containing climatic characteristics derived from basic meteorological factors (air temperature, atmospheric precipitation, snow cover, humidity, sunshine, solar radiation, wind direction and speed, soil temperature and selected atmospheric phenomena) and also processing of dryness indices, evaporation characteristics and air pressure. Basic phenological characteristics were also incorporated into the Atlas to illustrate climate characteristics.

The Atlas is characterized by a uniform selection of depictions and scales. Map scales of 1 : 1,000,000, 1 : 2,000,000 and 1 : 5,000,000 were proposed as principal scales and 1 : 3,000,000 as a supplementary scale. Preparation of a database of all the main features preceded map depiction of the climatic characteristics. Together with extensive control of the data, methodologies for supplementing and homogenizing time series of the processed factors were created or tested.

The geographic information systems, GIS, were used to create maps and estimates of the partial distribution of climatic factors. Statistical and interpolation processing methods were selected individually in relation to the character of the individual factors. The basic period for the processing was extended to forty years, 1961 – 2000, in order to ensure the topicality of the submitted information. The long-term view is supplemented by analysis of special (e.g. flood) situations recorded over the past 10 years.

8.2.1.3 CzechCarbo – study of the carbon cycle in the terrestrial ecosystem of the Czech Republic

Work on the R&D project 640/18/03 of the Ministry of the Environment in 2003 – 2007 at the Institute of Systems Biology AS CR in cooperation with the Institute of Forest Ecosystem Research, s.r.o.[37], the Forest Management Institute[38], the Faculty of Forestry and Wood Technology of the Mendel University of Agriculture and Forestry in Brno[39], the Czech Bioclimatology Society[40], the Applied Ecology Laboratory of the Faculty of Agriculture of the University of South Bohemia in České Budějovice[41], the Faculty of Agronomy of the Mendel University of Agriculture and Forestry in Brno[42], Czech Hydrometeorological Institute and ENKI s.r.o.[43] was concerned with study of the ability of landscape to bind carbon dioxide from atmosphere.

In the framework of the project, preliminary regional scenarios of anticipated climate change were prepared, the dependence of the processes of the carbon cycle on climatic conditions and other conditions in the environment was determined and research was performed on the possibility of targeted management interventions leading to an increase in the ability of

[37] www.ifer.cz

[38] www.uhul.cz

[39] www.ldf.mendelu.cz

[40] www.chmi.cz/meteo/CBKS/index.htm

[41] http://home.zf.jcu.cz/public/departments/lae

[42] www.mendelu.cz/af/

[43] http://www.enki.cz/

ecosystems to bind CO_2. The project contributed to knowledge of the current contribution of the landscape to the overall CO_2 balance and was also concerned with the potential for further development of the landscape in relation to means of land use.

A very important aspect of work on the CzechCarbo project consisted in its compatibility with the CarboEurope European integration project. The data obtained from the CzechCarbo project are fully complementary with the database of the CarboEurope project and thus it was possible to add outputs from this European database.

It is apparent from the results of the project that forest stands make the greatest contribution to absorption of atmospheric carbon dioxide, where the intensity of absorption depends on many factors, including the conditions in the environment, condition and structure of the vegetation and means of management. As the availability of water increases, the ability to absorb CO_2 also increases in meadow ecosystems. The development of phytoplankton, which also bonds carbon, is critical for the distribution of carbon in aquatic ecosystems.

The most likely climatic scenario for the Czech Republic was selected during the work. New experimental methods for measuring CO_2 fluxes were developed and tested and primarily the ability of spruce stands to absorb CO_2 in the current concentration (360 ppm) and twice this concentration (700 ppm) was investigated. The effect on selected tree parameters was also monitored (e.g. physiological processes, growth of biomass, tree stand structure). Meadows, wetlands and agricultural land are also objects of interest, where unique eddy-covariant networks are developed for measuring the carbon balance. Continuous measurement of CO_2 fluxes throughout the year were achieved and net ecosystem exchanges of this gas were calculated.

A method for quantification of the regional carbon balance system of these ecosystems was developed within the project. The methodology will be employed for more exact determination of emission balances for exploiting of the landscape and forestry, as an integral part of compliance with the obligations of the State following from the UN Framework Convention on Climate Change and its Kyoto Protocol. Trends in carbon stocks are analyzed using several types of models, which are capable of including key ecosystem processes, the effect of climate changes and management strategy. In addition, a process model was selected, modified and verified to stimulate the distribution of energy, and the water, nitrogen and carbon cycles in ecosystems. Data on flora and wetland species participating significantly in carbon absorption were added to improve the means of management of ecosystems.

8.2.1.4 Evaluation of the 2006 spring floods in the Czech Republic

Work on the project of the Ministry of the Environment is performed by the T.G. Masaryk Water Research Institute, v.v.i. and also encompasses the subproject Assessment of the effect of inundation from the Labe River in the Přelouč – Ústí n. L. section on the progress of the hydrogram in the 2006 floods. The objective of the subproject consists in preparation of a methodology concerned with development of hydraulic models that would enable calculation of nonstationary flow-through and water level regimes on medium-sized and large water courses under the conditions of controlled outflow. The principles of development of the methodology favour greater generality of its implementation under the actual conditions encountered by the administrators of water courses or hydro-forecasting services so as to create user-accessible instruments for proposing various scenarios of flood prevention measures along the water courses and support provided in managing hydrotechnical sites on water courses along the Labe water route.

The study was performed using the HEC-RAS ver. 3.1.3 and HEC-GeoRAS 4.1 systems, which form a set of procedures and instruments suitable for deriving the geographic and

hydraulic characteristics of the river network and can provide information for automatic creation of a hydraulic constant-flow model. The input time series and results of the calculation are processed and stored using the HEC-DSSVue database, which is also compatible with another means used by advanced designers, USACE HEC. When combined, these means provide an instrument for simulation analysis of the flow-through and water-level regimes, for monitoring the potential for affecting these factors, for quantitative expression of the protective effect of the water course and valley floodplain during floods, for simulation of technical measures and for stipulation of basic information for flexible management and for long-term planning from the standpoint of flood protection and land-use planning.

8.2.1.5 Research and Development projects performed by the Hydrology Department of the T.G.M. Water Research Institute v.v.i.

The department maps the impacts of climate change on selected individual river basins (e.g. the river basins of the Metuje, Blšanka and Sázava rivers) and also on large river basins (Vltava, Labe, Morava, Odra and Ohře rivers). The impacts of climate change are monitored from the standpoint of changes in the development of climatic factors (air temperature, precipitation, relative humidity) and also from the standpoint of the hydrological characteristics (total outflow, basic outflow, amounts of stocks of groundwater, water stocks in the snow cover, magnitude of evaporation, evapotranspiration, etc.). In addition to studies concerned with the impacts of changes on surface waters, studies are also being carried out in relation to groundwater stocks. Over the past two years, emphasis has also been placed on study of the dependence of water temperature on air temperature and the impacts of hydrological drought on water balance and variability of the occurrence of hydrological drought in relation to on-going climate change. The BILAN model is employed to analyze the impact of changes on components of the hydrological balance; its outputs are also used to analyze the impact of changes on water sources through a model of the water management system.

Regional studies have shown that the magnitudes of temperatures derived from regional climate change models for the time period of 2070 -2100 are quite variable during the year. All the considered scenarios agree on maximum warming in August (5 – 7 ^{o}C), minimum warming in the January – March period (1 – 4 ^{o}C) and the air temperature should increase on an average by 2.5 – 5 ^{o}C. There are also differences between the estimated maximum and minimum average monthly temperatures, attaining values greater than 10 ^{o}C in January and February, while this difference is generally up to 5 ^{o}C in August. A fundamental change in annual total precipitation cannot be expected under the conditions in this country; however, the anticipated change in the annual precipitation regime is very significant (increased total precipitation in the December to March period by 20 – 50%, with reduction by the same amount in the June to September period).

Run-off is affected most by the distribution of precipitation during the year, and the change in air temperature and dew point temperature. According to the “pessimistic” scenario HIRHAM A2, run-off will decrease in major river basins by approx. 40%; this figure corresponds to 10 – 15% in the “optimistic” scenario RCAO B2. Even more dramatic reductions will occur in smaller river basins.

8.2.1.6 Assessment of the increase in climatic drought in agriculture

The project was part of research project NAZV – QF3100 of the Ministry of Agriculture, carried out in 2004 – 2008 by the Czech Hydrometeorological Institute and was concerned with evaluation of the increase in climatic drought in agriculture and mitigation of its consequences through irrigation in areas endangered by climatic drought. The results of the

project consisted in preparation and practical verification of new indicators of drought stress in the territory of the country, which was termed the "meteorological potential drought index". Its can be useful for governmental bodies, especially when drought with serious economic consequences occurs. Apart from climatological parameters, initial stocks of moisture prior to the beginning of the calculation period are also taken into consideration.

The project also included a forecast study, concerned with estimation of expected drought in the time periods to 2025, 2050, 2075 and 2100. The estimates were made using two hydrothermal coefficients, the values of the reference evapotranspiration scenarios of the two most frequently used global circulation models of the climate HadCM3 and NCAR. The results of the models indicated various differences, where the lack of agreement was a result of the very different conception of trends in air humidity in the two models. HadCM3 combined with a high temperature increase predicts a moderate increase in air humidity with a consequent increase in saturation deficit and increase in evaporation. The NCAR model together with a slightly smaller temperature increase simultaneously also assumes a progressive increase in air humidity with a consequent reduction in the saturation deficit and reduction in evaporation. This is augmented by the different predictions of precipitation for the two models, where HadCM3 assumes a substantial reduction in the summer and NCAR tends to anticipate stagnation. According to NCAR, the climatic water balance is more favourable and the occurrence of drought less likely (less than at the present time), while HadCM3, on the other hand, assumes a substantial increase in the probability of the occurrence of drought above current levels, especially in the second half of the summer.

8.2.1.7 Care for the soil under the conditions with increased demands on protection of the environment.

Research project of the Ministry of Agriculture No. 1G57042 performed by the Research Institute of Agricultural Engineering, v.v.i.[44] consisted in obtaining information to form a basis for choice of suitable systems of soil management (variant technologies of soil working, use of intermediate crops, management of post-harvest residues) and care for the soil, including remedial measures, taking into account agro-ecological conditions.

The results indicated that various intensities of soil treatment affect the storage of carbon in the soil and its release into the atmosphere. The effect of various means of soil treatment on the state of soil organic material is apparent only after a longer time. Intensive soil treatment generally leads to greater release of CO_2 into the air and lower formation of humus. Under drier and warmer conditions in maize and sugar-beet production areas, a positive effect of reduced soil treatment on the content of oxidizable carbon in the soil was observed. Under the wetter and cooler conditions in potato production areas, ploughed land exhibited a higher content of oxidizable carbon; however, the determined qualitative humus parameters indicated better "effectiveness" of the humification process when using technology without ploughing.

Different ability of the soil to accept water from precipitation and different resistance of the soil to water erosion were observed in the individual variants of the experiments at sites with loamy soil. For the direct seeding variant under these conditions, very good ability to accept water was found in simulated precipitation of large intensity. The important function of macropores in the soil in this variant and the favourable effect of dead biomass from the preceding crop on the surface of the soil were manifested for the variant of seeding unworked soil, from the standpoint of the effect on the erosion resistance of the soil.

[44] www.vuzt.cz

A reduction in the consumption of diesel fuel in working the soil when employing the technology of replacement of ploughing by shallow loosening of the soil (minimization technology) can also have a connection to the impact on climate change. When minimization technologies of soil working are employed, diesel fuel is saved in an amount of 14 to 20% per hectare of cropland; minimization of soil working is used in this country over 1 to 1.2 mil. ha of cropland annually in this country. The savings in automotive fuels is outweighed, from the standpoint of costs, to a major degree by the necessity of increasing expenditures for pesticides. The environmental benefit of minimization technologies in this connection lies in limiting the production of exhaust gases connected with reduced consumption.

8.2.1.8 Ecological and economic evaluation of the function of the variants of forest structural types for society as a whole

The R&D project Sp-2d3-56-07 for 2007 – 2011 carried out by the Institute of Landscape Ecology of Mendel University of Agriculture and Forestry in Brno is a modification of the method of quantification and quantitative evaluation of the function of forests for society as a whole for the conditions of variant forest structures, i.e. both multi-structural forest stands and for forests in age classes. Work on the project is based on a comprehensive analysis of the functional structure of the forest ecosystem, i.e. the presence of the individual components, processes and dynamics and levels of anthropic influence.

Special attention is paid to analysis of the effect of stand structure on the current functional effects of forest stands. The amount of carbon bonded in the above-ground and underground biomass of forest stands is investigated as a possible mechanism for determination of the bioproduction function of forest stands in the project. The principle of binding of carbon in forest ecosystems is affected by two main functional groups, the bioproduction function and the edaphic-soil protection function, which then affect one another. There are also other indirect connections to the health and hygiene function and the hydric-water management function. However, under the current state of the art, complete datasets cannot be used for the spectra of forest conditions in the Czech Republic. Consequently, the position of the classification of carbon stocks in the system of forest functions is accented and evaluated as a subcategory taking into account the system of functions of forest ecosystems. The evaluated unit is a type of stand (tree species composition) within the management set of a specific stand group.

Analyses of the amplitudes of the amount of carbon bound in the soil and in the above-ground biomass and determination of the above mentioned criteria in functional value levels on the basis of functional intervals were performed in connection with establishment of the working procedure for incorporation of the function of binding carbon in the forest ecosystem.

This individual part of the work is methodically connected with R&D project 640/18/03 - CzechCarbo.

8.2.1.9 Assessing the increase in climatic drought in agriculture and mitigation of its consequences by irrigation

The Ministry of Agriculture project No. QF3100, carried out in the Research Institute of Ameliorations and Soil Conservation v.v.i.[45] in cooperation with the Czech Hydrometeorological Institute and Mendel Agriculture and Forestry University in Brno, was concerned with delimiting areas endangered by climatic drought at the present time and in case of climate change, with preparation of a methodology for determination of drought stress

[45] www.vumop.cz

in the territory of this country by monitoring the impacts of potential climate change on the occurrence of drought.

