EXECUTIVE SUMMARY

1. INTRODUCTION

Climate Change, caused by increasing anthropogenic emission of greenhouse gases (CO_2, CH_4, N_2O, CFCs, etc.), represents the most serious environmental issue in the history of mankind. The UN Framework Convention on Climate Change (FCCC) is the first binding international legal instrument to address this issue. The ultimate objective of this Convention is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The Convention came into effect in the Slovak Republic on 23 November 1994. The Slovak Republic accepted the specific obligations resulting from the Convention, including the commitment to take measures aimed at returning emissions of greenhouse gases to the base year (1990) level by the year 2000. The Slovak Republic will undertake all activities to achieve the "Toronto target" (20% CO_2 emission reduction in 2005 compared to 1988).

The First Slovak National Communication to the FCCC Conference of the Parties was adopted by the Government of the Slovak Republic on 23 May 1995. An in depth review of the Slovak National Communication was conducted by a group of specialists, nominated by the FCCC Secretariat, in June 1996. The in depth review confirmed the feasibility of achieving the “Toronto Target” in the Slovak Republic. This Second National Communication of the Slovak Republic is elaborated according to the COP 2 guidelines. It respects in the full scale the conclusions of the First National Communication, it takes into account updated sectorial strategies and results achieved in the framework of Slovak participation in the US Country Studies Program to Address Climate Change.

2. NATIONAL CIRCUMSTANCES

The Slovak Republic became an independent state on January 1, 1993 as a result of the division of the former Czech and Slovak Federal Republic into two independent state. The new Constitution of the Slovak Republic was adopted on September 1, 1992. The President of the Slovak Republic is the head of State. The Parliament is the supreme organ of State power and the legislative authority. It has 150 deputies. The Government of the Slovak Republic is directed by the Prime Minister and has 15 ministers. The legislative process is a combined effort of Ministries, Government and Parliament. From an administrative point of view Slovakia is subdivided into 8 regions, 79 districts and 2 904 communities (1995). The Slovak Ministry of the Environment, district offices and municipalities are executive authorities with respect of the environment. Slovakia is one of the Central European Countries undergoing the process of transition from a central planned economy to a market economy. Transformation of the whole economy together with disintegration of the Common East European market have caused a deep depression of industrial production and substantial decrease in the Slovak GDP. At the present time the Slovak Republic is in the phase of economic revitalisation. The Slovak Republic is based on democratic principles with orientation of its home and foreign policy to the OECD, North Atlantic Treaty Organisation (NATO) and the European Union.

Slovakia lies at the heart of Europe. The area of the country is 49,036 km^2, including agriculture land (24,471 km^2), arable land (14,860 km^2), forest land (19,911 km^2), water area (940 km^2) and built-up areas (1,275 km^2). Slovakia is a mountainous country, 60% of its territory is over 300 m a.s.l. Slovakia is in the mild climate zone. The average annual precipitation for the whole country is 743 mm, 65% of this is evaporated and 35% represents runoff. A temperature increase of about 1°C and precipitation decrease of about 5-15% were observed during the last 100 years.

The population of Slovakia has grown from 3 million inhabitants in 1920 to 5.37 million at the end of 1995. The highest natural population increase (over 1.7%) occurred in 1950, while in 1995 it was 0.16%. High demand for energy and raw materials (production of iron, steel, aluminium, cement, fertilisers, plastic materials, etc.) is a characteristic feature of the Slovak economy. However, there is a shortage of domestic sources of high-quality raw materials (excluding non-ore material and magnesite). The per capita acreage of 0.46 ha of farmland is relatively small. During the initial years of economic transformation no significant changes in crop production were registered, but all forms of animal production dropped significantly. The forest is one of Slovakia's most important natural resources. In 1991, Slovak timber resources represented 352 million m^3. Slovakia, a typical inland country, is situated on the "roof" of Europe. Therefore its natural water resources are limited. Average discharge of 405 $m^3.s^{-1}$ results from runoff. During the last several decades a significant decrease of Slovak rivers discharge has been observed. Several regions of Slovakia exhibit a considerable soil moisture deficiency during the vegetation period. More than 800,000 ha of arable land need irrigation.

3. EMISSIONS OF GREENHOUSE GASES

The Slovak Republic's share of global anthropogenic greenhouse gases emission is approximately 0.2%. The annual per capita CO_2 emission ca 11 tonnes in 1990 is lower than the average for OECD countries, nevertheless it places Slovakia among the 20 states with the highest per capita emissions. The highest emission level was at the end of eighties. After 1990 emissions began to decrease, as a consequence of the economic recession.

Table 1 Total anthropogenic greenhouse gas emissions in Slovakia (rounded)

		1990	1991	1992	1993	1994
CO_2	[Tg]	60	53	49	46	43
CH_4	[Gg]	410	380	360	330	310
N_2O	[Gg]	12	11	9	7	7

The 1990 emissions are modified as compared to the First National Communication (see text)

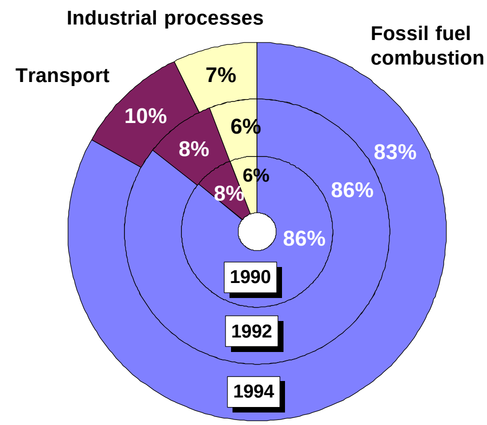
CO_2 emissions

Approximately 83% of primary energy used in the Slovak Republic in 1990 was from fossil fuels (78% in 1994)[1]. Therefore the energy sector is the dominant source of carbon dioxide in Slovakia. The total emission was estimated according to the reference approach of the IPCC methodology using primary energy consumption combined with import and export of some secondary fuels. In the period 1990-1994 CO_2 emissions dropped about 30% (Table 1). Fossil fuel combustion (stationary sources as well as transport) is the most important source of

[1] The remaining 17% (22% in 1994) comes from other sources (nuclear power plants, hydroelectric power plants, renewable sources of energy)

CO_2 emitted in the SR (93% in 1994, see Figure 1). The second but much less important source is industrial processes (cement, lime, magnesite, aluminium production). The amount of carbon from fossil fuels stored in different non-energy products was estimated by the IPCC method at 1,369 Gg C in 1990 (973 Gg C in 1994).

Figure 1 CO_2 emission by sectors in 1990-1994



CO_2 removals

The Slovak Republic's forest land covers about 2 mil. hectares, which represents about 41% of the total area of the republic. Forest areas are a significant CO_2 sink. The annual CO_2 net removal is about 5 Tg of CO_2 with uncertainty roughly 30%. The CO_2 emission from the conversion of grassland into arable land was estimated of 462 Gg per year.

CH_4 emissions

The major sources of CH_4 are agriculture (farming), fugitive emissions from natural gas handling and waste treatment. Less important is fuel combustion and industry (Figure 2). Between 1990-1994 methane emissions in the Slovak Republic decreased by 24% (Table 1).

N_2O emissions

The most important source of N_2O is agriculture (Figure 3). The substantial decrease of the average consumption of fertilisers (mineral + organic; in 1990 approximately 138 kg N/ha, in 1994 approximately 65 kg of N/ha) as a consequence of economic transition caused more than a 40% decrease of emissions (Table 1). Industry (production of nitric acid) is the second most important source of N_2O. Other sources are fossil fuel combustion and waste treatment.

Figure 2 CH_4 emission by sectors in 1990-1994

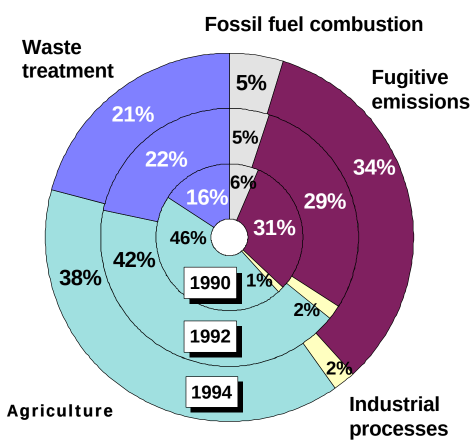
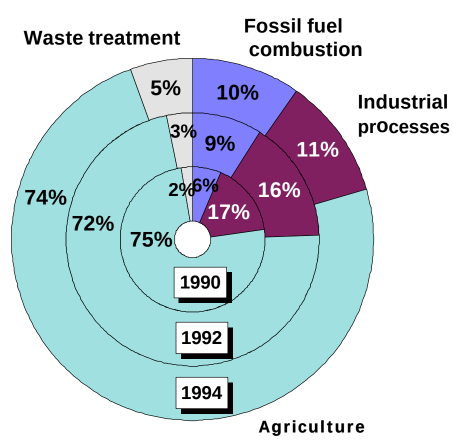


Figure 3 N_2O emission by sectors in 1990-1994



Other gases

Table 2 shows the trend of SO_2, NO_x, CO, NMVOC, CFC and PFC emissions in 1988, 1990-1994.

Table 2 Anthropogenic emissions of NO_x, CO, NMVOC, CFC, PFC and SO_2 [Gg]

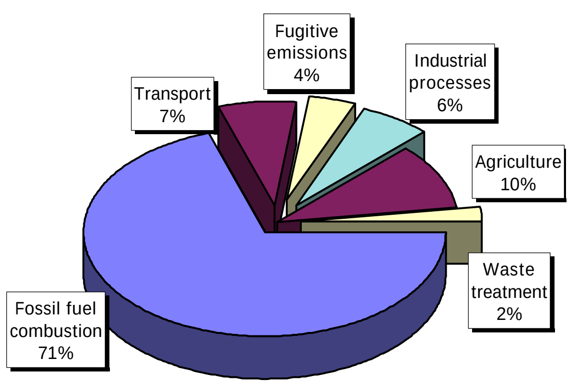
	1988	1990	1991	1992	1993	1994
NOx	*197	227	212	192	184	173
CO	457	489	439	382	408	411
NMVOC	(156)	147			116	
CFCs (consumption)	1.71			0.61	0.99	0.38
CF_4	0.074	0.074	0.099	0.099	0.084	0.048
C_2F_6	0.002	0.002	0.003	0.003	0.002	0.001
SO_2	585	543	445	354	326	239

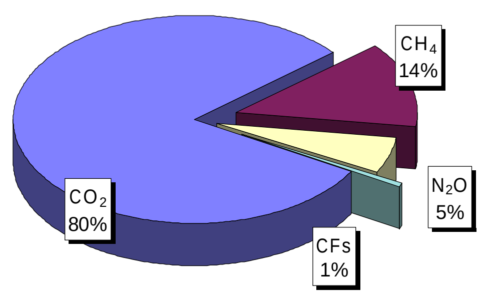
** data from 1987*

Aggregated GHG emissions

Aggregated GHG emissions are expressed as the CO_2 equivalent by means of GWP values for the time horizon of 100 years. In 1990 the CO_2 emissions contribute 80% of the total emissions, CH_4 emissions 14%, N_2O emissions 5% and C_xF_y emissions about 1% (Figure 4). In 1990 heat and electricity generation was the dominant source of emissions (71%). Agriculture contributed approximately 10%, transport 7%, industry 6%, fugitive emissions 4% and waste treatment 2% (Figure 4). Removals of CO_2 by forest ecosystems accounts for 6% of the total aggregated GHG emissions.

Figure 4 Aggregated GHG emissions in 1990 (*GWP 100 pre CO_2 = 1, CH_4 = 24.5, N_2O = 320, CF_4 = 6,300, C_2F_6 = 12,500*)





4. POLICY AND MEASURES TO MITIGATE GREENHOUSE GAS EMISSIONS

In the Slovak Republic no comprehensive GHGs related national policy has been adopted to date. Following the results of ongoing programmes adoptation of a national policy is expected by the end of next year. In a relatively short time during the period of political and economic transformation of the society and the development of a new state, a range of acts, regulations and measures, indirectly related to greenhouse gases emissions reduction or enhancement of sinks, was adopted. The First National Communication (adopted by the Slovak Government) introduces a survey of such activities originally devoted to other goals but indirectly linked to greenhouse gases emission reduction. It represents an effective instrument for the implementation of the Framework Convention on Climate Change in the Slovak Republic until the official national greenhouse gases mitigation and adaptation policies are adopted. The Government of the Slovak Republic accepted the specific obligations resulting from the UN Framework Convention, including the voluntary commitment to undertake all activities to reduce CO_2 emission from fossil fuel combustion by 20% in 2005 compared to 1988.

Strategies and policies

- **Strategy, Principles and Priorities of the Government Policy**
  This document determines the priorities of the state environmental policy and formulates the long-term, medium-term and short-term strategic objectives. The short-term strategy (up to 2000) explicitly includes the adoptation of greenhouse gases mitigation programme and its implementation in the period 2000-2010.
- **Energy, Strategy and Policy of the Slovak Republic up to the year 2005 (2010)**
  This document and the proposal of its up-dated version (up to the year 2010) respects the Slovak environmental legislation and international environmental commitments.
- **Strategy and Policy of Forestry Development in the Slovak Republic**
  The basic strategic goals of the Slovak forestry are conservation of forests and the gradual increase of afforested areas.
- **Waste Management Programme in the Slovak Republic**
  The objective of the waste management programme is to minimise the environmental risks (recycling, separate waste collection, incinerators and the development of managed landfills system).
- **Principles of Agricultural Policy**
  The adopted policy is concentrated on ecologisation of agricultural production, including rational consumption of fertilisers.
- **Harmonisation of the Slovak environmental policy and legislation with European Union**

The list of the most important legislative, economic and other measures having direct or indirect effect on the GHG emissions is given in the following survey. Details may be found in Chapter 4.

Strategy and measures to mitigate CO_2 emissions

I. Measures fully or partly implemented

Cross sectorial measures

- Act No. 309/1991 on the Protection of the Air against Pollutants amended by Act No. 256/95
  At present this act, even though oriented to the classic pollutants, represents one of the most important instrument to mitigate CO_2 emissions. The act establishes use of the best available technologies not entailing excessive costs (BATNEEC) at the construction of new and repowering of existing air pollution sources and also introduces emission charges.
- Act No. 311/1992 on Charges for Air Pollution
- Act No. 128/1992 on Government Fund for the Environment, Decree No. 176/1992 on Conditions for Providing and Use of the Financial Means from Governmental Fund for the Environment of the Slovak Republic

Energy sector

- Act No. 286/1992 on Income Tax amended by Act No. 326/1993
- Act No. 289/1995 on Value Added Tax
- Liberalisation of Energy and Fuel Prices
- Program Supporting the Economic Activities Resulting in Savings of Energy and Imported Raw Materials

Industry

- Closure of inefficient industrial production units
- Iron and Steel production in VSŽ (Continual steel casting, Combined cycle implementation)
- Innovation of aluminium production in ZSNP Žiar n/Hronom

Residential and service sector
- Program of Energy Consumption Reduction in Apartment and Family Houses
- Normalisation and Standardisation for Heat Conservation of Buildings - STN 730540

Transportation
- Inspection of vehicles in operation
- Creation and development of a combined transport system
- Preference for electric traction to diesel railway transport
- Acceleration of vehicle fleet replacement

II. Measures considered for the future

Action plan for GHG emissions reduction in the Slovak Republic

Energy sector
- Measures resulting from the Energy Policy and Strategy of the Slovak Republic to 2005
- Energy Act
- Act of energy conservation
  According to the act the energy policy will include the following activities:
  - Programs supporting more economical energy uses
  - Regional energy policy
  - Energy audits
  - Obligatory of heat and electricity cogeneration
  - Energy labelling of appliances
  - Energy standards
  - Education and training programs
- Energy Saving Fund (ESF)
- Carbon tax implementation
- More effective use of renewable energy potential - policy and strategy
- Demand side management

Transportation
- Automobile tax
- To maintain the present public transport level
- Education and training

Residential and service sectors
- Program of Energy Saving in Buildings until 2000, with the extension to 2005
- Tax allowances
- Education and training

Strategy and measures to reduce the emissions of other greenhouse gases

I. Measures fully or partly implemented

METHANE

Gas industry
- Gas distribution system (improvement of measuring and regulation techniques)
- Transit pipelines (reduction of fugitive emissions)

Waste management
- Waste management program of SR to 2000
- Act No. 239/1991 on waste

Agriculture
- Act No. 307/1992 on agricultural soil protection
- Code of Good Agricultural Practice - soil protection in the SR

NITROUS OXIDE

Agriculture

- Act No. 307/1992 on agricultural soil protection
- Code of Good Agricultural Practice - soil protection in the SR

II. Measures considered for the future

METHANE

Waste management

- Updating of legislative measures

Agriculture

- Policy and Strategy of Environment Protection in Agriculture

Gas industry

- Decreasing of leakage from gas transition and distribution systems

OTHER GASES

- UNO ECE Convention on Long-range Transboundary Transport of Air Pollution
- Act No.309/1991 on Protection of the Air Against Pollutants
- National Program of NMVOC Emission Reduction

Measures focused on the GHG sink increase

I. Measures fully or partly implemented

- Afforestation of non-forest areas
- Tree species composition change
- Protection of carbon stock in forests affected by immissions

Measures considered for the future

- Improvement of ecological forest management with regard to soil carbon conservation (erosion control measures)
- Preventive measures against noxious agents which decrease growth or damage the biomass, mainly trees
- Planting projects in urban and industrial areas

5. PROJECTIONS AND ASSESSMENT OF MEASURE EFFECTS

The emission projections in countries with economies in transition are significantly influenced by the uncertainties accompanying the transition process. Considering the on-going transformation process in the Slovak Republic and formation of the new state, the extrapolation of historical data for energy demands cannot be used. The emission projections were prepared by modelling in the energy and non-energy sectors, that has been carried out within the framework of the Slovak Republic's Country Study (US Country Studies Program).

Projections of energy related CO_2 emissions

The scenario modelling of energy consumption has been carried out using the ENPEP/BALANCE software package obtained from the ARGONNE NATIONAL LABORATORY, together with the training course within the framework of US Country Studies Program. The following key assumptions have been used in projections:

- Prediction of macro-economic indicators for the period 1995-2010
- Development of primary energy sources
- Assumption of annual energy intensity decreasing by 1%
- Assumption of energy and fuel prices development

- Maintenance of actual industry structure
- Assumption of steel production in Slovakia
- Assumption of district heat consumption from centralised sources
- Assumption of electricity production/consumption
- Liberalisation of fuel and energy prices
- Optimistic/higher scenario of population development
- Forecast of road transport development

The most important measures to mitigate energy related CO_2 emissions are:
Act on Protection of the Air Against Pollutants (determines the emission concentration limits of basic pollutants)
Energy conservation policy (in agreement with the actual and future proposed legislation)
National energy policy (Energy policy and strategy to the year 2005 and its updated version to 2010 - draft)

The following scenarios have been applied to model the whole energy system:

Scenario 1 Baseline scenario, the requirements of emission limits according to the Act on Air Protection are applied in the case of new energy sources only.
Scenario 2 Full application of the Act on Air Protection and emission limits for all sources (new installed and existing) is considered.
Scenario 3 The same as the scenario 2. Also the impact of energy saving measures, stimulated by the present and prepared legislation, is included in this scenario.
Scenario 4 The same as scenario 3, assumption of more expressive industrial restructuring is considered in this scenario. This restructuring can be characterised by the technology innovation and reconstruction. The annual decrease of industrial energy intensity by 1% has been considered after the year 1997.
Scenario 5 The same as scenario 4. The more intensive use of renewable energy sources is considered so that continual penetration of these sources to the energy balance will be achieved until the full penetration in the year 2010. This potential based on the data from Energy Strategy and Policy represents 32.4 PJ(2473 $GgCO_2$).

Figure 5 gives the results of modelled projections for CO_2 emission development for specific scenarios.

Figure 5 Projections of energy related CO_2 emissions

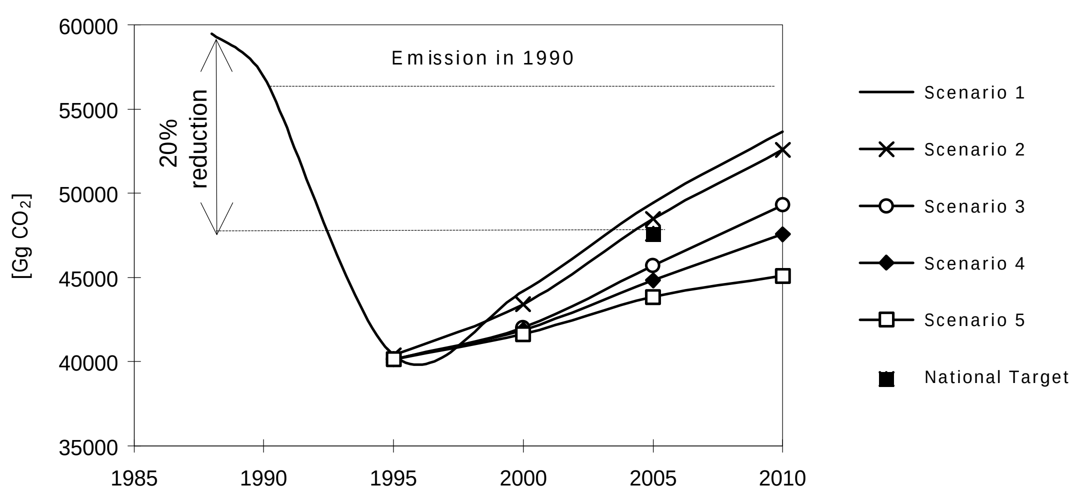


Figure 5 also contains the emission level according to the National target, e.g. expected reduction of energy related CO_2 emissions by 20% in 2005 in relation to the 1988 emission level. This target is possible to achieve in the case of applications of scenario 3 and 4, e.g. at the implementation of all future energy conservation measures and measures considered in transportation sector. On the other side, the CO_2 emission level stabilisation will not be achieved and the level of the National target will be exceeded in the year 2010 for the case of scenario 3 and balanced in the case of scenario 4. In the case of full implementation of the technical feasible potential of renewable sources (scenario 5) the development of energy related CO_2 emission is close to stabilisation.

Projections of CO_2 sinks in forestry and land use

The modelled projections of CO_2 sinks in forestry and land use have been based on the assumptions of tree species composition change (substitution of spruce for deciduous species), afforestation of non-forest lands and revitalisation measures impact on forests affected by immisions for three scenarios (with high, medium and low impact of measures). The total projection is summarised in Table 3. From the long-term view an increased amount of sequestered CO_2 in Slovak forests can be expected.

Table 3 The total projection of CO_2 sinks into tree biomass [$TgCO_2$]

Scenario	1990	2000	2010	2020	2030	2040	2050
High	0.00	1.82	5.26	10.81	20.41	36.42	58.96
Medium	0.00	0.97	3.70	8.14	16.22	29.43	45.59
Low	0.00	0.53	1.40	3.38	6.71	12.84	18.67

Projection of aggregated GHG emissions

Aggregated emission projections of greenhouse gases (CO_2 equivalent according GWP) have been developed in the three following scenarios:

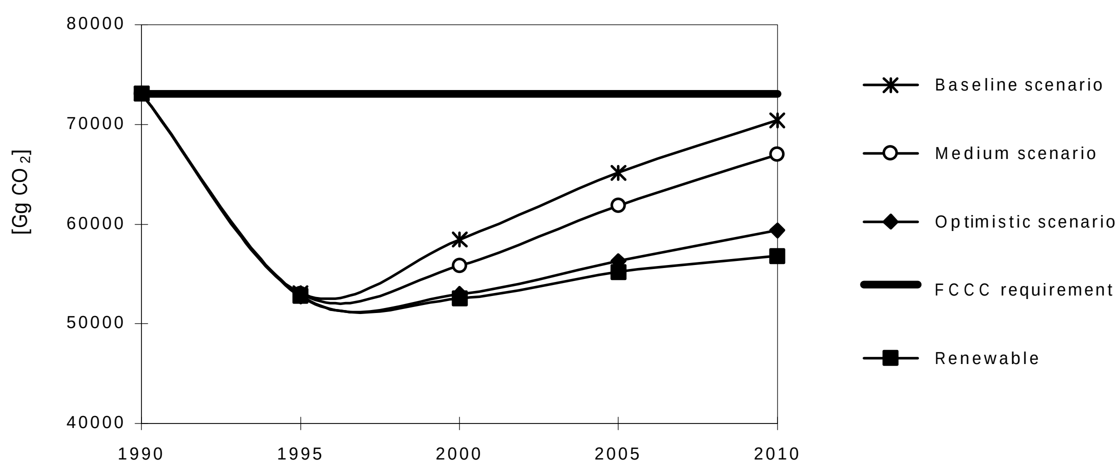
- **baseline scenario** represents the combination of baseline scenarios for all greenhouse gases;
- **medium scenario** represents the combination of scenario 2 for energy related CO_2 emission (scenario with the impact of Act on Air Protection) and medium scenarios for other greenhouse gases;
- **optimistic scenario** represents the combination of GHG emission scenarios with the highest impact of applied measures (It means the scenario 4 in the case of CO_2 and scenario 3 for the other greenhouse gases). In the case of optimistic scenario also the variant with the assumption of full renewable energy source potential application (scenario 5 for CO_2) has been followed.

The results are summarised in Table 4 and on Figure 6. It is obvious, from comparing the total GHG emission level with the year 1990, that in the whole period (until 2010) this level will not be exceeded. On the other side, all projections show the increasing trend of emission production, where the energy related CO_2 emissions play the most significant role. The trend of the optimistic scenario is the closest to stabilisation. In this scenario we suppose the operation of 4 nuclear power plant units in Mochovce, the successive restructuring of industry toward the less energy intensive technologies and the full exploitation of the technically available potential of renewable sources (determined by the level considered in the Energy Policy and Strategy up to 2010) .The GHG emission projection can be also influenced by other factors, such as: a lower GDP growth rate than is proposed during the modelling of the optimistic scenario; the strength of the impact of full energy price liberalisation on the less energy intensive production; the acceleration of energy conservation measure implementation in the commercial and residential sectors as well as in industry and the transportation sector. An important factor will also be the entrance of Slovakia into the EU, or essentially the influence of the harmonisation of the Slovak legislative options with EU ones (for example carbon tax).

Table 4 Aggregated emission projection of greenhouse gases for particular scenarios

		1990	1995	2000	2005	2010	GWP
Baseline scenario	**CO_2**	59,752	43,146	46,953	52,884	57,598	1
	CH_4	9,824	7,882	8,073	8,529	8,987	24.5
	N_2O	3,488	2,048	3,392	3,744	3,840	320
	Total	**73,064**	**53,076**	**58,418**	**65,157**	**70,425**	
Medium scenario	**CO_2**	59,752	43,146	46,178	51,919	56,519	1
	CH_4	9,824	7,881	7,022	7,317	7,684	24.5
	N_2O	3,488	1,980	2,640	2,639	2,772	320
	Total	**73,064**	**53,007**	**55,840**	**61,875**	**66,975**	
Optimistic scenario	**CO_2**	59,752	42,901	44,652	48,276	51,502	1
	CH_4	9,824	7,816	6,145	5,794	5,488	24.5
	N_2O	3,488	2,016	2,176	2,208	2,368	320
	Total	**73,064**	**52,733**	**52,973**	**56,278**	**59,358**	

Figure 6 Projections of aggregated GHG emissions



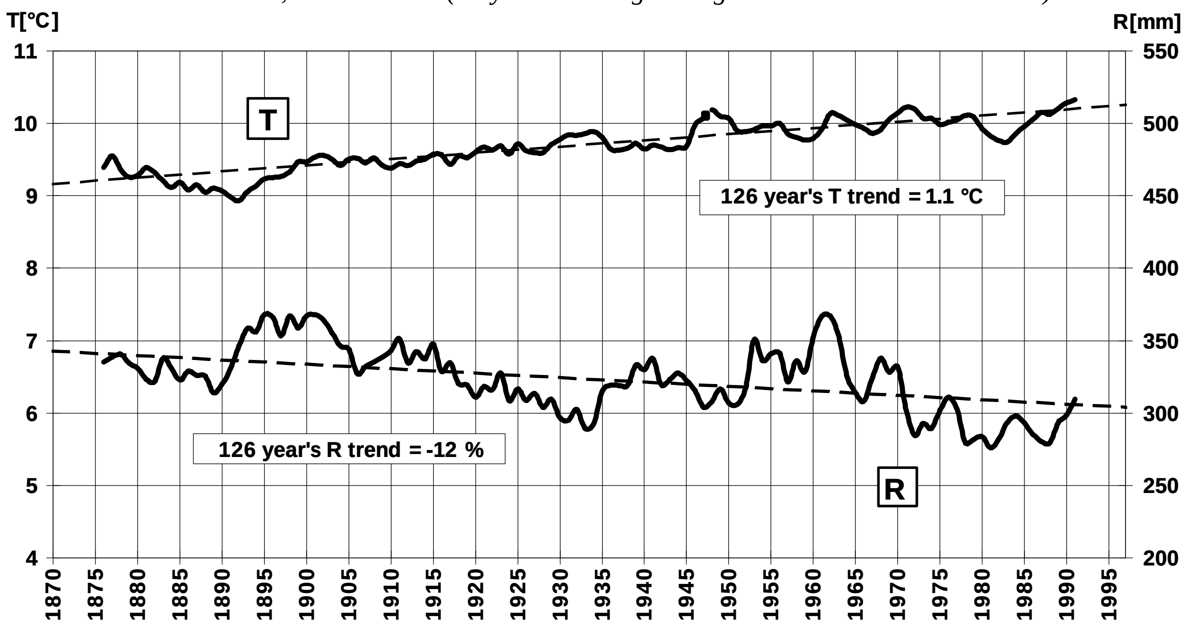
6. EXPECTED IMPACTS OF CLIMATE CHANGE, VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES

Climate changes and climate change scenarios for Slovakia

It is possible to describe climate change and variability in Slovakia according to the observations at the Hurbanovo observatory in the period 1871-1996 (Figure 7) and at several other climatic and precipitation stations in the period 1901-1996. Increase of mean annual air temperature (T) by about 1°C and decrease of annual precipitation totals (R) by about 15% in the South and by about 5% in the North of Slovakia as well as significant relative air humidity (U) decrease in south-western Slovakia and snow cover decrease in virtually all Slovakia were found since the beginning of the 20th century. Preliminary air temperature change scenarios were prepared in 1991 and preliminary analogue climate change scenarios were issued in

1993 with respect to 1-2°C mean annual warming in the 2025 time frame compared to 1951-1980 means (The First National Communication, 1995). Regional modification of the General Circulation Models (GCMs) outputs was finished in June 1995. The complete regional scenarios-based on GCMs outputs, updated analogues and incremental scenarios for Slovakia were issued in 1995 and 1996. An increase of annual T means by 2-4°C compared to the 1951-1980 means is expected in Slovakia in the 2075 time frame. A greater increase is expected in the winter months (by 3-7°C) than in summer (1-4°C). Uncertainty of annual R totals change scenarios is much higher than at T means. The analogue scenarios show a possible decrease of annual R totals up to 18%, the GCM's outputs regional modification suppose scenarios from small changes (CCCM) up to 16% increase (GISS) of annual R totals in Slovakia in the 2075 time frame. Scenarios of the other climate elements change is influenced mainly by T and R changes, the continuation of U decrease and significant snow cover decrease up to the 1000 m a.s.l. altitude is expected.

Figure 7 Annual means of air temperature and April-September precipitation totals at Hurbanovo, in south Slovakia, in 1871-1996 (11-year's moving averages and linear trends included)



The hydrological cycle, water resources and water management

In all of the climate change scenarios the decrease of mean annual discharges (decrease of surface water resources) is more likely than the conservation of current discharges (long-term means of the 1931-1980 period). These changes have a north-to-south gradient with northern Slovakia as the least affected region. The aridity of southern and south-eastern lowlands may reach the critical level during the typical summer-autumn low flow periods. In some regions the specific runoff may approach zero.

The analysis of climate change impacts on the Slovak hydrological conditions shows the overall decrease in potential of both surface and ground water resources. In general, this decrease together with expected population growth, revitalisation of the economy and more ecological water management rules can cause the worsening of the water economy budget. With regard to uneven temporal and spatial distribution of water resources and consumption the number of regions with negative or tight water balance will grow. This unfavourable state will have to be eliminated by new legislation and organisational and technical rules oriented toward the creation of new water resources (dams, water transfer, artificial infiltration) as well as the protection of water resources (details are in the Chapter 6).