Similarly, the project encompassed determination of the requirements for water for irrigation in relation to soil properties, annual requirements on irrigation water of agricultural crops and the occurrence of water deficits in their critical development stages in the driest parts of the country. The analyses evaluated the period from 1961 to 2000 and the outlooks to 2030, 2050 and 2075. The results determined for the driest parts of the country show that the maximum number of consecutive days with soil water contents below the lower limit for soil water contents Θ_Z determined in stages that are very critical for water for all the selected crops is very high, especially for a probability of exceeding the critical value of 60%. This serious lack of soil water as a result of drought in approx. 24 years of the forty-year period of 1961 – 2000 substantially reduces the yields of crops in unfavourable years. The results were based on evaluation for medium-heavy soils; they would be even less favourable for lighter soils.

One of the accompanying effects of the anticipated climate change lies in the potentially more frequent occurrence of meteorological drought – most of the methods were devoted to evaluation of this phenomenon. Other categories of drought occur as a consequence of meteorological drought, i.e. for example, hydrological drought, agricultural drought, etc. At the present time, no suitable methods are available for evaluation of agricultural drought. The results of the project propose a new evaluation method, which was used for evaluation of the hypothesis of the recent increase in the occurrence of agricultural drought in the Czech Republic. The research was concerned with the areas around Žatec, Louny and Litoměřice, central and eastern Bohemia and central, southern and south-eastern Moravia. These areas are located in the driest parts of the country, where the increase in agricultural drought through climate change should appear soonest. The evaluation method is based on the fact that the magnitude of consumption of irrigation water is directly proportional to the magnitude of the agricultural drought, i.e. the greater the requirement for irrigation water during the year, the greater the agricultural drought of the year.

8.2.2 Information on the most important research projects with international participation

Global climate models (GCM) quite reliably reproduce the basic climatic characteristics on a global and continental scale, but their precision and thus predictive ability are greatly limited on transition to a regional or local scale, which is essential for a qualified estimate of the impacts of climate change. The inadequate resolution of GCM is a problem especially for ground-level characteristics and especially for parameters depending on a complicated combination of physical processes (precipitation, extreme values of climatic factors). GCM have the advantage that they provide an instrument for global tasks in research on climate change, so that broad international cooperation (e.g. in the framework of IPCC) currently yields entire sets of results for many GCMs, enabling a certain estimate of the probability of the particular results.

Downscaling methods are employed for the transition to smaller (regional, local) units. In addition to statistical downscaling, dynamic downscaling is currently very broadly used; this employs the technique of the analogous method commonly used in dynamic forecasting methods, i.e. immersion of the model for a delimited area with greater resolution into the global model with lower resolution. This approach, i.e. regional climatic modeling, would seem to be more correct from the standpoint of description of the physical processes, but is far more demanding on computing capacity. Emphasis on a certain selected area is a limiting

factor in relation to cooperation, so it is not an easy matter to obtain a set of results from several models for statistical estimates.

The Faculty of Mathematics and Physics of Charles University, the Czech Hydrometeorological Institute and the Institute of Atmospheric Physics of the AS CR[46] participate in the international projects mentioned below and described in Chapters 8.3.1 to 8.3.4. In relation to experience with the ALADIN forecasting model, its climatic adaptations are employed in the projects. In addition to validation experiments controlled by ERA 40 Re-analyses, the climatic experiments were also performed using the boundary conditions from the ARPEGE model (for the ALADIN-CLIMATE/CZ model) and RegCM@25km/ECHAM5 for IPCC SRES scenario A1B. The 1961 – 1990 (or 2000) period was used as the control period and projections of climate change are simulated for the future periods 2012 – 2050 and 2071 – 2100, in which the impacts of climate change are also analyzed. Impacts on air quality constitute an exception; because of the great demands of the simulation, this factor is calculated only for the last decade of the analyzed period.

8.2.2.1 CECILIA

The object of the CECILIA[47] project (EC FP6 STREP No. 037005) - *Central and Eastern Europe Climate Change Impact and VulnerabiLIty Assessment* – carried out in the 2006 – 2009 period and coordinated for the Czech Republic by the Faculty of Mathematics and Physics of Charles University, was to evaluate the impacts of climate change in Central and Eeastern Europe with emphasis on provision of a scenario for climate change with very high resolution on the basis of local simulations of regional climate models. High-resolution models (10 km) provide a more realistic approximation of the modeled terrain to the actual terrain and thus allow more precise results for the climatic parameters in the given region to be obtained.
Climate simulations in the CECILIA are currently completed and finalization of the impact studies utilizing high spatial resolution of the scenario of climate change is expected to be completed by the end of the project (December 2009). The selected economic sectors for which the analysis of the impacts of climate change is performed encompass agriculture, forestry, the hydrological cycle, water quality and air quality, of course in the areas of interest in Central and Eastern Europe.

8.2.2.2 ENSEMBLES

The *ENSEMBLE-based Predictions of Climate Changes and their Impacts*[48] (EC-FP6 IP No. 505539) project, carried out in the 2004 – 2009 period, is coordinated in the MetOffice (Great Britain) and is intended to employ regional climate modeling to provide a probability "projection" of the development of climate change in greater resolution for the area of Europe using the method of combination of the results of 15 regional climate models, weighted on the basis of the developed method to yield the resultant probability distribution for some climate parameters.

8.2.2.3 QUANTIFY and ATTICA

The QUANTIFY[49] – *Quantifying the Climate Impact of global and European Transport Systems* (EC FP6 IP No. 003893) project, carried out in 2005 – 2010, is coordinated in DLR (Denmark) and is concerned with quantification of the impact of emissions from transport on

[46] www.ufa.cas.cz

[47] www.cecilia-eu.org

[48] www.ensembles-eu.org

[49] http://www.pa.op.dlr.de/quantify/

climate change. The Czech workplace (Faculty of Mathematics and Physics of Charles University) participated in the project primarily through a contribution to the modeling of spreading of ship emissions and chemical processes in the smoke trails of ships or shipping corridors. In connection with the parallel project 6.RP EC ATTICA[50] *(European Assessment of Transport Impacts on Climate Change and Ozone Depletion,)* evaluation of the impact of transport emissions on climate change is being prepared in relation to possible developments in connection, not only with climate change, but also with possible technologies.

8.2.2.4 MEGAPOLI

The MEGAPOLI[51] project – Megacities: Emissions, urban, regional and Global Atmospheric POLlution and climate effects, and Integrated tools for assessment and mitigation (EC FP7 CP No. 212520) , carried out in 2008 – 2011, is coordinated in DLR (Denmark) and is concerned with the aspect of the largest urban agglomerations and their impact and interactions with climate change. The Czech workplace (Faculty of Mathematics and Physics of Charles University) participates in regional climatic modeling of selected areas with high resolution in order to study the impact and interactions of climate change and air quality.

8.2.2.5 WATCH

The WATCH – *WATer and global CHange (*EC FP6) project, carried out in 2007 – 2010, with participation by the T.G. Masaryk Water Research Institute, v.v.i., is intended to describe the current water cycle, analyze predictions for the 21st century, find a relationship between the driving forces and global change, provide a detailed estimate of the risk connected with the climate and hydrology and develop a new consistent model framework for evaluation of water sources, hydrology and the climate.

In the initial phase, developments in the dry period in time and space were determined under the conditions of climate change using the BILAN model in daily and monthly steps using testing river basins with different characters – the Metuje river (cretaceous water basin with deep circulation of groundwater) and the Sázava river (river basin in the Crystallinicum with less important sources of groundwater). The results consist in changes in the long-term average values for the components of the hydrological balance as a consequence of climate change. The model was also used to simulate input data for the model of groundwater flow, MODFLOW. This method was employed to investigate the possible consequences of climate change for the groundwater levels. The impacts of climate change on water sources in these river basins will be studied in the coming years.

These projects are related to the results of a number of Czech projects.

8.3 Systematic observations

Systematic observations, which are directly connected to the subject of climate change, are provided mainly through the Czech Hydrometeorological Institute which, in connection with Act No. 219/2000 Coll., on the property of the Czech Republic and acts thereof in legal relations, and according to the founding document of the Ministry of the Environment of 2004, acts as the central State institute for the areas of air purity, hydrology, water quality, climatology and meteorology.

[50] http://www.pa.op.dlr.de/attica/

[51] http://megapoli.dmi.dk/

Its activities also encompass establishment of a state monitoring and observation network for monitoring the quantitative and qualitative condition of the atmosphere and hydrosphere and the causes leading to their pollution and damaging, processing of the results of the observations, measurements and monitoring while complying with the principles of the legislation of the European Communities, creation and administration of databases for the field and provision of up-to-date information on the state of the atmosphere and hydrosphere, including forecasts and warnings relating to dangerous hydrometeorological phenomena.

In the sense of its authorization and in connection with climate change, CHMI acts as the regional telecommunication centre in the World Weather Watch system coordinated by WMO, as the national reference centre for Hydrological Operational Multipurpose System of WMO, as the authorized professional entity for determining and evaluating the state of surface and groundwaters, the authorized professional entity for drawing up the hydrological balance, the meteorological calibration laboratory and the workplace of the flood forecast service.

A good database and its administration form the fundamental basis for all activities connected with protection of the climate of the Earth. The former globally employed database system CLICOM is no longer capable of comprehensive processing of all kinds of systematic observation of the Earth's atmosphere. Consequently, the developed countries, including the Czech Republic, are working on development and improvement of modern databases, permitting integration of the available methods of observation and their coordination with similar activities on an international scale.

The programme database of the CLIDATA[52] system was created through cooperation between CHMI and ATACO s.r.o. in Ostrava and has been highly praised by WMO. The Czech CLIDATA programme system is based on the modern ORACLE[53] database environment. It enables users easy transition from older database systems, especially the internationally used CLICOM system. Work with the CLIDATA system is lucid and comprehensible, but is protected against unauthorized access to the application. One of the main objectives in creating this system was maximum safeguarding of information contained in the database. It allows connection of the database with the geographic information system (GIS) and this connection can also be used to control data for other applications. The CLIDATA programme system was developed so as to enable simple creation of language mutations.

In connection with the increasing weather extremes and their manifestations in recent years, the warning system has been further improved on the basis of the innovated Integrated Warning Service System in the Czech Republic. This system includes forecast warning information on 26 dangerous phenomena and each phenomenon is awarded a danger level (low, medium, extreme). Information on the occurrence of dangerous phenomena is issued for five phenomena with extreme levels of danger[54]. A large number of stations with operative presentation of measured data and forecasts have been placed on the web site of the reporting and forecasting flood service[55]; the new version of presentation is more suitable for the needs and requirements of users.

In the framework of the Global Climate Observing System (GCOS), the Czech Republic participates only in meteorological atmospheric observations GCOS: in the network of GSN

[52] http://www.chmi.cz/OS/metspol/prednasky/Zidek_Operativni_vyuziti_DB_a_CLIDATA.pdf

[53] http://www.ataco.cz/clidata-web/introduction/introduction.jsp

[54] http://pocasi.chmi.cz

[55] http://hydro.chmi.cz

ground-level stations at the Milešovka observatory, in the GAW network at the Hradec Králové CHMI Solar and Ozone Laboratory and at the CHMI observatory for monitoring the quality of the natural environment on a regional level, located in Košetice. All three observatories adhere to the principles of climate monitoring introduced in GCOS/GOOS/GTOS. It has also been increasing international activities in the last few years. For example, the 15th congress of WMO supported the Intergovernmental GEO – *Group of Earth Observations,* of which the Czech Republic became a member in 2006. The programme of GEO encompasses the GEOSS programme – *Global Earth Observations System of Systems.*

The CHMI workplace in Hradec Králové acts as the European Dobson spectrophotometry calibration centre and, together with the workplace of the Slovak Hydrometeorological Institute, is also active in the area of measuring ozone and solar radiation levels. In 2007, the Czech Republic became a co-working member of the METEOALARM project of the EUMETNET (*Network of European Meteorological Services* organization. The project, which is available at the website[56], provides a rapid survey of warnings against dangerous meteorological phenomena in Europe

The 15th congress of WMO also favourably evaluated Czech foreign assistance to developing countries in meteorology and hydrology, as assistance is in increasing demand in creation of climatological database[57,58], where the CLIDATA system is currently one of the most widely recognized and best in the world.

[56] http://www.meteoalarm.eu

[57] http://www.ataco.cz/clidata-web/events/events.jsp

[58] www.**wmo**.ch/pages/prog/wcp/wcdmp/html/Mission%20Report%20Agrhymet.doc

9 Communication, education and public awareness

9.1 General policy

The international basis for the national policy in the area of environmental education and awareness (hereinafter EE&A) consists particularly in Chapter 36 of Agenda 21, the Aarhus Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters, to which the Czech Republic acceded in 1998 and ratified in 2004, and the UNECE Regional Strategy on Education for Sustainable Development, adopted in 2005 in the framework of the UN Decade of Education for Sustainable Development, 2005 – 2014.

The obligation to develop EE&A is regulated by several laws, the most important of which is Act No. 123/1998 Coll., on the right to information on the environment, and Act No. 561/2004 Coll. - the Act on Schools (for more details, see Chap. 9.6 Related education).

The State Environmental Policy 2004 - 2010 is the basic, strategic and cross-cutting document for preparation of detailed programmes on the individual components of the environment, including climate change. The most important measures of the State Environmental Policy in the area of EE&A include:

- Introduction of obligatory environmental education at elementary schools.
- Promotion of dissemination of information on:
    a. the assumptions and principles of sustainable development
    b. the right to information on the environment
    c. considerate behaviour towards nature and natural resources in all their favourable and unfavourable aspects
    d. sources of pollution by hazardous substances
    e. renewable energy sources and energy savings
    f. training the public in precaution related to chemical substances.

The Strategy of Sustainable Development in the Czech Republic formulates protection of the climate system of the Earth as one of its primary environmental pillars of sustainable development. “The introduced system of environmental education towards a sustainable development starting from pre-school education” is considered to be a strong aspect. Simultaneously, it emphasizes the necessity of “improving environmental communication, education and public awareness in the area of changing patterns of behaviour, production and consumption”, which necessarily requires “enabling the public to have access to relevant information, to actively promote environmental communication at all levels of education and environmental awareness”.

The basic strategic EE&A documents are related to these broader documents concerned with environmental policy and sustainable development:

- The State EE&A Programme of the Czech Republic (Government Resolution No. 1048/2000). The main objective of the programme is to raise awareness and knowledge of the environment amongst the population, education towards a sustainable development and public participation in environmental matters.
- The Action Plan of the State EE&A Programme for 2007 – 2009 (Government Resolution No. 1155/2006) and the previous Action Plan for 2004 – 2006.

- The Strategy of Education for Sustainable Development in the Czech Republic (Government Resolution No. 851/2008).