Forestry and forest ecosystems

The expected climate change impacts on forests and forest ecosystems can be summarised as follows:

- potential endangering all forest functions including forest production
- unfavourable synergism of the influence of climate under the ongoing imission load and the action of other anthropogenic noxious agents
- long production periods of forest stands

Different objective model were used for the analysis of possible impacts of climatic changes on forests of Slovakia. Two particular models, the Holdridge model (static model of vegetation associations) and the Forest Gap model (dynamic stochastic model of forest associations development). The **Holdridge model** scenario assumes a pronounced change of bioclimatic conditions for the present forest associations ranging from 25 - 35% of the total forested area according to individual regional scenarios of climate change. The most extensive changes of the bioclimatic conditions can be expected in the lowland and mountainous areas, the least extensive changes are expected in the mid-mountain altitudes. Decline of the bioclimatic conditions in the alpine zone and succession of new xerophilous associations of the warmer temperate zone in the lowland areas are also anticipated. The **Forest Gap model** makes it possible to analyse the time changes in the development of forest associations. The results can be summarised as follows: ***Region of spruce mountain forests*** *(spruce being the prevailing tree species at present):* pronounced increase of beech and sycamore occurrence, decreased spruce occurrence, increase of the total biomass production (+17% compared to the present state); ***Region of the mid-mountain mixed*** *forests (spruce, fir and beech being the prevailing tree species at present):* total absence of coniferous tree species, pronounced increase of oak, maple and ash occurrence, slight increase of the total biomass production (+5% compared to the present state); ***Region of the submontane mixed*** *forests (fir, sessile oak, beech and hornbeam being the prevailing tree species at present):* nearly total absence of sessile oak and hornbeam, predominance of forest steppe associations with *Quercus pubescens*, decrease of the total biomass production (-38% compared to the present state).

Adaptation strategy assumes (details are in the Chapter 6):

- Complex development of the principles and methods of the current typology with the aim to respect time changes in environmental conditions in the long-term period of rotation age and application of these principles in forest management planning.
- Creation of legislative and economic conditions to secure implementation of the principles of the functionally integrated management of forests, regardless of the ownership.
- Enforcement of silvicultural principles proceeding from the close-to-nature on the basis of species and genetic diversity based on the natural regeneration of forest stands.

Agricultural plant production in Slovakia

The necessary measures for risk reduction resulting from the climate change impacts upon agriculture to be prepared in advance in two main fields are as follows:

- **Long-term plans of agricultural strategies:** re-evaluation of the agricultural crop growing technologies, re-evaluation of the agroclimatic regionalisation and structure of growing crops and varieties, re-evaluation of breeding aims, in the field of crop protection focusing initially on the biological protection and re-evaluation of integrated protection.
- **Agricultural practice:** regulation of water regime by melioration, new aspects in plant nutrition, regulation of energy and water regimes of crops by mulching, remedition of soil activity, management changes in agriculture. Effective public information on climate change, impacts and adaptive measures in agriculture is very important.

7. CLIMATE CHANGE RESEARCH

Climate changes have been studied for a long time in research projects of the Slovak Hydrometeorological Institute, the Department of Meteorology and Climatology at Comenius University and the Geophysical Institute at the Slovak Academy of Sciences. Recently, the study of these issues has been initiated at the Institute of Hydrology of the Slovak Academy of Sciences, the Agriculture University in Nitra and the Forest University and the Forest Research Institute in Zvolen. National research programmes are listed below:

- National Climate Program of the Slovak Republic
- National Program of Greenhouse Gases Emission Reduction
- National Program to Reduce the Emission of Volatile Organic Compounds
- Hydrological regime changes as the result of global changes
- Slovak National Program to Stabilise And Reduce CO_2 Emissions in Transportation
- The Slovak Republic's Country Study to Address Climate Change (the 2nd round of US Country Studies Programme)

These long-term programs were established and are supervised by the Slovak Ministry of the Environment. More then twenty institutions are involved in this research. The Slovak Hydrometeorological Institute is the main research co-ordinator. Details can be found in Chapter 8. In the present economic situation costly technology research and development stagnates in Slovakia. Governmental funding is very limited and private sector interest is still absent.

8. EDUCATION AND PUBLIC AWARENESS

Global climate change represents one of the most serious environmental issues in the history of mankind. It seems however, that the Slovak public is not fully aware of the consequences of climate change. The important task of all relevant institutions is to support education and improve general public awareness, concerning these issues. Public awareness plays a key role in supporting governmental long-term climate change in strategy and policy. The measures, which will have to be taken, require the co-ordinated effort and assume co-operation of government and non governmental organisations.

The Ministry of Environment of the Slovak Republic as well as all participating institutions in the National Climate Programme and in the US Country Studies Programme have paid particular attention to improvement of education and public awareness concerning climate change issues. This initiative in the last three years included: Distribution of 1000 copies of the First National Communication (Slovak version), edition of information booklet "Climate change", production of two educational videofilms, broad distribution of National Climate Programme fact sheets, press clubs of Ministry of Environment, conferences and seminars, TV and radio presentations, special and newspaper articles and reports, lectures, information booklet "Country Study Results".

INTRODUCTION

1

Climate Change, the most pervasive and truly global of all issues affecting humanity, poses a serious threat to our environment. Potential impacts of the global warming on agriculture, water resources, energy, natural terrestrial ecosystems, and the social and economic sectors have generated calls for urgent responses by the international community to mitigate its effects. The UN Framework Convention on Climate Change (FCCC) is the first binding international legal instrument to address this issue. FCCC was signed in Rio de Janeiro in June 1992. The Convention came into effect the 21st of March 1994. FCCC represents the basis for further international co-operation in the field of global climate change. The ultimate objective of this Convention is to achieve stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

The Slovak Parliament ratified the UN Framework Convention on Climate Change in August 1994. The instrument of the ratification has been deposited on 25 August 1994 and thereafter the Convention came into force for the Slovak Republic on 23 November 1994. The Slovak Republic accepted the specific obligations resulting from the Convention, including the commitment to take measures aimed to reduce emissions of greenhouse gases to the base year level by the year 2000.

The First Slovak National Communication to the FCCC Conference of the Parties was adopted by the Government of the Slovak Republic on 23 May 1995. The Communication set out the Slovak Republic's approach for meeting the commitments under Articles 4 and 12 of the Convention. This report expressed the political will of the Slovak Government to address the problem of Climate Change on a national basis. In the First Communication the Slovak Republic outlined the aim of its national environmental policy to achieve the "Toronto Target" (20% CO_2 emission reduction in 2005 compared to 1988). An in depth review of the Slovak National Communication was conducted by a group of specialists, nominated by the FCCC Secretariat, in June 1996. The in depth review confirmed the feasibility achieving the "Toronto Target".

This Second National Communication of the Slovak Republic is developed according to the COP 2 guidelines. It respects in the full scale the conclusions of the First National Communication and takes into account updated sectorial strategies and results achieved in the framework of Slovak participation in US Country Study Program to Address Climate Change.

With respect to the FCCC implementation process in the Slovak Republic some special circumstances should be highlighted:

- The Slovak Republic has been an independent state since January 1st, 1993, as a result of the separation the former Czech and Slovak Federal Republic into two independent states. Therefore the economic transformation (started in the framework of the former Czech and Slovak Federal Republic before 1990) is occurring at the same time that the new state is being developed. The Slovak Republic is based on democratic principles with orientation of its home and foreign policy to the OECD, the North Atlantic Treaty Organisation (NATO) and the European Union.

- The Slovak Republic is one of the Central European countries undergoing the process of transition from a central planned economy to a market economy. This transition is an unprecedented complex process involving a wide-range of legislative, administrative, financial, economic, technological and social restructuring activities. Since the beginning of the economic transition Slovak industrial production and consequently the GDP decreased significantly. Currently the Slovak Republic is in the phase of economic revitalisation.

- The transformation process in the Slovak Republic started before 1990. Therefore the data for 1990 do not reflect the realistic economic situation. In spite of this the Slovak Republic accepts 1990 as the base year. In this case Slovakia does not use its right to take advantage of a “certain degree of flexibility” mentioned in the Article 4.6 of the Convention.

- The Slovak Republic is the successor for all international environmental commitments ratified in the former Czech and Slovak Federal Republic.

The Second National Communication of the Slovak Republic has been developed by the Ministry of Environment in co-operation with other relevant ministries, selected professional bodies and independent experts. The Slovak Government adopted the Second National Communication on 24 June 1997.

Jozef Zlocha
Minister of Environment
of the Slovak Republic

NATIONAL CIRCUMSTANCES

2

This Chapter contains a brief description of Slovak natural and economic conditions relevant to the Communication. Basic geographical data, climate profile, population development, economic characteristics and environmental information are presented. The national legislative process and environmental policies are outlined briefly.

2.1 GEOGRAPHY

The Slovak Republic lies at the heart of Europe. It occupies the territory between the river Danube and the Tatra Mountains. The area of the country is 49,036 km^2 , including agricultural land 24,471 km^2 (50%), arable land 14,860 km^2 (30%), forest land 19,911 km^2 (41%), water area 940 km^2 (2%), built-up areas 1,275 km^2 (3%). Slovakia is a mountainous country. All Slovak mountains belong to the Carpathian system. The Danube and East-Slovakian lowlands are the northern parts of Panonian plains. 60% of Slovakia's surface is over 300 m, 15% over 800 m and 1% over 1,500 m a.s.l. The lowest point in Slovakia is 94 m a.s.l. and the highest (the Gerlach peak in the High Tatras) is 2,654 m a.s.l. The territory belongs to the Danube river drainage basin, only a small part in the north drains into the Baltic Sea. The Danube river is part of the boundary with Austria and Hungary. The capital of Slovakia, Bratislava, is located in the south-western part of the country close to the border with Austria and Hungary. Bratislava is the biggest Slovak city, the centre of political and cultural life and an important industrial centre and Danube river port.

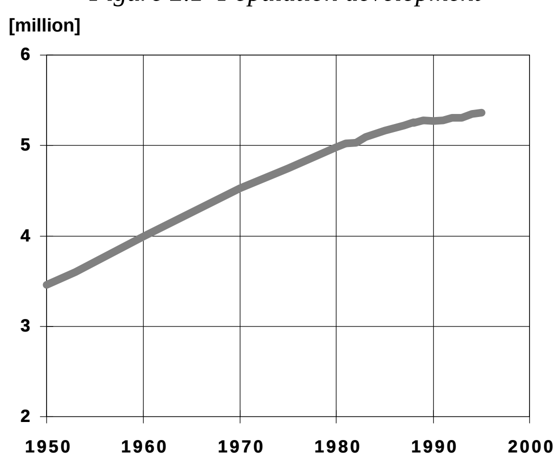
2.2 CLIMATE

According to the global climatological classification Slovakia is in the mild climate zone category. A regular rotation of four seasons and variable weather throughout the year are typical for this country. Compared to the Czech Republic and Austria which lie more to the west, the climate in Slovakia has more continental features. Winters are colder by about 3 °C and summers are warmer by about 2°C. The above mentioned differences increase from the west to the east within the country. The average January temperature ranges from -1°C in the Danube lowlands to -12°C on the top of the Tatra Mountains. Average temperatures in July exceed 20°C in the Slovak lowlands, while at the elevations of 1,000 m a.s.l. they reach about 14°C. Southern Slovakia receives about 2,000 hours of bright sunshine each year, while the north-west of the country receives only 1,600 hours. Average annual precipitation for the whole territory of Slovakia is 743 mm of which 65% is evaporated and 35% represents runoff. The smallest precipitation means (550 mm annually) are observed in the Danube lowlands, while in the highest elevations of the Carpathians it usually exceeds 1,500 mm. Snow cover is not stable, and winters in the lower altitudes are usually without permanent snow cover. A temperature increase of about 1°C and precipitation decrease of about 5-15% were observed during the last 100 years. The year 1994 was the hottest one since the beginning of meteorological observation. The heating period, defined by the number of days with daily average temperature below 12°C, in the lowlands of the South Slovakia is about 200 days, in 500 m a.s.l. about 250 days and in the altitudes above 1,000 m exceeds 300 days in the year. In such altitudes the heating period lasts the whole year with small interruptions. Heating degree-days, defined as the sum of differences between 20°C and daily average temperature, if the last is lower than 12°C, for district towns in Slovakia exhibit values in the interval 3,400-4,500 degree-days. In the highest district town Poprad (700 m a.s.l.) this value slightly exceeds 5,000 degree-days. Air conditioning of public buildings during the summer is not compulsory by law. Administrative buildings, hospitals, hotels, schools, shops and flats generally are not air-conditioned.

2.3 POPULATION

The population of Slovakia has grown from 3 million inhabitants in 1920 to 5.37 million to 31 December 1995. Figure 2.1 shows the population development between 1950 and 1995. The highest natural increase of population, over 1.7% occurred in 1950. Since then a systematic decrease in the natural population increase has occurred. The natural population increase was in 1990 0.48, 1991 0.46, 1992 0.40, 1993 0.39, 1994 0.28 and 1995 0.16%. Net annual population increases were smaller because of population migration. In 1994 a small population increase was registered corresponding to the natural population increase. The current average population density in Slovakia is 109 inhabitants per km^2. The largest city in Slovakia is Bratislava (450,776 inhabitants in 1994), followed by Košice (239,927 inhabitants in 1994). There are four other cities of more than 80,000 inhabitants. The average life expectancy at birth for men (68.3 years) is 5-6 years less and for women (76.5 years) 3-4 years less than in developed countries (data from 1994). The annual per capita CO_2 emission in Slovakia in 1990 was 11 tonnes and GWP aggregated per capita emission of greenhouse gases 14 tonnes.

Figure 2.1 Population development



2.4 ECONOMY PROFILE

Since 1992 the Gross Domestic Product (GDP) in Slovakia is calculated by the ESA method based on a quarterly reporting system. The GDP data presented in the First National Communication of the Slovak Republic were evaluated by the Transformation method. Recalculated ESA data are approximately 10% higher. The GDP trend in Slovakia is presented in Table 2.1. The GDP structure is given in Table 2.2. In the period between 1985-1990 the GDP (in constant prices) increased by about 10%. The political changes in central Europe, which started in 1990, influenced considerably the development of Slovak economy. These include the transformation from a central planned to a market economy, the privatisation process and the collapse of CMEA market resulting in a dramatic drop of GDP creation. In the period 1990-1993 the GDP decreased by more than 30%. The GDP increase started again in 1994 (4.8%) and this trend continued in the two following years (6.8% in 1995, 6.9% in 1996). In the second half of eighties the share of industry on the GDP structure was about 50%. Since the year 1991 the share of industry has been decreasing and on the other hand the share of market services is increasing (Table 2.2).

Inflation is under control at the present time (61.2% in 1991, 25.1% in 1993, 11.7% in 1994, 7.2% in 1995 and 5.4% in 1996). The foreign trade balance is reported in Table 2.3. The structure of foreign trade in 1994 was as follows: intermediate manufactured products (39.4%), machinery and transport equipment (19.0%), miscellaneous manufactured articles (13.4%) were the main export commodities and machinery and transport equipment (27.7%), fuels and related products (19.3%), intermediate manufactured products (16.8%), chemicals and related products (13.2%) created decisive part on the volume of imports.

Table 2.1 Gross domestic product (ESA methodology)

		1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
GDP in bill. SKK	- in prices of 1984	229.5	238.9	245.0	249.5	252.2	245.9	210.1	196.3	189.0	198.3
	- in prices of 1993	448.5	467.4	479.0	488.3	493.2	481.0	410.9	384.1	369.9	388.1
	- in current prices	232.0	241.7	247.7	256.9	267.3	278.0	319.7	332.3	369.9	441.3
Rate of exchange SKK/USD								29.6	28.3	33.4	32.0
GDP in bill. USD in current prices								10.8	11.7	11.1	13.4
GDP per capita in USD								2044	2214	2080	2579
GDP per capita USD with PPP (purchasing power parity)									*5620		**6600

* *EBRD Transition Report, October 1994* ** *Policies and Measures for Common Action, Working Paper 6, OECD , July 1996*

Table 2.2 Gross domestic product by selected branches in %

		1990	1991	1992	1993	1994
Economy in total		100	100	100	100	100
of which	Agriculture and forestry	7.4	5.7	6.2	6.6	6.6
	Industry	49.9	52.7	37.9	29.2	28.7
	Construction	9.2	7.4	6.8	6.7	4.6
	Market services	18.8	22.2	32.9	41.0	43.3
	(of which transport and communication)			(9.0)	(11.2)	(8.7)
	Non-market services	14.7	12.0	11.5	13.4	12.0
	Other			4.7	3.1	4.8

Table 2.3 Balance of foreign trade in bill. SKK

	1989	1990	1991	1992	1993	1994
Balance	3.1	-9.2	-14.1	-4.0	-26.9	2.6
Import (CIF)	51.6	61.2	110.9	110.2	195.0	211.8
Export (FOB)	54.7	52.0	96.8	106.2	168.1	214.4

Average interest rates of credits were 14,46% (1993) resp. 14,56% (1994) and of deposits 8.15% (1993) resp. 9.32% (1994). Discount rate was from January 1th,1993 to December 19th, 1993 9.5% and from December 20th, 1993 to December 31th, 1994 12.0% (Source: National Bank of Slovakia).

Agricultural subsidies:

	1980	1989	1990	1991	1992	1993	1994
% of GDP		(7.1)		3.1	2.4	2.1	1.8
bill. SKK in current prices		(17.8)		8.1	7.5	7.0	7.1

Greenhouse gas emissions per unit of GDP

		1990	1992	1994
GDP in current prices	[bill. USD]	9.2	11.7	13.4
CO_2 emission	[mil. tonnes]	60.0	48.8	43.4
Aggregated GHG emissions	[mil. tonnes]	74.6	60.4	53.8
CO_2 emission /GDP	[t/1,000 USD]	6.5	4.2	3.2
GHG emissions/GDP	[t/1,000 USD]	8.0	5.2	4.0

2.5 ENERGY STRUCTURE

The trend and structure of primary energy sources, disaggregated by sectors and fuels, are summarised in Tables 2.4-2.8. Data concerning electricity production are presented in Table 2.9. In Table 2.10 information about fuels is provided and in the Table 2.11 some macroeconomical indicators of energy sector are presented. These data document the decrease of final energy consumption, by about 25%, in the period 1989-1994. The share of final consumption of energy on primary energy sources represents about 70%. Consumption of liquid fuels is decreasing and consumption of natural gas is increasing. The share of nuclear power in the production of primary energy is 18% (1994) and of electricity production is 50%. The share of hydroenergy of the total energy balance is about 2%. Energy efficiency (the ratio PES/GDP, expressed in constant prices) exhibited no trend in the period 1990-1994 (Table 2.11). The Slovak Republic is heavily dependent on imported energy (85-89% of primary energy). The production of electricity does not fully cover consumption. From the establishment of Slovakia in 1993 about 5-10% of annual consumption of electricity is imported from surrounding countries, primarily from the Czech Republic.

The prices of heat and electricity are regulated by the State (Act 18/1996 on prices). The State subsidises the centralised heat supply and coal for households as well as coal mining. For example the current (1996) maximum price of heat for households is 140 SKK/GJ (roughly 4.5 USD/GJ). In spite of several price adjustments current prices of heat do not cover the real production costs. A complicated tariff system is used in the selling of electricity. In 1996 the prices of electricity were adjusted by 5% for commercial institutions and by 10% for households. At the same time the principles for further energy price adjustments were adopted. The Cost of Conserved Energy for many products (refrigerators, compact lights, etc.) do not cover the higher price of more efficient equipment, which limits the application of energy saving measures in households. The full energy prices liberalisation might be achieved after the year 2000. The average price of electricity (1996) for households was 0.87 SKK/kWh, roughly 3 USc/kWh, what is five times below the West European average. The average electricity price (1996) for the commercial sector and public institutions was 2.36 SKK/kWh (roughly 7 USc/kWh) and for industry 1.49 SKK/kWh (around 4.5 USc/kWh).

Table 2.4 Primary energy sources and final consumption of fuels and energy [TJ]

		1980	1990	1991	1992	1993	1994
Primary energy sources used in the SR		**903,584**	**945,279**	**848,624**	**820,816**	**754,803**	**743,605**
Final consumption		**604,791**	**654,483**	**578,758**	**559,878**	**544,925**	**507,063**
of which	Industry and Construction	364,323	367,042	317,597	314,990	284,678	275,787
	Agriculture	35,697	32,683	23,954	20,751	26,493	17,246
	Transport	23,417	25,502	18,284	13,975	15,805	19,765
	Non productive sphere	84,963	101,851	103,312	98,736	116,976	103,252
	Population	96,392	127,405	115,611	111,426	100,973	91,013
Primary energy sources per capita		0.181	0.178	0.161	0.155	0.142	0.139
Final consumption per capita		0.121	0.124	0.110	0.106	0.102	0.095
Share of final consumption on primary energy (%)		66.9	69.2	68.2	68.2	72.2	68.2

Table 2.5 Primary energy sources and final consumption of solid fuels [TJ]

		1980	1990	1991	1992	1993	1994
Primary energy sources used in the SR		**357,084**	**360,155**	**309,732**	**333,459**	**263,625**	**235,375**
Final consumption		**145,160**	**150,223**	**126,159**	**135,827**	**101,276**	**90,788**
of which	Industry and Construction	56,124	58,312	61,000	66,665	46,862	50,893
	Agriculture	3,986	4,626	2,949	3,128	2,085	1,577
	Transport	,615	1,268	1,430	1,494	1,146	,681
	Non productive sphere	35,726	33,989	16,290	17,928	19,857	25,889
	Population	48,709	52,028	44,490	46,612	31,326	11,748
Primary energy sources per capita		0.072	0.068	0.059	0.063	0.050	0.044
Final consumption per capita		0.029	0.028	0.024	0.026	0.019	0.017
Share of final consumption on primary energy (%)		40.7	41.7	40.7	40.7	38.4	38.6

Table 2.6 Primary energy sources and final consumption of liquids fuels [TJ]

		1980	1990	1991	1992	1993	1994
Primary energy sources used in the SR		**312,860**	**197,550**	**169,289**	**129,664**	**124,165**	**134,788**
Final consumption		**117,407**	**95,356**	**72,290**	**55,366**	**65,209**	**83,720**
of which	Industry and Construction	49,032	29,188	20,775	16,960	22,266	37,648
	Agriculture	24,179	19,505	12,877	8,813	12,345	9,114
	Transport	17,907	17,973	8,453	6,472	8,928	12,045
	Non productive sphere	15,240	12,732	21,048	16,123	13,926	14,668
	Population	11,049	15,958	9,137	6,998	7,744	10,245
Primary energy sources per capita		0.063	0.037	0.032	0.024	0.023	0.025
Final consumption per capita		0.024	0.018	0.014	0.010	0.012	0.016
Share of final consumption on primary energy (%)		37.5	48.3	42.7	42.7	52.5	62.1

Table 2.7 Primary energy sources and final consumption of gaseous fuels [TJ]

		1980	1990	1991	1992	1993	1994
Primary energy sources used in the SR		**157,382**	**223,014**	**213,980**	**194,777**	**207,591**	**198,369**
Final consumption		**127,927**	**177,830**	**159,782**	**145,440**	**159,446**	**153,426**
of which	Industry and Construction	85,197	103,800	82,025	75,982	78,967	63,471
	Agriculture	2,491	3,127	3,782	3,447	5,773	2,414
	Transport	410	554	2,014	489	899	1,286
	Non productive sphere	24,765	40,239	39,814	36,243	39,668	46,936
	Population	15,064	30,111	32,147	29,279	34,139	39,319
Primary energy sources per capita		0.032	0.042	0.041	0.037	0.039	0.037
Final consumption per capita		0.026	0.034	0.030	0.027	0.030	0.029
Share of final consumption on primary energy (%)		81.3	79.7	74.7	74.7	76.8	77.3

Table 2.8 Primary energy sources and final consumption of electricity [TJ]

		1980	1990	1991	1992	1993	1994
Primary energy sources used in the SR		**20,105**	**25,474**	**20,686**	**15,691**	**17,676**	**17,215**
Final consumption		**68,580**	**84,291**	**81,097**	**80,280**	**72,797**	**73,162**
of which	Industry and Construction	46,365	54,030	41,839	38,045	29,180	36,458
	Agriculture	4,279	4,147	3,503	4,305	5,732	3,445
	Transport	3,517	4,190	5,180	4,170	4,048	5,281
	Non productive sphere	5,832	8,683	16,405	20,436	18,944	11,818
	Population	8,587	13,241	14,170	13,324	14,893	16,160
Primary energy sources per capita		0.004	0.005	0.004	0.003	0.003	0.003
Final consumption per capita		0.014	0.016	0.015	0.0015	0.014	0.014
Share of final consumption on primary energy (%)		341.1	330.9	392.0	511.6	411.8	425.0

Table 2.9 Production of electricity[mill. kWh]

	1990	1991	1992	1993	1994
Heat electrical power	9,503	9,157	8,815	8,562	7,987
Nuclear electrical power	12,036	11,689	11,058	11,937	12,139
Hydroelectric power	2,515	1,886	2,360	3,891	4,601
Other electrical power	30	.	22	39	13
Total	**24,084**	**22,732**	**22,233**	**24,429**	**24,740**

Table 2.10 Fuels mixture in %

Fuels	1980	1990	1991	1992	1993	1994
Solid	40	38	38	41	35	32
Liquid	35	22	20	16	16	18
Gaseous	17	24	25	25	28	27
Nuclear	7	15	16	17	18	19
Hydro	1	1	1	1	2	3

Table 2.11 Some macro-economic indicators in power sector

		1980	1988	1989	1990	1991	1992	1993	1994
Primary energy sources	[PJ]	903	974	986	945	849	821	755	744
GDP - Constant prices of 1984	[bill. SKK]		249	252	256	210	196	189	198
- Constant prices of 1993	[bill. SKK]				481	411	384	370	388
- Current prices	[bill. SKK]	201	257	267	278	320	332	370	441
Rate of exchange SKK/USD					28.0	29.6	28.3	33.4	32.0
Energy efficiency:									
- GJ/1,000 USD constant prices of 1984					103	120	119	133	120
- GJ/1,000 USD constant prices of 1992					55	61	61	68	61
- GJ/1,000 USD current prices					95	79	70	68	54
- PJ/bill. SKK constant prices of 1984			3.91	3.91	3.69	4.04	4.19	3.99	3.75
- PJ/bill. SKK constant prices of 1992					1.96	2.07	2.14	2.04	1.92
- PJ/bill. SKK current prices		4.49	3.68	3.69	3.40	2.65	2.47	2.04	1.69
PES per capita	[GJ/person]	181	185	187	178	161	155	142	139
Final consumption per capita	[GJ/person]				124	110	105	102	99
Import PES	[%]								89
Import of electricity - balance import/export	[TWh]						3.5	1.1	0.4

2.6 INDUSTRY

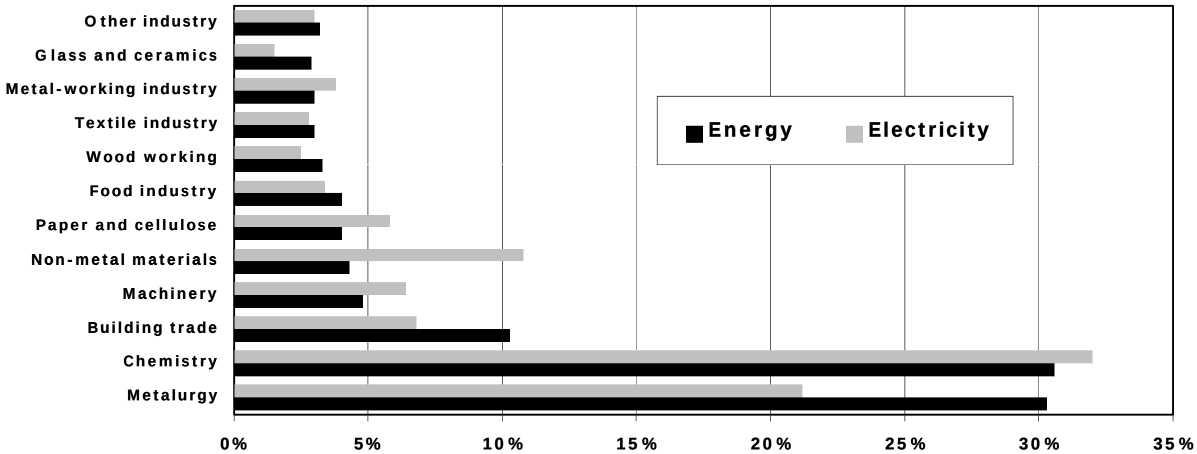
Some basic indicators of industrial production in the Slovak Republic during the first five years of the transition process are provided in Table 2.12. In the period 1990-1993 industrial production decreased by 30%. In 1994 it started to rise again. The share of industry in GDP dropped from 49.9% in 1990 to 28.7% in 1994. In the same period the final consumption of energy in the industrial sector decreased by 25%. The share of industrial branches in end-use of energy and electricity is illustrated in Figure 2.2. High demand for energy and raw materials is the key feature of the Slovak economy. However, there is a shortage of domestic sources of high-quality raw materials (excluding non-ore material and magnesite). Expenditures for imported coal, fuel for nuclear power plants, iron ore and concentrates, processed ores and raw materials for the production of non-ferrous metals are relatively high in the Slovak economy. Industry absorbs more than half of the final consumption of energy.

The transition of Slovak industry to its full economic potential is a long-term process. Disintegration of the East-European market, the drastic decrease in military production and increasing liquidation of non-effective economic activities have resulted in negative social consequences, such as increasing un-employment. Growing primary or secondary insolvency of enterprises requires temporary or long-term assistance through revitalisation programmes. The capital market is lacking and a chronic shortage of cre-dit sources persists. Limited domestic sources and slow penetration of foreign capital have slowed the transformation of Slovak economy.

Table 2.12 Industrial production

		1990	1991	1992	1993	1994
Share of industry on GDP	[%]	49.9	52.7	37.9	29.2	28.7
Production of goods in prices 1995	[bill. SKK]	559	495	420	378	390
Number of employees in industry	[%]	33.1	32.8	30.3	29.6	29.3
Production of selected industrial commodities:						
- pig iron	[mill. tonnes]	3.6	3.2	3.0	3.2	3.3
- crude steel	[mill. tonnes]	4.8	4.1	3.8	3.9	4.0
- cement	[mill. tonnes]	3.8	2.7	3.4	2.7	2.9
- plastics	[mill. tonnes]	0.48	0.44	0.43	0.37	0.39
- nitrogenous fertilisers	[mill. tonnes/N]	0.27	0.18	0.20	0.15	0.21
- aluminium	[thous. tonnes]	30	49	33	18	4
- gasoline	[mill. tonnes]	1.3	1.3	1.3	1.3	1.3
- diesel fuel	[mill. tonnes]	1.8	1.5	1.3	1.3	1.4

Figure 2.2 End-use of energy and electricity in industry (1990)



2.7 TRANSPORTATION

Slovakia ranks among the small European countries. The density of its transportation network could be considered as appropriate, but investments during the previous decades were very low in the transportation sector. The entire Slovak infrastructure urgently needs extensive reconstruction and change. Because of its position in the centre of the European continent the improvement of the Slovak transport system includes a strong international aspect.

The total length of railway track is 3,661 km, of which 1,430 km are electrified. The total length of roads and highways in 1994 was 17,880 km. The highway system is under construction. From 601 km of planned length 215 km is in operation. Highway construction is one of the main investment priorities of the Slovak government. The Danube is practically the only river used for water traffic. The number of motor vehicles and fuel consumption for road transport are given in Table 2.13. Basic indicators of public and freight transport are summarised in Table 2.14. From the beginning of the economic transformation process in Slovakia a decreasing trend of transportation activities has been observed. Individual transport is increasing, but public transport including city transport is still the dominant form. The number of automobiles, 0.19 car per inhabitant (1994), is at a considerably lower level than in West European countries. Since 1 October 1993 all new or imported second-hand cars have to be equipped by three-way catalytic converters.

Table 2.13 Number of motor vehicles and fuel consumption of road transport

	1987	1988	1989	1990	1991	1992	1993	1994
				Number of motor vehicles				
Passenger cars	769,769	769,806	837,221	875,550	906,129	953,239	994,932	994,046
Vans	20,677	21,408	22,026	22,893	22,989	17,752	17,061	16,765
Freight	64,078	64,863	67,722	69,101	72,347	84,543	84,491	85,705
Special	44,237	45,997	49,795	53,537	55,120	50,260	46,121	45,484
Buses	12,786	13,304	13,736	14,301	13,770	13,338	12,655	12,066
Tractors	64,053	65,709	66,162	67,056	67,642	64,713	65,150	64,729
Motorcycles	271,208	277,431	282,732	286,250	282,754	241,855	233,705	228,771
Total	**1,244,818**	**1,285,518**	**1,339,394**	**1,388,688**	**1,420,741**	**1,425,700**	**1,454,115**	**1,447,566**
				Fuel consumption (in tonnes)				

Gasoline	405,660	437,460	434,100	443,870	499,740	534,320
Diesel fuel	1,020,670	1,058,600	906,720	680,700	627,240	698,080

Table 2.14 Public and freight transport

			1990	1991	1992	1993	1994
Road transport	Goods traffic	[thous. t]	83,571	34,921	79,805	37,826	28,465
	Performance	[mill. t. km]	4,180	2,700	6,486	5,464	4,910
	Persons transported	[mill.]	938	939	855	826	761
	Performance	[bill. pass. Km]	15.2	14.8	14.3	11.4	10.6
Rail transport	Goods traffic	[thous. t]	117,237	83,873	76,123	64,825	58,953
	Performance	[mill. net t. km]	23,176	17,254	16,697	14,201	12,236
	Persons transported	[mill.]	119	112	107	87	99
	Performance	[bill. pass. km]	6.4	6.0	5.5	4.6	4.5
Water transport	Goods traffic	[thous. t]	3,715	1,946	1,648	1,399	1,416
	Performance	[mill. t. km]	3,017	2,384	1,641	843	846
	Persons transported	[mill.]	0.4	0.2	0.2	0.1	0.2
	Performance	[mill. pass. km]	12	11	7	7	7

2.8 AGRICULTURE AND FORESTRY

An extensive privatisation process had taken place in the Slovak agriculture and forestry. The co-operative form of farming remained the dominant form in agriculture, because most of the new land owners rented it to co-ops. Agriculture subsidies have decreased since 1989 by more than 50% and in the year 1994 it accounted for 7.1 billion SKK (1.8% of GDP), what is much less as in the EU countries. In the period 1986-1992 the Producer Subsidy Equivalents dropped by 40% and a gradual decrease continued up to 1994. Some indicators of agriculture and forestry are presented in Table 2.15. Compared to the past there were no marked changes in crop production. All species of animal production decreased. Compared to 1990, the inventory of cattle in 1994 dropped by 41%, pigs by 19%, and poultry by 13%. Fertiliser application decreased five times.

Table 2.15 Some indicators of agriculture and forestry

		1990	1991	1992	1993	1994
Surface area	[thous. ha]	4,903	4,903	4,903	4,904	4,904
of which agricultural soil		2,448	2,449	2,447	2,446	2,446
forest soil		1,989	1,989	1,990	1,991	1,992
water areas		94	94	94	94	94
Agricultural land per capita	[ha]	0.46	0.46	0.46	0.46	0.46
Cereals production	[thous. t]	3,617	4,004	3,552	3,152	3,700
Cattle	[thous. pieces]	1,563	1,397	1,182	993	916
Pigs	[thous. pieces]	2,521	2,428	2,269	2,179	2,037
Poultry	[thous. pieces]	16,478	13,866	13,267	12,234	14,246
Fertiliser consumption	[NPP per 1 ha in kg of pure nutrient]	240	123	64	42	44
Logging in total	[thous. m^3 i.b.]	5,277	4,399	3,956	3,516	3,751
Afforestation	[ha]	17,399	15,711	12,552	10,953	9,567

Forests are one of Slovakia's most important natural resources and are the basis for the forest industry. Forest land covers 19,911 km^2, 41% of the country's surface area. Broad-leaved trees prevail in the forests of Slovakia (57%). Conifers represent 43% of forest inventory. The general condition of forests in the Slovak Republic is positive. The comparison of forested land in 1920-1990 indicates that forested land increased by more than 20% mainly due to afforestation of farmland and acreage adjustments of agricultural crops. Positive changes were recorded also in the categorisation of forests. At present managed forests represent approximately 76% of the total woodland area, with a marked increase of area of protective forests (13%). Also the area of specific-purpose forest increased (11%). This provides the basic conditions for a gradual emphasising of the public welfare function of forests. The age composition of forest stands in the total forested area is also quite favourable. Forest stands up to the age of 40 years represent 33%, 41-80 year old trees about 43%, 81-120 year old trees 19% and the group of trees over 120 year of age approximately 5%. It may be concluded from the age structure of forest that by 2000 (2010) it is necessary to count with a stanation and decrease of timber cropping in Slovakia. In comparison with 1950, Slovakia's timber resources went up in 1991 from 193.5 million m^3 to 352.2 million m^3. The timber-growing stock increased from 140 to 189 m^3/ha. Besides the positive trends there are also negative ones. In the last decades the health condition of forests has markedly worsened. Important principles of the State Forestry Policy in Slovakia are inter alia gradual afforestation of farmland area unsuitable for agricultural purposes and overall ecologisation of forestry.

2.9 WATER MANAGEMENT

Slovakia, a typical inland country, is situated on the "roof" of Europe. Therefore its natural water resources are limited. The water areas of Slovakia covers only about 2% of the territory. The length of water courses is 8,437 km. On the basis of 1931-1980 average data the following annual is the water balance for Slovakia:

Precipitation	**36,923**	**million m^3**
Runoff	**12,798**	**million m^3**
Evaporation	**24,125**	**million m^3**

The average discharge from runoff is 405 $m^3.s^{-1}$. During the previous decades a significant discharge decrease has been observed in Slovak rivers. From the registered useable capacity of the Slovak underground water recourses (73.8 $m^3.s^{-1}$) in 1995 was exploited 18.8 $m^3.s^{-1}$, of which 14.4 $m^3.s^{-1}$ in public water supply systems. In 1995 as much as 79.4% of population was supplied from public water network. The useable capacity of the Danube alluviums represents about 23 $m^3.s^{-1}$ of drinking water. Protection of this highly valuable natural source against anthropogenic pollution is one of the most important goals of the state environmental policy. The volume of water reservoirs increased from about 300 million m^3 in 1975 to 1,858 million m^3 in 1994. More than 800,000 ha of arable land need irrigation systems. In 1994 the total volume of waste waters made 1,223 million m^3, of which 819 million m^3 were treated.

2.10 SELECTED SOCIAL INDICATORS

Table 2.16 Some social indicators

		*1991	1994
Income of the population in current prices	[bill. SKK]	186	320
Consumer price index	(January 1989=100%)	178	274
Cost of living index	(January 1989=100%)	173	268
Number of dwellings		**1,617,828**	**1,675,749**
of which family houses		811,440	838,448
block of flats		806,388	837,301
Living area	[m^2]	**76,486,174**	
of which family houses		44,777,297	
block of flats		31,708,877	
Live in persons		**5,245,338**	
of which family houses		2,761,128	
block of flats		2,484,210	
Average living area per 1 flat	[m^2]	**47.3**	
of which family houses		55.2	
block of flats		39.3	
Average number of persons per 1 flat		3.2	
Number of cars per capita		0.17	0.19
Number of cars per 1 household		0.56	0.59

** Figures from Housing and population census in 1991.*

Space heating in apartments provides a significant potential for energy savings. Heat consumption in Slovak buildings is much higher than in western European countries. Around 600,000 flats are of the prefabricated panel design. These in general have very poor thermal properties, although those built after 1983 (around 270,000), have external walls with 50% improvement in insulating properties because of the introduction of thermal performance requirements in this year. Final consumption of energy by the population decreased from 127 PJ in 1990 to 91 PJ in 1994. According to the Austrian Energy Agency (EVA), comprehensive improvements in insulation could save as much as two thirds of the heat consumed, or 47 PJ per year. The cost of such action is high, approximately 153 billion SKK (around 5 bill. USD). However, simple improvements could yield one third of this savings potential, 15.6 PJ, while only requiring 1% of the total cost. A study by the Dutch ECN Institute highlights the potential for energy conservation in the building sector of the Slovak Republic. In the residential sector, measures such as the installation of thermostatic valves, seals to windows and doors, improvements to district heating systems, installation of attic insulation, insulation of exterior walls and addition of a third pane of glass for triple glazing were analysed. The financially viable measures could save an estimated 27.4 PJ, or about 40% for energy consumption in the residential sector. According to the same Institute the energy savings potential in non-residential buildings a 41.5 PJ (1994), or 60% of present consumption, was identified.

2.11 NATIONAL POLICYMAKING AND LEGISLATIVE PROCESSES, AND PRESENT ENVIRONMENTAL STRATEGY

The President of the Slovak Republic is the head of the State. He is elected by the Slovak Parliament for a period of 5 years. The Parliament is the supreme organ of state power and of legislative authority. It has 150 deputies. The government of the Slovak Republic is directed by the Prime Minister and has 15 ministers. From an administrative point of view Slovakia is subdivided into 8 regions, 79 districts and 2 904 communities (1995). The legislative process is a combined effort of Ministries, Government and Parliament. All legislative instruments are published in The Bulletin of Acts. The Slovak Ministry of the Environment, region and district offices and municipalities are executive authorities with respect to the environment (Act 595/1990 on state administration for the environment).

National environmental policy is based on the 1st September 1992 Constitution of the Slovak Republic, proclaiming the right of every citizen to a favourable environment and to timely and complete information on the state of the environment and the causes and consequences of that state. All citizens are required by the Constitution to preserve and protect their environment and cultural heritage. No one may endanger or damage the environment, natural resources, or historical artefacts beyond the limit specified by the law. The State is required by the Constitution to ensure environmental balance, conservation of natural resources, and effective environmental protection.

The Slovak Parliament (Resolution 339 of November 18, 1993) approved the Strategy, Principles and Priorities of the National Environmental Policy, in which inter alia short-term, medium-term and long-term objectives are formulated. The governmental environmental policy respects the principles of sustainable development including greenhouse gas emissions reduction.

INVENTORY OF GREENHOUSE GAS EMISSIONS

3

This chapter presents the results of greenhouse gas emission inventory in the Slovak republic within the period 1990-1994. CO_2 emission from combustion is presented from 1988 as the starting point for the Toronto target commitment. The inventory was developed in compliance with the IPCC Guidelines. Aggregated emissions of all greenhouse gas emissions are converted into the CO_2 equivalent with the help of global warming potential (GWP).

3.1 INTRODUCTION

Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and ozone (O_3) are greenhouse gases. Though CO_2, CH_4 and N_2O occur naturally in the atmosphere, their recent atmospheric build-up appears to be largely the result of human activities. Halogenated hydrocarbons (CFCs, PFCs, HFCs, HCFCs,…), human made compounds are also GHGs. In addition, there are other photochemical active gases such as carbon monoxide (CO), oxides of nitrogen (NOx) and non-methane volatile organic compounds (NMVOCs) that while not greenhouse gases, they contribute indirectly to the greenhouse effect of the atmosphere. These are generally referred to as tropospheric ozone precursors, because they effect the creation and destruction of O_3 in the troposphere. Sulphur dioxide (SO_2) as a precursor of sulphate and aerosols are believed to contribute negatively to the greenhouse effect.

The recommended IPCC method (IPCC,1995) was used to estimate greenhouse gas emissions for all gases and sources except the few cases specifically mentioned. The emission inventory includes the following gases CO_2, CH_4, N_2O, NOx, CO, NMVOCs, SO_2, CF_4 and C_2F_6. Emissions of halogenated hydrocarbons are not known and therefore data on consumption are presented in Table 3.6[1].

Overall emissions for period 1990-94 are presented in Table 3.1. The complete standard summary (Standard data tables 1-6) are included in Appendix. The most important GHG is CO_2. An almost 30% decrease of CO_2 is also apparent.

Table 3.1 Total anthropogenic greenhouse gas emissions in Slovakia (rounded)

		1990	1991	1992	1993	1994
CO_2	[Tg]	60	53	49	46	43
CH_4	[Tg]	410	380	360	330	310
N_2O	[Gg]	13	11	9	7	7

The 1990 emissions are modified as compared to the First National Communication (see text)

[1] Commitments of Montreal Protocol and its amendments the consumption of substances damaging ozone layer are fulfilled.

Almost all emission estimates presented in the First National Communication Presented were updated and a few new sources were included. These results were obtained from the projects "Country Study Slovakia" and "National Programme of Greenhouse Gas Emission Inventory".

3.2 CO_2 EMISSIONS

Fossil fuel combustion (stationary sources as well as transport) is the most important source of CO_2 emitted in the SR (95%). The second however, much less important source is industrial processes (cement, lime, magnesite, aluminium production). Significant CO_2 sinks are forest areas.

The results of inventory of CO_2 emissions are in Table 3.2. The division of stationary sources into sectors is sometimes confusing and therefore we explicitly mention only transport, which is expected to grow in the future.

Table 3.2 Total CO_2 emissions and removals in Slovakia in 1988, 1990-1994

	1988	1990	1991	1992	1993	1994
	CO_2 anthropogenic emissions [Gg]					
Fossil fuel combustion**	58,484	56,585	50,035	45,616	43,584	40,389
Stationary sources	53,735	51,417	45,609	41,500	39,555	36,200
Transport***	*4,506	5,168	4,426	4,116	4,029	4,189
Industrial processes	(3,000)	3,447	2,717	2,869	2,831	3,065
Total	**61,484**	**60,032**	**52,752**	**48,725**	**46,415**	**43,454**
	CO_2 removals [Gg]					
Forest ecosystems. grassland conversion	**-3,938**	**-4,258**	**-4,258**	**-4,258**	**-4,258**	**-5,117**
Forest ecosystems****		-4,720	-4,720	-4,720	-4,720	-5,579
Grassland conversion	462	462	462	462	462	462
	CO_2 net emissions [Gg]					
	57,546	**55,744**	**48,495**	**44,468**	**42,158**	**38,300**

* *1987*
** *total CO_2 emissions from fossil fuel combustion were estimated upon the reference of IPCC method (Appendix, Worksheet 1-4)*
*** *emissions from transport quoted in this table were estimated by the COPERT method*
**** *removals by forest ecosystems were estimated for the years 1990 and 1994*

3.2.1 CO_2 emissions from the energy sector

Approximately 83% of primary energy used in the Slovak Republic in 1990 is from fossil fuels (80% in 1994)[2]. Therefore the energy sector is the largest source of carbon dioxide in Slovakia. The total emission was estimated according to the reference approach of the IPCC methodology using primary energy consumption combined with import and export of some secondary fuels. Emission coefficients used there are default coefficients from the mentioned methodology[3] (details see Appendix, worksheets 1-4).

Primary fuel consumption by sector and fuels is not available in The Statistical Yearbook. Therefore in the summary tables and in Table 3.2 only the division by stationary sources and transport is presented. The second item, emissions from mobile sources (road traffic, railway traffic, air traffic and shipping)

[2] The remaining 17% (20% in 1994) comes from other sources (hydroelectric power plants, nuclear power plants, renewable sources of energy).
[3] The CO_2 emission is dependent only upon the fuel consumption and is not affected by the type of boiler.

were estimated by the COPERT method[4] and emissions from stationary sources are the difference between total and transport emissions.

For 1990 year the REZZO (National Inventory System) and "Energy Strategy and Policy of the Slovak Republic up to the year 2005" (Ministry of Economy, 1994) were used for production of the Standard Data Table 1A. Emission factors used here are aggregated numbers derived from carbon contents and low heating values of fuels used in Slovakia. Emissions from coke and aluminium production were included in the energy sector[5]. The amount of carbon from fossil fuels stored in different non-energy products was estimated by the IPCC method.

3.2.2 CO_2 emissions from industrial processes

The most important industrial sources of CO_2 in Slovakia are cement, lime and magnesite production. The food industry is a less important source (item other in the Standard Table 2). The data for production were taken from the Statistical Yearbook (1990, 1995 and 1996). Carbon dioxide occurring by coke production, aluminium production, crude oil processing and metallurgy is included in the emissions from combustion in industry (Appendix, Standard table 1A).

3.2.3 CO_2 removals

The Slovak Republic's forest land covers about 2 mil. hectares, which represents about 41% of total area. Between 1950 and 1990 the forests area of Slovakia increased approximately by 20%.

In 1990 and 1994, a storage of carbon in the forest ecosystems of Slovakia was estimated by the balance of carbon in the part of forest above ground (trees, plant cover, overlying humus) and below ground (roots, humus in soil), including the estimate of wood cutting and forest fires. The annual CO_2 net removal about 5 Tg of CO_2 with uncertainty roughly 30% (Appendix, Standard Table 7).

Land conversion is almost negligible. In the period 1965-1990 about 90 000 ha meadows and pastures had been converted into arable land. Applying the IPCC method, the CO_2 emission from the conversion of grassland into arable land was equal to 462 Gg per year (Appendix, Standard Table 7).

3.3 CH_4 EMISSIONS

The CH_4 emissions in Slovakia are presented in Table 3.3, The major sources are agriculture and fugitive emissions from liquid fossil fuels and natural gas handling. Less important are waste treatment and fuel combustion.

Activities in agriculture (numbers of livestock) were taken from the 1996 Statistical yearbook. Emission factors of IPCC methodology were used. A substantial decrease in CH_4 emissions is caused by the decreasing number of livestock as a result of the transformation in the economy from a planned system to market one. Detailed data are given in Standard data tables 4A and 4B.

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[4] The COPERT method is a bottom-up type method, where consumption is calculated using the type of vehicles, speed and type of driving (city, countryside, highway).

[5] The IPCC method leaves the choice to include these sources into the energy or industry sector because of its complicated traceability.

The distribution network for natural gas is the most important source of methane. The data on natural gas loses from distribution companies were inconsistent (substantial changes in years for the same consumption) and therefore we have used the IPCC method based on consumption from the 1995 Statistical yearbook and default emission factors for emission estimates. The volume of methane released during brown coal and lignite extraction (underground mines) was estimated based upon the extracted coal volume (Statistical Yearbook 1995) and default emission factors (IPCC). According to local experts they are probably overestimated.

The estimation of emission from municipal solid waste disposal sides is the first attempt in the Slovak Republic. It was based upon specific communal waste production per capita and estimated volume of degradable organic carbon in the waste. Since a considerable share of waste is not stored in landfills under control, estimated emissions were reduced by factor of 0.5. Emissions from sewage water and sludge handling were estimated based upon the data from 1990-1993 within the range 10.4-13.5 Gg CH_4 per year. (Appendix, Standard data table 6A, 6B)

Methane emissions from fossil fuel combustion are of little significance (about 6% see Appendix Standard data table 1A). Methane from industrial technologies contributes to the total emission by only 2-3%. (Appendix, Standard data table 2). Probably not all sources are covered.

Table 3.3 CH_4 emissions [Gg] in 1990-1994

	1990	1991	1992	1993	1994
Fossil fuel combustion	25	17	18	16	15
Fugitive emissions	122	114	102	106	105
Industrial processes	7	6	7	6	6
Agriculture	187	172	151	130	121
Forest ecosystems	3	3	3	3	3
Waste treatment	65	69	77	70	65
Total	**409**	**381**	**359**	**331**	**315**

3.4 N_2O EMISSIONS

As compared to the other greenhouse gases, the mechanism of nitrogen oxide emissions and sinks has not yet been investigated completely. The estimated emissions have a high degree of uncertainty, perhaps as high as 100%. The most important source is agriculture. The substantial decrease of the average consumption of fertilisers (mineral + organic, in 1990 approximately 138 kg N/ha, in 1993 approximately 60 kg of N/ha) as a consequence of economic transition resulted in a more than 40% decrease in emissions (Table 3.4).

Industry is the second most important source of N_2O. The emission from production of nitric acid was estimated (Appendix, Standard data table 2). Adipic acid has not been produced in the Slovak Republic.

Table 3.4 N_2O emissions [Gg] in 1990-1994

	1990	1991	1992	1993	1994
Fossil fuel combustion	0.6	0.6	0.8	0.7	0.7
Industrial processes	2.1	1.5	1.4	1.1	0.8
Agriculture	9.5	8.5	6.5	5.0	5.4
Forest ecosystems	0.0	0.0	0.0	0.0	0.0
Waste treatment	0.3	0.3	0.3	0.4	0.4
Total	**12.5**	**10.9**	**9.0**	**7.1**	**7.3**

3.5 OTHER GASES

Table 3.5 shows the SO_2, NO_x, CO, NMVOC and CF emissions. The CFC and HCFC emissions are not known. The NOx, CO and SO_2 emissions were estimated based upon the data on fuel consumption in REZZO. It is necessary to note, that the sector splits here do not correspond exactly to those in IPCC. Power and heat generation is the major source of SO_2, NOx and CO emissions. The contribution of transport to NOx and CO emissions is still growing. Metallurgy is an important source of CO emissions (estimated with a considerable degree of uncertainty).

Table 3.5 Anthropogenic emissions of NOx, CO and NMVOC [Gg] in 1988, 1990-1994

	1988	1990	1991	1992	1993	1994
NO_x	***197**	**227**	**212**	**192**	**184**	**171**
Energy/Industry	*126	146	135	127	122	112
Medium sources	5	5	5	5	5	5
Small sources	6	7	5	5	4	4
Transport	*60	69	(66)	55	52	53
CO	**457**	**489**	**439**	**382**	**408**	**411**
Energy/Industry	(330)	162	160	132	160	168
Medium sources		27	27	27	23	11
Small sources		144	103	79	70	47
Transport	*127	156	(148)	143	151	185
NMVOC	**(156)**	**147**			**116**	
Energy		11			11	
Transport	*36	42	NE	38	42	41
Use of solvents		49			33	
Crude oil. products		26			21	
Others		19			9	
CFCs**	**1.71**			**0.61**	**0.99**	**0.38**
CF_4	**0.074**	**0.074**	**0.099**	**0.099**	**0.084**	**0.048**
C_2F_6	**0.002**	**0.002**	**0.003**	**0.003**	**0.002**	**0.001**
SO_2	**585**	**543**	**445**	**354**	**326**	**239**
Energy/Industry	461	422	347	269	246	183
Medium sources	38	38	38	38	38	27
Small sources	87	79	57	44	39	26
Transport		4	3	3	3	3

* *data from 1987*

** *consumption - potential emission*

Emissions of NMVOC were estimated under the framework of the National programme of NMVOC emission reduction. Updating was carried out for the year 1993, using 1990 as a starting point. The major sources of emissions come from the use of solvents, transport, refinery/storage and transport of crude oil and petrol (see Standard data table 1B2, 2, 3).

The source of C_2H_6 and CF_4 emissions is aluminium production. CFCs and HCFCs are not produced in Slovakia. Because emission coefficients are not known Table 3.5 contains data only on consumption. Their use is controlled by the Montreal Protocol and its appendices. Since 1986 the total consumption of substances under control has been decreasing. Freons in cooling systems are gradually being replaced by perfluorocarbons and it is assumed that their consumption will increase several times following 1996 (the Copenhagen Amendment allows their use until 2030).

3.6 AGGREGATED EMISSIONS

The emissions aggregated by means of GWP values for 100 years span and expressed as the CO_2 equivalent are presented in Table 3.6. The CO_2 emissions contribute 80% to the total emission, CH_4 emissions by 14-15%, N_2O emissions by 4-5% and CxFy emissions by about 1%.

Power and heat generation is the largest source of emissions (70%). Agriculture contributes approximately 11%, transport 7%, industry 6% and fugitive emissions 4%. Removals of CO_2 by forest ecosystems accounts for 5% of the total emissions.

Table 3.6 Aggregated emissions of CO_2, CH_4, N_2O, CF_4 and C_2F_6 in 1990 and 1994

	CO_2 [Gg]		CH_4 [Gg CO_2 equivalent]		N_2O		C_xF_y		Aggregated	
	1990	**1994**	**1990**	**1994**	**1990**	**1994**	**1990**	**1994**	**1990**	**1994**
Stationary sources - combustion	51,417	36,200	606	343	189	160			52,212	36,703
Transport	5,168	4,189	17	0	13	64			5,198	4,235
Fugitive emissions	0	0	3,067	2,573	0	0			3,067	2,573
Industrial processes	3,447	3,065	137	147	672	256	**491	**315	4,747	3,783
Agriculture	0	0	4,582	2,965	3,040	1,728			7,622	4,693
Forestry	*(-4,258)	*(-5,116)	78	74	13	13			91	87
Waste treatment	NE	NE	1,587	1,593	90	128			1,676	1,721
Total emissions	**60,032**	**43,454**	**10,074**	**7,695**	**4,017**	**2,349**	**491**	**315**	**74,614**	**53,813**
Net emissions	55,774	37,529							**70,358**	**48,697**

** carbon sinks are not included in total CO_2 emissions* *** Al production*

(GWP according to the IPCC report from 1994, for CO_2=1 and N_2O=320, CH_4=24.5, CF_4=6,300, C_2F_6=12,500)

Uncertainty of emission estimation

Quantification of uncertainty according to the IPCC method was not processed due to the lack of input data but the summary table in Appendix (Table 8A) gives data quality and coverage by sources according to the IPCC method.

It is estimated, that the uncertainty of the CO_2 emission estimation from fossil fuel combustion is less than 10%. The estimate is based on a comparison of the emissions estimated using national and IPCC default factors. The difference is 3%. Another source of uncertainty was assessed by comparing energy balance and the bottom-up fuels accounting which is larger.

The accuracy of the CO_2 balance (carbon cycle) in forest ecosystems was estimated at 35%. Uncertainty of the CH_4 emission estimation is generally about 30-50%. Estimated N_2O emissions (mainly from agricultural soils) show the highest degree of uncertainty, however it is quantifiable. For some emission factors the uncertainty may reach 100%.

3.7 DISCUSSION AND CONCLUSIONS

The share of the Slovak Republic of global anthropogenic greenhouse gas emissions is approximately 0.2%. The annual per capita emission of the main greenhouse gas CO_2 is about 10 ton/year, placing Slovakia into 20 countries with the highest per capita emissions throughout the world.

The maximum level of emissions was reached by the end of the 1980s (in 1988). The decrease which followed was caused by a slowing of economic activity and emissions in 1993 has decreased below the level of the 1987 values.

The information about sources of GHG emissions in Slovakia were significantly extended in comparison with the First National Communication. In spite of this the information about GHG emissions presented in this report have not been completed yet.

In 1993 the first studies dealing with the climate change issue started in Slovakia. GHG emission sources were identified and the first emissions estimated. Currently, several projects are underway, financed by the Environmental Fund of the Slovak Republic, the Ministry of Environment and from the US Country Studies program. These projects continually contribute to complete and to improve information on sources, emissions and sinks of greenhouse gases in Slovakia.

POLICY AND MEASURES TO MITIGATE GREENHOUSE GAS EMISSIONS

4

An integrated strategy in Slovak Republic focused exclusively on the green house gases mitigation has not yet been adopted. This chapter outlines the comprehensive survey of environmental protection measures accepted in Slovakia after the year 1990 with the secondary impact on the GHG mitigation and sinks. The measures resulting from the present environmental legislation as well as the energy conservation measures are presented. The following chapter complies with the recommendation of COP-2 FCCC.

4.1 ENVIRONMENTAL STRATEGIC AND LEGISLATIVE FRAMEWORK

The Slovak Republic as one of the candidates for EU membership harmonises its legislation and policy with the members of the European Community.

4.1.1 Strategy and policies adopted

- **Strategy, Principles and Priorities of the Governmental Policy**
  This document has been approved by the decision of the Slovak Government No. 619, September 7,1993 and the decision of the National Council of the Slovak Republic No. 339 November, 18, 1993. This material determines the priorities of the state environmental policy and formulates the long-term (strategic), medium-term and short-term objectives. The strategy explicitly includes the program of greenhouse gas mitigation in the period 2000-2010.
- **Energy Strategy and Policy of the Slovak Republic up to the year 2005**
  This document has been approved by the decision of the Slovak Government No. 562/1993.The strategic goal of energy policy is to provide all consumers with fuels and energy. At the same time energy should be produced with the minimum price and with minimum impact on the environment. From an ecological point of view, the energy policy is aimed at environmental improvement and reduction of contaminating substances emissions in compliance with Slovak legislation and international commitments.
- **Strategy and Policy of Forestry Development in the Slovak Republic**
  This document has been approved by the decision of the Slovak Government No. 8, January 12, 1993. One of the strategic goals of forestry development in Slovakia is to preserve forests, i.e. to maintain and gradually increase the afforested area and forestry as an important contributor to the ecological balance and landscape stability.
- **Waste Management Program in the Slovak Republic**
  This document has been approved by the decision of the Slovak Government No. 500, July 13, 1993. The waste management program objective is to minimise environmental risks (waste disposal, the development of managed landfills system, incinerators, recycling and separate waste collection).
- **Principles of Agricultural Policy**

This document has been approved by the decision of the National Council of the Slovak Republic July 12, 1993. The policy is concentrated on the fundamental measures to ensure ecologisation of agricultural production, including rational consumption of fertilisers.

4.1.2 Legislation

General environment

- Act No. 17/1992 on Environment amended by Act No. 127/1994 on Environmental Impact Assessment
- Act No. 127/1994 on Environmental Impact Assessment
- Act No. 140/1961 - Penal Code
- Act No. 248/1994 - Civil Code

Environmental administration

- Act No. 347/1990 on Organisation of the Ministries and Other Central State Administration Authorities of the Slovak Republic as amended
- Act No. 595/1990 on Environmental State Administration as amended
- Act No. 134/1992 on the State Administration of Air Protection amended by Act No. 148/1994
- Act No. 494/1991 of the Slovak National Council on State Administration of the Waste Management as amended

Air protection

- Act No. 309/1991 on Protection of the Air Against Pollutants as amended
- Decree of Government of Slovak Republic No. 92/1996, to Act No 309/1991 on Protection of the Air Against Pollutants as amended
- Promulgation of the Ministry of the Environment of the Slovak Republic No. 111/1993 on expert licensing in the field of air protection
- Promulgation of the Ministry of the Environment of the Slovak Republic No. 112/1993 on establishing the regions requiring special air protection, and on the operation of smog warning and regulation systems

Waste management

- Act No. 238/1991 on Waste
- Decree of the Slovak Government No. 605 /1992 on Keeping Evidence on Waste
- Decree of the Slovak Government No. 606 /1992 on Waste Treatment

Territorial planning and building order

- Act No. 50/1976 on Territorial Planning and Building Order amended by Act No. 103/1990 and Act 262/1992
- Promulgation of the Federal Ministry of Technical and Investment Development No. 83/1976 on general technical requirements for construction amended by Promulgation No. 45/1979 of the same ministry and also by Promulgation of Ministry of the Environment of The Czech Republic and Slovak Commission for Environment No. 376/1992
- Promulgation of the Federal Ministry of Technical and Investment Development No. 84/1976 on the territorial planning and territorial planning documentation amended by Promulgation No. 337/1992 of the Federal Ministry of Technical and Investment Development
- Promulgation No. 85/1976 of the Federal Ministry of Technical and Investment Development on detailed provisions related to territorial proceedings and building order amended by Promulgation No. 378/1992 of the Federal Ministry of Technical and Investment Development and the Slovak Commission of Environment.

- Promulgation of the Federal Ministry of Technical and Investment Development No. 12/1978 on protection of forest land in territorial planning activities
- Regulation of the Ministry of Transport, Communications and Public Works No. 14/1994 of October 1, 1994 on procedures and technical conditions for additional insulation and removal of defects in residential buildings.
- Regulation of Ministry of Construction and Public Activities of the Slovak Republic No. 70/410/1996 of March 1, 1996 on additional residential building insulation and defects removing in this area.
- Act of the Slovak National Council No. 124/1996 on Government fund of housing development.
- Decree of Government of Slovak Republic No. 181/1996 on the programs of housing development.

Energy management

- Act No. 79/1957 on Production, Distribution and Consumption of Electricity
- Act No. 67/1960 on Production, Distribution and Utilisation of Gaseous Fuels
- Act No. 89/1987 on Production, Distribution and Consumption of District Heat
- Act No. 88/1987 and No. 347/1990 on Energy Inspection
- Act No. 44/1988 on Protection and Use of Mineral Resources amended by Act No. 498/1991

Economic instruments

- Act No. 128/1991 on State Fund for the Environment of the Slovak Republic amended by Act No. 311/1992 on Air Pollution Charges
- Promulgation of the Slovak Commission on Environment No. 176/1992 on conditions for providing and use of the funds from State Fund for the Environment of the Slovak Republic
- Act of the Slovak National Council No. 311/1992 on charges for air pollution
- Act of the Slovak National Council No. 309/1992 on charges for waste disposal
- Act No. 222/1992 on value-added tax
- Act No. 286/1992 on income tax amended by Act No. 326/1993
- Act No. 316/1993 on consumption tax for hydrocarbon fuels and oils
- Act No. 87/1994 on road tax

4.1.3 Climate change strategy and policy

A consistent national policy relevant to climate changes in the Slovak Republic, that would be focused on the climate change issues and reduction of greenhouse gas emissions has not been yet accepted. A large amount of on-going activities, focused predominantly on the energy conservation and on the decrease of negative environmental impacts of energy system, agriculture and another economical sectors is in existence, that also results in greenhouse gas emission mitigation. The First National Communication on Climate Changes produced a survey of relevant activities. After its approval by the Government of the Slovak Republic in May 1995 it became an effective instrument for the implementation of the Framework Convention on Climate Change until the national policy directly related to greenhouse gases emissions will be adopted. The Government of the Slovak Republic together with accepting the requirements of FCCC has accepted the National Target to reduce energy related emissions of CO_2 in the year 2005 by 20% in comparison with the year 1988.