Key documents in the area of school environmental education and awareness are:

- the Methodical Instruction of the Ministry of Education, Youth and Sports on EE&A – updated in October 2008 (replaces the older document of December 2001).
- Individual framework educational programmes (see below), which newly introduced education on the environment as a compulsory cross-cutting subject for all types and levels of schools.

The Intersectoral Agreement on cooperation in the area of environmental awareness, education and communication was concluded between the Ministry of the Environment and the Ministry of Education, Youth and Sports in 2004 and was updated and specified by addenda in 2007. Both ministries emphasize environmental education, communication and public awareness as a multidisciplinary instrument providing information, facts, knowledge and skills and creating a responsible relationship and behaviour of individuals towards the environment. An Intersectoral EE&A working group has been established at the Ministry of the Environment.

The Government Council for Sustainable Development (hereinafter the Council) was established by Government Resolution No. 778/2003 as a permanent consulting, initiative and coordinating body of the Government of the Czech Republic for the area of sustainable development and strategic management. The Statute of the Council was approved in Government Resolution No. 836/2003. The members of the Council consist in representatives of the central governmental bodies, local governments, social partners, academic communities and the nonprofit sector. The council prepares, coordinates and monitors implementation of the principles of sustainable development in achieving dynamic equilibrium of its economic, social and environment components. A Working Group for education for sustainable development was created within the Council in connection with the preparation and implementation of the Strategy of education for sustainable development in the Czech Republic.

The regions have become important actors in EE&A in recent years. The level of provision for and support for EE&A differs in the individual regions, but all the regions have adopted a regional conception of EE&A and most of them have created systems of financing EE&A.

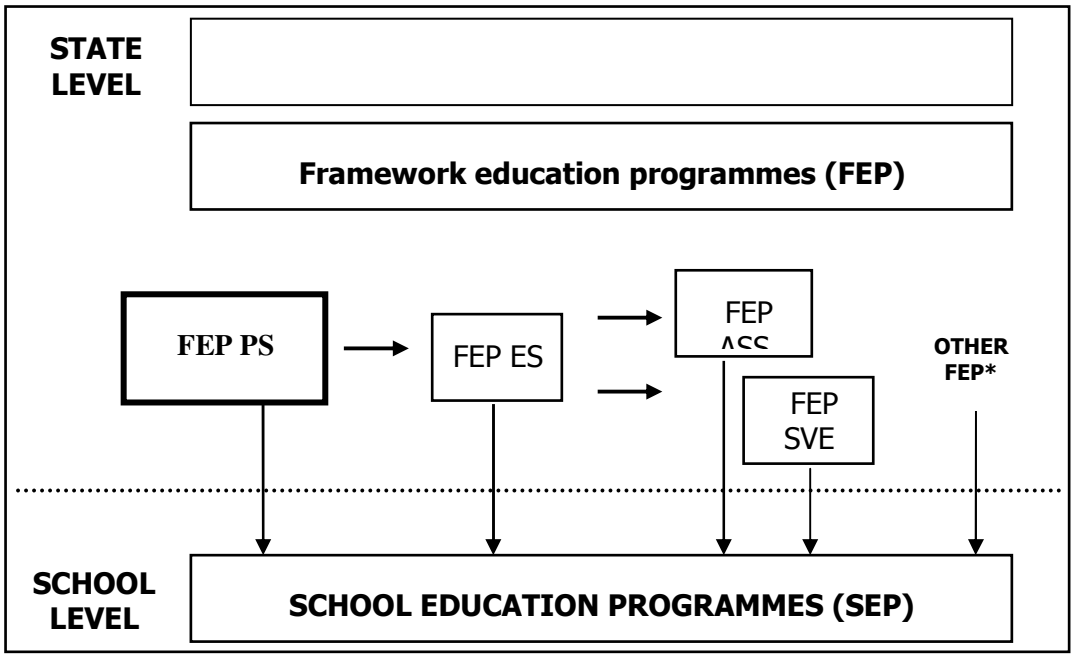
9.2 The education system

EE&A is part of the National Programme of Development of Education in the Czech Republic – the White Paper (2000). One of the targets of the programme consists in education in environmental protection in the sense of providing for sustainable development in society. The Act on Schools of 2004 stipulates acquiring knowledge of the environment and its protection based on the principles of sustainable development as one of the components of a general education. The Strategy of Lifelong Learning, adopted in 2007 by Government Resolution No. 761, mentions, in the main strategic directions, social partnership, intended to promote harmonization of the supply of educational opportunities with the needs of economic, environmental and social development and also contains proposals for measures that emphasizes sustainable development. The long-term plan for education and development of the educational system in the Czech Republic was also adopted in 2007 in Government Resolution No. 535. It also contains proposals for measures emphasizing sustainable development and describes the reasons for reform steps in education, based, amongst other things, on the role of education as a guarantee of sustainable development.

9.2.1 Formal education

In accordance with the new principles of curriculum policy formulated in the White Paper and new Act on Schools, a new system of curriculum documents for education of children from the age of 3 and pupils aged 6 to 19 years is being introduced into the educational system. Curriculum documents are created at two levels – state and school. Framework educational programmes (hereinafter FEPs) constitute the central level of the curriculum system. FEPs delimit a binding framework of education for the individual stages and types of education (for preschool, elementary, secondary academic and secondary vocational education). The school level corresponds to school education programmes, according to which education is provided at the individual schools. Each school creates its own school environmental programme according to the principles laid down in the FEP. Framework and school education programmes are public documents available for the pedagogical and general public.

Fig. 9.1 System of curriculum documents



Legend:
FEP PS – Framework education programme for preschool education; FEP ES - Framework education programme for elementary education; FEP ASS – Framework education programme for academic secondary schools; FEP SVE -- Framework education programme(s) for secondary vocational education.

** Other FEP – framework education programmes that, in addition to the above, are defined by the Act on Schools - Framework education programme for basic artistic education, Framework education programme for language education, and others, as appropriate.*

Source: The Ministry of Education, Youth and Sports

Framework education programmes include cross-cutting issues that are concerned with education and training of students in selected socially important and topical areas. These aspects are a compulsory part of FEP.

Cross-cutting subjects in FEP for elementary, secondary academic and secondary vocational education also encompass subjects that are important for education on climate changes – especially Man and the Environment (in FEP secondary vocational education) and

Environmental education (in FEP elementary education and FEP secondary academic education, and also, e.g., Education in thinking in a European and global context.

A methodical web site[59] has been established to support schools and pedagogues in creating and planning school education programmes, including sections concerned with cross-cutting subjects, including EE&A for the individual FEPs.

The Methodical Instruction of the Ministry of Education, Youth and Sports on EE&A in schools and educational facilities, which replaced the previous one of 2001, was also updated in 2008. This document describes in detail the system of environmental education in schools and educational facilities; it also introduces and describes the function of the school coordinator of EE&A and recommends how to plan and incorporate EE&A into school documents, etc.

Preschool education

Since September 1, 2007, all kindergartens have worked according to their own school education programmes created on the basis of the updated version of the Framework education programme for preschool education, which came into effect in 2004. The environmental area is one of five basic areas in which individual targets and outputs of preschool education are set.

The national Mrkvička (Little Carrot) network (with participation of approx. 770 kindergartens in all the regions) has been in existence since 2007 for kindergartens that are interested in EE&A. A wide range of environmental educational programmes of environmental education centres is available for kindergartens, supported, for example, by the joint programme of the Ministry of the Environment and Ministry of Education, Youth and Sports National network of EE&A centres.

Elementary education

The Ministry of Education, Youth and Sports issued an FEP for elementary education in 2004, with validity from 2005. Environmental education appears in the FEP for elementary schools at the level of key competences, targeted educational areas (educational goals), outputs and teaching in some fields of education and is simultaneously a cross-cutting subject that must be included at levels 1 and 2. According to the conditions for school integration, cross-cutting subjects can be included in various subjects in the form of projects or courses and also in the form of an independent subject concerned with the environment.

Several hundred elementary schools interested in EE&A are associated in the M.R.K.E.V. network –Methodology and Implementation of Comprehensive Environmental Education (coordinated by the Pavučina association of environmental centres), in the Environmental Education Club and a number of school environmental projects – national and regional. The best known are the Ekoškola project (Tereza Association) and the School for sustainable life (SEVER Partnership Foundation and Environmental Education Centre). A wide range of aids, publications and also environmental educational programmes provided by lecturers from environmental education centres are available for elementary schools. These are either short programmes for several teaching hours or several days long with accommodation in the centres. They are supported by National network of EE&A centres, a joint programme of the Ministry of the Environment and Ministry of Education, Youth and Sports, and, as appropriate, by the regions and cities. Examples of these programmes related to protection of the climate include, e.g., the "Solar energy is most moral" and "There is only one Earth" programmes, intended for grades 6 – 9 of elementary schools and secondary schools,

[59] http://www.rvp.cz/

particularly for teaching of geography, the natural sciences, civic education and physics (SEVER Environmental Education Centre), "You too control the Earth" (Čtyřlístek Zlín) and the several-day programme "Week for sustainable life" (SEVER Environmental Education Centre and Rychta Krásensko) and "Seven colours of the rainbow" (Sluňákov Environmental Education Centre).

Secondary education

FEP are also gradually being introduced for higher academic schools and the individual fields of secondary vocational education. They all include the cross-cutting subjects "Environmental education" (academic secondary schools) and "Man and the environment" (secondary vocational education). At present, there are 8 fields of study at 26 secondary schools, with emphasis on protection of the environment, protection of the landscape and industrial ecology. Similar to elementary schools, some of the secondary schools are also associated in the M.R.K.E.V. network, in the Environmental Education Club and in school environmental projects, based on one-day and several-day environmental education programmes (in addition to the above-mentioned , e.g., the Střevlík centre in the Liberec region offers special several-day programmes for secondary schools under the name "Mosaic of the Earth".

University education

Over 100 fields of study at universities are concerned with ecology and protection of the environment. The study programmes also include post-gradual studuies in these university subjects.

The potential for an interdisciplinary approach and cooperation amongst universities is amongst the basic EE&A subjects at the university level. Consequently, the "Forum of University Teachers: Education for a sustainable future" has been established following the initiative of the Environment Centre of Charles University in Prague. The Forum is intended to permanently contribute to clarification and creation of the content, extent and methods of education for sustainable development and provision for mutual awareness of the activities of the individual members, and to strengthen cooperation in preparation of courses, lectures, textbooks, research work and projects.

The university training of future teachers deserves special attention – there are 26 universities in the Czech Republic that perform this function. EE&A forms a part of the study programmes of some of these universities (e.g. Masaryk University in Brno, Palacký University in Olomouc, partly Charles University in Prague). However, it has so far not been possible to ensure that all future teachers undergo training in the area of EE&A.

The Ministry of the Environment promotes a competition for the best thesis in the area of protection of the environment. The Czech Republic also employs some of the EU educational programmes for university students, such as SOKRATES, LEONARDO etc.

Further education of pedagogical workers

Further education of pedagogical workers is also an important area. The Ministry of Education, Youth and Sports is responsible for integration of the elements of environmental education and awareness into the post-graduate education of pedagogues. A number of NGOs and educational facilities offer certified EE&A seminars and courses for pedagogues lasting from several hours to several dozen hours.

In 2006 – 2008, over 250 school EE&A coordinators were trained in several rounds of specialized EE&A courses (organized, e.g. by SSEV Pavučina, the Lipka Brno Educational Facility for Environmental Education, the SEVER Environmental Education Centre and the

Club of Environmental Education). New terms of these courses are being open and the number of organizers is gradually growing.

The funds from the Operational Programme for Development of Human Resources from the European Social Fund was a significant source of support for education of pedagogues in EE&A.

9.2.2 Non-formal and informal education

The education system (and thus also EE&A) encompasses both activities taking place at schools and educational facilities (formal education) and also in employers' facilities of, private educational institutions, NGOs, school facilities and other organizations (non-formal education), as well as unorganized, every-day experience and activities at work, in the family, during free time, interactions with society and nature and through the influence of the media (informal learning).

The State EE&A programme and the regional EE&A conceptions also pay great attention to education of various target groups. Here, emphasis is placed especially on education in the public administration and the business sector. The Ministry of the Environment has prepared an e-learning programme for education of government employees on the subject of environmental education and awareness. The subject of the environment forms a part of some courses of the Institute for Local Administration in Benešov (national training center, where examinations of the professional qualifications of government employees are also held) and of the Office of the Government. NGOs, such as the National Network of Healthy Cities and the Czech Environmental Management Centre[60] (CEMC) also provide some training. The training is related to legislation, EMAS, ISO standards, cleaner production, voluntary agreements, waste management, packaging technology, chemical and hazardous substances, monitoring, modern technologies, foreign and domestic experience, work with the public, codices and charters in this sphere, etc. CENIA, the Czech Environmental Information Agency is also authorized to act as the National Cleaner Production Centre.

A wide range of extracurricular education for children and young people is available, with participation of numerous of school facilities and NGOs.

At present, great emphasis is placed on public participation in decision-making on environmental matters and community cooperation. Some NGO's are concerned with support of civic participation in environmental issues. The public is invited to participate in the creation of some important documents, which are, in the preparatory stages, placed on the web site of the Ministry for public discussion and comments (e.g. the State Programme of Environmental Education and Awareness in the CR, etc.). The Green Circle, as an umbrella and service organization associating over 20 member organizations, is the contact point for comments on draft documents submitted by the Ministry of the Environment.

NGO's also play an important role. Greenpeace[61], the DUHA Movement[62], the CZ Biom Association[63], etc. are systematically concerned with the subject of climate change.

Support for EE&A related to climate change is also provided by some important foundations, such as the Partnership Foundation, the Foundation for the Development of a Civic Society, the

[60] http://www.cemc.cz

[61] http://www.greenpeace.cz

[62] http://www.hnutiduha.cz

[63] http://www.czbiom.ecn.cz

Via Foundation and the Open Society Fund, and also regional foundations – for example, the Foundation for the Jizera Mountains and the Community Foundation of *Ústí nad Labem.*

Governmental institutes in the area of the environment participate in environmental education of the general public – in addition to the Ministry of the Environment (see below), also the Regional Authorities, Administrations of Protected Landscape Areas and National Parks, CENIA, the Czech Environmental Information Agency, the Nature Protection Agency and some other institutions, such as universities and institutes of technology, professional scientific institutes, medical or enlightenment and cultural educational facilities, some tourist centres, etc.

An important role is played by public-service media which, in addition to specialized programmes and news, also have regular programmes concerned with the environment (e.g. the *Zeměžluč (Earth bile)* programme on Czech radio and *Nedej se (Don't give in)* on Czech Television).