The preparation of mitigation and adaptation measures is based on the results of following research programs and projects:

- **National Climate Program of Slovak Republic**
- **National Program of Greenhouse Gas Monitoring**
- **National Program to Stabilise and Reduce CO_2 Emission in the Transportation**

■ **US Country Study Program**

As the main bottleneck for the practical implementation of the Greenhouse Gas Strategy and Policy seems to be the slow process of energy and fuel price liberalisation. It is the typical problem of countries with economies in transition, where social issues play quite an important role.

4.2 EMISSIONS OF CO_2

4.2.1 Cross sectorial measures

I. Measures fully or partly implemented

Although the Act on Protection of the Air is focused mainly on the base pollutants (SO_2, NO_x, CO, solid particles and other), it represents one of the most important tools to decrease CO_2 emissions. This law established the use of Best Available Technologies Not Entailing Excessive Cost (BATNEEC) for new and retrofitted units as well as air pollution charges. According to the BATNEEC requirements the technologies must meet emission standards. The present emission standards applied in Slovakia for fossil fuel combustion are harmonised with the EU ones. The existing facilities must meet these standards within a strictly determined period. The emissions of CO_2 are reduced together with the air pollution.

⇨ **Act No. 309/1991 on the Protection of the Air against Pollutants amended by Act No. 256/95**
Pursuant to paragraph 6 of Act No. 309/1991 in the construction of new and repowering of existing air pollution sources, the best available technologies not entailing excessive cost must be applied.

⇨ **Decree of Slovak Government No. 92/1992 by which the Act No. 309/1991 on the protection of the Air against Pollutants is executed**
The emission standards for SO_2, NO_x, CO, particulate matter and other pollutants have been determined for new air pollution sources. The existing sources must meet these standards before December 31, 1998.

⇨ **Act No. 134/1992 on the Governmental Administration of the Air Protection amended by later decree**
According to this Act the state administration for Air Protection has been established and the competence in this area is given to the Ministry of Environment, to the regional and district offices and to the communities.

⇨ **Act No. 311/1992 on Charges for Air Pollution**
Pursuant to this Act every operator of a pollution source is obliged to pay charges for air pollution depending upon the amount and pollutant type. For examples: the charge of particulate matters is 3,000 SKK/t; SO_2 1,000 SKK/t; NO_x 800 SKK/t; CO 600 SKK/t; organic compounds 1,000-20,000 SKK/t; 100 SKK ≅ 3 US$. Although the charges for CO_2 were not specified, CO_2 emissions are indirectly affected.

⇨ **Act No. 128/1992 on Governmental Fund for the Environment, Promulgation No. 176/1992 on Conditions for Providing and Use of the Financial Means from Governmental Fund for the Environment of the Slovak Republic**

Pollution charges and government subsidies create the government fund for the environment. From this fund environmental friendly activities are supported (fuel switching, natural gas powered buses, cogenerations, etc.).

⇨ **Act No. 89/1987 on Production, Distribution and Consumption of Heat**

The Act requires the preparation, verification and control of heat consumption efficiency as well as technical and economical indicators. In the case of centralised heat supply distribution for inhabitants, the subsides are acknowledged on the base of heat production efficiency assessment and on judgement of soundness production cost. The assessment is carried out by the Energy Inspectorate consistent with the Act No. 88/1987.

⇨ **Act No. 88/1987 and No. 347/1990 on Energy Inspectorate**

The Energy Inspectorate has been established in 1987 under the supervision of the Ministry of Economy for inspecting the efficiency of energy production and consumption. This institution also provides the information on modern technologies and energy management. This act stimulates the energy conservation measures implementation, preferably at the final energy uses.

⇨ **Act No. 286/1992 on Income Tax amended by later decrees**

Pursuant to paragraph 19 of this act it is possible to obtain a 5-year tax allowance for the operation of small hydropower plants, and for implementation of cogeneration cycles, solar energy sources, heat pump and the use of geothermal energy and biogas production. The synergy of this act and the Air Protection Act stimulates the implementation cogeneration units.

⇨ **Liberalisation of energy and fuel prices**

Promulgation of the Ministry of Finance No. 87/1996 for the execution of Act No. 30/1996 on prices in April 1996 represents the first step to full energy and fuel prices liberalisation. The prices are established on the bases of economically justified cost and adequate profit. Since the June 1997 because of this decree electricity prices increased for large consumers by about 5%, and for household of 10%. Systems of centralised district heat supply and solid fuel use in households are still subsidised. The natural gas and electricity prices for household are still regulated. The strategic target of the national energy policy is removing of subsidies and price deregulation step by step, as stated in the Energy Policy and Strategy of Slovak Republic up to 2005.

⇨ **Program Supporting the Economic Activities Resulting in Savings of Energy and Imported Raw Materials**

This program has been developed by the Ministry of Economy of Slovakia together with the Slovak Deposit Bank. The program adjusts the support conditions for the implementation of projects focused specifically on the energy intensity decrease, decrease of imported material and feedstock consumption in industrial and tertiary areas. Part of the interest rate is covered by the government.

⇨ **Act No. 289/1995 on Value Added Tax**

A lower level of value added tax (6%) is applied for biogas, fuel wood, wood waste from industry, solar collectors and heat pumps.

It is not possible at this time to quantify the impact of the above described measures.

BOX 4.1

The impact of the Air Protection Act as amended primarily affects the amount and share of individual fossil fuel consumption representing the primary energy sources. The emission standards for the base pollutants SO_2, CO, NO_x and solid particles acts as the driving force for the implementation of the new technologies and/or fuel switch processes The following technologies are the most suitable from an availability and capability point of view and their impact is not only in the basic emission decrease but also in the decrease of CO_2 emission:

- Retrofit and/or repowering of energy sources with higher thermal efficiency
- Fluidised bed combustion (brings boiler thermal efficiency increase)
- Fuel switch - coal and heavy fuel oil are replaced by natural gas
- Implementation of combined cycles (brings the net efficiency increase at the electricity and heat cogeneration)
- The use of coal with lower sulphur content

Using the least cost method analysis in the case of energy sources with a thermal capacity over 5 MWt the technical and economical feasible potential of individual technology penetration into the energy market has been determined. These technologies replace the old ones in order to meet the requirements of Act No. 309/1991and emission standards. It results in a decrease of CO_2 emission in industrial and other energy sources. The potential of individual technology penetration is expressed by possible total amount of CO_2 emission decrease together with yearly cost and specific cost for 1 t of CO_2, emission decrease in Tables 4.1-4.3.

Table 4.1 Potential of CO_2 emission decrease in industrial energy sources

	[SKK/t CO_2]	[tCO_2/y]	[mil. SKK/y]
Boiler efficiency increase	999	98,242	98
Fuel switch	1,223	958,256	1,172
Low sulphur coal	3,157	108,155	341
Combined cycles	1,719	1,035,733	1,780
Fluidised bed combustion	1,279	4,335	6
Total	**1,541**	**2,204,721**	**3,397**

Table 4.2 Potential of CO_2 emission decrease in non-industrial energy sources

	[SKK/tCO_2]	[tCO_2/y]	[mil. SKK/y]
Boiler efficiency increase	-1,855	9,571	-18
Fuel switch	1,563	24,488	38
Combined cycles	3,430	21,666	74
Low sulphur coal	5,035	11,951	60
Total	**2,276**	**67,676**	**154**

Table 4.3 Potential of CO_2 emission decrease at centralised district heat supply

	[SKK/tCO_2]	[tCO_2/y]	[mil. SKK/y]
Boiler efficiency increase	-1,645	35,468	-58
Fuel switch	1,158	83,519	97
Fluidised bed combustion	2,096	1,356	3
Combined cycles	3,152	24,018	76
Low sulphur coal	5,046	17,125	86
Total	**1,259**	**161,486**	**203**

The real level of CO_2 emission reduction will be influenced by the possibility of new technologies penetration in the energy supply market, covered by existing industrial, non-industrial sources and sources for centralised district heat supply. This value can be evaluated on the base of modelling process of the whole energy supply system. The results of modelling are included in Table 4.6. From all options the fuel switch of coal to gas and combined cycle implementation give us the largest potential of the CO_2 emission decrease.

II. Measures considered for the future

⇨ Action Plan for GHG Emissions Reduction

Development of greenhouse gases mitigation programme and its implementation in the period 2000-2010.

⇨ Energy Act

is submitted for approval by government and integrates the following existing acts:
Act No. 79/1957 on production, distribution and consumption of electricity
Act No. 57/1960 on production, distribution and consumption of fuel gases
Act No. 88/1987 on Energy Inspectorate
Act No. 89/1987 on production, distribution and consumption of heat
This new act is focused on the behaviour of energy market at the new economical conditions.

⇨ Act of energy conservation

is in the preparation stage. The aim of this act is to stimulate the following activities, focused on more economical energy use and increasing energy efficiency:

- ***Programs supporting more economical energy uses***
  Financial resources from the national budget will be given to support energy intensity decrease projects: A Fund of Energy Saving and Renewable Energy Uses will be established together with a tax allowance and other measures that will stimulate energy saving projects.
- ***Regional energy policy***
  The regional energy policy should include measures that result in the gradual development of energy plans to the district level, in which all local energy sources, including waste heat and renewable energy sources, will be identified and quantified. Cogeneration should be also taken into account.
- ***Energy audits***
  These audits will be obligatory for all organisations working on a government budget or with a governmental contribution and for the all enterprises asking for governmental subsidies to apply energy conservation measures.
- ***Obligatory of heat and electricity cogeneration***
  This is relative to all new heat supply sources in the case that an energy audit confirms the cost feasibility of the alternative.
- ***Energy labelling of appliances***
  Energy appliances must include energy labelling before sale on the domestic market.
- ***Energy standards***
  For several categories of selected products the minimal values of energy efficiency in accordance with the available technologies are determined. These characteristics are obligatory for all appliances and represent the bases for energy labelling.
- ***Education and training programs***
  A long-term tradition of education and training programs exists in the industrial sector in Slovakia. These activities are carried out by the Slovak Energy Inspection- Energy Agency.

The enforcement of this law will be carried out by the Slovak Energy Inspection.

⇨ Energy Saving Fund (ESF)

The aim of this fund is to provide cost attractive credits, focused on the support of small and medium energy saving investment projects. The fund was created through a 3.8 mill. ECU grant from PHARE, 7.6 mill. ECU from the EBRD and by domestic resources.

⇨ Carbon tax implementation

A carbon tax is not currently being considered. It is anticipated to implement of this tax in connection with full energy and fuel price liberalisation, in agreement with the EU measures. The current modelling of carbon tax implementation did not show any substantial efficiency.

Table 4.5 Total potential of CO_2 emission decrease at the full renewable source implementation (year 2010)

	Potential [TJ]	CO_2 decrease [Gg]
Small hydropower plants	1,986	168
Energy forest	5,100	502
Geothermal energy	7,160	508
Others (tab. 4.4)	18,400	1,295
Total	**32,646**	**2,473**

⇨ More effective use of renewable energy potential - policy and strategy

The higher level of renewable energy sources implementation represents the possibility of an additional CO_2 emission decrease. The renewable energy sources, considered in the Slovak Republic, are summarised in the box 4.2.

BOX 4.2

- **Hydropower plants** represents the largest potential of all renewable energy sources. This potential is in both the large run-off hydropower plants as well as the small hydropower units. The utilisation of hydropower units represent an important part of the public electricity supply system. Besides hydropower plants are already part of the public electricity system, or are considered in the future expansion plan, the additional potential of small hydropower plants is available. This potential represents 552 GWh/year. Using the aggregated emission factor of electricity generation 305 tCO_2/MWh it represents an emission decrease potential of 168 $GgCO_2$.

Table 4.4 Potential of CO_2 emission decrease at the additional renewable sources implementation

Renewable energy source	Potential [TJ]	End-energy use type	AGEF [tCO_2/TJ]	CO_2 decrease [Gg]
Solar	4,900	heat	70.99	348
Wind	1,100	electricity	84.72	93
Biogas	4,300	heat	70.99	305
Waste	3,600	heat	70.99	256
Waste heat*	4,500	process heat *	65.14	293
Total	**18,400**			**1,295**

* *The replacement of gas boilers and kilns was considered.*

- **Biomass** represents a source of heat which is used in the residential sector and industry for electricity and heat generation. The industrial utilisation of biomass as a fuel is preferred in the combustion of wood waste in the wood processing industry (furniture, pulp and paper, etc.) and this use has been the subject of the modelling of energy consumption scenarios in the industrial sector. According the study of the Forestry Research Institute Zvolen, the total amount of biomass, suitable for energy uses represents 2.2 mil tonne per year, e.g. 26.8 PJ. Currently 8.2 PJ is used. The additional biomass potential represents *Energy forest* with an estimated value of 5,100 TJ of non-fossil fuel. This energy source will penetrate on the coal energy market preferably in the residential sector. An achievable potential of 502 $GgCO_2$ emission decrease for the year 2010 has been estimated, considering the brown coal emission factor 100.43 t CO_2/TJ and 98% combustion efficiency.
- **Geothermal energy.** The achievable potential of geothermal energy is 7.160 TJ. The CO_2 emission decrease has been estimated at the level of 508 Gg CO_2, considering the aggregated CO_2 emission factor of centralised heat production 70.99 t CO_2/TJ.

Additional renewable energy sources have been evaluated in the framework of the Energy Policy and Strategy up to 2010 and are summarised in the Table 4.4. The potential of CO_2 emissions decrease and its implementation has been calculated with the use of the aggregated emission factor (AGEF) of energy carrier, applied at relevant final energy uses. The total potential of CO_2 emission decrease is summarised in the Table 4.5.

4.2.2 Energy and transformation processes

The system of public power stations is characterised by a large share of non-fossil primary energy sources. Because the amount of electricity produced from nuclear and hydropower units is limited, the increasing demand for electricity consumption will bring an increase of electricity generation from fossil fuel power plants. The cross sectorial measures, presented in section 4.2.1., stimulates the independent energy producers to implement cogeneration units. The increasing demand for electricity will be partially compensated in this way. The impact of these measures on the electricity production in the system of public power plants is quantified in Table 4.6.

⇨ **Measures resulting from the Energy Policy and Strategy of Slovak Republic up to 2005**

The measures resulting from the energy policy are not the "c*lassical measures*" of greenhouse gas mitigation, but are focused directly on the expansion plan of energy sources in Slovakia, and this indirectly influences the CO_2, emission level. The following measures are incorporated:

- A higher degree of natural gas use in heat and electricity cogeneration as well as electricity production by classical steam cycles. At the present time there is going on the construction of combined cycle in CHP Bratislava II. The predicted output is about 115 MWt in heat supply and 215 MWe in electricity generation. The operation is anticipated in the year 1998.
- Repowering of the Thermal Power Plant Nováky A (ENO A) to the fluidised bed combustion and installation of the FGD (flow gas desulphurisation) by the wet scrubber method together with the primary measures to the NO_x in Thermal Power Plant Nováky B (ENO B) are implemented. These measures can be accepted in order to preserve domestic coal as energy source in this locality, where the large coal mines are located. The first boiler with a fluidised bed combustion and a thermal capacity of 98 MWt is being pilot at this time. The installation of a second unit is proposed prior to 2000, and the installation of additional units will depend on the heat supply demands in this area.
- Gradual retrofit of Thermal Power Plant Vojany I (EVO I) to units with fluidised bed combustion enables to preserve the coal as a primary energy source for this power plant. This measure will not substantially influence the CO_2 emission decrease.
- The 65%- increase in hydropower potential use prior to 2005 can bring the share of non-fossil primary energy sources. This measure will cause a specific CO_2 emission decrease per 1 MWh of electricity production. The hydropower plant Gabèíkovo with an installed electricity output of 780 MWe has been put into operation in 1994. At present, the set-up of a hydropower plant Žilina with electricity output of 62 MWe is being developed. Also the installation of a hydropower plant in Sereï with an output of 60-70 MWe is under consideration.
- The installation of 4 units (4x440 MWe) in the nuclear power plant Mochovce as a replacement for the retired units in NPP Jaslovské Bohunice.
- The possibilities for better renewable source utilisation were described in the framework of cross sectorial measures in section 4.2.1.

The impact of theses measures to the CO_2 emission level is described in Chapter 5.

⇨ **Demand side management**

Demand side management enables to decrease the peak load electricity demand as well as an overall decrease in electricity demands. According to the analysis carried out by the PSI Canada, a total electricity consumption saving of about 742GWh-1059 GWh is proposed in the time horizon 2010.

The measures within the framework of demand side measurements represent:

- Implementation of more efficient lighting system (discharge lamps).
- Increase of electric water heater efficiency
- Implementation of heat pumps
- Implementation of demand side management for the individual users.

Currently, there is no government regulation for electricity consumption conservation. It can be supposed, that the electricity price increase will act as a stimulating factor for the decrease in electricity consumption.

4.2.3 Transportation

From the GHG emission point of view, transport management, the full utilisation of transportation system, as well as the use of proper type of transport, play important roles. At the beginning of transition period, fuel consumption decreased significantly with respect to industrial production became of the general economy decline. Later, the increasing share of private enterprises reversed this development. The transportation sector represents one of the most sensitive sectors with respect to the economic revival therefore both an increase in fuel consumption and CO_2 emissions can be expected. The results of the modelling enable to assume the increase in road transport activity compared with rail transport. In order to compensate for this undesirable development, it seems to be necessary to develop measures focused on the transfer of transportation activity from road to rail. Public transport is subsidised, but the market oriented economy brings with it a considerable increase in public transportation prices. Nevertheless, this price increase has not significant influenced the public transport intensity of use. It is necessary to find the means to conserve the present level of public transport.

II. Measures fully or partly implemented

⇨ **Act No 316/1993 on Consumption Tax on Hydrocarbon Fuels and Oils**

Consumption tax is determined by law as follows:
- the level of 10,800 SKK/t, resp. 9,390 SKK/t, for gasoline,
- the lower value of consumption tax at the level 8.250 SKK/t is applied for diesel fuel,
- the consumption tax for LPG is 2.370 SKK/t,
- the consumption tax for natural gas is 2 SKK/m^3.

The impact of consumption tax results in a preference of gaseous fuels to liquid ones.

⇨ **Act No. 87/1994 on Road Tax**

The importance of the road tax from the GHG emission point of view is that the tax allowance for the vehicles, that are exclusively used in the combined transportation. The share of 25-75% tax allowance is used, depending on the range of vehicles participation in combined transport.

⇨ **Control of vehicles in operation**

The control of the technical state of vehicles is carried out in agreement with the Promulgations of the Federal Ministry of Transport No. 41/1984 and No. 284/1991,as well as the Promulgations of the Ministry of Transport, Mail and Telecommunication of SR No. 130/1995, No. 184/1996 and No. 265/1996. Emission control of vehicles is mandatory by these promulgations. There are 50 licensed emission control stations in Slovakia. Since 1.6.1996 the requirement for emission control has been also extended to personal cars equipped with diesel and gasoline engines with the catalyser. Taking into account the technical level of the control station, the period of this control is every three years. In the case of business vehicles and lorries the period is shorter. These controls also contribute to the emission and fuel consumption decrease.

⇨ **Development of combined transport system**

The strategy of combined transport development in Slovakia is based on the government intention expressed in Decisions No. 833/92 and No. 644/91. The legislative measures have been focused on limitation of road transport (See Act No. 87/1994 on road tax). In comparison with the European standard, the combined transport is less. The first terminal has been given in operation since October, 1996 (Dobrá in neighbourhood of Èierná nad Tisou). Additional terminals will be located in Bratislava, Žilina and Košice (prior to year 2000). The other expansion of this type of transport depends on the development of its technical basis. Vagónka Poprad plans to start production of *basket wagons*, used in this type of rail transport, by the year 1997.

⇨ **Lowering of ineffective transport in urban settings**

These measures are focused on the improvement in information systems, on parking place monitoring, on the possibilities of the limitation of parking places together with limitations on urban traffic in the city centre. The increase of shuttle service and the use of low emission transport systems (from the CO_2 emission point of view) also represents an important part of these measures. Although all these measures are applied at present, they should be more widely implemented.

⇨ **Preference of electric traction to diesel railway transport**

As can be seen from the following data, this measure is applied successfully.

a) At present, the distance 1,430 km of track, e.g. 39.1% of the total length of rail is electrified.
b) 578 out of 1,378 locomotives, e.g. 41.9% are electric.
c) 87% of rail transport output was as the electric tracks.

⇨ **Improvement of using alternative fuels**

The Act No. 87/1993 gives a road tax allowance for a 5 year period to commercial transportation using electric or solar energy and reduces by 50% the taxes for vehicles powered by liquid propane gas or compressed natural gas for two years. Also the Act No. 316/1993 gives relatively lower fuel taxes for the gaseous fuels. The gaseous fuel application in transport of the SR is in the initial stages. At the present time, only 300 personal cars and 10 busses for local transport use gaseous fuels. The barriers for additional implementation can be an insufficient information as well as an insufficient financial resources in local municipalities. The 6 producer of biodiessel fuel type MERO(metylester colza oil) with a total capacity of 4,000 t/year and a price of about 19.20 SKK/l MERO are located in Slovakia now.

⇨ **The acceleration of vehicle fleet replacement**

The present vehicle fleet is out of a date and the average operation time is approximately 14.8 years for personal cars, 13.7 years for lorries and 7.7 years in the case of busses. By government Decree No. 188/ 1995 the freight charge for personal cars $< 1{,}500$ cm^3 was temporary abolished until 31.12.1996. It resulted in the increasing import of foreign vehicles and acceleration of vehicle fleet exchanges. During the year 1996 74,689 new vehicles were imported and this amount represents a three fold increase in comparing with the year 1995.

II. Measures considered for the future

⇨ **Optimization of motor-car traffic in cities**

In larger cities of Slovakia the traffic flow is assured by a co-ordination of the traffic light signal system. The modernisation of this system needs a large expenditure, which currently is not available at the municipal level.

⇨ **Municipal charges**

In order to achieve a reduction in traffic intensity in city centres, the tolls for use of streets as well as increasing the parking charges might be effective. As an additional measure the price of local public traffic should be decreased. This reduction depends on local financial capacity.

⇨ **Tax on motor-cars**

Some countries implemented a tax on automobiles. This tax should take into account the engine output, fuel consumption, emission, vehicle age, etc. and should be considered as an environmental tax. The replacement of the tax by increasing the fuel price would not be effective. The possibility of implementing this tax in Slovakia is currently being analysed at the Transport Research Institute in Žilina.

⇨ **The retaining of the public transport level**

The share of public transit in Slovakia is relatively higher in comparison with other countries into EU and the level is currently quite stabile. There is evidence, of the share of public transport is declining in the case of occasional journeys replaced by an increase in individual traffic. The number of connections for public traffic is decreasing due to the reduction in less effective ones. The leads to the overall stagnation of public transport. In order to make public transit more attractive, the exchange of vehicle fleet busses is necessary. This will require of about 500 mill. SKK per year. Modernisation and retirement of public transit needs governmental support. The preference of public to individual transportation represents one of the most effective measure to decrease CO_2 emission in this sector. Rail transport of goods over the lorry transport is also preferable.

⇨ **Cycling development**

The routes for bicycles are being intensively initiated in the new roads as well as in urban and recreation areas . Nevertheless, the speed of this construction together with the implementation of combined travelling possibilities (train - bicycle) do not comply to the present requirements and are generally lower than in EU countries. Activities in this area need more support.

⇨ **Education and training**

The focus of this activities is concentrated on the increase of environmental oriented behaviour of residents. The driver licence training is oriented not only to the correct style of driving, but also to the maintenance and economical use of cars.

The impact on CO_2 emission level is difficult to disaggregate into the individual measures. During the modelling only two CO_2 emission scenarios were followed: baseline scenario including the applied measures and scenario modelling the synergy of all, for future measures. The results are summarised in Table 4.6.

4.2.4 Industry (energy related)

In the period 1990-1994 many less-effective production units were shut down. It brought both a total fuel consumption decrease for direct technology uses (feedstock, process heat) as well as in industrial heating and cogeneration plants, and also a decline in the demand for electricity. The Ni production in Sereï and the iron ore treatment facility in Rudòany were closed, together with the closing or decline of some chemical production. The production decline was typical also for the other types of industrial productions such as oil derivates, inorganic fertilisers, etc. The resulted in a decrease of energy related CO_2 emissions for industry. The other possibilities of fossil fuel consumption decrease can be found in technology modernisation and industrial restructuring. These measures may be extended as a result of full price liberalisation The quantification of these measures is impossible at the present time.

Similarly as the case of the public electricity generation system, cross-sectorial measures, preferably the Air Protection Act and energy conservation measures will bring a decline in the CO_2. emissions. The results are summarised in Table 4.6.

⇨ **Steel production in VSŽ**

Continual steel casting *in* metallurgical enterprise VSŽ Košice. This technology result in reduction of the fuel consumption. This measure has already been applied.

Combined cycle implementation in VSŽ Košice. Although the environmental requirements, e.g. emission standards of SO_2 and solid particles in industrial cogeneration can be achieved by the import of low sulphur coal, the combined cycle implementation will bring a large CO_2 emission reduction.

⇨ **Innovation of aluminium production in ZSNP Žiar n/Hronom**
Modernisation of this technology will bring a decrease in total energy intensity together with the reduction in CO_2 emissions by about 67% in the period 1988-2005.

⇨ **Cement production**
One of the possible measure to reduce CO_2 emission in this industry is the combustion of used tires, which will result in a fossil fuel consumption decrease as well as net CO_2 emission decline. At the present time this measure is applied in the cement factories Hirocem Rohožník and Považske cementárne Ladce. During the years 1986-1993, the average annual volume of used tires was 6,700 t/year (LHV 20,000 kJ/kg), in the year 1996 this volume declined to the value of 3,600 t/year, e.g. by 50%. This situation is due to the fact, that Slovak market for the used tires is not developed enough and import has been forbidden.

The impact of the described measures can be found in Table 4.6.

4.2.5 Residential, commercial and institution sectors

I. Measures fully or partly implemented

⇨ **Programme of Energy Consumption Reduction in Apartment and Family Houses**
The program is designed for owners of apartments and family houses and their heat suppliers. Government financial support is provided in the form of:

- partial refund of interests from loans (maximum 70%), the maximum support for one project must not exceed 200 SKK for 1 GJ of heat saving per year, or 0.30 SKK for 1 kWh of electricity saved;
- the financial support which is repayable within 3 years. This support is available only to legal persons and to a maximum amount 3 mill. SKK. Maximum support for one project is 300 SKK for 1 GJ of heat savings per year, or 0.50 SKK for 1 kWh of electricity saved.

Under this programme, in the year 1994, subsidies totalling of 20 mill. SKK (reconstruction of heat source and its measuring and regulation equipment) were provided. Total annual savings were estimated at 130 TJ (for the year 1994). Programme of additional salution and removal of defects in apartment houses is a part of this programme. Government subsidies are provided to owners of apartment houses for improvements of thermoinsulating properties of building structures; the houses with the large thermal losses built up till 31.12.1993 in the case, that calculated heat consumption is not higher than the standard of 9.3 MWh/year; the house owner with the house excessive thermal losses and built up before 1.1.1984. During the years 1992-1994 subsidies of more than 320 mill. SKK were provided and 3,432 of flats were insulated in this programme. In the residential sector there is a large potential of energy saving (65%, e.g. 54 PJ) according to the estimate of Dutch experts. Currently this potential is utilized in the small extend only, bacause the cost of these measures (insulation and district heat supply regulation) are too high in comparison with the energy prices. The preliminary estimate is about 1,500 SKK/m^2. Only the 1.15% of household built up till the year 1984 were insulated.

⇨ **Normalization and Standardization the Heat Insulation of Buildings - STN 730540**
Since 1.2.1997 the fifth standard up-dating has been eccepted. In the construction sector stronger requirements for the heat transfer coefficients were applied, preferably for new and retrofitted buildings. The target is to achieve the EU level in a short time. For new buildings the requirement of a maximum annual energy consumption of 85 kWh/m^2 is applied, compared with the 102 kWh/m^2

applied from the year 1992. By the application of new construction designs, measurements and regulation options the specific energy consumption of 70 kWh/m^2 could be achieved. This level can be expected only after the year 2005. The implementation of the former stringent requirements for new buildings will bring an energy consumption reduction of more than 105 PJ during the period 1992 to 2005 (see First National Communication on Climate Change of Slovak Republic).

II. Measures considered for the future

⇨ **Programme of Energy Saving in Buildings until 2000, with the extension to 2005**
Projection of primary energy consumption estimates an energy intensity decrease by 16% in the year 2005 and by 24% in the year 2010, compared to the 1993 level. Implementation of energy conservation programs in buildings enables the use of financial resources, resulting from energy cost savings, with positive environmental impacts. On the bases of this aspect the Ministry of Construction and Public Work proposes to include this programme in the ***Government Development programme of public investments.***

⇨ **Tax allowance**
A tax allowance will be provided to consumers buying appliances with lower energy consumption. This measure stimulates the penetration of less energy intensive appliances to the domestic market. It is very difficult to estimate exactly the impact of this measure, at present.

⇨ **Education and training**
The Slovak Energy Inspection organises training courses for energy advisers, focused on the thermal insulation of buildings according to valid standards and consistent with the Programme of Energy Saving of the Ministry of Economy. Besides these activities, consultation centres have been established to provide all basic information and consultation focused on energy saving problems. All information is available without charge. Additional activity to disseminate information on energy conservation is carried out through the annual exhibition Racioenergia.

4.2.6 Fugitive emissions of CO_2

Measures oriented to the mitigation of fugitive emissions of CO_2 have not been adopted and are not incorporated to the GHG inventory.

4.2.7 Agriculture

The measures focused on CO_2 emission reduction from energy sources in the agriculture sector were included in the cross-sectorial measures. The CO_2 sinks are evaluated in Chapter 3 (Inventory).

4.2.8 Land use change and forestry.

The measures focused on the GHG mitigation in this sector can be summarised as follows:

⇨ **Tree species composition change**
In the framework of the economical planning and in agreement with the Decree of Ministry of Agriculture No. 5/1995 on economical forests adjustment, the share of leafy forest will be increased in the area with conifer forests. (replacement of spruce by beech).The Beech forests have a higher specific content of carbon per 1ha area, compared with the conifers.

⇨ **Afforestation of non-forest areas**
This program is in agreement with the Decree of Government No. 550/1994. The optimal variant of forestry policy proposes the afforestation of 245,000 ha (the full potential) of non-forest areas prior to year 2050.

⇨ **Protection of carbon stock in forests affected by immissions**
Implementation of measures focused on the improvement of vegetation condition in forests affected by immisions.

It is very difficult to quantify the effect of individual measures, so the estimates have been carried out on the bases of assumptions included to the following scenarios:

Baseline scenario .... business as usual. no implementation of new measures
High scenario .... high degree of implementation of new measures
Low scenario.................... low degree of implementation of new measures
Medium scenario.............. medium degree of implementation of new measures

The results of modelling the impacts of the baseline, low, high and medium scenarios are presented in Chapter 5.

4.2.9 Total impact of measures, focused on CO_2 emission reduction

Table 4.6. summarises the impacts of individual measures, applied within the scenarios of CO_2 emission reduction. The measures are divided to the following groups:
- Measures applied in connection with the Air Pollution Act (scenario 2, Chapter 5).
- Measures applied in connection with the energy conservation policy in industrial and non-industrial sectors (scenario 3, Chapter 5).
- Decrease of energy intensity in industry (scenario 4, Chapter 5)
- Measures applied in connection with the penetration of renewable energy sources in the energy market (scenario 5, Chapter 5).

4.3 EMISSIONS OF CH_4

Waste management and waste water treatment represents, along with agriculture, the main sectors, where the measures to CH_4 emission mitigation can be applied in Slovakia. The development of fugitive CH_4 emissions level will be also influenced by the intensity of underground mining and by the demand for crude oil processing and drilling together with the demands for natural gas drilling, transportation and distribution. In the case of fossil fuel combustion the CH_4 emission decline will be due to the implementation of the same measures as to the CO_2 emission reduction.

4.3.1 Waste management and waste water treatment

I. Measures fully or partly implemented

⇨ **Waste Management Program of SR up to 2000** includes the following targets focused on CH_4 emission reduction:

- extending the collection and utilisation of secondary resources through the implementation of separated collection to reduce the amount of municipal waste by 20% compared with 1992;
- utilisation of at least 20% of biological waste as organic fertiliser;
- disposal of all municipal waste by 50% in landfills meeting the environmental requirements;
- application of sanctions to unmanaged landfills; building new municipal waste incinerators as well as reconstruction of existing ones in Bratislava and Košice;
- to build 10 composting facilities;
- to build 9 high-capacity regional landfills for municipal waste;

Legislative measures

In 1991 several legislative measures have been adopted to support the goals for waste management regarding the problems of methane emissions from landfills for municipal waste.

⇨ **Act No. 239/1991 on Waste** represents the fundamental legal norm for waste management. It establishes the duty of every waste generator to use the waste as a source of secondary materials or energy. Disposal of waste in landfills should be the last step of waste treatment.

⇨ **Decree of the Slovak Government No. 606/1992 on Waste Treatment** establishes the rules for landfill management. The building of new landfills where gas generation is anticipated must contain a gas drainage system. There is also an obligation to monitor the quantity and composition of gas at least twice a year.

⇨ **Decree of the Slovak Government No. 605/1992 on Keeping Evidence on Waste** specifies the basic principles for keeping evidence on waste.

⇨ **Act of the Slovak National Council No. 309/1992 on Charges for Waste Disposal** determines the charges for municipal waste disposal in landfills and the application of higher charges for waste disposal in dumps that do not meet the legislative requirements.

⇨ **Order to the Act of the Slovak National Council No. 309/1991 on Protection of the Air Against Pollutants** places waste landfills on the list of air pollution sources. Current legislation does not force the owners or operators of landfills to utilise or dispose of gas.

Economic Instruments

⇨ **Act of Slovak National Council No. 128/1991 on the Governmental Fund of Environment.** The government, under this law, supports separate collection, the implementation of communal waste landfills complying with the conceptual requirements (regional dump). All these measures provide the possibility of higher biogas utilisation.

II. Measures considered for the future

⇨ **Updating of legislative measures**

Work to update the waste management legislation has already started. New legislation will take into account the recovery, disposal and utilisation of landfill gases.

⇨ **Information system**

With respect to waste management legislation the information system will be completed. This system will contain sufficient input data to calculate the landfill gas inventory.

Preliminary impact assessment of the measures

The evaluation of the measures of impact or the GHG reduction for the waste management and waste water treatment sectors was modelled in the aggregated scenarios (Box 4.3). The results of the preliminary estimates of impact measures are summarized in Table 4.7.

BOX 4.3

A. **Baseline scenario**	***Communal waste dumps*** • old landfills are sanitised only in rare cases • the construction of small, and rarely medium dumps, continues without neutralisation or utilisation • of released waste-dump gases • strict legislative measures are not adopted • separated collection is realised only locally with small effects • in new dumps the share of methane increases due to technologies employed ***Waste water treatment*** • construction of sewerage systems and WTP is very slow • anaerobic stabilisation and utilisation of sludge gas remains at the present level • the storage of nitrogen in WTP output will not be levelled
B. **Scenario with lower impact of measures**	***Communal waste dumps*** • sanitation of dumps will concentrate on the most problematic ones because of the negative • impact on water, soil, and the like • legislation will stimulate the obligation to neutralise dump gases from selected dumps (exceeding a certain level of gas production) • the production of communal gases will grow slightly • the efficiency of separated waste collection will grow slightly (paper) ***Waste water treatment*** • Some WTP and sewerage systems will be built
C. **Scenario with medium impact of measures**	***Communal waste dumps*** • through separated waste collection, the amount of waste dumps will be reduced to 10% of current level • construction of small dumps will be realised only in justified cases • legislation will stimulate the obligation to neutralise dump gases ***Waste water treatment*** • prior to 2005, the share of population connected to the public sewerage system will increase to 57% • the utilisation of sludge gas will increase by approximately 10% in comparison with the present situation
D. **Scenario with higher impact of measures**	***Communal waste dumps*** • all dumps will be sanitised and produced dump gas, in excess of a certain level, will be either disposed of or utilised • all communal waste will be dumped in secured dumps (suitable anaerobic environment) and gas will be either disposed of or utilised • the contents of organic substances stored in waste dumps will be limited • the separated collection will achieve an efficiency of 30-40% ***Waste water treatment*** • 90% of the population will be connected to sewerage systems • 70% of the population will be connected to waste water treatment plants

4.3.2 Agriculture - non-energy sources

The essential elements of the mitigation measures system for methane emissions from livestock production represent:

- intensity of breeding
- storage of the manure
- stabling conditions
- manure application method

The metabolic fermentation represents one CH_4 emission source. In general, it can be concluded that by increasing the utility of farm animals greenhouse gases' production is decreased (through the reduction of the counts, through more intensive utilisation of forage energy). High utility of dairy cattle with milk yield of 7,000 kg/per head/year, methane production can be 120 kg/per head/year. That represents 17 g of methane/1 kg of milk. In comparison, low-utility dairy cattle with mainly straw forage emit 50-60 g of methane/ 1 kg of milk. The improvement of milk yield corresponding to at least the average in neighbouring countries of Slovakia (i.e. around 4,000 l) may lead eventually to a decrease of CH_4 emission from metabolic fermentation of dairy cattle by as much as one half (approximately 25 kg). That means that an improvement of the herd genotype (controlled reproduction, increase of the herd turnover), improvement of the nutritional value of the forage (biologically, chemically, mechanically) and its balance in time contribute to the reduction of methane emissions from metabolic fermentation considerably. For methane formation from manure (stable manure, liquid manure, dung-water) there is a rule that the greater the extent of anaerobic conditions, the greater the percentage of methane formed. Therefore the condition of stabling of farm animals', removal and subsequent excrement storage are, along with the amount and quality, among the most important limiting factors for methane emissions. In addition, the reduction of gases by approximately 20-90% can be achieved by the application of excrement as an organic manure (technology, time, soil type, culture).

I. Measures fully and partly implemented

The following legislation has been adopted in the agriculture sector which is directly or indirectly related to GHG emissions:

⇨ **Act No. 285/1995 on Plant Medical Care**

⇨ **Act No. 291/1996 on Race and Seeds**

⇨ **Act No. 132/1989 on Protection of Claim of New Plant Race and Animal Breeds**
These acts replace Act No. 61/1964 on Plant Production Development. These acts also specify the principles of agricultural plant cultivation and fertilisation.

⇨ **Guideline of the Ministry of Agriculture and Nutrition of the SR No. 5001/1982 on Handling of and Fertilization with Liquid Manure and on Disposal of Silage Juices**
Determines the principles for handling and application of liquid manure as fertilizer.

⇨ **Decree of Government No. 606/1992 on Waste Management**
This decree outlines the necessity to elaborate programmes of waste reduction for consumer products and packaging, including agrochemical waste and packaging.

⇨ **Code of Good Agricultural Practice in the SR**
This code has been approved and published in August 1996 as a recommended document for agricultural enterprises as well as for local and regional agriculture related authorities. This code deals with: the soil fertility protection against physical degradation, protection against pollution and its impacts, managment of water and air mode of soil, environmental oriented agriculture system and the soil quality monitoring in Slovakia.

II. Measures considered for the future

The following measures are prepared for approval:

⇨ **Policy and Strategy of Environment Protection in Agriculture**
The negative environmental impacts of agriculture production will be reduced. GHG reduction issues will probably be included in this policy and strategy.

⇨ **Principles of Livestock Farming, Creation and Disposal of Livestock Farming Area in Villages of SR**
Contains the programme for changes of the genetic fond as well as style of livestock farming and manure handling.

The impact of individual measures was aggregated into the following scenarios: baseline scenario, scenarios with lower, medium and higher impacts. The impact to CH_4 emission in individual scenarios is quantified in Table 4.7.

4.3.3 Fugitive CH_4 emissions

The fugitive CH_4 emissions arise mainly from the gas distribution and transportation systems. The following measures have been applied or considered in CH_4 emission reduction:

I. Measures fully and partly implemented

⇨ **Gas distribution system**
- an electronic measuring system with an accuracy of 1% is gradually implemented at the sites of large consumers
- the same measuring system is implemented at the local nets inlet
- a gas metering system with temperature compensation is implemented at the level of small consumers and in residential area
- establishing measuring points to evaluate qualitative parameters where different origin gases are mixed
- commercial measuring in the stations from transition pipelines to domestic ones

⇨ **Transit pipelines**
- The use of compressors enabling the feed back of gas, supplied from the transition pipeline, at the decreased pressure of domestic line.
- Installation of a gas metering system for measuring the gas consumption in the compressor driving turbines together with an emission monitoring system.

4.4 NITROUS OXIDE EMISSIONS

Agriculture is only one sector, where the effective measures for N_2O emission mitigation can be applied in Slovakia. The energy related N_2O emission projection is similar to CO_2 and CH_4. Measures with a positive impact on CO_2 reduction will have the same impact as the energy related N_2O emission. In the case of waste water treatment the measures focused on decreasing CH_4 emission also increase the N_2O emissions. Emission of nitrogen gases from soil into the atmosphere depends on the nitrate content in the soil. In soils with sufficient amount of carbon containing energy sources compared with energy depleted soils, the acceleration of N_2O emissions can be expected. During the period of central economic planning the consumption of nitrogen containing fertilisers had been increasing prior to 1988, after that time a rapid decline in consumption has been observed. The decline in consumption of fertilisers is not due to more sophisticated behaviour by farmers but rather due to the economic recession. Increase in consumption may be expected in the future (revival of the economy). In order to mitigate N_2O emissions, the implementation of measures focused on better fertiliser utilisation, on more effective utilisation of plant production and higher utilisation of soil natural potential, will play important roles.

I. Measures fully or partly implemented

⇨ **Act No. 307/1992 of Agricultural Soil Protection (part 3, § 4, 5, 6)**
According to the above law, the user of agricultural land is obliged to use it in such a way that he will not impair the quality of other environmental components (water, atmosphere). Changes in agricultural land use may be carried out only after approval by the agricultural soil stock protection body.

⇨ **Act No. 285/1995 on Plant Medical Care**

⇨ **Act No. 291/1996 on Race and Seeds**

⇨ **Act No. 132/1989 on Protection of Claim of New Plant Race and Animal Breeds**
These acts replace Act No. 61/1964 on Plant Production Development. These acts also specify the principles of agricultural plant cultivation and fertilisation.

⇨ **Directive of Ministry for Agriculture No. 5000/1982 on the Water Protection against Agricultural Contamination** outlines the principles of application of mineral nitrogenous and organic fertilisers in water protected areas.

⇨ **Directive of Ministry for Agriculture No. 5001/1982 on manipulation with and utilisation of liquid manure and liquidation of ensilage juices** outlines the principles of handling and use of liquid manures.

⇨ **Code of Good Agricultural Practice in the SR**
This code has been approved and published in August 1996 as a recommended document for agricultural enterprises as well as for local and regional agriculture related authorities. This code deals with: the soil fertility protection against physical degradation, protection against pollution and its impacts, management of water and air mode of soil, environmental oriented agriculture system and the soil quality monitoring in Slovakia.

II. Measures considered for the future

⇨ **Programme of Water Protection against Agricultural Contamination**
This programme has been developed in agreement with the "EC Nitrate Directive 1991". Strict measures against increasing soil nitrogen content with their indirect impact on the N_2O emission reduction are defined in it.

⇨ **Methodology for Special System of Management in Areas of Water Sources' Protection and in Polluted Areas**
The above methodology strictly outline the requirements for correct fertilisation with nitrogenous manures which can indirectly contribute to the decrease of nitrous oxide emissions from the soil into the atmosphere.

Similarly to the case of CH_4, the impacts of measures were incorporated in the following scenarios

- Baseline scenario

- Scenario with lower impact of measures
- Scenario with medium impact of measures
- Scenario with higher impact of measures

The results of preliminary measures impact estimates are summarised in Table 4.8.

4.5 OTHER GASES

The greenhouse effect is indirectly influenced by non-methane volatile organic compounds (NMVOC), NO_x, CO (ozone precursors) and SO_2 (sulphate precursors). Emissions of these gases are gradually reduced consistent with environmental legislation and international agreements.

⇨ **Convention on Long-range Transboundary Air Pollution**

To meet the requirements of the Protocol to the 1979 Convention on Long-range Transboundary Air Pollution (on Long-term Financing of the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe) the following protocols have been signed:

- Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on Reduction of Sulphur Emissions or their Transboundary Fluxes by at least 30 per cent (Helsinki 1985)
- Protocol to the 1979 Convention on Long-range Transboundary Air Pollution on further Reduction of Sulphur Emissions (Oslo, 1994)
- Protocol to the 1979 Convention on Long-range Transboundary Air Pollution concerning the Control of Emissions of Nitrogen Oxides or their Transboundary Fluxes (Sofia, 1988)
- Protocol to the 1979 Convention on Long-range Transboundary Air Pollution concerning the Control of Emissions of Volatile Organic Compounds or their Transboundary Fluxes (Geneva, 1991)

The Slovak Republic as a successor of the first sulphur protocol and NO_x emission decrease protocol has fulfilled them as well as all related commitments. Ratification of the Protocol on VOC emission signification is expected in the beginning of the year 1998.

⇨ **Act No. 309/1991 on Protection of the Air Against Pollutants as amended**

⇨ **National Program of NMVOC Emission Reduction**

The program was negotiated by the Slovak Government in January 1996 and its fulfilment will be assessed at the beginning of 1998.

4.6 MEASURES FOCUSED ON THE GHG SINK INCREASE

I. Measures fully or partly implemented

The most important measures of the increase GHG sink are in the forestry sector (section 4.2.8):

⇨ **Afforestation of non-forest areas**

⇨ **Tree species composition change**

⇨ **Protection of carbon stock in forests affected by immissions**

Measures considered for the future

In order to increase the carbon stock in forest ecosystems the following activities will be considered in future:

⇨ **Improvement of ecological forest management with regard to soil carbon conservation (erosion control measures)**

⇨ **Preventive measures against noxious agents which decrease increment or damage the biomass, mainly trees**

⇨ **Afforestation activities in agriculture landscape linking up with „The territorial systems of ecological stability"**

⇨ **Planting projects in urban and industry areas**

These measures, together with an increase in the carbon stock, result in the environmental benefitial impact on forests. Similarly to the previous cases aggregated modelling has been applied in the following scenarios:

- Baseline scenario
- Scenario with lower impact of measures
- Scenario with higher impact of measures
- Scenario with medium impact of measures

Results are summarised in Table 4.9.

Table 4.6 Summary of policies and measures focused on CO_2 emission reduction

Policy / Measures	Type of instrument	Method of achieving reduction	Status of implementation	Sector / subsector	Impact of measures [$GgCO_2$]			Monitoring
					2000	**2005**	**2010**	
Air act and emission	Regulation	Fuel switch		Public electricity sector	-206	-331	-398	
concentration standard		Fluidised bed combustion		District heat supply [1]	--31	-35	-35	GHG Inventory
The impact of these standards		Combined cycles	Act is in force	Industrial sources	-478	-547	-606	Energy statistics
implementation is incorporated		Boiler efficiency increase		Other sources [2]	0	52	40	
in scenario 2, Chapter 5				**Total**	**-716**	**-861**	**-999**	
		Lighting and DSM	Planning	Public electricity sector	-300	-719	-664	
Energy conservation	Demand Side	Heat consumption saving	Planning	Residential	-21	-56	-94	GHG Inventory
measures incorporated	Management (DSM)			Industry	-768	-658	-645	Energy statistics
in scenario 3, Chapter 5		Continual steel casting	Implemented	Metallurgy (VSŽ)	-48	-42	-38	
and measures applied	Act of energy economy	Lighting and heating	In consideration	Commercial & institution	-71	-269	-348	
in transportation sector		Measure by the section 4.2.3.	In consideration	Transport	-191	-1,032	-1,510	
				Total	**-1,398**	**-2,777**	**-3,299**	
Decrease of energy	Energy Charta EU	Implementation of new	In consideration	Industrial energy sources	-61	-402	-812	GHG Inventory
intensity in industry	Energy policy	technologies in industry		Industrial technologies	-67	-464	-907	Energy statistics
scenario 4, Chapter 5				**Total**	**-128**	**-865**	**-1,718**	
		Small hydro-power plants	In consideration	Public electricity sector	-17	-67	-168	
The full use of renewable	Energy policy	Energy forest	In consideration	Residential	-50	-201	-502	GHG Inventory
energy sources potential		Geothermal energy	In consideration	District heating	-51	-203	-508	Energy statistics
scenario 5, Chapter 5		Other renewable	In consideration	Cross -sectorial	-130	-518	-1295	
				Total	**-247**	**-989**	**-2,473**	

[1] *Centralised heat supply system from local energy sources.*

[2] *Negative values in the case of this sector are due to the fact that when new cogeneration units are implemented the total fuel consumption increases compared with the previous heating station. The CO_2 emissions increase, but this increase is compensated for by the electricity consumption of the public power plants.*

Table 4.7 Summary of implemented measures and their impacts, CH_4 emissions.

Policy / Measures	Type of instrument	Method of achieving reduction	Status of implementation	Sector / subsector	Impact of measures [$GgCH_4$] 2000	2005	2010	Monitoring
Legislation on waste management and waste water treatment	Regulation	Scenario with lower impact of measures	Fully implemented measures	Communal waste	-4.5	-7.3	-10.2	
				Waste water treatment	-0.7	-1.0	-1.2	
				Waste total	-5.2	-8.3	-11.4	
		Scenario with medium impact of measures	Partly implemented measures	Communal waste	-6.5	-23.3	-40.2	
				Waste water treatment	-1.2	-2.5	-3.7	
				Waste total	-7.7	-25.8	-43.9	
		Scenario with higher impact of measures	Considered measures	Communal waste	-16.5	-40.8	-65.2	
				Waste water treatment	-4.7	-7.0	-9.2	
				Waste total	-21.2	-47.8	-74.4	
Legislation in agricultural sector	Regulation	Scenario with lower impact of measures	Fully implemented measures	Excrements	-4.4	-5.1	-5.1	
				Fermentation	-8.6	-10.0	-9.9	
				Total	-13.0	-15.1	-15.0	
		Scenario with medium impact of measures	Partly implemented measures	Excrements	-12.8	-13.7	-14.3	
				Fermentation	-24.9	-26.6	-27.8	
				Total	-37.7	-40.3	-42.1	
		Scenario with higher impact of measures	Considered measures	Excrements	-22.1	-23.1	-24.5	
				Fermentation	-42.9	-45.0	-47.5	
				Total	-65.0	-68.1	-72.0	

Table 4.8 Impact of measures for the mitigation of the N_2O emissions

Politics / Measure	Type of instrument	Method of achieving reduction	Status of implementation	Sector / subsector	Impact of measures [GgN$_2$O]			Monitoring
					2000	2005	2010	
Legislation applied	Regulation	Scenario with lower impact	Fully implemented	Agriculture	-1.5	-1.7	-1.7	
in the agricultural sector		Scenario with medium impact	Partly implemented		-2.2	-3.3	-3.3	
		Scenario with higher impact	In consideration		-3.8	-5.0	-5.0	

Table 4.9 Summary of measures focused on the carbon sink in biomass

Policy measures	Type of instrument	Method of achieving reduction	Status of implementation	Sector	Impact of measures			Monitoring
					2000	2005	2020	
Afforestation	Political	Scenario with lower impact	Start in the year 1995	Forestry	-0.22	-0.62	-1.91	Forestry inventory
of non-forest area		Scenario with medium impact			-0.29	-1.25	-3.74	
		Scenario with higher impact			-0.33	-1.39	-4.40	
Tree species composition change	Political	Scenario with lower impact	Planning	Forestry	-0.11	-0.18	-0.37	Forestry inventory
		Scenario with medium impact			-0.18	-0.55	-1.10	
		Scenario with higher impact			0.73	-1.47	-2.38	
Protection of carbon stock in forests affected by immisions	Political	Scenario with lower impact	Planning	Forestry	-0.20	-0.60	-1.10	Forestry inventory
		Scenario with medium impact		and land use	-0.50	-1.90	-3.30	
		Scenario with higher impact			-0.76	-2.40	-4.03	
Total		**Scenario with lower impact**			**-0.53**	**-1.40**	**-3.38**	
		Scenario with medium impact			**-0.97**	**-3.70**	**-8.14**	
		Scenario with higher impact			**-1.82**	**-5.26**	**-10.81**	

PROJECTIONS AND ASSESSMENT OF MEASURE EFFECTS

5

The emission projections in countries with economies in transition, including the Slovak Republic, are influenced by the uncertainties accompanying the transition process. Considering the on-going transformation process, and the creation of the new independent state, the simple extrapolation of energy consumption historical data cannot be used. The emission projections are based on the energy and non-energy sector modelling carried out in the framework of the US Country Study of Slovakia. The input data for the modelling and analyses were taken from the draft of up-dated version of Energy Policy and Strategy of Slovakia up to 2010, from the National Program of CO_2 emission decrease and stabilisation in the transportation sector and from the analyses of the impact of legislation and regulatory measures in the economic sectors of Slovakia.

5.1 PROJECTION OF ANTROPOGENIC CO_2 EMISSION

5.1.1 Projection of energy related CO_2 emission

Scenario modelling of energy consumption was conducted using the ENPEP/BALANCE software package. This software was obtained from the ARGONNE NATIONAL LABORATORY, together with the training course in the framework of the US Country Studies Programme. The system of modelling and other details of software application are described in the final report of Element 3 of the US Country Study Programme.

The following key assumptions have been used, summarised in Table 5.1:

- Scenarios of GDP development in individual sectors
- Scenarios of primary energy consumption
- Assumption of energy intensity development in industry, used in scenario 4.
- Assumption of energy and fuel price development
- The higher scenario of GDP development. This higher scenario is not attractive from the CO_2 emission point of view, but enables to make better analysis of individual measure's impact.
- Assumption of steel production in Slovakia.
- Assumption of district heating consumption, supplied from centralised sources, and the development of price deregulation.
- Assumption of electricity production/consumption.
- Optimistic/higher scenario of population development.

The measures, used to mitigate the energy related CO_2 emissions were described in Chapter 4. As the driving force the following legislation and regulatory measures play the most important role:

Act on Protection of the Air Against Pollutants, containing the emission concentration limits of basic effluents (SO_2, CO, NO_x and solid particles). This regulatory measure will stimulate the energy sources retrofit and repowering as well as fuel switching in industrial energy sources and heat supply sources in residential, commercial and other sectors.

Energy conservation policy (consistent with the legislation, see Chapter 4) will stimulate project implementation, focused on the energy conservation and decrease of energy intensity both on the supply and demand sides of the energy system, including measures applied in transportation sector.

National energy policy (updated energy strategy and policy up to the year 2005/2010) is focused on the security of the electricity supply system. An integral part of this policy is the replacement of retired nuclear power plant units by new ones and the implementation of new hydropower units. All these activities will result in the decrease of CO_2 emissions.

The above mentioned measures have been included in the individual scenarios of CO_2 emission production and the following input data were used:

- GHG inventory, prepared in the framework of Element 1 Country study of Slovakia.
- GHG Inventory carried out in Element I.
- Energy Statistics of Period 1980 a 1992 issued by FSÚ (Federal Statistics Office of ÈSFR, Prague).
- Energy Policy and Strategy of the Slovak Republic up to the year 2005.
- Energy Policy and Strategy of the Slovak Republic, up-dated version for period 1993-2010 (draft).
- National Emission Inventory REZZO.
- First National Communication on Climate Change of the Slovak Republic.
- Macroeconomics Forecast for Period 1995-2010.
- Yearbook of Slovak Power Plants.

Table 5.1 Key assumption used at CO_2 emission modelling

Parameter		Unit	1995	2000	2005	2010
Fuel and energy carrier prices						
Brown coal domestic [2]		SKK/GJ	73.88	83.69	97.92	102.46
Annual growth rate		%		2.52	3.19	0.91
Brown coal import [1]		SKK/GJ	68.32	70.04	71.81	73.62
Annual growth rate		%		0.50	0.50	0.50
Hard coal import [1]		SKK/GJ	50.25	51.52	52.82	54.15
Annual growth rate		%		0.50	0.50	0.50
Crude oil import [1]		SKK/GJ	100.58	111.60	123.82	137.38
Annual growth rate		%		2.10	2.10	2.10
Natural gas [1]		SKK/GJ	102.44	113.65	126.10	139.91
Annual growth rate		%		2.10	2.10	2.10
NG for district heating [3]		SKK/GJ	51.79	unregulated	unregulated	unregulated
Nuclear fuel [1]		SKK/GJ	14.31	18.17	23.08	29.32
Annual growth rate		%		4.90	4.90	4.90
Centralised supply heat for district heating [3]		SKK/GJ	140	170	unregulated	unregulated
Electricity						
Import		SKK/kWh	1.41	1.61	1.84	2.11
Electrical heating [3]		SKK/kWh	0.44	unregulated	unregulated	unregulated
GDP (stable prices 1984)		bil.SKK	213	281	364	462
Inhabitants [4]		millions	5.366	5.486	5.600	5.676
Primary energy sources [1]		PJ	728	820	902	970
Index of steel production [4]	1995 = 100%	%	100	102	101	100
Index of electricity production [1]	1995 = 100%	%	100	112	123	132
Index of centralised heat supply [1]	1995 = 100%	%	100	100	101	98

1 *Energy Policy and Strategy of Slovak Republic, up-dated version for period 1993-2010*
2 *Input data from INKO a.s. used at [1]*
3 *Decree on prices, Ministry of Finance of SR, 1996*
4 *P.Karasz, J.Renèko: Macroeconomics Forecast for Period 1995-2010, Prognostic Institute of the Slovak Academy of Sciences, Bratislava, December 1995*

In the transportation sector all types of transportation were considered (road, rail, air and water). From the CO_2 point of view the road transport plays the most important role. The following indicators were used in this sector, (summarised in Appendix):

- Vehicles fleet in accordance by the EU classification

- Average vehicle mileage by individual car type according to the EU classification
- Vehicle efficiency development by individual car type according to EU classification

The following scenarios have been applied to the aggregate approach of energy sector modelling:

Scenario 1 ..... Baseline scenario, the requirements of emission limits according to the Act on Air Protection are applied in the case of new energy sources only;

Scenario 2 ..... Full application of the Act on Air Protection and emission limits for all sources (new and existing) is considered;

Scenario 3 ..... The same as the scenario 2. Also the impact of energy saving measures, stimulated by current and proposed legislation (see Table 4.6), is included in this scenario. The following measures will be applied:

- DSM
- Energy saving measures in space heating in residential and non-residential buildings
- Measures applied to the transportation sector, that will bring a fuel consumption decrease
- Continual casting in metallurgy enterprise VSŽ Košice
- Combined cycle implementation in metallurgy enterprise VSŽ Košice

Scenario 4 ..... The same as scenario 3. The impact of more expressive industrial restructuring is considered in this scenario. This restructuring is characterised by technology innovation and reconstruction. An annual decrease in industrial energy intensity by 1% since the year 1997.

Scenario 5 ..... The same as scenario 4. The more intensive use of renewable energy sources is considered. This scenario is not based on the results of energy supply-demand modelling. It is based on the assumption of continual renewable sources penetration to the energy balance so, that in the year of 2010 the full renewable source potential penetration will be achieved. This potential based on the data from Energy Strategy and Policy represents 32.4 PJ. Providing that the renewable energy sources will replace the different primary energy sources this potential represents 2,473 GgCO_2.

Energy related CO_2 emissions are determinated by primary energy consumption. Figure 5.1. presents the structure of primary energy source consumption in individual scenarios as the result of energy balance modelling. In the year 1995 the consumption of individual types of primary energy sources is the same in individual scenarios. In the following years the impact of measures brings a change of total fossil fuel consumption as well as a change of individual fuel type consumption shares (solid, liquid and gaseous).

Figures 5.1 and 5.2 provide the results of modelling obtained in scenarios 1-4. Figure 5.3 presents, together with modelling results from scenarios 1-4, the results of scenario 5 with the impact of renewable source's penetration to energy balance. Implementation represents the most optimistic scenario of energy related CO_2 emission. The national target, e.g. 20% decrease in energy related CO_2 emissions in the year 2005 compared to the 1988 emission level, is also shown in this figure. It is possible to achieve this target in the case of scenarios 3 and 4, e.g. at the implementation the all considered energy conservation measures and measures considered in the transportation sector. On the other hand, CO_2 emission level stabilisation will not be achieved and the level of the National target will be exceeded in the year 2010 for scenario 3 and balanced in scenario 4. In the case of full implementation of the technical feasible potential of renewable sources (scenario 5) the development of energy related CO_2 emission is close to stabilisation.

The higher scenario of GDP development was used for the energy consumption modelling, together with the assumption of the stable structure of fossil fuel consumption in industrial final uses (technology feedstock, industrial kilns, etc.). This assumption should be rapidly changed through full energy price liberalisation and later at the implementation of a carbon tax. The impact of both will provide a decline in production of energy intensive industrial products (preferably in chemistry, metallurgy and construction material production). It can also support the achievement of energy related CO_2 emission stabilisation.

The CO_2 emission development in the public electricity production sector is based upon the power plant expansion plan consistent with the Energy Strategy and Policy. The impact of another expansion plan for power plants is characterised in box 5.1.