In addition to periodicals published by the Ministry of the Environment, a number of other titles related to the environment are published by the NGOs – e.g. Ekolist, Sedmá generace, Bedrník. Regional periodicals are also concerned with EE&A – e.g. Ekoton in the Hradec Králové region and the Southern Moravian Ekolisty.

Specialized eco-websites are also available in the area of environmental awareness[64].

9.3 Examples of some educational and public awareness programmes

Become an advocate for the climate!

Since 2008, the Czech Republic has participated in the Challenge Europe project organized by the British Council and intended for young people aged 18 – 35 years from various professions. They work together for one year as "climate advocates" and look for new ways to reduce CO_2 emissions or use existing methods in unusual ways.

Change your clothes, change the climate

The British Council organized an unusual project in the Czech Republic, concerned with the impacts of human clothing on climate change and their presentation to the public and employees in the area of clothing. The project is based on the use of media such as fashion magazines or the Czech Radio. The project is intended to promote good practice in environmentally sound and sustainable clothing, called eco-fashion as an ethical and prestigious choice. It emphasizes the fashionableness and creativeness of this approach and is based on the fact that customers have many opportunities to change their behaviour and that a number of inspiring ideas is already available.

The Prima Klima exhibition

In 2008, the Veronica NGO[65] prepared a travelling exhibition concerned with protection of the climate. On 12 panels, it presents a description of the greenhouse effect, how solar energy works, how the gaseous envelope of the Earth regulates temperature, what man causes by his behaviour, local and global relationships, how tropical rainforests are related to protection of the climate and what each of us can do in our every-day decisions. The data are derived from the 4th IPCC report. It is a travelling exhibition, lectures can be ordered and it is intended for schools, the public administration as well as the general public.

[64] The most visited ones include www.ekolist.cz, www.ecn.cz and www.enviweb.cz.

[65] http://www.veronica.cz/?id=247

Alternative energy sources and energy savings at schools

Several school projects on the subject of energy have been held in the Czech Republic. The Tereza Association coordinated the "Let's throw a light on savings" project for several years. In 2006, the Partnership Foundation and the SEVER Environmental Education Centre organized the "Energy savings at schools" project. In addition to lectures on the subject of energy savings, this also encompassed performance of a pupils' energy audit of the school.

Ecological footprint

This internet calculator offers individuals, cities and schools in the Czech Republic the possibility of estimating the size of their "ecological footprints". For individuals, the calculator is located on the web[66] operated by Green Circle and, for cities and schools, at http://www.ekostopa.cz/ (part of the project by the Institute for Environmental Policy o.p.s.). Measuring the ecological footprint using the automatic on-line calculator facilitates and standardizes the complicated calculation. The calculation is based on the data that each individual, city or school collect themselves. Calculation of the ecological footprint is voluntary and no fee is charged.

Green office

Projects of environmentally sound – "green" offices have been offered to public institutions (e.g. municipal and city authorities, schools, ...) and also enterprises for a number of years. They consist in introduction of practical measures from use of office paper through computer technology to cleaning and waste. The criteria that are taken into account include recyclability, biodegradability, material and energy intensity of production, health safety, transport distance from the manufacturer to the consumer, etc. This principle is not only environmentally friendly, but also has other important consequences: the office has an important influence on its surroundings – citizens and visitors – and simultaneously, through its demand, increases the availability of environmentally friendly products on the market. In addition to large institutions such as the Ministry of the Environment and the Office of the Ombudsman, a number of regional authorities and smaller institutions promote this idea (for example, since 2008, the Hradec Králové authority has announced a competition for municipal and city authorities and schools). The STEP network of Environmental Consulting Centres is engaged in promoting and promulgating these projects. The website http://zeleneuradovani.cz/ is intended for smaller institutions.

Enersol

Enersol is a project and annual competition of secondary vocational schools concerned with how to present the subject of renewable energy sources to the students of secondary schools in a popular manner and to gain their active participation in the area of use of renewable energy sources and protection of the environment and its further development[67]. The project was established on the basis of international cooperation with VEV Nijkerk/Kenteq Hilversum (Netherlands), which was held in 2001 – 2005.

EcoSchool

In the framework of the EcoSchool[68] international project, offered in the Czech Republic by the Tereza Association, pupils learn about four basic environmental subjects and simultaneously attempt to improve the environment themselves – specifically by trying to minimize and separate waste, save energy and water as well as improve the environment of their school and its surroundings. These are subject areas in the framework of which the

[66] www.hraozemi.cz

[67] http://www.nuov.cz/enersol

[68] http://www.ekoskola.cz/.

school can carry out a large number of practical activities, offering the opportunity to explain to students one of the basic principles of sustainable development – activities on a local level affecting issues on a global level – and that are reflected in the everyday lives of the pupils. Thus, they offer pupils the opportunity to adopt a certain attitude and habits that they will also apply outside the school.

Pupils establish a school-wide EcoSchool working team, create their own Eco-Code, analyze current conditions in the school in the mentioned areas and suggest improvements, which they gradually try to implement. Successful schools obtain an international title, flag and the EcoSchool logo. The title is awarded for two years, then the school must renew it. Over 200 schools in the Czech Republic participate in the programme. **School for sustainable life**

School for sustainable life is a joint assistance and grant programme of the Partnership Foundation and the SEVER Environmental Education Centre, operating since 2004[69]. In the first year 10 schools participated; this had increased to 26 schools by 2008. The programme is intended to promote education in the area of sustainable development and public participation in specific activities related to improvement of the environment. Basically, it consists in initiating the processes of local sustainable development through schools functioning as initiation centres of municipalities. These can consist in projects of the type of, e.g., planting trees in the public premises of the municipality and tree alleys along roads, renewal of orchards, landscaping and improving the public premises of municipalities of schools, creation of safe paths to schools, sound waste management, water and energy savings, etc.

The programme was commenced in 2004 in the Hradec Králové region and is currently implemented throughout the Czech Republic and also in Great Britain and Poland.

Man and the Environment – Week for sustainable development

Since 1995, the Horní Maršov SEVER Environmental Education Centre offers a five-day course entitled "Week for sustainable development" for the upper level of elementary schools and secondary schools[70]. The composition of the programme is based on the "Man and the Environment" programme, prepared by the Society for Sustainable Development, which contains the following blocks:

- Functioning of human society, the importance of cooperation and communication in dealing with environmental issues
- Nature and the environment in the location, region and Czech Republic
- Development of the relationship between man and the environment – historical development and future prospects
- Environmental ethics, the position of man in the environment
- Global problems, globalization
- Economics and the environment, sustainable development
- Instruments of environmental protection, potential for resolving problems and participation of individuals in environmental protection.

Each year, 30 of these courses are held for various schools in the Czech Republic. A number of schools include them regularly in a certain year as part of learning.

[69] www.skolaprozivot.cz

[70] www.ekologickavychova.cz.

9.4 Educational, information and consulting centres

Environmental education centres, environmental information centres and environmental consulting centres are important entities in promulgation of information and in education.

Some regions and cities have also established specialized contributory organizations or more-or-less independent sections of contributory organizations – e.g. zoological gardens and educational facilities and schools. The public administration can also establish NGOs – beneficiary companies. The role of NGOs is of key importance in EE&A. A number of environmental education centres and environmental consulting centres were established during the 1990's either on the basis of the Brontosaurus movement or CNCS (Czech Unionfor Nature Conservation) or as completely new organizations.

The Pavučina Association of Environmental Education Centres[71] currently associates more than 35 environmental education centres. The STEP network of Environmental Consulting Centres of the Czech Republic is a member of the European Association of environmental consultants – EcoCounselling Europe – and its activities are supported by the Ministry of the Environment through a public contract in the amount of approx. CZK 2 million.

Czech National Council Act No. 173/1989 Coll. requires the Ministry of the Environment to create an information system on the environment, an integral part of which consists in public information services coordinated by the Ministry. These include services provided to the professional and general public by general, professional and other specialized public libraries, scientific, technical and economic information centres, archives and other processing or mediating workplaces. These activities are supplemented by printed outputs and presentation of information on the internet. The web site also contains an Environmental Library, containing important and interesting publications published or financially supported by the Ministry of the Environment. Some of these are available in English or German or, less frequently, in French. CENIA, the Czech Environmental Information Agency, operates the Uniform Environmental Information System and its web site[72] provides access to information, databases and applications.

9.5 Funding

EE&A is financed in the Czech Republic from various sources of different importance, the most important being: the State budget, State funds, local government budgets (regions and municipalities), EU funds, foundations, funds from the business sector and the internal funds of NGO's.

Funds from the public administration are expended both in the form of financing of the activities of the bodies of the public administration and the activities of directly subordinate organizations, and also in the form of grants, subsidies and contracts for other entities. The structure of the budget contains a special budgetary item for EE&A; however, it is difficult to monitor overall funding for EE&A as it is partly financed within other items. The Liberec and Southern Moravia regions finance organizations specially established for EE&A; In other cases, EE&A units are financed within larger contributory organizations.

Amongst the grant and subsidy support for EE&A from national sources, the most important are the programmes of the Ministry of the Environment (from the first half of the 1990's for NGOs), Ministry of Education, Youth and Sports (new programmes from 2007 for NGOs and schools) and regions (gradually established from 2002).

[71] http://www.pavucina-sev.cz/

[72] www.cenia.cz

Contracts for EE&A services are another important source. Since 1990, the most important has been the Ministry of the Environment contract for a national EE&A Network in the amount of approx. CZK 5 mil. p.a.; this has been promulgated together with Ministry of Education, Youth and Sports since 2008 and expanded to a volume of approx. CZK 10 ml. p.a. The contracts of some regions are also important (e.g. the Pardubice, Hradec Králové and Central Bohemia regions).

The State Environmental Fund of the Czech Republic (SEF CR) is also a source for investment and noninvestment projects. In recent years, it has supported especially the creation of centres and consulting centres. Since 2008, new subsidy programmes have been established in the area of EE&A – promoting the construction of centres and consulting centres in the Capital City of Prague (outside Prague, funds can be obtained from European Funds – see below), creation of education centres and consulting centres and educational programmes on selected subjects – in the first request, the subject "climate change and protection of the air" was announced as one of three priorities. In the past, the SEF CR has also supported the "Sun into Schools" programme, aimed at installation of photovoltaic and photothermal low-output equipment in school facilities. This programme was primarily intended to demonstrate the potential for obtaining energy from solar radiation to the students of elementary and secondary schools as part of the educational process.

Between 2004 and 2008, the Development of Human Resources Operational Programme, financed by the European Social Fund, was an important source of support. In the framework of the grant scheme of the Network of Environmental Information and Consulting Centres, support was provided for their formation and activities in the individual regions. In 2007, the first request was announced for the new Environment Operational Programme for investments into the construction and reconstruction of environmental education centres and environmental consulting centres and, in 2008, requests were announced for the Education for Competitiveness Operational Programme which, amongst other things, also includes the area of EE&A.

EE&A is also financed by foundations (see Chapter 9.2.2) and the business sector – extensive support is provided, e.g., by Lesy ČR (Forests CR) (the "Forest in the school, School in the forest" project, creation of teaching material, implementation of teaching programmes and seminars, nature trails) and the Toyota company (the "School for sustainable life" and "Green package" projects). Other examples include funding by producers of packaging through EKO-KOM, a.s. and companies in the area of water and waste management.

9.6 Related legislation

Act No. 106/1999 Coll., on free access to information, as amended, outlines the conditions of the right to free access to information by the public and establishes the basic conditions under which this information is provided. For the purposes of this law, an applicant is any natural or legal person who requests information.

Act No. 123/1998 Coll., on free access to information on the environment, as amended by Act No. 6/2005 Coll., stipulates the right of the public to timely and comprehensive information on the state of the environment and natural resources which is available to the state administrative bodies, territorial self-governing bodies and legal persons established, directed or authorized by them. Amongst other things, the amendment to the Act reformulated Article 13, which deals with environmental education and awareness, and also newly defined environmental consulting.

Act No. 561/2004 Coll., on preschool, elementary, secondary, higher vocational and other education, as amended (the *Act on Schools*), came into effect on January 1, 2005. It mentions "acquiring and implementing knowledge about the environment and its protection based on the principles of sustainable development" in the preamble as one of the general targets of education, and thus EE&A must be seen as a priority reflected throughout the law.

9.7 International activities

Organizations in the Czech Republic participate in a number of international projects concerned with environmental education, and awareness. Some of these activities are supported methodically and financially directly by the Ministry of the Environment and Ministry of Education, Youth and Sports.

The *GLOBE* programme is a global programme for schools, which the CR joined together with other countries in 1995. For the *GLOBE* programme, scientists prepared a system of demonstration measurements, which were easy for students to perform, thus enabling them to monitor trends in global environmental issues. In the international framework of participants in the *GLOBE* programme, students perform measurements and observations of the quality of the environment in the areas of meteorology, hydrology, biometry, phenology, pedology and remote sensing of the Earth. They send their observations via internet to the NASA centre in the USA. The project also includes monitoring of the carbon cycle, with participation by about 400 pupils at 14 schools.

Several projects are also underway in the Czech Republic in the framework of the "Intelligent Energy – Europe" grant programme of the European Commission. The SEVEn organization participates in the "Cities with Sustainable Energy Consumption" project, concerned with promoting examples of sustainable energy consumption at an urban level in the new EU Member States; in 2008, the "Carbon Detectives" project for elementary schools and the "Intelligent Use of Energy at School" project for secondary vocational schools, with participation of the SEVER centres were newly approved.

"Clean Up the World" is an international environmental programme providing inspiration and opportunities for individuals and societies throughout the world to clean up and care for the environment. In the Czech Republic, the project is coordinated by the Czech Union for Nature Conservation.

The Ministry of the Environment, the Ministry of Education, Youth and Sports and some NGOs participated in dissemination of the teaching material Green Pack, which was prepared in the Czech version by the Regional Environmental Centre for Central Europe[73].

Several projects concerned with EE&A were implemented in the framework of bilateral and especially cross-border cooperation with Polish, German, Slovakian, Serbian and Austrian organizations. These included projects in the area of environmental consulting, environmentally oriented kindergartens and EE&A for children and young people.