Figure 5.1 Structure of primary energy consumption in individual scenarios

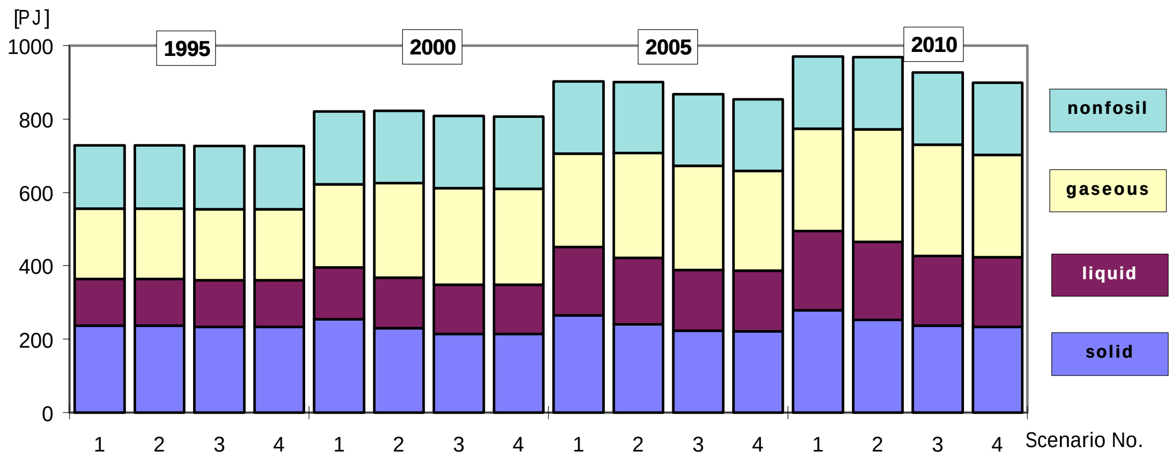


Figure 5.2 CO_2 emission scenarios by the fossil fuel type

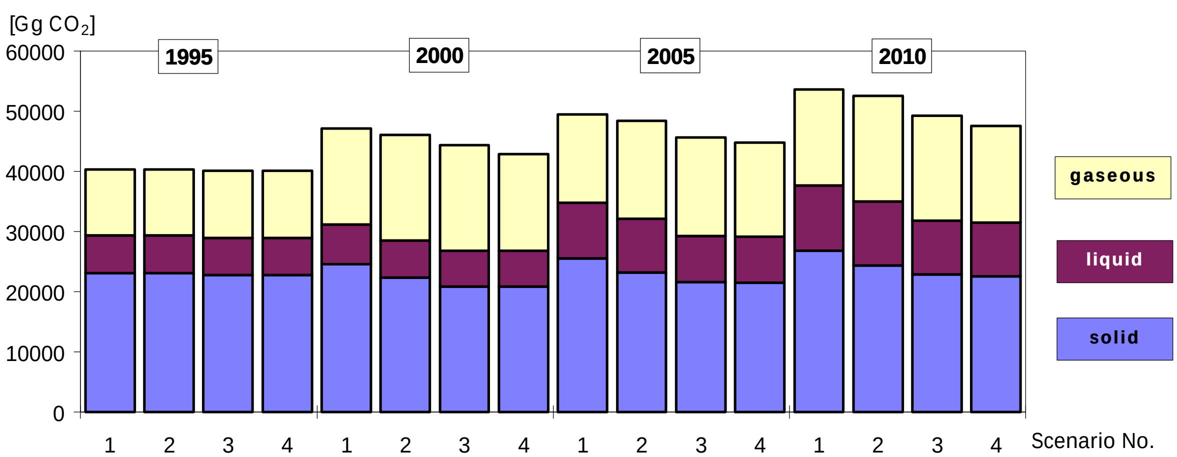
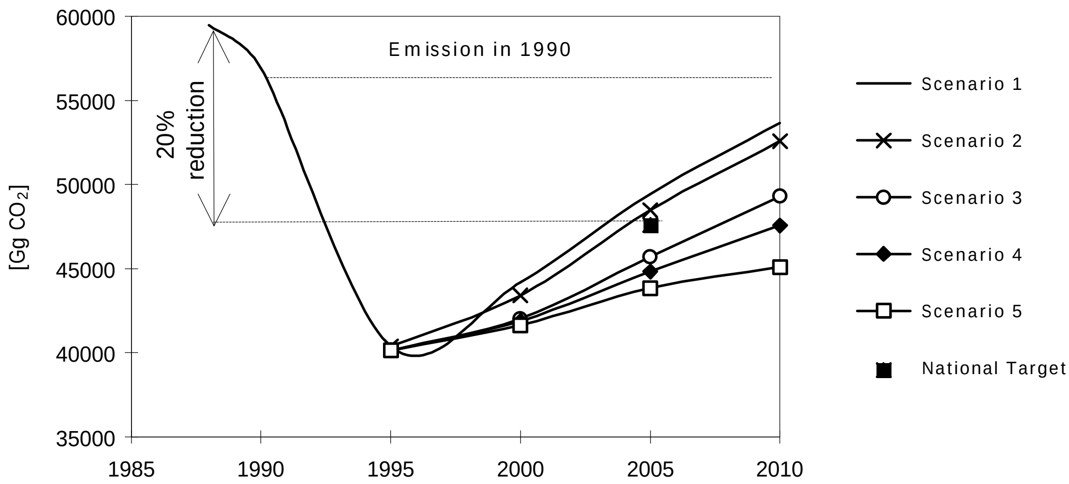


Figure 5.3 Energy related CO_2 emission scenarios



BOX 5.1

Analyses of power plant expansion plan influence to the CO_2 emission scenarios

The impact of the electricity supply system to the CO_2 emission level is substantial. This emission is influenced not only by the total volume of electricity production, but also by the share of individual types of power plant. From this point of view, the following indicators play the most important role:

- Share of fossil and non-fossil (nuclear, hydropower and other renewable) primary energy sources.
- Share of individual type of fossil fuel, used for electricity generation in thermal power plants.

In the public power plant sector, more than 60% of electricity is generated from non-fossil sources, predominately from nuclear fuel. The future of nuclear energy in Slovakia together with the operation of new hydro power plant Gabèíkovo is the subject of international interest as well as the interest of domestic and foreign environmental NGO´s. In order to analyse the impact of different power plant expansion plan, the following scenarios were applied in modelling the public electricity supply system:

Scenario A …… Baseline scenario, the continuous replacement of nuclear units in the Nuclear power plant in Bohunice EBO by the new units in the Nuclear power plant Mochovce EMO is assumed. In the coal power plant ENOB in Nováky the abatement technology (wet scrubber) will be installed and this retrofit will not have any effect on the CO_2 emission balance. In other coal power plants ENOA in Nováky in and EVO1 in Vojany installation of the fluidised bed combustion units is planned There is evident the different way of technology impact to the CO_2 emission level:

- a higher combustion efficiency will result in a CO_2 emission decrease
- the combustion stabilisation by the oil and gas will be removed and this fact has negative effect on the CO_2 balance.

The load of units in ENOA will be in the range of 88-220 MWe, and, according to the electricity demands.

Scenario B …… represents the policy of decreasing the role of nuclear power. The units in the power plant will be retired but they will not be replaced by new units from the power plant Mochovce. Required electricity demand will be meet by the new combined cycle installation with the 50% efficiency of electricity generation (without cogeneration). Installed capacity should be about 2,000 MWe. In the case of the fluidised bed units in ENOA capacity in the range of 192-330 MWe was considered.

Scenario C …… represents the case, that only the nuclear power plant EMO1 with a capacity of 880 MWe will be implemented. Additional demands should be covered by the same combined cycle as in scenario 2. The parameter of the other unit will be the same as in the case of scenario 1.

Scenario D …… represents the case with an increasing role for coal power plants in Novaky (ENO). The total capacity of the fluidised unit is 192-330 MWe from implementation until 2004 and following the year 2004 it will increase to about 196-440 MWe. In ENO B after the year 1996 there will be 4 units in operation. This represents an amount of 440 MWe. In this scenario there is a problem in achieving the emission limits in the two old units without installing abatement technology.

The summary of individual scenarios is well illustrated in the installed capacity, considered for the year 2004 (Table 5.2):

Table. 5.2 The key assumption for modelling the electricity generation in public power plant

	The installed capacity of key sources past the year 2004 [MWe]				
Scenario	**EMO1**	**EMO2**	**ENO Fluid**	**ENO B**	**CC**
A	880	880	220	220	0
B	0	0	330	220	2,000
C	880	0	330	220	2,000
D	880	0	440	440	0

The emissions of CO_2 , as well as the aggregated CO_2 emission factor, balanced upon the unit of electricity, are in scenarios B-D higher than in the case of scenario A (Figures 5.4 and 5.5). It is obvious, that the impact of electricity conservation measures to the CO_2 emission level will be lower in the case of the baseline scenario than in the case of scenarios B-D. The value of the aggregated CO_2 emission factor is increasing during the total period in the case of all scenarios. It is due to fact, that for the stabilised level of electricity production in nuclear power plants (scenario A), and preferably for the decline of this level (scenarios B-D), the increasing electricity demands have to be supplied from fossil thermal power plants. Each measure that will bring a slow down in electricity demand increase will contribute to the CO_2 emission level stabilisation in this sector.

The impacts of electricity generation expansion plan scenarios (A-D) on the total energy related CO_2 emission level as well as to the National target achievement are illustrated in Figures 5.6 and 5.7. Figure 5.6 illustrates the impact of scenarios A-D to the scenario 1 of aggregated energy sector and the Figure 5.7 the same influence to the scenario 4 of the aggregated energy system. The role of nuclear power plants and higher (scenario D), or lower (scenario A-C) role of coal for the electricity generation in the period after the year 2004 is obvious from these figures. The comparison of CO_2 emission level is important because of the other following emission level:

- emission level in the year 1990, e.g. FCCC requirements for the year 2000
- 80% of emission level in the year 1988, e.g. National target for the year 2005.

Although, the CO_2 emission level in the year 2000 will not be exceeded in the case of all scenarios and combinations, it is possible to achieve the National Target only in the case of a combination the scenario A (public power system) with the scenarios 3-5 (aggregated energy system). It is not possible to achieve this without loading the 4x440 MWe new nuclear power plants after the old nuclear units retirement and without significant industry restructuring and decreases in total energy intensity on the demand side of the energy sector, including in transportation.

Figure 5.4 CO_2 emission scenarios for electricity generation in SE a.s

Figure 5.5 Aggregated emission factor of CO_2 for electricity generation in SE a.s.

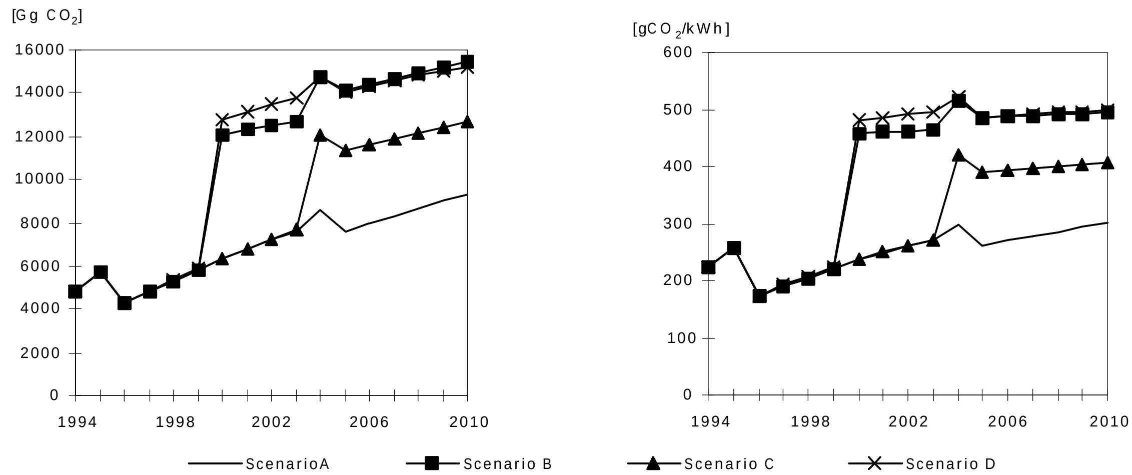
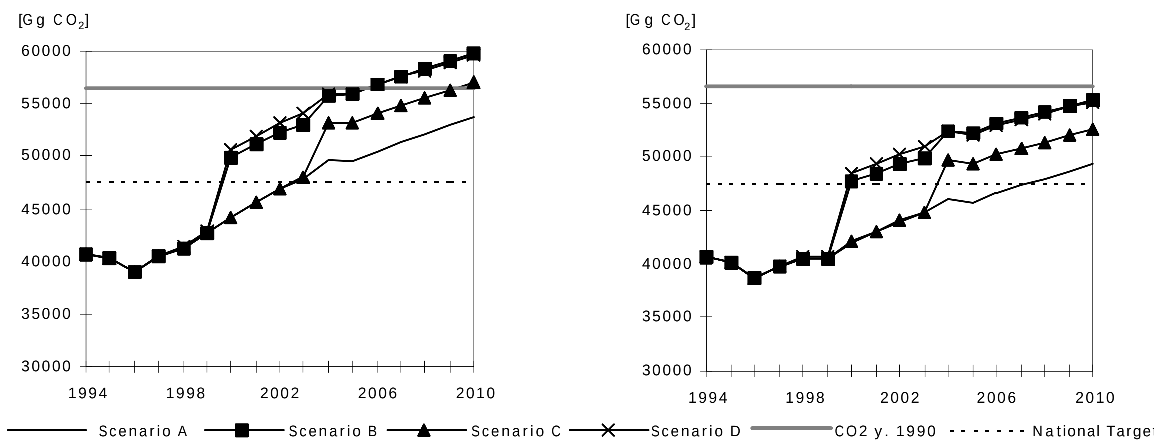


Figure 5.6 Impact of scenarios A-D to the total CO_2 emission level in the case of scenario 1

Figure 5.7 Impact of scenarios A-D on the total CO_2 emission level in the case of scenario 4



5.1.2 Non-energy related CO_2 emissions in industry

Emissions of CO_2 in industry, originating not from the carbon contained in fossil fuel used as energy source or-and technological feedstock, were calculated on the base of its inventory (see Chapter 3) and from the proposed annual growth rate for the production of construction material (cement, lime, MgO). The emission level is the same for all scenarios and the impacts of considered measures are focused on energy consumption only. CO_2 emission production is linearly dependent on the production level. Results are included in Tables 5.3-5.6.

5.1.3 Total anthropogenic CO_2 emission projection

Total anthropogenic CO_2 emissions, summarising the energy related emissions and the non-energy related emissions from industry (cement, lime and MgO production) are presented in Tables 5.3-5.6.

Table 5.3 Summary of anthropogenic CO_2 emission projection [Gg CO_2], scenario1

	1990	1995	2000	2005	2010
Fuel Combustion Energy &Transformation	11,970	17,485	19,593	21,765	24,333
Fuel Combustion Industry	25,398	13,230	13,962	14,678	14,980
Fuel Combustion Transport	5,168	4,809	5,950	8,378	9,773
Fuel Combustion Other	14,049	4,853	4,679	4,624	4,581
Fuel Combustion Total	**56,585**	**40,377**	**44,184**	**49,445**	**53,668**
Industry non-energy	3,167	2,769	2,769	3,439	3,930
Total emission CO_2 [1]	**59,752**	**43,146**	**46,953**	**52,884**	**57,598**

Table 5.4 Summary of anthropogenic CO_2 emission projection [Gg CO_2], scenario 2

	1990	1995	2000	2005	2010
Fuel Combustion Energy &Transformation	11,970	17,485	18,878	20,852	23,294
Fuel Combustion Industry	25,398	13,230	13,962	14,678	14,980
Fuel Combustion Transport	5,168	4,809	5,950	8,378	9,773
Fuel Combustion Other	14,049	4,853	4,620	4,573	4,542
Fuel Combustion Total	**56,585**	**40,377**	**43,409**	**48,480**	**52,589**
Industry non-energy	3,167	2,769	2,769	3,439	3,930
Total emission CO_2 [1]	**59,752**	**43,146**	**46,178**	**51,919**	**56,519**

Table 5.5 Summary of anthropogenic CO_2 emission projection [Gg CO_2], scenario 3

	1990	1995	2000	2005	2010
Fuel Combustion Energy &Transformation	11,970	17,365	17,789	19,418	21,890
Fuel Combustion Industry	25,398	13,229	13,913	14,636	14,943
Fuel Combustion Transport	5,168	4,722	5,760	7,345	8,263
Fuel Combustion Other	14,049	4,816	4,549	4,303	4,194
Fuel Combustion Total	**56,585**	**40,132**	**42,011**	**45,703**	**49,290**
Industry non-energy	3,167	2,769	2,769	3,439	3,930
Total emission CO_2 [1]	**59,752**	**42,901**	**44,780**	**49,142**	**53,220**

Table 5.6 Summary of anthropogenic CO_2 emission projections [Gg CO_2], scenario 4

	1990	1995	2000	2005	2010
Fuel Combustion Energy &Transformation	11,970	17,365	17,728	19,016	21,079
Fuel Combustion Industry	25,398	13,229	13,847	14,172	14,036
Fuel Combustion Transport	5,168	4,722	5,760	7,345	8,263
Fuel Combustion Other	14,049	4,816	4,549	4,303	4,194
Fuel Combustion Total	**56,585**	**40,132**	**41,883**	**44,837**	**47,572**
Industry non-energy	3,167	2,769	2,769	3,439	3,930
Total emission CO_2 [1]	**59,752**	**42,901**	**44,652**	**48,276**	**51,502**

[1] *The industrial fermentation processes are not included*

5.1.4 Projection of CO_2 sinks in forestry and land use

Projections of CO_2 sinks in forestry and land use modelled in low, high and medium scenarios was based on the analyses of the impact of measures outlined in section 4.2.8 (tree species composition change, afforestation of non-forest lands, protection of existing carbon stock in forests affected by immisions). The results are summarised in Tables 5.7-5.9.

Table 5.7 Amount of sequestered CO_2 [Tg CO_2] from the atmosphere by forest tree biomass for individual scenarios of tree species composition change (The calculation of the sequestered CO_2 has been made on the basis of specified areas and the carbon stock differences between spruce and beech in relation to stand age.)

Scenario	Measures	1990	2000	2010	2020	2030	2040	2050
Baseline	without measures							
High	tree species composition change on the area of 300,000 ha	0.00	0.73	1.47	2.38	3.30	4.40	5.50
Medium (optimal)	tree species composition change on the area of 200,000 ha	0.00	0.18	0.55	1.10	2.02	2.93	3.67
Low	tree species composition change on the area of 100,000 ha	0.00	0.11	0.18	0.37	0.73	1.28	1.83

Table 5.8 Amounts of sequestered CO_2 [Tg CO_2] from the atmosphere into tree biomass for individual afforestation scenarios

Scenario	Measures	1990	2000	2010	2020	2030	2040	2050
Baseline	without afforestation projects							
High	afforestation of 245 000 ha nonforest areas up to 2050	0.00	0.33	1.39	4.40	11.11	23.72	42.46
Medium (optimal)	afforestation of 166 500 ha nonforest areas up to 2050	0.00	0.29	1.25	3.74	9.20	19.29	33.48
Low	afforestation of 43 000 ha nonforest areas up to 2050	0.00	0.22	0.62	1.91	4.36	8.76	13.90

Table 5.9 The decrease of sequestered CO_2 [Tg CO_2] losses in tree biomass at individual scenarios of revitalisation measures in forests affected by immissions

Scenario	Measures	1990	2000	2010	2020	2030	2040	2050
Baseline	without realisation of revitalisation measures							
High	realisation of revitalisation measures on 80% of areas	0.00	0.76	2.40	4.03	6.00	8.30	11.00
Medium (optimal)	realisation of revitalisation measures on 60% of areas	0.00	0.50	1.90	3.30	5.00	6.60	8.44
Low	realisation of revitalisation measures on 40% of areas	0.00	0.20	0.60	1.10	1.62	2.20	2.94

5.2 CH_4 EMISSION PROJECTION

5.2.1 Projection of CH_4 emission from fossil fuel combustion

The modelling of CH_4 emission from fossil fuel combustion projections has been based on the fuel consumption in the individual scenario using the IPCC methodology including the recommended default emission factors. In the case of CH_4 emissions in the transportation sector for the individual type of vehicles, the emission factors from the COPERT method have been used. The results of the calculations didn't provide any substantial differences between individual scenarios and Table 5.10 illustrates the marginal values from the scenarios 1 and 3 (see section 5.1.1).

Table 5.10 CH_4 emissions from fossil fuel combustion [Gg CH_4]

Source	Scenario 1 1990	1995	2000	2005	2010	Scenario 3 1990	1995	2000	2005	2010
Fuel Combustion Energy &Transformation	0.29	0.64	0.661	0.70	0.75	0.29	0.53	0.34	0.36	0.39
Fuel Combustion Industry	2.34	0.52	0.573	0.65	0.69	2.34	0.52	0.57	0.65	0.69
Fuel Combustion Transport[2]	0.71	0.84	0.738	0.72	0.67	0.71	0.84	0.74	0.72	0.67
Fuel Combustion Other	17.08	11.99	12.00	12.01	12.02	12.04	11.99	11.98	11.98	11.99
Fuel Combustion Total[1]	**20.42**	**13.99**	**13.97**	**14.08**	**14.13**	**20.42**	**13.88**	**13.63**	**13.71**	**13.74**

[1] *Emission from biomass combustion is not included* [2] *Emission balance with using the COPERT emission factors*

5.2.2 Fugitive emissions of CH_4 from fuels

The yearly emissions have been calculated for the following activities, consistent with the IPCC methodology of CH_4 fugitive emission inventory:

- underground coal mining,
- crude oil processing,
- storage and transport and natural gas transport and distribution.

The aggregated emission factor for the level in the 1990 was used. As activity data the amount of lignite production, crude oil processing and NG consumption have been used from the energy system modelling in scenarios 1-4. The most substantial differences between individual scenarios were obtained from natural gas storage and transportation, where the CH_4 emission is determined by the volume of NG consumption. Table 5.11 presents the marginal values for the scenarios 1 and 3 (see section 5.1.1).

Table 5.11 CH_4 fugitive emission from fuels, [Gg CH_4/year]

	Scenario 1 1990	1995	2000	2005	2010	Scenario 3 1990	1995	2000	2005	2010
Coal mining	33.4	23.6	22.0	20.0	20.9	33.4	23.6	20.1	18.5	19.6
Crude oil	0.2	0.1	0.1	0.1	0.2	0.20	0.1	0.1	0.1	0.2
NG	88.1	74.9	88.4	99.6	108.4	88.1	72.3	98.0	106.0	113.2
Total	121.7	98.6	110.5	119.7	129.4	**121.7**	**96.0**	**118.2**	**124.6**	**133.0**

5.2.3 Projection of non-energy related CH_4 emission in industry

Metallurgy and plastic production are mainly responsible for the CH_4 non-energy related emissions in industry. The CH_4 emission projection for metallurgy has been calculated using the activity level for 1994 and steel production growth rate. Similarly, in the case of CH_4 emission for plastic production, the CH_4 emission projection has been calculated on the base of activity level in 1994 and GDP growth rate of chemical industry. The results are summarised in Table 5.12.

Table 5.12 CH_4 non-energy related emission in industry [Gg CH_4/year]

	1990	1995	2000	2005	2010
Metallurgy	6.4	6.0	6.2	6.1	6.0
Plastics production	0.5	0.4	0.5	0.6	0.6
Industry non-energy	**6.9**	**6.4**	**6.7**	**6.6**	**6.7**

5.2.4 Projection of CH_4 emission in agriculture

In Chapter 4, the 4 scenarios for CH_4 emission in agriculture were presented. These scenarios represent the various combinations of measures to mitigate emissions.

Scenario 1 ….. baseline scenario

Scenario 2 ….. low degree of applications - Low scenario

Scenario 3 ….. medium degree of applications - Medium scenario

Scenario 4 ….. high degree of applications - High scenario

Scenarios 2 and 4 correspond to the tolerances of possible greenhouse gas emission reductions. The real variant - scenario 3, e.g. medium degree of applications - represents the midpoint between the high and low scenarios. Table 5.13 presents the estimated values of individual scenarios.

Table 5.13 Scenarios of CH_4 emission in agriculture [Gg CH_4/year]

		1990	1995	2000	2005	2010
	Excrement	66	47.5	44.3	44.1	44.1
Scenario 1	Fermentation	121	92.2	86.0	85.6	85.5
	Total	**187**	**139.7**	**130.3**	**129.7**	**129.6**
	Excrement	66	47.5	39.9	39.0	39.0
Scenario 2	Fermentation	121	92.2	77.4	75.6	75.6
	Total	**187**	**139.7**	**117.3**	**114.6**	**114.6**
	Excrement	66	47.5	31.5	30.4	29.8
Scenario 3	Fermentation	121	92.2	61.1	59.0	57.8
	Total	**187**	**139.7**	**92.6**	**89.4**	**87.6**
	Excrement	66	47.5	22.2	20.9	19.6
Scenario 4	Fermentation	121	92.2	43.1	40.7	38.0
	Total	**187**	**139.7**	**65.3**	**61.6**	**57.6**

5.2.5 Scenario of CH_4 emission at waste management

In order to analyse the future development of GHG emissions from waste treatment and mitigation, as in the case of agriculture sector, 4 scenarios have been established:

Scenario 1 ….. baseline scenario

Scenario 2 ….. scenario with lower impact of implemented measures

Scenario 3 ….. scenario with medium impact of implemented measures

Scenario 4 ….. scenario with higher impact of implemented measures

The baseline scenario is the starting point for other scenarios. The baseline scenario is the most unfavourable one, however likely the least probable one. It presumes the continuation of the present situation. In Chapter 4, the key assumptions applied to individual scenarios have been described, including the measures and stage of implementation. The results illustrating the impact of applied measures in individual scenarios on the CH_4 emission level are summarised in Table 5.14.

Table 5.14 Emission of CH_4 at waste and waste water treatment [Gg CH_4/rok]

		1990	1995	2000	2005	2010
Scenario 1	Communal waste dumps	53	51	57	66	75
	Waste water treatment	12	12	12	12	12
	Total	**65**	**63**	**68**	**78**	**87**
Scenario 2	Communal waste dumps	53	51	52	59	65
	Waste water treatment	12	12	11	11	11
	Total	**65**	**63**	**63**	**69**	**76**
Scenario 3	Communal waste dumps	53	51	50	43	35
	Waste water treatment	12	12	11	9	8
	Total	**65**	**63**	**61**	**52**	**43**
Scenario 4	Communal waste dumps	53	51	40	25	10
	Waste water treatment	12	12	7	5	3
	Total	**65**	**63**	**47**	**30**	**13**

5.2.6 Summary of CH_4 emission projection

The CH_4 emission projection results are summarised in Table 5.15 for scenarios 1 and 3 respectively, in order to present the marginal values.

Table 5.15 Summary of CH_4 emission projection[GgCH_4/rok]

	Scenario 1					Scenario 3				
	1990	**1995**	**2000**	**2005**	**2010**	**1990**	**1995**	**2000**	**2005**	**2010**
Fuel combustion	20.4	14.0	14.0	14.1	14.1	20.4	13.9	13.6	13.7	13.7
Fugitive emission from fuels	121.7	98.6	110.5	119.7	129.4	121.7	96.0	118.2	124.6	133.0
Industrial processes	6.9	6.4	6.7	6.6	6.7	6.9	6.4	6.7	6.6	6.7
Excrement's	66.0	47.5	44.3	44.1	44.1	66.0	47.5	22.2	20.9	19.6
Fermentation	121.0	92.2	86.0	85.6	85.5	121.0	92.2	43.1	40.7	38.0
Waste	65.0	63.0	68.0	78.0	87.0	65.0	63.0	47.0	30.0	13.0
Total	**401.0**	**321.7**	**329.5**	**348.1**	**366.8**	**401.0**	**319.0**	**250.8**	**236.5**	**224.0**

5.3 N_2O EMISSION PROJECTION

5.3.1 Projection of N_2O emission from combustion

Similar to the case of CH_4, the emission of N_2O has been calculated using the IPCC methodology including default emission factors. In the transportation sector, the COPERT emission factors for individual vehicle types have been used. The marginal values for scenarios 1 and 3 (see section 5.1.1) are summarised in Table 5.16.

Table 5.16 Emission of N_2O from fossil fuel combustion [Gg N_2O]

	Scenario 1					Scenario 3				
	1990	**1995**	**2000**	**2005**	**2010**	**1990**	**1995**	**2000**	**2005**	**2010**
Fuel Combustion Energy &Transformation	0.19	0.18	0.20	0.22	0.24	0.19	0.16	0.12	0.14	0.16
Fuel Combustion Industry	0.24	0.03	0.04	0.04	0.04	0.24	0.03	0.04	0.04	0.04
Fuel Combustion Transport[2]	0.20	0.17	0.17	0.20	0.21	0.20	0.13	0.14	0.15	0.16
Fuel Combustion Other	0.15	0.10	0.10	0.10	0.10	0.15	0.10	0.10	0.10	0.10
Fuel Combustion Total[1]	**0.78**	**0.48**	**0.51**	**0.56**	**0.59**	**0.78**	**0.42**	**0.40**	**0.43**	**0.46**

[1] *Emission from biomass combustion is not included* [2] *Emission balance with the use of COPERT emission factors*

5.3.2 N_2O emission projection from industrial processes

N_2O emissions from industrial processes have been projected similar to the case of CH_4 non-energy related emissions. In this case nitric acid production represents the dominant source. The emission calculation was based upon the inventory value for the year 1994 and projected GDP growth rate in the chemical industry. The results are summarised in Table 5.18.

5.3.3 Projection of N_2O emission in agriculture

Scenarios have been designed, similarly to the case of methane emission, as follows:

Scenario 1 ….. baseline scenario
Scenario 2 ….. scenario with lower impact of implemented measures
Scenario 3 ….. scenario with medium impact of implemented measures
Scenario 4 ….. scenario with higher impact of implemented measures

Results are summarised in Table 5.17.

5.3.4 N_2O emission projection from waste water treatment

N_2O emission projection from waste water treatment by individual scenario is summarised in Table 5.17. Implementation of measures, focused on the decrease of nitrogen containing pollution in water, provide an increase of N_2O emissions.

Table 5.17 Emission of N_2O in agriculture and from waste water treatment [Gg N_2O/rok]

Scenario	N_2O in agriculture					N_2O from waste water treatment				
	1990	**1995**	**2000**	**2005**	**2010**	**1990**	**1995**	**2000**	**2005**	**2010**
Baseline scenario	7.7	3.8	7.7	8.4	8.4	0.28	0.28	0.28	0.28	0.28
Minimal. impact of measures	7.7	3.8	6.2	6.7	6.7	0.28	0.28	0.29	0.31	0.33
Medium. impact of measures	7.7	3.8	5.5	5.1	5.1	0.28	0.28	0.33	0.44	0.54
Maximal. impact of measures	7.7	3.8	3.9	3.4	3.4	0.28	0.28	0.40	0.60	0.80

5.3.5 Summary of N_2O emission projection

Similar to the case of CH_4, the summary of N_2O emission is provided for two scenarios. Scenario 1 is the baseline and scenario 3 is the sum of scenarios with the highest impact. The results of both scenarios are presented in Table 5.18.

Table 5.18 Summary of N_2O emission projection [Gg N_2O/rok]

Scenario	Scenario 1					Scenario 3				
	1990	**1995**	**2000**	**2005**	**2010**	**1990**	**1995**	**2000**	**2005**	**2010**
Transport	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.2	0.2
Fuel combustion (without transport)	0.6	0.3	0.3	0.4	0.4	0.6	0.3	0.3	0.3	0.3
Industrial processes	2.1	1.8	2.1	2.4	2.7	2.1	1.8	2.1	2.4	2.7
Agriculture	7.7	3.8	7.7	8.4	8.4	7.7	3.8	3.9	3.4	3.4
Waste water treatment	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.6	0.8
Total	**10.9**	**6.4**	**10.6**	**11.7**	**12.0**	**10.9**	**6.3**	**6.8**	**6.9**	**7.4**

5.5 AGGREGATED EMISSION PROJECTION OF GREENHOUSE GASES

The aggregated emission projections of greenhouse gases (CO_2 equivalent according to GWP) have been developed in the following scenarios:

- **baseline scenario** represents the combination of baseline scenarios for all greenhouse gases.
- **medium scenario** represents the combination of scenario 2 for energy related CO_2 emission (scenario with the impact of Air Protection Act) and medium scenarios for other greenhouse gases.
- **optimistic scenario** represents the combination of GHG emission scenarios with the highest impact of measures. In the case of CO_2 it is scenario 4 and scenario 3 for the other greenhouse gases. In the optimistic scenario also the other variant (scenario 5 for CO_2 - with full renewable energy source potential) is assumed.

The results are illustrated in Figures 5.8, 5.9 and 5.10 ($GWP_{CO_2} = 1$, $GWP_{CH_4} = 24.5$, $GWP_{N_2O} = 320$).

The scenarios for aggregated emission projection of greenhouse gases are summarised in Figure 5.11. It is obvious, from comparing the total GHG emission level in the year 1990 with the followed period (until 2010) that this level will not be exceeded. On the other hand, all projections show an increasing trend, where energy related CO_2 emissions play the most significant role. The trend of optimistic scenario is the closest to stabilisation. This scenario assumes the operation of 4 nuclear power plant units in Mochovce, the restructuring of industry toward the less energy intensive technologies and full exploitation of technical available potential for renewable sources (determined by the Energy Policy and Strategy).

Figure. 5.8 Aggregated emission projection of greenhouse gases -baseline scenario

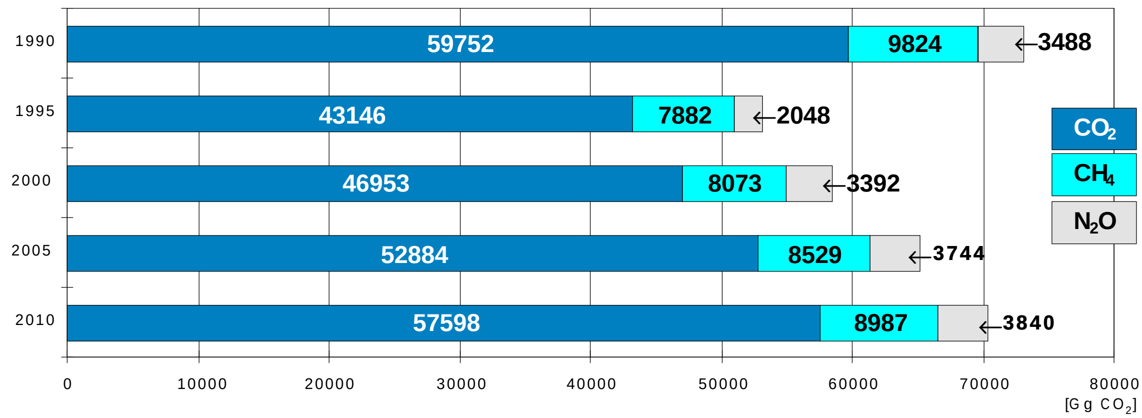


Figure 5.9 Aggregated emission projection of greenhouse gases -medium scenario

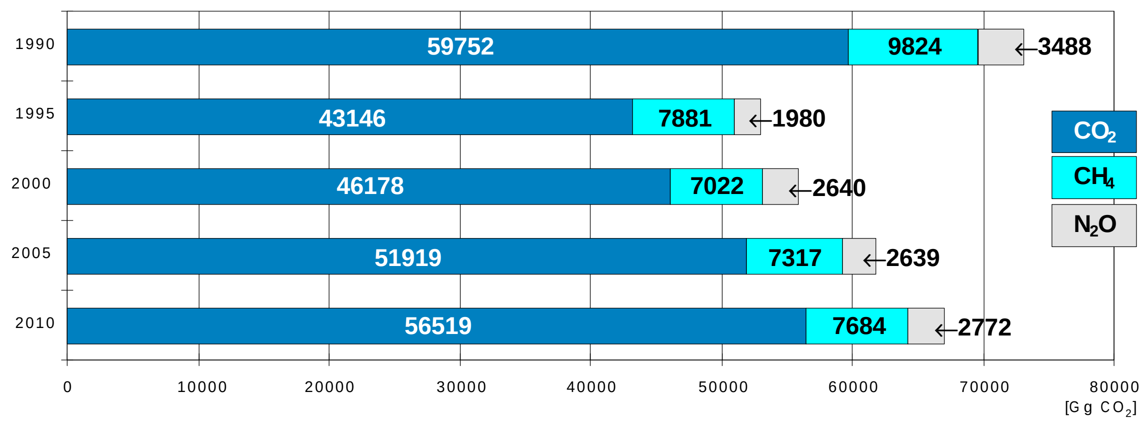
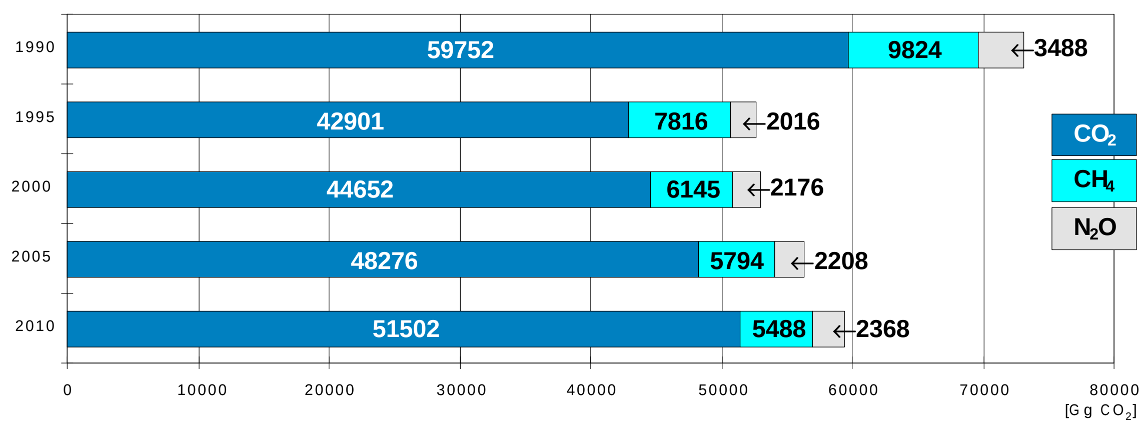
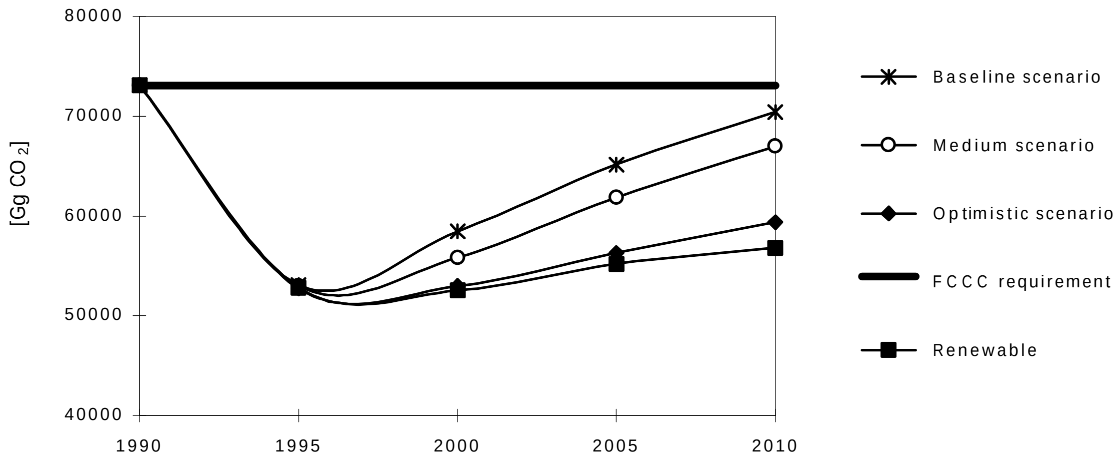


Figure 5.10 Aggregated emission projection of greenhouse gases -optimistic scenario



The GHG emission projections can be influenced by other factors such as is a lower GDP growth rate than has been modelled, a stronger impact of full energy price liberalisation, and the acceleration of energy conservation measures in the commercial and residential sectors as well as in industry and the transportation sector. An important factor will also be the entrance of Slovakia into the EU. This will result in full harmonisation of legislation with the EU (for example carbon tax) and it will influence the further economic development significantly.

Figure 5.11 Aggregated GHG emission projection



6

EXPECTED IMPACTS OF CLIMATE CHANGE, VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES

This Chapter deals with the analysis of climate change and variability (connected with the increase in atmospheric greenhouse effect), the assessment of natural environment and some socio-economic sectors vulnerability to climate change with adapting strategies designed to mitigate the possible negative climate change impacts in Slovakia. The results were adopted from the Slovak National Climate Program and Slovak Republic's Country Study (implemented through the US Country Studies Programme) reports.

6.1 CLIMATE CHANGE SCENARIOS IN SLOVAKIA

Climate change and variability in Slovakia may be described using the observations at the Hurbanovo observatory from 1871-1996 (Figure 6.1) and at several other climatic and precipitation stations for 1901-1996 (selected results are shown in Figure 6.2). An increase of mean annual air temperature (T) of about 1°C and a decrease of annual precipitation totals (R) by about 15% in the South and by about 5% in the North of Slovakia as well as significant relative air humidity (U) decrease in south-western Slovakia and snow cover decrease in nearly all of Slovakia were found. Preliminary air temperature change scenarios were prepared for CSFR (former Czecho-Slovakia) in 1991 and preliminary analogues climate change scenarios were issued in December 1993 with respect of 1-2°C mean annual warming in 2025 compared to 1951-1980 means (The First National Communication, 1995). Regional modification of the General Circulation Models (GCMs) outputs was finished in June 1995. The complete regional scenarios of T, R and global solar radiation (GR) - based on GCMs outputs (GISS, CCCM and GFD3 models), updated analogues and incremental scenarios for Slovakia were issued in 1995 and 1996. The sample is shown in Figures 6.3-6.5. A selection of the GCMs scenarios for Slovakia was done according to the 1xCO_2 GCMs output comparison with 1951-1980 means and annual courses of climatic data. Interpolation of T, R and GR at GCMs scenarios was done by linear interpolation between the time frames 1980 (0 change) and 2075 (2xCO_2 change). The final GCMs scenarios have been calculated for the 2010, 2030 and 2075. The regional T rise R and GR regimen change scenarios were prepared with the assistance of US experts (US Country Studies Programme, 1994).

None any of those 1xCO_2 outputs satisfactorily corresponds with current T, GR and R means and annual courses in Slovakia, but the deviations at selected GCMs (GISS, CCCM and GFD3) are the smallest among the 5 GCMs outputs obtained from the US Country Studies Management Centre. This is one of the reasons for the preparation of several updated alternative regional T, R, U, snow cover, wind speed and some other elements change scenarios based on historical climate change analogues (relatively warmer periods since 1871, analysis of atmospheric circulation change, correlation and trend analyses) taking into account the mean annual T rise of the GCMs based scenarios and statistical models (linear and non-linear regression).

Detailed analysis of the possible temperature rise impact upon other climate elements in Slovakia indicates that after a 1-2°C warming probably a similar change of precipitation and air humidity regimen can be expected as was observed in the last several decades in Slovakia. The "incremental climate change scenarios" were prepared for T, R, U, number of precipitation days change and for snow cover elements change.

Figure 6.1 Annual air temperature means T and April-September precipitation totals R at Hurbanovo, 115 m a.s.l., SW Slovakia, 1871-1996 (11-year's moving averages and linear trends included)

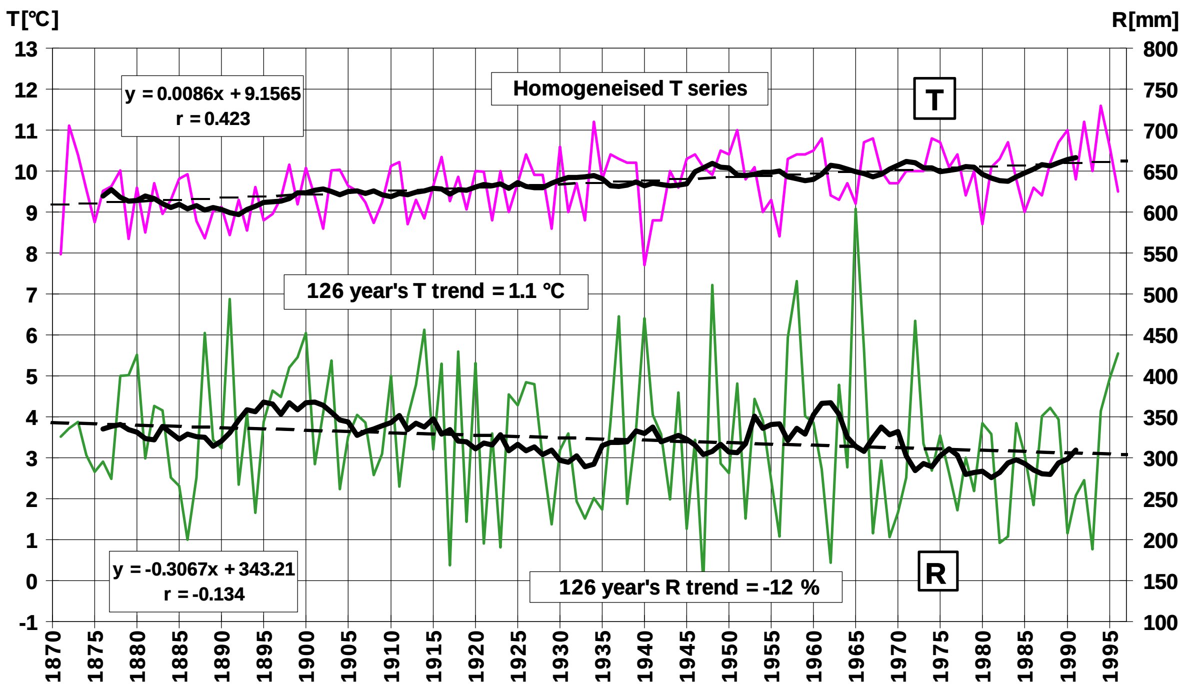


Figure 6.2 Annual precipitation totals R at Oravská Lesná (O), Habura (H), Košice (K) and Hurbanovo (R), Slovakia, 1901-1996 (3-year's moving averages and linear trends)

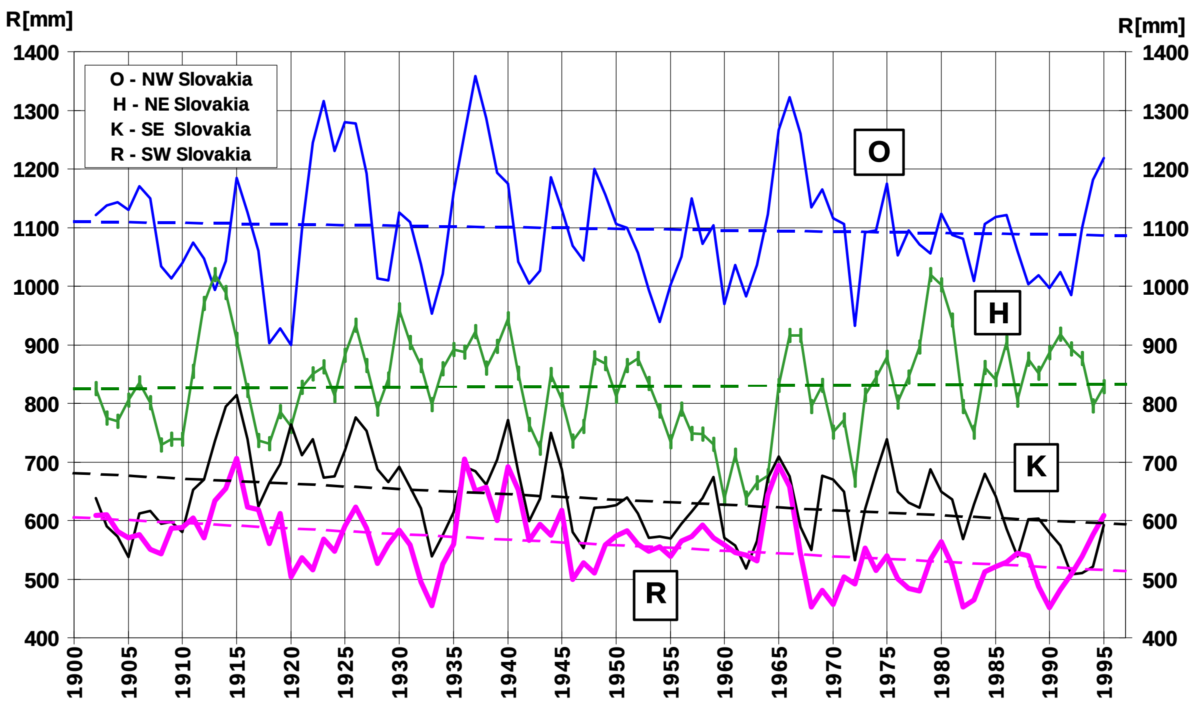


Figure 6.3 Areal air temperature means (T) for Slovakia and modified GCMs 2xCO_2-1xCO_2 scenarios of T deviations (dT) from Tn in Slovakia

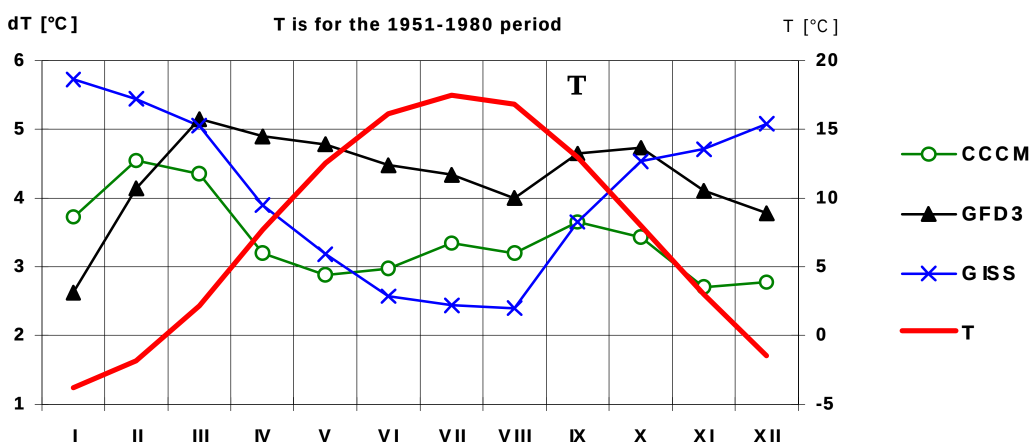


Figure 6.4 Areal mean precipitation totals in northern Slovakia (R N) and monthly quotients of GCMs 2xCO_2/1xCO_2 precipitation scenarios

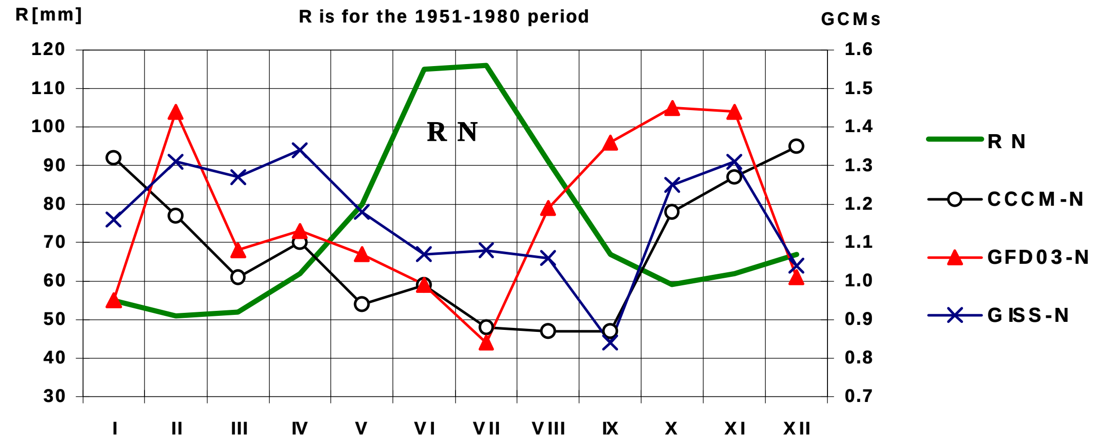
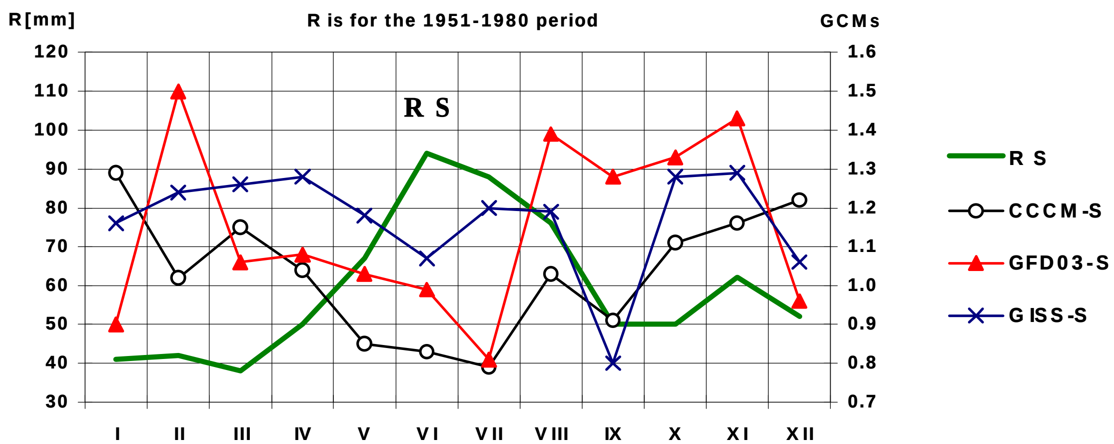


Figure 6.5 Areal mean precipitation totals in southern Slovakia (R S) and monthly quotients of GCMs $2xCO_2/1xCO_2$ precipitation scenarios



These scenarios will be acceptable for the next decades, when a narrow range of mean T change is projected. Monthly T change scenarios (GCMs based) range from 1 to 7°C in the 2075 time frame and this results in an unusable wide range of other climatic elements change scenarios (analogues and incremental scenarios).

6.2 THE HYDROLOGICAL CYCLE, WATER RESOURCES AND WATER MANAGEMENT

The impacts of potential climate change on water in its natural environment are expressed by hydrological scenarios, which quantify mainly the potential changes of surface and ground water resources. These changes have a complex structure, usually in a chain form. The consequences of the quantitative changes of water resources (together with changes in air and water temperature) the biological and chemical processes in biosphere as well as development of vegetation and soil conditions are likely to be influenced. Furthermore, the change in the above mentioned factors will, in reverse, develop a change in water quality and water balance.

The changes in water balance will occur first in water management. The other spheres of economy and society like agriculture, forestry, energetics, urban development, tourism and last but not least environmental protection will be influenced both directly and indirectly (i.e. through water). This is the reason why the hydrological scenarios that are based upon existing climate scenarios create an important basis for estimation of climate change impacts on the natural and socio-economic spheres.

Scenarios of possible water resources change are based upon two groups of climate scenarios:

- scenarios derived from the General circulation models outputs (GCMs)
- incremental and combined scenarios developed in the Slovak National Climate Program (NKP) framework based on the long-term climate observation results in Slovakia.

In general, both groups predict a temperature increase. The difference between these groups is that the first group predicts the status quo or slight increase of precipitation whereas the second one projects a slight decrease in precipitation. Climate scenarios were developed for 2010, 2030, 2075; these time horizons were also applied for the hydrological scenarios.

According to all climate change scenarios the decrease of mean annual discharges (decrease of surface water resources) is more likely than the present state or increase of discharges. As the present state is considered the long-term means of the 1931-1980 period. In Slovak hydrology this period is considered as representative (reference).

The decrease in discharges is proportional to the mean annual air temperature increase and the decrease in annual precipitation totals. The decrease of discharges is more significant in more distant time horizons. These changes have a north-to-south gradient with northern Slovakia as the least affected region. The aridity of the southern and south-eastern lowlands may reach a significant level during the typical summer-autumn low flow periods. In some regions the specific runoff (per unit of surface) may approach zero.

The changes of mean annual discharges may be relatively small, but the economy will be highly effected by the seasonal changes. These changes can be characterised for the time horizon 2030 as follows:

- Rise of discharges in all regions in the winter months, smaller (up to 20%) but longer lasting rise (December to March) in northern Slovakia, more intensive (up to 40%) but shorter lasting rise (January to February) in southern and central Slovakia
- Important decrease in discharges during the spring and summer (until September) can be expected; in the North by 20-25%, in the South by 30-40% (in some cases up to 60% or even more)
- Slight increase of discharges (by 10-15%) in the October to December period - according to the GCMs scenarios - whereas, on the other hand, a fall in the discharges by 60-80% according to the NKP scenarios (by the end of the year by only 20%)

The changes of ground water resources were evaluated for crystalline mountains; in alluvial sediments of valley plains they were only estimated. The greatest decrease in utilizable ground water sources quantity is predicted for the regions of Považský Inovec, Nízke and Vysoké Tatry. Relatively better conditions can be expected in regions Malé Karpaty, Ve¾ká and Malá Fatra and Strážovské vrchy (Figure 6.6).

One of the most important quaternary sediments regions from the ground waters point of view is Žitný Ostrov (south-western Slovakia). Its ground waters and their recharge are directly connected with the Danube river. From the point of view of climate change impacts this region is considered to be inert. Ground water in other alluvial sediments are connected with hydrological regimen of streams along which they were created. In these regions the changes of discharges on particular rivers (ground water donors) must be considered.

The feedback of discharge series on potential climate change was examined by mathematical models, especially by the balance and statistical ones. The sensitivity of the territory's surface water resources was assessed according to the feedback and variability of measured discharge series. The relative ability of surface water to react to possible climate change was evaluated. The sensitivity of the Slovak territory is shown in the Figure 6.7 in three levels. The highest sensitivity (vulnerability) level can be found in the area, where an increased demand for water or the water pollution can cause shortages. Even at present, especially during the vegetation season, these areas suffer from balance pressure. Therefore, it was possible to unite the sensitivity and vulnerability maps into a single map.

The analysis of climate change impacts on the Slovak hydrological conditions shows an overall decrease in the potential of both surface and ground water resources. In general, this decrease can cause, together with expected population growth, revitalisation of economy and more ecological water management laws a worsening of the water economy budget. With regard to the uneven temporal and spatial distribution of water resources and consumption the number of regions with negative or tight water balance will grow. This unfavourable state will have to be eliminated by new legislation, regulations and organisational and technical rules oriented toward the creation of new water resources as well as on the protection of existing ones (and also on the protection of areas around these water resources).

In the average year the theoretically utilizable potential of surface water is estimated to be 405 $m^3.s^{-1}$ (12.798 billions m^3). This amount satisfies the demand for drinking water, agriculture, industry, energetics and water transport even in dry years (the runoff from the Slovak territory is approximately 30% from this long-term average in extremely dry years). However, because of the uneven temporal distribution, these demands cannot be satisfied without storage.

Theoretically, the water supply capacity can drop to 12.05, 11.05 and 9.42 billions m^3 of water per year, when according to the mid-change scenarios the long-term mean annual runoff decreases by 4%, 12% and 25% in the 2010, 2030 and 2075 time horizons. Assuming that the variance of mean annual discharge time series will not change, the increase in the mean annual discharges variation coefficient can be expected. This process can result in increase of runoff extremes and in decrease of runoff in dry years by about 3% to 25% compared to the reference values.

With regard to the analyses, it is expected for the 2010 and 2030 time horizons, that in spite of a decrease in the demand for drinking water, the overall demand for water will grow. This results from the expected economic growth and from increase of water use for irrigation in agriculture.

The reduction of high ground water resources exploitation as well as pollution decrease will probably have a positive influence on the water economy budget in the future. These trends currently exist. Similar impacts will result from ecologically derived methods for low flow limits, which will be introduced into practise in the next few years.

Figure 6.6 Areal illustration of the assumed utilizable groundwater amounts in evaluated mountains (not available)

Figure 6.7 Sensitivity and vulnerability of the territory on possible climate change (from the point of view of the surface water resources) (not available elctronically)

The most important proposals for adaptation measures for the mitigation of possible climate change impacts on hydrological cycle, water resources and water management include:

- Special legislative protection (in the proposed "water law") for strategic water resources - especially in the northern part of Slovakia (where climate change will have the least impact) and along the Danube river, where unique ground water resources were created.
- Continuation of the systematic observation of water balance in the smaller water basins, especially during the dry periods. This will help in the early identification of potential decline in water resources.

Several strategic decisions must be accepted and new priorities of water management must be set. These activities must be implemented both financially and organisationally by Ministries of Environment and Soil management (Agriculture, Forestry and Water). Systematic implementation of the water economy balance and based on the evaluation the development of water demands and potential water resources will be imported.

- In the areas, where larger exploitation is expected (because of industrial, agriculture and water demand growth) it will be necessary to formulate regional and national economic, technical and organisational policy at the government level. These precautions, that will be required especially in the southern and eastern Slovak regions, will ensure the rational use of water resources.
- The program of building and reconstructing water supply reservoirs, and the implementation of long-term water resources management conceptions (the Water Master Plan and the Hydroecological Plans) must be oriented also toward small reservoirs with seasonal effects (besides the high capacity reservoirs) to be able to utilise the local water resources.
- The estimated capital cost that will be needed for the construction of new reservoirs (by the year 2075 the present capacity will have to be enlarged by 800 millions m^3) is 116 billions SKK (Slovak Crowns, 1$ ≅ 34 SKK) in present prices; in other words, this is approximately 1.9 billion SKK per year in the period 2015-2075.
- The transfer of water from the resources in Žitný Ostrov to areas with negative water budget (up to 250 km) requires the sum of 27.5 billions SKK in current prices, which is approximately 0.5 billion SKK per year in the period 2015-2075.
- The reconstruction and maintenance of the existing water delivery structures and municipal distribution networks will require annual expenditures of approximately 0.6 billion SKK in current prices.
- The co-operative activities between the Ministries of the Environment and Soil management will have to focus on the systematic protection and development of watersheds' vegetation cover as well as on forest protection and raising, antierosion measures and country revitalisation.
- The Slovak public will have to be more informed about the possible climate change impacts on water resources.

6.3 FORESTRY AND FOREST ECOSYSTEMS

About 41% of the Slovak territory is covered by forests. The present state of forest stands can be considered as the result of natural factors and human economic utilisation. The changes in natural conditions (air pollution, soil acidification, climatic change) results inevitably in changes in development and ecological stability of forests. The expected climate change represents a serious threat (at least on the level of climatic optimum in Holocene) that, with regard to a long-term production of forest (app. 100 years), makes it necessary to adopt adequate measures in the area of forest management with the aim to minimise the negative risks of possible changes.

The present development of forestry in Slovakia is based on the principle of sustainable development of natural resources emphasising the production importance and the amenity functions of forests. With regard to the unfavourable health state of forests in Slovakia, a set of rehabilitation improvement and curative restoration measures have been currently developed to moderate or eliminate the influence of anthropogenic noxious agents, mainly immissions. The present concept of forestry development does not suggest any exactly formulated measures related to the impact of climate change. Presumably, the newly prepared concept of forestry development will include at least some general measures related to the impacts of the expected climate change.

The necessity of adopting independent adaptation strategy may be summarised as follows:
- potential endangering of all functions including the forest production function,
- unfavourable synergism of the influence of climate under the ongoing immission load and the action of other anthropogenic noxious agents
- long production periods of forest stands make it impossible to adopt short-term effective measures (measures need to be taken a long time in advance).

6.3.1 Modelling of the climate change impacts on forest stands

Different model procedures were used with the aim of comparison of the total results for the analysis of possible impacts of climatic changes on forests of Slovakia. Two particular models, the Holdridge model (static model of vegetation associations) and the Forest Gap model (dynamic stochastic model of forest associations development) were used.

The Holdridge model
This model scenario assumes a pronounced change of bioclimatic conditions for the present forest associations ranging from 25-35% of the total forested area according to individual regional scenarios of climate change. On the basis of the analysis carried out according to the Holdridge model (vegetation associations defined by the threshold values of biotemperature, precipitation and evapotranspiration) the following facts emerge:
- the Holdridge classification reflects, in principle, zonality of forest associations in the Carpathian region,
- the most significant changes in the bioclimatic conditions can be expected in the lowland and mountainous areas,
- minimal changes are expected in the mid-mountain altitudes
- the decline of the bioclimatic conditions in the alpine zone and a succession of new xerophilous associations of the warmer temperate zone in the lowland areas are anticipated.

The Forest Gap model
This model makes it possible to analyse the time changes of the development of forest associations which are due to environmental changes (temperature, precipitation, evapotranspiration, etc.). The analysis of changes in forest associations development, using the above model, was carried out for 3 characteristic forest associations in various altitudes above sea level. The results can be summarised as follows:

- ***Region of spruce mountain forests*** *(spruce being the prevailing tree species at present)*
  – pronounced increase of beech and sycamore occurrence
  – decreased spruce
  – increase of the total biomass production (+17% compared to the present state).
- ***Region of the mid-mountain mixed forests*** *(spruce, fir and beech being the prevailing tree species at present)*
  – total absence of coniferous tree species
  – pronounced increase of oak, maple and ash occurrence
  – slight increase of the total biomass production (+5% compared to the present state).
- ***Region of the submontane mixed forests*** *(fir, sessile oak, beech and hornbeam being the prevailing tree species at present)*
  – nearly total absence of sessile oak and hornbeam

– predominance of forest steppe associations with Quercus pubescens
– decrease of the total biomass production (-38% compared to the present state).

For the conditions of climate change the conifers (spruce and fir) will be more affected than the broad-leaved tree species. Using similar models for the respective regions in Germany and Switzerland (the Alps region, Solling), it is necessary to point out an important transition phase from the current climate conditions up to the equilibrium state under the new climatic conditions, when the most significant changes in forest ecosystems will take place. The beginning of this phase might occur in the first half of the 21st century.

On the basis of the model outputs related to current tree species compositions of forests in Slovakia, the analysis of forests in Slovakia being endangered by climate change has been developed as follows:

Endangered forest stands	Acreage in ha	Proportion of the forested area
Acutely endangered forest stands (already being endangered at present)	29,000	1.5%
Directly endangered forest stands (will be endangered around 2030)	260,000	13.0%
Potentially endangered forest stands (will be endangered around 2050 -75)	964,000	48.3%

6.3.2 Adaptation strategy for forestry

The existing real risk of climate change impacts on forests in Slovakia requires preventive measures in order to moderate them, with regard to the long-term reproduction in forestry. The adaptation strategy must be based upon:

- Complex development of the principles and methods of the present typology with the aim to respect time changes environmental conditions in long-term (period of rotation age) and application of these principles in forest management planning.
- The creation of legislative and economic conditions to secure the implementation of the principles of the function integrated management of forests, regardless of ownership.
- The enforcement of silvicultural principles proceeding from the close-to-nature on the basis of species and genetic diversity based on the natural regeneration of forest stands.

The proposal for specific measures of adaptation strategy in the forestry sector for the time horizon of the year 2005:

- Finalising the strategic study with respect to the potential impacts of global change on the forests in Slovakia and adaptation measures to minimise the negative impacts according to precisely defined regional scenarios.
- Subsidisation of scientific and technical projects aimed at forestry bioclimatology, ecophysiology, forestry dendroclimatology, forest protection, genetics and the breeding of forest tree species.
- Subsidisation of the monitoring of the health and production state of the forest in the network of 4x4 km and investigation of the changes of ecological (including climatic changes) on selected plots.
- Development of a complex program which will solve the problem of spruce pure stands from the 1st up to the 5th altitudinal zone (up to the altitude of app. 900 m above sea level).