[73] http://www.reccr.cz/greenpack.html

10 Annexes

10.1 Summary tables of trends in emissions and sinks in the main inventory categories

Tab. 10.1 Carbon dioxide emissions in the 1990 – 2007 period in IPCC categorization (Gg), Part 1: 1990 – 1999

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Energy production	**145,613**	**139,912**	**124,194**	**123,104**	**113,312**	**117,653**	**125,200**	**117,785**	**111,052**	**109,287**
A. Fuel Combustion	145,613	139,912	124,194	123,104	113,312	117,653	125,200	117,785	111,052	109,287
1. Energy industry	57,707	57,401	51,270	53,502	53,658	56,621	59,257	59,033	55,694	52,504
2. Processing industry	46,616	49,140	41,106	41,997	32,609	32,766	36,626	29,069	28,588	29,956
3. Transport	7,342	6,675	7,438	7,334	7,615	9,454	10,476	11,119	11,657	11,877
4. Other sectors	32,347	25,288	23,060	18,995	18,145	17,799	17,750	17,425	13,856	13,713
5. Other	1,601	1,409	1,321	1,276	1,285	1,013	1,092	1,140	1,258	1,237
B. Fugitive emissions from fuels	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1. Solid fuels	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2. Oil and natural gas	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2. Industrial processes	**18,169**	**13,599**	**14,888**	**11,958**	**12,683**	**13,004**	**12,721**	**13,322**	**12,498**	**10,721**
A. Mineral products	4,830	4,035	3,852	3,514	3,610	3,602	3,908	4,036	4,187	4,082
B. The chemical industry	807	782	806	754	842	743	800	733	756	644
C. Metal production	12,533	8,781	10,230	7,690	8,231	8,659	8,012	8,553	7,555	5,996
D. Other products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of F-gases	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Use of F-gases	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Use of solvents and other substances	**550**	**514**	**476**	**436**	**402**	**382**	**372**	**370**	**366**	**364**
4. Agriculture	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
A. Enteric fermentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Manure management	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Rice cultivation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. LULUCF	**–4,693**	**–10,180**	**–11,973**	**–10,602**	**–8,253**	**–8,316**	**–8,785**	**–7,849**	**–8,170**	**–8,302**
A. Forest land	–5,987	–10,517	–12,191	–10,883	–8,344	–8,354	–8,635	–7,852	–8,454	–8,364
B. Fertile land	1,315	548	305	299	269	273	269	248	368	200
C. Pastures	–128	–294	–200	–196	–306	–331	–544	–381	–284	–361
D. Wetlands	22	33	19	9	8	10	11	16	24	24
E. Settlements	85	51	94	170	120	87	114	119	176	199
6. Waste	**NE**	**357**	**357**	**357**	**357**	**357**	**357**	**357**	**357**	**357**
A. Landfilling of solid waste	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Wastewater handling	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C. Waste incineration	NE	357	357	357	357	357	357	357	357	357
Total emissions with LULUCF	**159,639**	**144,201**	**127,942**	**125,253**	**118,501**	**123,080**	**129,865**	**123,984**	**116,103**	**112,427**
Total emissions without LULUCF	**164,332**	**154,381**	**139,916**	**135,854**	**126,754**	**131,396**	**138,650**	**131,833**	**124,273**	**120,729**
Items reported separately:										
International air transport	617	555	491	484	449	453	492	498	542	513
International marine transport	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from biomass	2,304	2,350	2,309	2,267	2,220	2,352	2,437	2,671	2,906	3,110

LULUCF – Land Use, Land Use Change and Forestry *Source: CHMI*
NE – not estimated
NO – not occurring
NA – not applicable

Tab. 10.1 Carbon dioxide emissions in the 1990 – 2007 period in IPCC categorization (Gg), Part 2: 2000 – 2007

Year	2000	2001	2002	2003	2004	2005	2006	2007
1. Energy production	**114,438**	**116,935**	**113,266**	**113,659**	**113,304**	**113,934**	**114,948**	**116,298**
A. Fuel Combustion	114,438	116,935	113,266	113,659	113,304	113,934	114,948	116,297
1. Energy industry	59,616	58,810	57,122	57,856	57,277	57,275	59,077	61,316
2. Processing industry	28,185	29,432	27,912	26,365	26,003	26,632	24,399	24,940
3. Transport	12,159	12,981	13,533	15,307	16,022	17,329	17,655	18,461
4. Other sectors	13,244	14,501	13,555	13,065	12,890	11,601	12,751	10,503
5. Other	1,233	1,211	1,144	1,065	1,112	1,097	1,066	1,078
B. Fugitive emissions from fuels	NE	NE	NE	NE	NE	NE	NE	NE
1. Solid fuels	NE	NE	NE	NE	NE	NE	NE	NE
2. Oil and natural gas	NE	NE	NE	NE	NE	NE	NE	NE
2. Industrial processes	**11,989**	**11,091**	**11,026**	**11,981**	**13,098**	**11,783**	**12,982**	**12,941**
A. Mineral products	4,166	3,859	3,603	3,701	3,908	3,856	3,976	4,367
B. Chemical industry	736	620	541	704	699	609	581	544
C. Metal production	7,086	6,612	6,882	7,576	8,491	7,318	8,425	8,030
D. Other products	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of F-gases	NA	NA	NA	NA	NA	NA	NA	NA
F. Use of F-gases	NA	NA	NA	NA	NA	NA	NA	NA
3. Use of solvents and other substances	**354**	**335**	**325**	**311**	**305**	**299**	**298**	**298**
4. Agriculture	NA	NA	NA	NA	NA	NA	NA	NA
A. Enteric fermentation	NA	NA	NA	NA	NA	NA	NA	NA
B. Manure management	NA	NA	NA	NA	NA	NA	NA	NA
C. Rice cultivation	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural soils	NA	NA	NA	NA	NA	NA	NA	NA
5. LULUCF	**–8,680**	**–9,016**	**–8,791**	**–6,897**	**–7,344**	**–7,835**	**–4,607**	**–1,919**
A. Forest land	–8,613	–8,919	–8,694	–6,879	–7,284	–7,763	–4,480	–1,775
B. Fertile land	200	180	155	161	141	144	134	127
C. Pastures	–419	–400	–396	–380	–393	–389	–394	–383
D. Wetlands	27	12	33	23	19	20	20	19
E. Settlements	125	111	111	179	173	153	113	93
6. Waste	**357**	**357**	**357**	**368**	**327**	**358**	**386**	**413**
A. Landfilling of solid waste	NO	NO	NO	NO	NO	NO	NO	NO
B. Wastewater handling	NA	NA	NA	NA	NA	NA	NA	NA
C. Waste incineration	357	357	357	368	327	358	386	413
Total emissions with LULUCF	**118,458**	**119,702**	**116,183**	**119,422**	**119,689**	**118,541**	**124,008**	**128,031**
Total emissions without LULUCF	**127,138**	**128,719**	**124,974**	**126,318**	**127,033**	**126,375**	**128,615**	**129,950**
Items reported separately:								
International air transport	572	614	664	771	993	1,033	1,062	1,091
International marine transport	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from biomass	3,254	3,270	3,833	7,158	7,847	8,679	7,403	8,465

LULUCF – Land Use, Land Use Change and Forestry *Source: CHMI*
NE – not estimated
NO – not occurring
NA – not applicable

Tab. 10.2 Methane emissions in the 1990 – 2007 period in IPCC categorization (Gg), Part 1: 1990 – 1999

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Energy production	**474.10**	**409.31**	**388.88**	**370.86**	**349.15**	**341.13**	**333.52**	**324.46**	**311.24**	**285.05**
A. Fuel Combustion	69.53	51.97	49.47	40.38	35.39	32.76	30.64	27.21	22.67	21.37
1. Energy industry	0.67	0.68	0.60	0.64	0.63	0.70	0.72	0.80	0.78	0.73
2. Processing industry	4.31	4.88	3.91	4.22	3.34	3.30	3.69	3.26	2.98	3.01
3. Transport	1.27	1.09	1.26	1.31	1.43	1.59	1.62	1.52	1.36	1.25
4. Other sectors	62.96	45.02	43.43	33.95	29.72	26.95	24.39	21.45	17.40	16.28
5. Other	0.34	0.29	0.27	0.26	0.26	0.21	0.21	0.18	0.15	0.10
B. Fugitive emissions from fuels	404.57	357.35	339.41	330.48	313.76	308.37	302.88	297.25	288.57	263.68
1. Solid fuels	361.90	320.98	305.97	298.00	281.99	276.61	268.48	263.47	253.05	228.96
2. Oil and natural gas	42.67	36.36	33.45	32.49	31.77	31.76	34.40	33.78	35.52	34.72
2. Industrial processes	**6.59**	**5.61**	**4.33**	**4.41**	**4.53**	**4.78**	**4.85**	**4.41**	**4.29**	**3.74**
A. Mineral products	0.14	0.12	0.12	0.13	0.14	0.14	0.16	0.18	0.20	0.18
B. Chemical industry	0.39	0.29	0.33	0.33	0.39	0.37	0.39	0.40	0.45	0.47
C. Metal production	6.06	5.20	3.88	3.95	4.00	4.26	4.30	3.84	3.64	3.09
D. Other products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of F-gases	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Use of F-gases	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Use of solvents and other substances	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
4. Agriculture	**279.95**	**264.61**	**238.09**	**207.96**	**182.15**	**176.46**	**175.26**	**164.68**	**154.85**	**157.27**
A. Enteric fermentation	231.88	218.47	195.78	169.36	148.31	144.39	143.04	133.43	125.11	127.78
B. Manure management	48.07	46.14	42.31	38.61	33.83	32.07	32.22	31.26	29.74	29.49
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural soils	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. LULUCF	**4.64**	**3.44**	**3.62**	**4.19**	**4.32**	**4.03**	**5.31**	**5.72**	**4.95**	**4.56**
A. Forest land	4.64	3.44	3.62	4.19	4.32	4.03	5.31	5.72	4.95	4.56
B. Fertile land	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C. Pastures	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**118.48**	**120.66**	**120.93**	**121.12**	**125.43**	**127.36**	**126.15**	**125.36**	**126.80**	**127.45**
A. Landfilling of solid waste	79.17	82.79	85.97	89.48	92.95	96.20	97.12	95.20	97.30	100.01
B. Wastewater handling	39.31	37.88	34.96	31.64	32.48	31.16	29.02	30.16	29.50	27.43
C. Waste incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total emissions with LULUCF	**883.76**	**803.63**	**755.85**	**708.55**	**665.58**	**653.76**	**645.08**	**624.64**	**602.13**	**578.07**
Total emissions without LULUCF	**879.12**	**800.19**	**752.23**	**704.36**	**661.26**	**649.73**	**639.77**	**618.91**	**597.18**	**573.50**
Items reported separately:										
International air transport	0.13	0.11	0.10	0.10	0.09	0.09	0.10	0.10	0.11	0.10
International marine transport	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

LULUCF – Land Use, Land Use Change and Forestry *Source: CHMI*
NE – not estimated
NO – not occurring
NA – not applicable

Tab. 10.2 Methane emissions in the 1990 – 2007 period in IPCC categorization (Gg), Part 2: 2000 – 2007

Year	2000	2001	2002	2003	2004	2005	2006	2007
1. Energy production	**292.68**	**297.98**	**289.72**	**280.11**	**273.62**	**276.89**	**299.12**	**277.38**
A. Fuels combustion	20.70	22.30	20.41	22.94	24.72	23.27	30.04	26.95
1. Energy industry	0.73	0.74	0.68	0.87	0.96	0.76	0.82	0.86
2. Processing industry	3.03	3.21	3.25	3.17	3.02	3.41	2.75	2.87
3. Transport	1.74	1.77	1.68	1.73	1.64	1.64	1.55	1.56
4. Other sectors	15.11	16.50	14.72	17.10	19.02	17.39	24.85	21.60
5. Other	0.09	0.08	0.08	0.07	0.08	0.08	0.07	0.07
B. Fugitive emissions from fuels	271.98	275.69	269.31	257.17	248.90	253.62	269.08	250.43
1. Solid fuels	239.00	244.74	237.48	228.21	222.00	221.44	236.18	217.46
2. Oil and natural gas	32.99	30.95	31.83	28.96	26.90	32.18	32.90	32.97
2. Industrial processes	**3.94**	**4.01**	**4.03**	**4.02**	**4.22**	**3.98**	**4.06**	**3.96**
A. Mineral products	0.25	0.25	0.20	0.20	0.22	0.22	0.21	0.23
B. Chemical industry	0.41	0.44	0.41	0.40	0.50	0.50	0.46	0.41
C. Metal production	3.28	3.32	3.42	3.42	3.50	3.25	3.38	3.33
D. Other products	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of F-gases	NA	NA	NA	NA	NA	NA	NA	NA
F. Use of F-gases	NA	NA	NA	NA	NA	NA	NA	NA
3. Use of solvents and other substances	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
4. Agriculture	**150.60**	**151.33**	**147.31**	**143.33**	**138.37**	**137.62**	**135.19**	**136.29**
A. Enteric fermentation	122.72	123.61	120.71	117.53	113.80	113.97	111.84	112.94
B. Manure management	27.88	27.72	26.60	25.80	24.57	23.64	23.35	23.35
C. Rice cultivation	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural soils	NA	NA	NA	NA	NA	NA	NA	NA
5. LULUCF	**4.20**	**4.36**	**4.71**	**5.91**	**5.40**	**5.16**	**6.40**	**8.32**
A. Forest land	4.20	4.36	4.71	5.91	5.40	5.16	6.40	8.32
B. Fertile land	NO	NO	NO	NO	NO	NO	NO	NO
C. Pastures	NA	NA	NA	NA	NA	NA	NA	NA
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**128.24**	**129.50**	**132.79**	**131.26**	**133.69**	**136.02**	**137.55**	**139.58**
A. Landfilling of solid waste	102.48	104.68	106.15	106.69	109.25	111.70	112.69	115.09
B. Wastewater handling	25.75	24.82	26.64	24.57	24.44	24.32	24.86	24.49
C. Waste incineration	NE	NE	NE	NE	NE	NE	NE	NE
Total emissions with LULUCF	**579.66**	**587.19**	**578.55**	**564.63**	**555.31**	**559.66**	**582.32**	**565.53**
Total emissions without LULUCF	**575.46**	**582.83**	**573.84**	**558.72**	**549.90**	**554.50**	**575.92**	**557.22**
Items reported separately:								
International air transport	0.11	0.12	0.13	0.15	0.19	0.20	0.20	0.21
International marine transport	NO	NO	NO	NO	NO	NO	NO	NO

LULUCF – Land Use, Land Use Change and Forestry *Source: CHMI*
NE – not estimated
NO – not occurring
NA – not applicable

Tab. 10.3 Nitrous oxide emissions in the 1990 – 2007 period in IPCC categorization (Gg), Part 1: 1990 – 1999

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Energy production	**2.15**	**2.14**	**1.99**	**2.08**	**2.01**	**2.27**	**2.47**	**2.52**	**2.77**	**2.96**
A. Fuel combustion	2.15	2.14	1.99	2.08	2.01	2.27	2.47	2.52	2.77	2.96
1. Energy industry	0.81	0.80	0.72	0.75	0.74	0.79	0.82	0.83	0.79	0.74
2. Processing industry	0.58	0.65	0.52	0.54	0.43	0.42	0.46	0.39	0.36	0.37
3. Transport	0.27	0.31	0.40	0.52	0.57	0.83	0.96	1.09	1.42	1.64
4. Other sectors	0.43	0.32	0.29	0.22	0.21	0.19	0.19	0.16	0.13	0.13
5. Other	0.06	0.06	0.05	0.05	0.05	0.04	0.04	0.05	0.08	0.08
B. Fugitive emissions from fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1. Solid fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and natural gas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Industrial processes	**3.90**	**2.64**	**3.25**	**2.54**	**3.21**	**3.64**	**3.33**	**3.60**	**3.86**	**3.22**
A. Mineral products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical industry	3.90	2.64	3.25	2.54	3.21	3.64	3.33	3.60	3.86	3.22
C. Metal Production of	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of F-gases	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Use of F-gases	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Use of solvents and other substances	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**
4. Agriculture	**30.93**	**26.31**	**22.43**	**19.61**	**18.76**	**18.95**	**17.72**	**17.89**	**17.23**	**17.09**
A. Enteric fermentation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Manure management	2.23	2.14	1.98	1.84	1.62	1.54	1.55	1.51	1.45	1.44
C. Rice cultivation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural soils	28.70	24.17	20.45	17.77	17.14	17.41	16.17	16.38	15.79	15.65
5. LULUCF	**0.10**	**0.09**	**0.09**	**0.09**	**0.08**	**0.08**	**0.08**	**0.07**	**0.07**	**0.06**
A. Forest land	0.03	0.02	0.02	0.03	0.03	0.03	0.04	0.04	0.03	0.03
B. Fertile land	0.07	0.07	0.06	0.06	0.05	0.05	0.04	0.03	0.04	0.03
C. Pastures	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**0.52**	**0.52**	**0.52**	**0.52**	**0.52**	**0.52**	**0.52**	**0.52**	**0.52**	**0.52**
A. Landfilling of solid waste	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Wastewater handling	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
C. Waste incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total emissions with LULUCF	**38.30**	**32.39**	**28.96**	**25.54**	**25.28**	**26.15**	**24.81**	**25.30**	**25.14**	**24.54**
Total emissions without LULUCF	**38.20**	**32.30**	**28.88**	**25.45**	**25.19**	**26.08**	**24.73**	**25.22**	**25.07**	**24.48**
Items reported separately:										
International air transport	0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.07
International marine transport	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

LULUCF – Land Use, Land Use Change and Forestry *Source: CHMI*
NE – not estimated
NO – not occurring
NA – not applicable

Tab. 10.3 Nitrous oxide emissions in the 1990 – 2007 period in IPCC categorization (Gg), Part 2: 2000 – 2007

Year	2000	2001	2002	2003	2004	2005	2006	2007
1. Energy production	**2.69**	**2.85**	**3.00**	**3.38**	**3.57**	**3.72**	**3.74**	**3.90**
A. Fuel Combustion	2.69	2.85	3.00	3.38	3.57	3.72	3.74	3.90
1. Energy industry	0.83	0.83	0.80	0.83	0.84	0.81	0.85	0.89
2. Processing industry	0.37	0.39	0.39	0.38	0.36	0.41	0.32	0.34
3. Transport	1.28	1.42	1.61	1.91	2.08	2.22	2.25	2.35
4. Other sectors	0.12	0.13	0.12	0.19	0.21	0.21	0.25	0.24
5. Other	0.08	0.08	0.08	0.07	0.08	0.07	0.07	0.07
B. Fugitive emissions from fuels	NA	NA	NA	NA	NA	NA	NA	NA
1. Solid fuels	NA	NA	NA	NA	NA	NA	NA	NA
2. Oil and natural gas	NA	NA	NA	NA	NA	NA	NA	NA
2. Industrial processes	**3.63**	**3.59**	**3.14**	**3.13**	**3.73**	**3.53**	**3.26**	**2.80**
A. Mineral products	NA	NA	NA	NA	NA	NA	NA	NA
B. Chemical industry	3.63	3.59	3.14	3.13	3.73	3.53	3.26	2.80
C. Metals production	NA	NA	NA	NA	NA	NA	NA	NA
D. Other products	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of F-gases	NA	NA	NA	NA	NA	NA	NA	NA
F. Use of F-gases	NA	NA	NA	NA	NA	NA	NA	NA
3. Use of solvents and other substances	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**	**0.69**
4. Agriculture	**16.85**	**17.45**	**16.97**	**15.36**	**16.55**	**15.72**	**15.58**	**16.05**
A. Enteric fermentation	NA	NA	NA	NA	NA	NA	NA	NA
B. Manure management	1.36	1.35	1.30	1.26	1.20	1.15	1.14	1.13
C. Rice cultivation	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural soils	15.49	16.10	15.67	14.10	15.36	14.57	14.45	14.92
5. LULUCF	**0.06**	**0.06**	**0.06**	**0.07**	**0.06**	**0.06**	**0.07**	**0.08**
A. Forest land	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.06
B. Fertile land	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02
C. Pastures	NO	NO	NO	NO	NO	NO	NO	NO
D. Wetlands	NO	NO	NO	NO	NO	NO	NO	NO
E. Settlements	NO	NO	NO	NO	NO	NO	NO	NO
6. Waste	**0.65**	**0.64**	**0.64**	**0.66**	**0.66**	**0.66**	**0.66**	**0.66**
A. Landfilling of solid waste	NA	NA	NA	NA	NA	NA	NA	NA
B. Wastewater handling	0.65	0.64	0.64	0.64	0.64	0.64	0.65	0.65
C. Waste incineration	NE	NE	NE	0.02	0.01	0.01	0.01	0.01
Total emissions with LULUCF	**24.57**	**25.28**	**24.50**	**23.29**	**25.26**	**24.38**	**24.00**	**24.18**
Total emissions without LULUCF	**24.51**	**25.22**	**24.44**	**23.23**	**25.20**	**24.32**	**23.93**	**24.10**
Items reported separately:								
International air transport	0.08	0.08	0.09	0.10	0.14	0.14	0.14	0.15
International marine transport	NO	NO	NO	NO	NO	NO	NO	NO

LULUCF – Land Use, Land Use Change and Forestry *Source: CHMI*
NE – not estimated
NO – not occurring
NA – not applicable

Tab. 10.4 Overall inventory of greenhouse gases in the 1990 – 2007 period (Gg CO_2eq), Part 1: 1990 – 1999

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
1. Energy production	**156 235**	**149 169**	**132 978**	**131 538**	**121 268**	**125 521**	**132 971**	**125 380**	**118 447**	**116 190**
A. Fuel combustion	147 739	141 665	125 851	124 598	114 679	119 045	126 610	119 137	112 387	110 652
1. Energy industry	57,970	57,664	51,507	53,748	53,902	56,882	59,527	59,307	55,955	52,748
2. Processing industry	46,885	49,442	41,349	42,254	32,814	32,964	36,847	29,258	28,761	30,135
3. Transport	7,453	6,793	7,589	7,521	7,821	9,745	10,807	11,488	12,125	12,411
4. Other sectors	33,803	26,333	24,063	19,778	18,835	18,425	18,320	17,926	14,262	14,094
5. Other	1,628	1,432	1,342	1,297	1,306	1,029	1,109	1,160	1,284	1,264
B. Fugitive emissions from fuels	8,496	7,504	7,128	6,940	6,589	6,476	6,361	6,242	6,060	5,537
1. Solid fuels	7,600	6,741	6,425	6,258	5,922	5,809	5,638	5,533	5,314	4,808
2. Oil and natural gas	896	764	702	682	667	667	722	709	746	729
2. Industrial processes	**19,596**	**14,612**	**16,062**	**12,916**	**13,848**	**14,310**	**14,037**	**14,873**	**14,166**	**12,146**
A. Mineral products	4,833	4,038	3,854	3,517	3,613	3,605	3,912	4,040	4,191	4,086
B. Chemical industry	2,025	1,606	1,819	1,550	1,844	1,881	1,840	1,859	1,961	1,652
C. Metal Production	12,660	8,891	10,312	7,773	8,315	8,748	8,103	8,633	7,632	6,061
D. Other products	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of F-gases	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Use of F-gases	78	77	77	77	76	76	183	341	382	347
3. Use of solvents and other substances	**765**	**728**	**691**	**651**	**616**	**596**	**587**	**585**	**580**	**578**
4. Agriculture	**15,467**	**13,714**	**11,952**	**10,445**	**9,642**	**9,580**	**9,174**	**9,004**	**8,594**	**8,602**
A. Enteric fermentation	4,869	4,588	4,111	3,556	3,115	3,032	3,004	2,802	2,627	2,683
B. Manure management	1,700	1,634	1,503	1,381	1,213	1,149	1,156	1,124	1,073	1,065
C. Rice cultivation	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural soils	8,898	7,492	6,338	5,508	5,314	5,398	5,014	5,077	4,894	4,853
5. LULUCF	**–4,565**	**–10,080**	**–11,870**	**–10,486**	**–8,136**	**–8,207**	**–8,650**	**–7,707**	**–8,044**	**–8,186**
A. Forest land	–5,880	–10,437	–12,108	–10,786	–8,244	–8,261	–8,512	–7,720	–8,339	–8,258
B. Fertile land	1,336	568	325	318	285	288	281	258	380	210
C. Pastures	–128	–294	–200	–196	–306	–331	–544	–381	–284	–361
D. Wetlands	22	33	19	9	8	10	11	16	24	24
E. Settlements	85	51	94	170	120	87	114	119	176	199
6. Waste	**2,650**	**3,052**	**3,057**	**3,062**	**3,152**	**3,193**	**3,167**	**3,150**	**3,180**	**3,194**
A. Landfilling of solid waste	1,663	1,739	1,805	1,879	1,952	2,020	2,040	1,999	2,043	2,100
B. Wastewater handling	987	956	895	826	843	815	770	794	780	736
C. Waste incineration	NE	357	357	357	357	357	357	357	357	357
Total emissions with LULUCF	**190,148**	**171,195**	**152,871**	**148,125**	**140,390**	**144,993**	**151,286**	**145,284**	**136,924**	**132,522**
Total emissions without LULUCF	**194,712**	**181,275**	**164,741**	**158,611**	**148,526**	**153,200**	**159,936**	**152,991**	**144,968**	**140,709**
Items reported separately:										
International air transport	647	582	515	508	471	475	516	522	567	537
International marine transport	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions from biomass	2,304	2,350	2,309	2,267	2,220	2,352	2,437	2,671	2,906	3,110

LULUCF – Land Use, Land Use Change and Forestry *Source: CHMI*
NE – not estimated
NO – not occurring
NA – not applicable

Tab. 10.4 Overall inventory of greenhouse gases in the 1990 – 2007 period (Gg CO_{2eq}), Part 2: 2000 – 2007

Year	2000	2001	2002	2003	2004	2005	2006	2007
1. Energy production	**121,418**	**124,075**	**120,280**	**120,589**	**120,156**	**120,902**	**122,390**	**123,330**
A. Fuel combustion	115,707	118,285	114,625	115,189	114,929	115,576	116,739	118,071
1. Energy industry	59,890	59,081	57,383	58,133	57,557	57,543	59,359	61,609
2. Processing industry	28,364	29,619	28,103	26,549	26,178	26,830	24,556	25,107
3. Transport	12,593	13,459	14,067	15,935	16,701	18,052	18,385	19,223
4. Other sectors	13,599	14,888	13,902	13,482	13,355	12,029	13,351	11,031
5. Other	1,261	1,238	1,170	1,089	1,137	1,122	1,088	1,101
B. Fugitive emissions from fuels	5,712	5,789	5,655	5,401	5,227	5,326	5,651	5,259
1. Solid fuels	5,019	5,139	4,987	4,792	4,662	4,650	4,960	4,567
2. Oil and natural gas	693	650	668	608	565	676	691	692
2. Industrial processes	**13,610**	**12,863**	**12,558**	**13,753**	**15,011**	**13,650**	**15,055**	**15,593**
A. Mineral products	4,172	3,864	3,607	3,705	3,913	3,860	3,980	4,372
B. Chemical industry	1,870	1,742	1,524	1,684	1,864	1,713	1,600	1,420
C. Metals production	7,155	6,682	6,954	7,648	8,564	7,387	8,496	8,100
D. Other products	NA	NA	NA	NA	NA	NA	NA	NA
E. Production of F-gases	NA	NA	NA	NA	NA	NA	NA	NA
F. Use of F-gases	413	574	473	716	670	690	978	1,702
3. Use of solvents and other substances	**569**	**550**	**540**	**525**	**519**	**514**	**513**	**512**
4. Agriculture	**8,387**	**8,587**	**8,353**	**7,772**	**8,037**	**7,765**	**7,670**	**7,838**
A. Enteric fermentation	2,577	2,596	2,535	2,468	2,390	2,393	2,349	2,372
B. Manure management	1,007	1,000	960	932	887	853	842	842
C. Rice cultivation	NA	NA	NA	NA	NA	NA	NA	NA
D. Agricultural soils	4,803	4,991	4,858	4,372	4,761	4,518	4,479	4,624
5. LULUCF	**–8,573**	**–8,907**	**–8,674**	**–6,752**	**–7,211**	**–7,708**	**–4,452**	**–1,720**
A. Forest land	–8,516	–8,818	–8,586	–6,742	–7,159	–7,643	–4,332	–1,583
B. Fertile land	210	189	164	169	149	151	141	134
C. Pastures	–419	–400	–396	–380	–393	–389	–394	–383
D. Wetlands	27	12	33	23	19	20	20	19
E. Settlements	125	111	111	179	173	153	113	93
6. Waste	**3,250**	**3,275**	**3,344**	**3,328**	**3,337**	**3,419**	**3,479**	**3,550**
A. Landfilling of solid waste	2,152	2,198	2,229	2,240	2,294	2,346	2,367	2,417
B. Wastewater handling	741	720	758	715	712	710	722	715
C. Waste incineration	357	357	357	373	331	363	391	417
Total emissions incl. LULUCF	**138,661**	**140,443**	**136,401**	**139,215**	**139,849**	**138,541**	**144,654**	**149,103**
Celkové emise nezahrnující LULUCF	**147,234**	**149,350**	**145,075**	**145,967**	**147,061**	**146,249**	**149,107**	**150,823**
Items reported separately:								
International air transport	598	643	695	807	1,039	1,080	1,111	1,142
International marine transport	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 emissions of from biomass	3,254	3,270	3,833	7,158	7,847	8,679	7,403	8,465

LULUCF – Land Use, Land Use Change and Forestry *Source: CHMI*
NE – not estimated
NO – not occurring
NA – not applicable

10.2 Survey of supplementary information pursuant to Article 7.2 of the Kyoto Protocol

Table 10.5 gives a survey of supplementary information pursuant to Art. 7.2 of the Kyoto Protocol in classification according to the 5th National Communication.

Tab. 10.5 Survey of supplementary information pursuant to Article 7.2 of the Kyoto Protocol

Information pursuant to Art. 7.2		**Relevant part of the 5th National Communication**
National system of inventories of greenhouse gases pursuant to Art. 5.1		Chapter 3.3
National registry of emission trading		Chapter 3.4
Mechanisms pursuant to Art. 6, 12 and 17		Chapter 5.5
Policies and measures pursuant to Art. 2		Chapter 4.2, 4.3 and 4.4
Domestic and regional programmes, legislative instruments, effectiveness and administrative procedures		Chapter 4.1
Information pursuant to Art. 10	Art. 10a	Chapter 3.3
	Art. 10b	Chapter 4.1, 4.2, 4.3 and 4.4
	Art. 10c	Chapter 7.3
	Art. 10d	Chapter 8
	Art. 10e	Chapter 9
Funding		Chapter 7

10.3 Summary survey of all quantifiable implemented and prepared measures

Tab. 10.6 Summary survey of all measures classified according to the individual sectors and gases

Name of measure *(framework / multisectoral measure)*	Target and/or affected activity	Affected greenhouse gases	Type of measure	State of affairs	Implementation	Expected benefit in reducing greenhouse gas emissions (for each year, not accumulated, in thousand t. CO_{2eq})			
						2007	**2010**	**2015**	**2020**
Enterprise and Innovations Operational Programme	Increasing the energy efficiency of production and of energy consumption in industry and an increased share of renewable energy sources	CO_2	Economic	Implemented	Industrial enterprises	780	3,200	3,200	3,200
EU-ETS	Stimulation of decisive industrial producers to reduce CO_2 emissions	CO_2	Economic, Regulatory	Implemented	Industrial enterprises	500	4,900	6,400	2,600[74]
Preferential purchase tariffs for electricity produced from renewable sources	Replacement of fuel in production of electricity	CO_2	Regulatory, Legislative, Economic	Implemented	Ministry of the Environment, Ministry of Industry and Trade, Energy Regulation Authority	234	980	1,350	1,700
Support for afforestation of unused agricultural areas	More rational use of agricultural land	CO_2	Economic	Implemented	Ministry of Agriculture	96	160	150	140

[74] Around 2020, obsolete coal-burning sources, which substantially contributed to high emissions in the reference year of 2005, will be gradually shut down in the Czech Republic. The scenario anticipates a reduction in primary coal consumption by approx. 10% in 2020.

State Programme to in Support of Energy Savings and the Usage of Renewable Energy Sources, Part B - State Environmental Fund Programmes	Reduction of the energy intensity of the economy, savings in energy materials and minimization of the environmental impact from pollutant emissions and reduction of greenhouse gas emissions	CO_2	Economic	Implemented	State Environmental Fund of the CR, owners and operators	75.2	100	100	100
Industry and business operational programme	Increasing the energy efficiency of production and of energy consumption in industry and an increased share of renewable energy sources	CO_2	Economic	Implemented	Industrial enterprises	70.1	170	170	170
Implementation of the Directive on cogeneration	Increase the efficiency of energy production and improve security of supply through the creation of a framework for support for and development of highly efficient combined production of heat and electricity	CO_2	Economic / Regulatory	Implemented	Ministry of Industry and Trade, Energy Regulation Authority	26	110	300	210
Environmental tax reform	Replacement of fuel in consumption of energy	CO_2	Regulatory, Legislative, Economic	Implemented	Ministry of the Environment, Ministry of Industry and Trade, Energy Regulation Authority	0	1,100	2,500	2,300

Implementation of the Directive on the energy performance of buildings	Reduction of the energy requirements of buildings in relation to the outdoor climate and local conditions, requirements on the indoor environment and effectiveness of expenditures	CO_2	Legislative, normative	Implemented	Investors, owners and operators of buildings	0	310	590	840
Directive on CO_2 emissions from automobiles	Reduction of energy consumption and greenhouse gas emissions from passenger automobile transport	CO_2	Legislative, normative	Prepared	Ministry of Transport	0	0	2,500	3,100
Set of measures in the transport sector	Reduction of emissions of pollutants	CO_2, CH_4, N_2O	Regulatory	Implemented	Ministry of Transport in cooperation with other sectors	1,100	2,700	3,700	4,500
Act on packaging and Act on waste	Harmonisation of CR legislation with European Union legislation	CO_2, CH_4, N_2O	Legislative	Implemented	Ministry of the Environment, Ministry of Industry and Trade	42	100	270	420
Use of landfill gas and biogas from waste water treatment plants	Reduction of methane emissions from landfills and waste water treatment plants	methane	Technical	Implemented	Operators of landfills and waste water treatment plants	940	1,200	1,350	1,400
Measures to reduce greenhouse gas emissions introduced jointly	Energy savings and reduction of emissions in the framework of a JI project	All greenhouse gases	Economic, Voluntary activities	Implemented	Ministry of the Environment, State Environmental Fund of the CR, Czech Energy Agency	700	700	700	700

Infrastructure Operational Programme	Reduction of the amount of emitted pollutants, improving pollution levels in the affected locations, improvement of the state of health of the population and condition of vegetation, reduction of greenhouse gas emissions	All greenhouse gases	Economic	Implemented	Ministry of the Environment, State Environmental Fund of the CR, municipalities	85	150	150	150
Environmental Operational Programme	Improving the state of the environment and health of the inhabitants	All greenhouse gases	Economic	Implemented	Ministry of the Environment, State Environmental Fund of the CR	0	1,600	6,500	6,500
Transport Operational Programme	Modernization and development of transport infrastructure	All greenhouse gases	Economic	Implemented	Ministry of Transport	0	850	1,600	1600
Green Investment Scheme and the programme to repair the housing fund	Energy savings in the housing fund	All greenhouse gases	Economic	Prepared	State Environmental Fund of the CR, owners of buildings	0	500	1,600	1,600
Total						**4,648.3**	**18,830**	**36,730**	**31,230**

10.4 Tables

Tab. 10.7 Trends in overall national PM_{10} emissions (kt p.a.) in 2000 - 2007

Substance	Total annual emissions [kt p.a.]							
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
PM_{10}	40	40	40	38	34	36	35	37[75]

Source: CHMI

Tab. 10.8 Sources of GDP in current prices in the 1995 – 2008 period (part 1)

Year/ quarter	Agriculture, gamekeeping and forest management	Fishing, fish breeding, associated activities	Mining of mineral resources	Processing industry	Production and distribution of electricity, gas and water	Construction	Trade, repairs of motor vehicles and consumer goods	Catering and accommodation
1995	65,648	666	29,174	321,419	69,806	87,214	147,665	37,496
2002	73,764	604	29,574	568,359	86,207	139,096	303,633	45,675
2003	72,720	611	26,547	578,150	86,804	149,213	303,963	49,009
2004	82,761	603	34,153	676,028	99,396	164,494	290,471	55,833
2005	80,420	576	36,328	703,329	103,791	167,996	342,396	52,839
2006	73,489	575	38,049	765,755	127,705	179,756	380,314	50,753
2007	75,761	576	36,342	875,692	129,171	199,240	401,670	55,071
2008	77,076	340	47,431	850,106	139,800	208,902	452,142	59,521

Tab. 10.8 Sources of GDP in current prices in the 1995 – 2008 period (part 2)

Year/ quarter	Transport, storage, post and tele-communications	Finance and insurance	Real estate, services for enterprises, research development	Public administration; defense; social security	Education	Health care, veterinary and social work	Other public, social and personal services	House holds employing personnel	Gross added value in basic prices
1995	138,096	42,591	180,870	71,685	53,776	46,642	32,855	210	**1,325,813**
2002	252,065	68,854	291,256	125,930	91,113	91,816	72,326	323	**2,240,595**
2003	273,224	83,796	306,524	138,846	99,646	95,490	78,612	371	**2,343,526**
2004	271,231	88,631	329,309	142,817	104,257	102,724	84,557	423	**2,527,688**
2005	268,007	81,500	366,909	155,468	115,067	109,133	89,397	435	**2,673,591**
2006	303,555	90,087	391,115	165,323	122,089	115,991	98,315	475	**2,903,346**
2007	327,270	116,638	433,836	174,451	131,101	119,691	108,177	479	**3,185,166**
2008	331,541	126,881	462,906	184,464	134,565	130,485	111,775	484	**3,318,419**

Source: CSO

[75] Data for 2007 are preliminary data

Tab. 10.9 Energy balance (TJ)

	2000	2004	2005	2006	2007[1)]
Total inputs	**1,421,175**	**1,557,564**	**1,577,209**	**1,594,403**	**1,602,185**
of which:					
heat production	276,633	252,402	249,638	239,100	227,272
electricity production	708,263	821,718	811,917	826,603	870,791
fuel improvement, total	436,279	483,444	515,654	528,700	504,122
Total outputs	**909,043**	**971,054**	**994,448**	**1,009,322**	**982,339**
of which:					
heat production	219,783	207,174	205,473	198,123	184,254
electricity production	259,016	296,305	288,641	294,340	309,535
fuel improvement, total	430,244	467,582	500,334	516,859	488,550
Total losses	**572,681**	**654,255**	**650,022**	**653,381**	**686,922**
of which:					
heat production	62,430	50,470	50,249	46,705	48,368
electricity production	469,303	548,510	546,269	555,580	585,686
fuel improvement, total	40,948	55,275	53,504	51,096	52,869
Total primary sources	**1,656,660**	**1,849,515**	**1,855,737**	**1,878,712**	**1,879,464**

[1)] *Preliminary data*

Source: CSO

Tab. 10.10 Total energy balance (PJ)

	2000	2003	2004	2005	2006	2007[1)]
Domestic natural resources	**1,246.7**	**1,352.1**	**1,350.6**	**1,343.0**	**1,363.8**	**1,357.2**
of which:						
solid fuels	1,078.4	1,047.8	1,037.9	1,045.8	1,055.9	1,052.6
liquid fuels	7.4	13.3	14.1	13.2	12.1	10.4
gaseous fuels	7.1	5.3	6.8	6.5	6.2	6.4
primary heat and electricity	153.8	285.7	291.8	277.5	289.6	287.8
Exports	**338.5**	**335.4**	**333.5**	**329.5**	**365.5**	**377.1**
of which:						
solid fuels	229.7	193.8	207.3	196.2	232.7	234.8
liquid fuels	39.9	42.9	28.2	36.1	36	28
gaseous fuels	1.5	3.9	6.1	7.1	9.9	19.3
Imports	**728.3**	**792.4**	**785.7**	**840.9**	**880.9**	**851.2**
of which:						
solid fuels	45	49.8	61	43.7	74.9	86.5
liquid fuels	333.5	376.8	383	428.4	423.7	428.4
gaseous fuels	318.3	329.4	306.5	324.4	341	299.6
Total primary sources	**1,656.7**	**1,815.9**	**1,849.5**	**1,855.7**	**1,878.7**	**1,879.4**
of which:						
solid fuels	906.4	908.8	907.6	899.4	914.9	933.1
liquid fuels	314.7	343	371.4	389.8	390.9	416.4
gaseous fuels	317.8	336.9	335.4	334.6	328.9	300.3
primary heat and electricity	117.8	227.2	235.1	231.9	244	229.6
Total losses	**623.4**	**689.5**	**709.8**	**704.6**	**712.6**	**741.1**
of which:						
in fuel extraction and treatment	13.4	12.6	12.2	10.7	12.7	13.1
in fuel improvement	40.9	44.7	55.3	53.5	51.2	52.9
in heat production	62.4	43.6	50.5	50.2	46.6	48.4
in electricity production	469.3	544.7	548.5	546.3	555.6	585.7

	2000	2003	2004	2005	2006	2007[1)]
in distribution of energy and transport of fuels	37.4	43.9	43.3	43.9	46.5	41
Final consumption total	**1,002.6**	**1,088.8**	**1,118.8**	**1,130.8**	**1,146.9**	**1,128.7**

1) Preliminary data

Source: CSO

Tab. 10.11 Electricity balance (mil. kWh)

	2000	2003	2004	2005	2006	2007[1)]
Total production	73,466	83,227	84,333	82,578	84,361	88,198
Exports (measured)	18,742	26,299	25,493	24,985	24,097	26,357
Imports (measured)	8,725	10,086	9,776	12,351	11,466	10,204
Internal consumption for production	5,725	6,568	6,414	6,387	6,477	6,786
Losses in distribution	4,683	5,087	5,084	5,027	4,885	4,915
Domestic (net) consumption	53,041	55,359	57,118	58,530	60,368	60,344
Final consumption total	47,958	50,649	52,370	53,729	55,541	55,856

1) Preliminary data

Source: CSO

Tab. 10.12 Production of electricity from renewable energy sources and waste

	2000	2003	2004	2005	2006	2007[1)]
	Electricity (GWh)					
Hydro-electric plants	2,313	1,794	2,563	3,027	3,257	2,524
Wind power plants	-	4	10	21	49	125
Solid biomass	382	360	565	560	732	970
Industrial waste	201	195	0	0	0	0
Municipal waste	5	10	10	11	11	12
Biogas	-	108	139	161	175	222
	Heat (TJ)					
Solid biomass[2)]	3,219	31,946	40,230	40,892	41,760	44,471
Industrial waste	-	-	-	990	400	400
Municipal waste	1,664	2,048	2,052	1,979	1,910	1,888
Biogas	384	781	968	1,010	919	1,002
Heat pumps (heat of the environment)	-	-	500	545	676	826
Solar thermal collectors	-	-	84	103	128	163

1) Preliminary data
2) from 2004, incl. fuel wood in households

Source: CSO

Tab. 10.13 Transport outputs in passenger transport in the 1990 – 2007 period (bil. person km)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
IAT	39.9	54.5	63.9	63.4	65.2	67.3	67.57	68.64	69.63	71.54
Public road transport	12.3	7.67	9.35	10.6	9.63	8.89	8.52	8.61	9.50	9.52
Total road transport	52.2	62.2	73.3	74.0	74.9	76.2	76.09	77.25	79.13	81.06
Railway transport	13.4	8.0	7.3	7.3	6.6	6.5	6.59	6.67	6.92	6.90
Air transport	2.2	3.0	5.9	6.4	6.9	7.1	8.81	9.74	10.23	10.48
Water transport	0.003	0.010	0.008	0.008	0.008	0.008	0.022	0.018	0.013	0.018
Total	67.8	73.2	86.4	87.7	88.4	89.8	91.5	93.7	96.3	98.5

Source: TRC

Tab. 10.14 Transport outputs in freight transport 1990 - 2007 (bil. t.km)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
Total road transport	16.82	32.50	39.03	40.26	45.06	46.56	46.01	43.45	50.37	48.14
Public road transport	8.81	22.90	31.36	34.21	37.78	39.12	37.42	38.12	45.09	43.27
On own account	8.01	9.60	7.67	6.05	7.28	7.45	8.59	5.33	5.28	4.87
Railway	41.14	25.50	17.30	16.88	15.77	15.85	15.09	14.87	15.78	16.30
Air	0.06	0.03	0.04	0.03	0.03	0.04	0.05	0.05	0.05	0.04
Water	1.41	1.23	0.77	0.61	0.54	0.52	0.41	0.78	0.82	0.90
Total	59.43	59.26	57.14	57.78	61.4	62.98	61.6	59.2	67.0	65.4

Source: TRC

Tab. 10.15 Number of motor vehicles in the CR 1990 - 2007 (thousand vehicles)

	1990	1995	2000	2001	2002	2003	2004	2005	2006	2007
One-track	1,172	915	749	755	760	752	757	794	823	860
Passenger and vans	2,411	3,043	3,439	3,530	3,619	3,702	3,816	3,959	4,471	4,708
Trucks	156	203	276	296	324	340	371	415	203	208
Buses	26	20	18	18	21	21	20	20	20	20
Total	3,765	4,181	4,482	4,599	4,724	4,815	4,964	5,188	5,520	5,796

Source: TRC

Tab. 10.16 Output of air transport in the 2000 – 2007 period

Indicator	2000	2004	2005	2006	2007[1)]
Total number of flights	53.040	82.591	95.310	95.184	100.839
Total number of km flown (thousand)	61.554	87.824	96.833	98.796	104.626
Total number of persons transported (thousand)	3.483	5.750	6.330	6.710	6.977

[1)] *Preliminary data*

Source: CSO

Tab. 10.17 Index of industrial production according to sector

Sector	Industrial production index[1, 2)]					
	2002	2003	2004	2005	2006	2007
Industry, total	**101.9**	**105.5**	**109.6**	**106.7**	**111.2**	**109**
Mining of mineral materials	100.9	100.3	99.4	100.5	102.5	98.3
Mining of energy-production materials	98.8	99.4	97.8	99.8	100.6	95.8
Processing industry						
Fibres, paper and paper products	100.5	99	107.3	106	101.1	104.5
Coke, nuclear fuel, refinery petroleum processing	103.8	103.6	104	112.6	102.6	95.7
Chemical substances, preparations, drugs and chemical fibres	97.4	100.7	111.4	105.7	102.1	100.7
Rubber and plastic products	111.2	115.2	111	112.7	115.3	118.6
Basic metals, metallurgical and leather products	98.5	109.9	109.3	99	109.1	99.6
Repair of machinery and equipment not listed elsewhere	97.7	105.1	114.3	114	120.8	121
Electrical and optical instruments and equipment	117.9	109.8	129.2	105	121	117.3

Sector	Industrial production index[1, 2)]					
	2002	**2003**	**2004**	**2005**	**2006**	**2007**
Means of transport and transport equipment	100.9	106.4	113.2	123.1	122.2	115.7
Processing industry not listed elsewhere	102.5	98.3	107.9	108.8	109.7	102.4
Production and distribution of electricity, gas and water	100.2	108.8	100.9	98.8	102.6	101.7

[1)] *Reference year = 2000*
[2)] *The industrial production index (IPI) is calculated from production statistics and statistics of industrial revenues for industrial activities themselves in constant prices for business entities with 20 or more employees*

Source: CSO

Tab. 10.18 Waste production in the 1996 – 2007 period according to origin (thousand t)

Year	Waste from agriculture and forestry	Waste from mining activities	Industrial waste	Waste from energy production[1)]	Municipal waste	Other waste	Total
1996	3,288	157	23,232	10,279	3,200	11,906	52,062
1997	4,412	1,890	14,083	13,306	3,289	31,538	68,508
1998	8,124	600	8,900	10,409	4,535	11,550	44,118
1999	7,175	2,351	8,867	4,941	4,200	7,935	35,469
2000	6,989	2,568	9,375	8,989	4,509	9,045	41,475
2001	5,935	2,285	9,040	6,491	4,243	10,700	38,694
2002	5,817	597	9,510	6,425	4,615	11,044	37,968
2003	5,281	689	7,525	6,501	4,639	11,304	35,939
2004	3,876	685	7,647	5,305	4,651	6,299	38,704
2005	2,180	612	5,794	1,884	4,439	4,576	29,802
2006	1,304	459	6,575	2,047	3,979	4,605	28,066
2007[2)]	782	107	6,418	1,900	4,130	2,316	31,453

[1)] *Except radioactive waste*
[2)] *Preliminary data*

Source: MoE, CENIA

Tab. 10.19 Production of the agricultural sector in constant 2000 prices in the 1998 – 2006 period (CZK mil.)

Year	Total	Plant production	Animal production	Production of agricultural services	Non-agricultural secondary activities (not separable)
1998	102,623	47,479,	53,244	1,900	
1999	105,214	51,471,	52,549	1,194	
2000	101,188	49,765,	50,550	873	
2001	104,460	53,640,	49,896	924	
2002	102,616	49,913,	49,697	783	2,223
2003	97,219	44,032,	49,830	1,184	2,173
2004	111,286	59,587,	47,937	1,184	2,578
2005	107,853	55,493,	47,731	1,150	3,479
2006	101,468	49,489,	47,350	1,261	3,368

Source: CSO, CENIA

Tab. 10.20 Trends in the consumption of mineral fertilizers in the 1999 – 2007 period (kg/ha)

Fertilizers	Financial year					
	1999/2000	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007
Total	88.4	89.7	99.8	97.0	98.9	104.6
of which:						
nitrogen	67.4	65.2	73.7	71.7	74.1	77.6
phosphorus	12.6	14.1	15.6	15.0	14.9	16.3
potassium	8.4	10.4	10.5	10.3	9.9	10.7

Source: CSO¨

Tab. 10.21 Trends in the area of forest land in 1920 – 2007 (thousand ha)

	1920	1930	1945	1950	1960	1970	1980	1990	2000	2003	2005	2007
Area	2 369	2 354	2 420	2 479	2 574	2 606	2 623	2 629	2 637	2 644	2 647	2 651

Source: MoA, COSMC

Tab. 10.22 Trends in the total stand stocks of wood in forests in 1930 – 2006 (mil. m^3)

	1930	1950	1960	1970	1980	1990	1998	1999	2000	2001	2002	2003	2006
Stand stocks	307	322	348	445	536	564	615	625	630	638	641	650	668

Source: MoA

Tab. 10.23 The results of inventories of F-gases for the 1990 – 2007 period (CO_2eq)

	1990	1991	1992	1993	1994	1995	1996	1997	1998
HFCs	0	0	0	0	0	1	101	245	317
PFCs	0	0	0	0	0	0	4	1	1
SF_6	78	77	77	77	76	75	78	95	64
F-gases (total)	78	77	77	77	76	76	183	341	382

	1999	2000	2001	2002	2003	2004	2005	2006	2007
HFCs	268	263	393	391	590	600	594	872	1 606
PFCs	3	9	12	14	25	17	10	23	20
SF_6	77	142	169	68	101	52	86	83	76
F-gases (total)	347	413	574	473	716	670	690	978	1,702

Source: CHMI

Tab. 10.24 Categorization of sources included in EU ETS for the entire 2005 – 2007 period according to branch of industry

Sector	Number
Public energy production	126
Corporate energy production	96
Refineries	4
Chemical industry	16
Coke	2
Metal production and working	19
Cement and lime	10

Sector	Number
Glass	17
Ceramics	50
Paper and cellulose	15
Total	**355**

Source: MoE

Tab. 10.25 Classification of sources included in EU ETS according to emissions (2007)

Size of source (t p.a.)	Number	% of total number	Emissions(t)	% of emissions
< 1 000	16	4.5	6,293	0.007
1 000 – 10 000	122	34.4	598,791	0.683
10 000 – 25 000	89	25.1	1,390,346	1.587
25 – 100	55	15.5	2,596,536	2.964
> 100	73	20.5	83,022,554	94.759
Total	**355**	100	87,614,520	**100**

Source: MoE

Tab. 10.26 Survey of JI projects

Project type	Number	ERU p.a.
Small hydro power plants	17	67,076
Replacement of fossil fuels by biomass	14	254,096
Decomposition of dinitrogen oxide	1	175,500
Conversion from coal to gas	2	28,200
Energy-production use of landfill gas	8	148,807
Total	42	715,678

Source: MoE

Tab. 10.27 Demographic projection (thousand)

	2002	2005	2007	2010	2015	2020
Population	10,203	10,236	10,324	10,283	10,284	10,284
Households	3,824	3,861	4,001	3,978	4,150	4,311

Source: CSO, ENVIROS, s. r. o.

Tab. 10.28 Projection of trends in gross added value (constant prices[76] of 2000) in EUR bil.

Sector	2005	2006	2007	2010	2015	2020
Industry	22.2	25.7	27.6	26.5	29.8	35.0
Construction	3.8	3.9	3.9	3.9	4.2	4.7
Agriculture	2.5	2.4	2.1	2.1	2.2	2.4
Transport	6.5	7.1	7.6	7.6	8.2	9.4
Services	32.1	32.5	35.0	37.8	43.8	53.4
Total	67.1	71.6	76.2	78.0	88.3	104.9

Source: ENVIROS, s. r. o.

[76] Exchange rate 35.61 CZK/€ – average for 2000

10.5 References

National Program To Abate the Climate Change Impacts in the Czech Republic, Government Resolution No. 187 from 3 March 2004 (http://iris.env.cz/AIS/web-pub2.nsf//cz/narodni_program_zmirnovani_dopadu_zmeny_klimatu)

Assessment of Program To Abate the Climate Change Impacts in the Czech Republic, MoE, 2008 (http://iris.env.cz/AIS/web-pub2.nsf//cz/vyhodnoceni_narodniho_programu)

Program „Green light for energy savings“ (Czech Green Investment Scheme), State Environmental Fund, May 2009, (http://www.zelenausporam.cz/sekce/470/popis-programu/)

State program on energy savings and use of renewable energy sources (http://www.mpo.cz/dokument37411.html and http://www.mdcr.cz/cs/Legislativa/Programy+a+projekty/Uspora+energie/Uspora_energie.htm)

Strategy for sustainable development (Government Committee for Sustainable Development, Prague 2004) (http://www.cenia.cz/web/www/web-pub2.nsf/$pid/MZPMSFHDHBNA)

National strategic reference framework of the Czech Republic (2007-2013), July 2007, Ministry for Regional Development, Prague

National development plan of the Czech Republic, Government Resolution No. 175 from 22 February 2006 (http://www.strukturalni-fondy.cz/getdoc/8f1552fc-d149-4a99-9638-2903d6e7dcc3/Narodni-rozvojovy-plan-Ceske-republiky-2007—2013)

Strategy for regional policy of Czech Republic for period 2007-2013, Government resolution No. 560 from 17 May 2006. (http://www.mmr.cz/getdoc/f77e14bc-2c26-4884-9fda-b47c24a5294b/Strategie-regionalniho-rozvoje-Ceske-republiky-pro)

Strategy of protection of global climate system in Czech Republic, Government Resolution No. 480 from 17 May 1999. (http://www.chmi.cz/cc/usn480.html)

Operational Programme Enterprise and Innovations (OPEI) 2007 – 2013 (http://www.mpo.cz/en/business-support/opei/)

Operational Programme Transport 2007 – 2013 (http://www.opd.cz/cz/Programove-dokumenty)

The Operational Programme Environment for the period 2007 (http://en.opzp.cz/sekce/515/documents-for-download/)

Government Decree No. 80/2008 Coll., on National Allocation Plan for trading period 2008 –2012, Official Gazette 2008.

Directive 2009/29/EC amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community

Directive 2009/28/EC on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

Directive 2009/31/Ec on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006

State Energy Policy of the Czech Republic (approved by Government Decision No. 211 of March 10, 2004)

Renewable Energy Sources in the Czech Republic 2007 (Ministry of Industry and Trade, 2008)

Report of the Independent Expert Commission for Evaluation of long-term Energy Needs of the Czech Republic (2008)

Opponent Testimony of the Report of the Independent Expert Commission for Evaluation of long-term Energy Needs of the Czech Republic (2008)

Annual Reports of the Czech Energy Agency (2001 – 2006)

Annual Reports of the State Environmental Fund (2000 – 2007)

Annual Reports of the State Fund of Housing Development (2004 – 2007)

Annual Reports of the State Fund of Transport Infrastructure (2005 – 2007)

Annual Data Summary of Electric Power System of the Czech Republic (Energy Regulatory Authority, 2000 – 2007)

Detailed Balances of Renewable Energy Sources - 2nd phase (Association for Use of Renewable Energy Sources, 2008)

International Energy Outlook (US Energy Information Administration, 2005 – 2008)

Annual Energy Outlook (US Energy Information Administration, 2005 – 2008)

FAOSTAT Forestry (Online statistics of the Food and Agriculture Organization of the United Nations)

Transport Yearbooks of the Czech Republic (Ministry of Transport, 2000 – 2008)

Overview of Production and Sales of Cars from domestic producers (Consortium of Car Industry, Online statistics)

Steel Statistical Yearbook 2007 (World Steel Association, 2008)

Czech Hydrometeorological Institute – web page for National Inventory System (http://portalh.chmi.cz/http://portal.chmi.cz/files/portal/docs/uoco/oez/nis/nis_uv_aj.html)

Annual Report of the Czech Hydrometeorological Institute 2007 (CHMI, 2008)