The long-term adaptation strategy on climate change for the forestry sector in Slovakia requires an orientation on the maintenance of genetic diversity, breeding and selection of generalists (i.e. provenances with a wide ecological amplitude) and preparation for a possible transfer of provenances or their mixtures from regions with a warmer climate. Generally, it will be necessary to exercise the differentiated management of forests. In the forests of Slovakia, the conception of small-area shelterwood system can be used on acreage representing 60-65% of the selection system aimed at forming the structure of selection forests can be used on more than 18%. Mitigation of the climate change impacts requires measures as follows:

- Maximum limitation of one-storey pure stands and the relevant clear-cutting system which creates the forest with low biomass and carbon accumulation; in spruce pure stands, there is, in addition, the risk of low ecological stability as an accompanying factor of climatic changes.
- Regardless the ownership relationships the enforcement of the close-to-nature silvicultural systems, i.e. small-area shelterwood system and both forms of selection system which should have typical local characteristics and a high resistance potential in forests.
- From the 1st up to the 4th altitudinal zone (up to an altitude of 700-800 m above sea level), the small-area shelterwood system should prevail in the future. A certain proportion should cover the stands with the silvicultural system of long-term two-storey stands; they should include the light-demanding and shade-bearing deciduous tree species, the others, the light-demanding coniferous species (pine, larch) and shade-bearing deciduous tree species (beech).

6.3.3 Economic analysis of the climate change impacts on forests

The economic analysis of the climate change impacts risk on forests in Slovakia has been developed on the basis of simulation of the standing volume development for the period from 1990 to 2070 in consideration of expected tree species composition change (according to the Holdridge model). Spruce, oak and beech were selected as model tree species, i.e. the tree species with the highest occurrence in forests of Slovakia (more than 70%). The analysis was based on the current stumpage prices (Regulation No. 465/1991 of the Digest) and calculations of present values (PV) during the period 1990-2070 (discount rate = 2.5%). Three scenarios were derived:

1. **Basic scenario**
2. **Scenario of the climate change impact - minimum + maximum versions**
3. **Scenario of the climate change impact + adaptation measures - minimum + maximum versions**

The results of the preliminary economic analysis are presented in Table 6.1. The risk of possible impact of climatic changes varies according to these data from -67.32 to -126.7 billions of Slovak Crowns (SKK, 1$ ≅ 34 SKK). By taking the simulated adaptation measures, the risk decreases from 20.7 to 33.7 billion of SKK. Differences between individual tree species are evident, the worst situation is in Norway spruce, followed by in beech and finally in oak, which even is in the span of positive values of differences compared to the basic scenario.

Table 6.1 Comparison of projected scenarios expressed in present value (PV) of standing timber of Norway spruce, beech and oak stands in the period from 1993 to 2070 in billions of SKK.

Baseline scenario	Climate change impacts	Climate change impacts + adaptation measures	Economic effect of adaptation measures
0	-67.3 a ž-126.7	-46.61a ž-93.0	20.7 a ž33.7

6.4 AGRICULTURAL PLANT PRODUCTION IN SLOVAKIA

Agricultural production of the Slovak Republic is significantly influenced by the great variability of soils, climatic and orographical conditions. From the historical point of view this production depends on changes in socio-economic sphere as well as on scientific progress in agricultural sciences (primarily agronomy, agrochemistry, phytopathology, genetics and breeding).

In 1995 there were 2,446,000 ha of total agricultural land (1,479,000 ha of it was arable land) in Slovakia. However, the structure of soils and plant production is in continual change as documented in Tables 6.2 and 6.3. For instance, from these tables it can be seen, that the area of agricultural land in the years 1950-1995 decreased by 12% and arable land by 14%. A further decrease of total agricultural land by 197,000 ha is projected by 2010; 134,000 ha of it should be afforested.

Table 6.2 Lands according to the statistical yearbooks and estimates for the year 2010 (in thousands of hectares) according to the restructuring of plant production

		1950	1960	1970	1980	1990	1995	2010
Agricultural land		**2,785**	**2,768**	**2,631**	**2,530**	**2,448**	**2,446**	**2,249**
of which:	arable land	1,711	1,767	1,690	1,551	1,509	1,479	1,325
	hope plantation	0	0	0	1	2	1	2
	vineyards	12	17	23	31	31	29	31
	grasslands	995	909	829	851	808	840	793
	orchards	67	75	89	96	98	97	98
Non-agricultural land		**2,115**	**2,130**	**2,267**	**2,368**	**2,455**	**2,458**	**2,654**
of which:	forests	1,723	1,785	1,850	1,912	1,989	1,992	2,123
Total area		**4,900**	**4,898**	**4,898**	**4,898**	**4,903**	**4,904**	**4,903**

Table 6.3 Changes in the area of basic field crops structures in Slovakia

Crop	1988	1990	1 992	1 993	1994	1995	2010
Cereals	838,155	825,196	808,859	845,085	873,676	857,012	650,696
Legumes	44,304	45,003	65,489	66,271	52,718	50,746	44,902
Potatoes	57,246	55,245	51,257	47,091	41,407	41,262	55,060
Sugar beet	53,305	51,288	45,437	32,875	33,399	34,900	36,730
Oil plants	62,144	71,734	70,451	74,670	87,571	125,418	88,965
Fodder crops	435,009	443,015	439,503	392,763	371,180	348,099	393,341
Others	54,710	52,035	64,324	59,546	52,339	57,091	56,000

A specific problem, from the point of view of plant production, is connected with the water regime. Irrigation needs in Slovakia are dependant primarily upon the climatic conditions. Drainage needs depend upon soils and hydrology. The 60´s could be considered as the beginning of large and systematic irrigation and drainage systems construction. The largest area of irrigation systems were constructed during 1971-1975 when the new irrigation area was of 81,000 ha. An increase in utilisation of irrigation was observed up to year 1990. After this a significant decrease in the water supply to plant production was documented. The decrease from 1,010 to 309 $m^3.ha^{-1}$. $year^{-1}$ represents a drop of 69%.

The projected climate change will cause multilateral (positive and negative) impacts. CO_2 concentration rise, air temperature and photosynthetic active solar radiation sums increase in the vegetation period result in an increase of the biomass production potential. At the Hurbanovo station in south-western Slovakia, for example, the increase of agroclimatic production potential by 47% is projected according to the CCCM scenario in the 2075 time frame. The utilisation of primary agroclimatic production potential is limited however by the water certainty. The analogues and GCMs based scenarios show various precipitation changes. A rise in winter and decrease in summer precipitation totals is generally expected. This will probably cause (at increase of potential evapotranspiration) an aridity rise, especially in the southern half of Slovakia. An increase of mean air temperature will cause a vegetation period prolongation by 29 to 62 days in the 2075 time frame (according to the various scenarios). In addition the climate change will cause significant changes in the crops growing physiology condition, phenology, winter conditions, soil moisture and in pests, diseases and the occurrence of weeds.

6.4.1 Adaptation strategies design for Slovakia

The preventive measures for risk reduction resulting from climate change impacts upon agriculture are as follows:

- Re-evaluation of agricultural crop growing technologies. There is a demand for "sustainable agriculture" without extremes, systems with natural rejuvenation of soil fertility without the destruction of landscape in agriculture. There is also attention being paid to decreasing human intervention in soil and optimisation of management.

- Re-evaluation of the agroclimatic regionalisation and structure of growing crops and varieties. It will be necessary also to respect the basic economical aspects.
  - Re-evaluation of the thermopile crops regionalisation (maize, sugar beet, sorghum, and others)
  - The utilisation ratio of arable land for cereals should be stabilised at the level of 52-60% and intensive cereals crops should cover 40-50%, maize 8.5-10.0%.
  - Root crops because of their high efficiency and deep root systems should be covered from 7 to 9% of the arable lands.
  - Oil plants are characterised by an important agronomic functions from the point of view of wind erosion, weed control, fixation of atmospheric nitrogen. The areas of these crops should be stabilised at the level of 4-5% of arable lands.
  - Fodder crops should be produced on 25-28% of the area including the area of long term crops (alfalfa) at the level of 15-20%.
  - Some structural changes are projected in fruit production. The present area of orchards in Slovakia represents 19,349 ha, including 2,674 ha of irrigated soil. Apples are considered to continue in the changed climate conditions as the basic fruit in Slovakia, but renaissance of the pear trees is also projected. There was a decrease in the planting of plum trees due to the bad health stay of trees caused mainly by the plum pox virus which occurred during the last period. The area of peach trees is stable, the area of apricot trees is slightly decreased because of the occurrence of frost.
  - A re-evaluation will be needed in the structure of thermopile horticultural crops. Growing of thermopile species of vegetables (peppers, tomatoes, melons) in the north districts will break transport by 30%.
  - Special attention should be paid to the biomass production for energetics (biogass, biopetrol) use as well as for industrial processing. From this point of view especially less fertile soils with bad water regime are used.
  - It is recommended to include the crops adaptable to climate change conditions - mainly to drought and increased radiation inputs. *Amaranthus* is one of those plants. Water is also highly effective utilised by the sorghum, HISO, millet etc. In dry conditions it will be necessary to change annual plants perennial ones.

- Re-evaluation of breeding objectives: Due to the climate change research workers in genetics and breeding should focus on new productive type varieties and hybrids breeding with a stress on the adaptability to the biotic and abiotic extremes. It makes new varieties less useful in reaction to the temperature extremes, drought and disease occurrences. In breeding it is necessary to prefer parameters which increase the uptake of the nutrition and the rate of the photosynthesis. Special attention should be paid to the regionalisation of seeds and nurselings.

- In the field of crop protection it is necessary to focus first of all on the biological protection and re-evaluation of integrated protection.

- The regulation of water regime by melioration: Utilisation of the irrigation in Slovakia decreased in previous years by two thirds. Therefore it is necessary to reconstruct of the existing irrigation systems. Existing irrigation systems especially in the southern regions of Slovakia are necessary particularly for the growing of vegetables and thermopile fruit trees. Special attention is necessary for technical anti-erosion measures.
- New aspects of plant nutrition: The most significant effect from the point of view of drought resistance is the application of the combined industrial and organic fertilisers, mainly nitrogen ones. Only nitrogen nutrition leads to a terramare content decrease in the soils resulting in the worsening of physical and chemical properties.
- The regulation of energy and water regimes of crops by mulching.
- Rejuvenation of soil activity: Use of chemical compounds in the past as well as negative water balance in soils influence the life of their micro-organisms. For instance, the application of MICCROBION O-Fertiliser helps the more economically use of water in soil.
- Management changes in agriculture: Changes in agronomy results in soil conservation. After 30% of plant residuals tillage is incorporated into the soil deepness of 0.1 m. As a consequence evaporation is decreased as well as the warming of surface and the soil is protected from erosion.
- An exigency and very effective support is considered the public information on climate change, impacts and adaptive measures in agriculture.

CLIMATE CHANGE RESEARCH

7

This chapter provides a brief review of research projects in Slovakia related to climate change, possible climate change impacts, mitigation options and adaptation strategies.

In the framework of science and research in Slovakia, climate changes have been studied only within the scientific and research projects of the Slovak Hydrometeorological Institute, the Department of Meteorology and Climatology at Comenius University and the Geophysical Institute at the Slovak Academy of Sciences. Recently, the study of these issues has also started at the Institute of Hydrology of the Slovak Academy of Sciences, the Agriculture University in Nitra, and the Forest University and the Forest Research Institute in Zvolen. Research with this orientation requires above all a climatological database, which can be provided only by the Slovak Hydrometeorological Institute. In the present economic situation in Slovakia costly technology research and development stagnates. Governmental funding is very limited and private sector interest is non existent. The Slovak Ministry of the Environment established the following long-term research programs:

■ National Climate Programme of the Slovak Republic

With respect to the currently identified need to address the issues associated with the expected impacts of climate change, the federal minister of environment established the National Climate Programme of the former Czech and Slovak Federate Republic (CSFR) in 1991. After the Czecho-Slovakia split into two independent countries, from 1993 independent National Climate Programmes for the Slovak and Czech republics (NCP SR and NCP CR) were established.

NCP SR has the following basic goals:

- Development of activities in accordance with the aims of the World Climate Programme co-ordinated by WMO and UNEP
- Development of background information for state authorities and other institutions with respect to meeting international commitments related to climate change issues (UN Framework Convention on Climate Changes, 21st Century Agenda).
- Co-ordination of activities and tasks including climate change issues within the country as a whole.

The NCP SR is managed by a committee consisting of representatives of the participating institutions and the Slovak Ministry of Environment as the main guarantor of activities. In 1994-1996 twenty two institutions participated. The Slovak Hydrometeorological Institute is the main research co-ordinator.

The NCP Project tasks are as follows: design of observation networks for climate changes and the monitoring of impacts; analysis of regional changes (trends) and climate variability; regional interpretation of global climate change scenarios; estimation of possible climate change impacts related to natural environment components and socio-economic issues; preparing the framework design for adaptation measures to mitigate possible negative climate change impacts.

■ National Programme of Greenhouse Gases Emission Reduction

This programme was established by the Slovak Ministry of the Environment in 1993. The objectives of this programme include a detailed inventory of emissions and sinks of greenhouse gases and the preparation and assessment of technical measures to mitigate greenhouse gases emission or to enhance the GHGs sinks.

- **National Programme to Reduce the Emission of Volatile Organic Compounds**

  This programme was established by the Slovak Ministry of the Environment in 1993. Its main objective is to prepare a proposal of measures to reduce NMVOC emission by 30% in Slovakia before 2000. This is in accordance with the UN ECE Protocol on the reduction of NMVOC.

- **Hydrological Regime Changes as the Result of Global Changes**

  In 1994, a scientific and research project of the Slovak Academy of Sciences titled "Hydrological regime changes in rivers and water regime changes in soil resulting from global changes in atmosphere and in human activities in relevant river basins" was started. The Institute of Hydrology at the Slovak Academy of Sciences is the main research site for this project. The goal is to identify how the expected climate changes in the atmosphere and in relevant river basins caused by human activities will be reflected in the changes of hydrologic regime in soil and surface runoff in the Slovak regions. The information obtained will serve as background data for the re-evaluation of water management systems functionality with respect to the climate changes.

- **Slovak National Programme to Stabilise and Reduce CO_2 Emissions in the Transportation**

  The objective of this project is to identify initial measures to stabilise and reduce CO_2 emissions from the transportation sector in the Slovak Republic so that the emissions in the target year (2000) will be lower that those in 1990. This programme is financed by the Slovak Ministry of Transportation and Telecommunications.

- **The Slovak Republic's Country Study to Address Climate Change**

  The Slovak Republic participated in the second round of US Country Studies Programme to Address Climate Change. The objective of this programme, co-financed from financial resources of the Slovak Ministry of the Environment and USAID, was to support the preparation of national communications, to develop a draft proposal for an action plan for greenhouse gases emission abatement and implementation of climate change adaptation strategies. The final report was completed in May 1997 and the final seminar took place in 26 June 1997. The Government of the Slovak Republic asked the Government of USA to continue in climate change research in the framework of project SNAP (Support of National Action Plans).

EDUCATION AND PUBLIC AWARENESS

8

Global climate change represents one of the most serious environmental issues in the history of mankind. It seems however, that the Slovak public is not fully aware of the consequences of climate change. The important task of all relevant institutions is to support education and improve general public awareness, concerning these issues. Public awareness plays a key role in supporting governmental long-term climate change strategy and policy. The measures, which will have to be taken, require a co-ordinated effort and assume the co-operation of governmental and non governmental organisations.

The Ministry of Environment of the Slovak Republic as well as all participating institutions in the National Climate Programme and in the US Country Studies Programme have paid particular attention to the improvement of education and public awareness concerning climate change issues. This initiative in Slovakia in the last three years included:

- **The First National Communication on Climate Change**
  Distribution of 1000 copies of the National Communication (Slovak version) to members of parliament, state administration at all levels, research institutes, schools, industries, libraries, NGOs and other interested parties.

- **Information booklet - Climate Change**
  The Climate Change booklet was issued by the Ministry of Environment in 1995. The 30 page booklet summarises the basic facts on greenhouse effects, risks of global warming and explains international and national mitigation and adaptation strategies. Several thousand copies were distributed to the public.

- **Educational videos**
  - Climate Change - educational TV film made specifically for the of Slovak Ministry of Environment. This film together with a TV discussion club were presented several times on Slovak Television and is available for schools.
  - Global Warming - educational video was finished in September 1996 in the framework of the Country Study activities. More than 100 copies of this video were provided to all Slovak TVs, NGOs, schools and other interested parties.

- **Press clubs of Ministry of Environment**
  In the framework of regular press clubs of the Ministry of Environment ministry officials several times informed representatives for the public mediums concerning FCCC commitments and national climate change strategies and policies.

- **Fact sheets of National Climate Programme**
  A series of fact sheets, containing a simple explanation of the greenhouse effect, global warming and the environmental risks, greenhouse gases emission inventory, mitigation and adaptation strategies, have been widely distributed in NCP seminars, lectures and other activities.

- **Publications**

The list of research reports, studies, conference presentations and special articles from the period of last three years contains more than 200 items. More than 100 contributions relating to global warming issues were published in newspapers and popular journals.

- **Conferences and seminars**
  In the framework of Country Study Slovakia 1997 and National Climate Programme 11 conferences, seminars and workshops took place in 1995 and 1996. Slovak researchers participated in many international conferences and workshops. The Final Slovakia Country Study seminars took place in Bratislava 26 June 1997 (more than 100 participants, including government officials, NGO representatives and journalists).

- **Radio and TV**
  In the last two years more than 30 contacts, including climate specialist presentations, were made in Slovak radio and TV stations.

- **Lectures**
  The Slovak Meteorological Society and National Climate Programme regularly organise special and popular lectures concerning climate change issues.

- **Information booklet - Country Study Slovakia**
  The booklet contains the survey of basic results and achievements of Country Study Programme in the Slovak Republic.

- **Co-operation with non governmental organisations**
  Currently there are more than 120 local environmental organisations, foundations and associations registered in the Slovak Republic. The largest one is the Slovak Union of Nature and Landscape Protectors, involving more than 7,000 members in more than fifty local organisations.

  Most of these non governmental organisations do not pay enough attention to the issues of global warming. The following organisations are involved in the issue:
  - Fund for Alternative Energy Bratislava (an organisation within the Slovak Union of Nature and Landscape Protectors).
  - Love Mother Earth Movement Bratislava (an organisation within Slovak Union of Nature and Landscape Protectors). Activities connected with the issue of global warming and its consequences are the basis of their work.
  - Global Releaf Banská Stiavnica. In the spirit of the US forest association "Green Traditions of Life" challenge this movement is engaged in the support of afforestation programmes.
  - Tree of Life Bratislava, Banská Stiavnica, Kosice. Educational programmes and lectures.
  - Children of the Earth Bratislava. Educational programmes and lectures.

  Greenpeace, Community for sustainable development and other organisations of the Slovak Union of Nature and Landscape Protectors support measures which are in the spirit of Agenda 21. With respect to the energy policy of Slovakia, they severely criticise the idea of establishing the nuclear power plant at Mochovce, recommending an increase in efficiency of classical thermal power plants and the support of cogenerative production of energy. However, this approach would not result in greenhouse emission reduction corresponding to international commitments and recommendations. The Fund for Alternative Energy participated in international independent NGO review of national climate change mitigation plans. This activity was co-ordinated by the Climate Network Europe and by US Climate Action Network. The findings of the Fund does not doubt the fulfilment of basic requirements of the Convention (GHG emissions in 2000 below the 1990 level) and Toronto Target as well in the Slovak Republic. However, the Fund emphasises that these targets will be probably achieved due to commissioning of NPP Mochovce. In the statement it is further stressed that the necessary conditions for the stabilisation and later reduction of GHG emissions in Slovakia beyond the year 2005 are still not present.

- **Booklet - Climate Change**
  The Climate Change booklet was issued by the Fund for Alternative Energy Bratislava in 1996. The 64 page booklet summarises the basic facts on greenhouse effects, risks of global warming and explains mitigation and adaptation strategies. The issue was supported by the Swedish NGO secretariat on acid rain.

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TABLE 1A ENERGY: Fuel Combustion Activities

Year 1990

SOURCE AND SINK CATEGORIES Sector Specific Data by fuel	ACTIVITY DATA A Apparent Consumption (PJ)	EMISSIONS ESTIMATES B Quantities Emitted (Gg of Full Mass of Pollutant)						AGGREGATE EMISSION FACTORS C Emission Factor (kg/GJ)	(g Pollutant/GJ) C=B/A				
		CO2	CH4	N2O	NOx	CO	NMVOC	CO2	CH4	N2O	NOx	CO	NMVOC
1A Fuel Combustion	**766.5**	**56,585**	**25.46**	**0.64**	**228**	**421**	**53**	73.8	33.2	0.8	297	549	69
Liquid	206.3	10,939	1.13	0.12									
Gas	222.7	12,741	1.21	0.02									
Solid	337.6	32,904	23.12	0.50									
1A 1 Energy & Transformation	154.9	11,970	0.29	0.19	0	0	0						
Liquid	67.3	5,205	0.20	0.04				77.4	3.0	0.6			
Gas	-23.3	-4,088	-0.02	0.00				175.1	1.0	0.1			
Solid	111.0	10,853	0.11	0.16				97.8	1.0	1.4			
1A 2 Industry	365.3	25,398	2.34	0.24	0	0	0						
Liquid	56.6	-302	0.11	0.03				-5.3	2.0	0.6			
Gas	172.5	12,517	0.86	0.02				72.6	5.0	0.1			
Solid	136.3	13,184	1.36	0.19				96.8	10.0	1.4			
1A 3 Transport	70.7	5,168	0.71	0.04	0	0	0						
Liquid	70.7	5,168	0.71	0.04				73.1	10.0	0.6			
Gas	0.0	0	0.00	0.00									
Solid	0.0	0	0.00	0.00									
1A 4 Commercial	82.7	6,370	0.62	0.06	0	0	0						
Liquid	6.6	505	0.07	0.00				76.0	10.0	0.6			
Gas	40.8	2,392	0.20	0.00				58.6	5.0	0.1			
Solid	35.3	3,473	0.35	0.05				98.5	10.0	1.4			
1A 5 Residential	79.6	6,622	15.01	0.07	0	0	0						
Liquid	1.5	97	0.02	0.00				63.7	10.0	0.6			
Gas	28.6	1,677	0.14	0.00				58.6	5.0	0.1			
Solid	49.5	4,849	14.85	0.07				98.0	300.0	1.4			
1A 6 Agriculture&Forestry	10.2	821	1.43	0.01	0	0	0						
Liquid	2.4	185	0.02	0.00				75.9	10.0	0.6			
Gas	3.1	183	0.02	0.00				58.6	5.0	0.1			
Solid	4.6	453	1.39	0.01				97.9	300.0	1.4			
1A 7 Other	3.1	234	0.02	0.00	0	0	0						
Liquid	1.1	82	0.01	0.00				74.9	5.0	0.6			
Gas	1.0	61	0.01	0.00				58.6	5.0	0.1			
Solid	0.9	92	0.01	0.00				99.1	10.0	1.4			
Biomass	16.8	1,806	5.04	0.02	0	0	0						
Liquid	0.0	0	0.00	0.00									
Gas	0.0	0	0.00	0.00									
Solid	16.8	1,806	5.04	0.02				107.4	300.0	1.4			

Emissions of NOx, CO and NMVOC are estimated in national inventory system, where the source category do not fits the IPCC requirements, therefore just the national
Bunkers are negligible (<0.5%) comparing to other fuel combustion emissions
Emissions of N2O and CH4 are estimated on the base on default emission factors (IPCC, 1995)

TABLE 1A ENERGY: Fuel Combustion Activities

Year 1991-1994

SOURCE AND SINK CATEGORIES Sector Specific Data by fuel	ACTIVITY DATA A Apparent Consumption (PJ)	EMISSIONS ESTIMATES B Quantities Emitted (Gg of Full Mass of Pollutant)						AGGREGATE EMISSION FACTORS C Emission Factor (kg/GJ)	(g Pollutant/GJ) C=B/A				
		CO2	CH4	N2O	NOx	CO	NMVOC	CO2	CH4	N2O	NOx	CO	NMVOC
Year 1991													
1A Fuel Combustion	**693.0**	**50,039**	**17.1**	**0.6**	**212**	**439**	**53**	72.2	24.7	0.8	305.9	633.5	76.5
Liquid	169.3	8,626	0.5	0.1				51.0	3.0	0.6			
Gas	214.0	12,222	0.6	0.0				57.1	3.0	0.1			
Solid	284.9	29,191	8.5	0.4				102.5	30.0	1.4			
Biomass	24.8	2,182	7.4	0.0				87.9	300.0	1.4			
Year 1992													
1A Fuel Combustion	**657.9**	**45,616**	**17.3**	**0.6**	**169**	**382**	**50**	69.3	26.3	0.9	256.9	580.6	76.5
Liquid	129.7	7,556	0.4	0.1				58.3	3.0	0.6			
Gas	194.8	12,276	0.6	0.0				63.0	3.0	0.1			
Solid	309.9	25,784	9.3	0.4				83.2	30.0	1.4			
Biomass	23.5	2,054	7.1	0.0				87.2	300.0	1.4			
Year 1993													
1A Fuel Combustion	**645.4**	**43,584**	**15.0**	**0.5**	**156**	**400**	**49**	67.5	23.2	0.8	241.7	619.8	76.5
Liquid	154.2	6,351	0.5	0.1				41.2	3.0	0.6			
Gas	207.6	12,005	0.6	0.0				57.8	3.0	0.1			
Solid	263.6	25,228	7.9	0.4				95.7	30.0	1.4			
Biomass	20.0		6.0	0.0				0.0	300.0	1.4			
Year 1994													
1A Fuel Combustion	**588.1**	**40,389**	**14.1**	**0.5**	**171**	**407**	**45**	68.7	23.9	0.8	290.8	692.0	76.5
Liquid	134.4	6,623	0.4	0.1				49.3	3.0	0.6			
Gas	198.4	11,493	0.6	0.0				57.9	3.0	0.1			
Solid	235.4	22,273	7.1	0.3				94.6	30.0	1.4			
Biomass	20.0		6.0	0.0				0.0	300.0	1.4			

Emissions of NOx, CO and NMVOC are estimated in national inventory system, where the source category do not fits the IPCC requirements, therefore just the national totals a
Apparent consumption according Statistical yearbook 1996
**NMVOC emissions were estimated in 1990 for VOC protocol and updated for 1993*
CO2 emissions from biomass combustion are not included in national totals

TABLE 1B1 ENERGY: Fugitive Emissions from Fuels (Coal Mining) Year 1989-1993

SOURCE AND SINK CATEGORIES	A ACTIVITY DATA Production (Mt)	B METHANE EMISSIONS (Gg)	C EMISSION FACTOR (kg CH4/t Production)	D EMISSION FACTOR (m3 CH4/t Production)
			C=B/A	C=B/A/ 0.67
I B I Solid fuels				
I B I a Coal Mining				
I B I a i Underground mines **1989**	5.27	**36.9**	7.00	10.45
Underground activities	5.27	35.3	6.70	10.00
Post-mining activities	5.27	1.6	0.30	0.45
I B I a i Underground mines **1990**	4.77	**33.4**	7.00	10.45
Underground activities	4.77	31.9	6.70	10.00
Post-mining activities	4.77	1.4	0.30	0.45
I B I a i Underground mines **1991**	4.15	**29.0**	7.00	10.45
Underground activities	4.15	27.8	6.70	10.00
Post-mining activities	4.15	1.2	0.30	0.45
I B I a i Underground mines **1992**	3.52	**24.7**	7.00	10.45
Underground activities	3.52	23.6	6.70	10.00
Post-mining activities	3.52	1.1	0.30	0.45
I B I a i Underground mines **1993**	3.49	**24.4**	7.00	10.45
Underground activities	3.49	23.4	6.70	10.00
Post-mining activities	3.49	1.0	0.30	0.45

0.67Gg/100 000 m3 conversion factor converts the volume CH_4 to weight measure

TABLE 1B2 ENERGY: Fugitive Emissions from Fuels (Oil and Natural Gas) Year 1990

SOURCE AND SINK CATEGORIES		ACTIVITY DATA	EMISSION ESTIMATES			AGGREGATE EMISSION FACTORS		
		A Fuel Quantity (PJ)	B (Gg)			C=B/A (kg/GJ)		
			CH4	CO2	NMVOC	CH4	CO2	NMVOC
I B 2 a Oil			***0.2***	***0.0***	***22.4***			
I B 2 a ii Production of Crude Oil		4.1	0.0	0.0		0.0027		
I B 2 a iii Transport of Crude Oil		258.5	0.0	0.0	22.4	0.0000		0.0866
I B 2 a iv Refining/Storage		258.5	0.2	0.0		0.0007		
I B 2 a vi Other	(Qnty.consumed)	258.5	0.0	0.0	0.0			
I B 2b Natural Gas			***88.1***	***0.0***	***3.7***			
I B 2 b i Production/Processing	(Qnty.produced)	16.6	1.1	0.0	3.1	0.0670		0.1867
I B 2 b ii Distribution-pipeline	(Qnty.transfer.)#	2,238.7	11.2	0.0	0.0	0.0050		
I B 2 b iii Other Leakage	(Qnty.consumed)	223.0	75.8	0.0	0.6	0.3400		0.0015
Total Fuels			**88.3**	**0.0**	**26.1**			

TABLE 1B2 ENERGY: Fugitive Emissions from Fuels (Oil and Natural Gas) Year 1991

SOURCE AND SINK CATEGORIES		ACTIVITY DATA	EMISSION ESTIMATES			AGGREGATE EMISSION FACTORS		
		A Fuel Quantity (PJ)	B (Gg)			C=B/A (kg/GJ)		
			CH4	CO2	NMVOC*	CH4	CO2	NMVOC
I B 2 a Oil			***0.1***	***0.0***	***14.9***			
I B 2 a ii Production of Crude Oil		3.3	0.0	0.0	0.0	0.0027		
I B 2 a iii Transport of Crude Oil		172.6	0.0	0.0	14.9	0.0000		0.0866
I B 2 a iv Refining/Storage		172.6	0.1	0.0	0.0	0.0007		
I B 2 a vi Other	(Qnty.consumed)	172.6	0.0	0.0	0.0			
I B 2b Natural Gas			***84.4***	***0.0***	***2.3***			
I B 2 b i Production/Processing	(Qnty.produced)	10.4	0.7	0.0	1.9	0.0670		0.1867
I B 2 b ii Distribution-pipeline	(Qnty.transfer.)#	2,185.0	10.9	0.0	0.0	0.0050		
I B 2 b iii Other Leakage	(Qnty.consumed)	214.0	72.8	0.0	0.3	0.3400		0.0015
Total Fuels			**84.5**	**0.0**	**17.2**			

TABLE 1B2 ENERGY: Fugitive Emissions from Fuels (Oil and Natural Gas) Year 1992

SOURCE AND SINK CATEGORIES		ACTIVITY DATA	EMISSION ESTIMATES			AGGREGATE EMISSION FACTORS		
		A Fuel Quantity (PJ)	B (Gg)			C=B/A (kg/GJ)		
			CH4	CO2	NMVOC*	CH4	CO2	NMVOC
I B 2 a Oil			***0.1***	***0.0***	***11.5***			
I B 2 a ii Production of Crude Oil		2.8	0.0	0.0	0.0	0.0027		
I B 2 a iii Transport of Crude Oil		132.5	0.0	0.0	11.5	0.0000		0.0866
I B 2 a iv Refining/Storage		132.5	0.1	0.0	0.0	0.0007		
I B 2 a vi Other	(Qnty.consumed)	132.5	0.0	0.0	0.0			
I B 2b Natural Gas			***77.6***	***0.0***	***2.0***			
I B 2 b i Production/Processing	(Qnty.produced)	9.2	0.6	0.0	1.7	0.0670		0.1867
I B 2 b ii Distribution-pipeline	(Qnty.transfer.)#	2,152.8	10.8	0.0	0.0	0.0050		
I B 2 b iii Other Leakage	(Qnty.consumed)	194.8	66.2	0.0	0.3	0.3400		0.0015
Total Fuels			**77.7**	**0.0**	**13.5**			

For CH4 default emission factors "rest of world" are used (IPCC, 1995)
Activity data according statistical yearbook 1990, 1995, 1996
 # preliminary data
**NMVOC emissions were estimated in 1990 for VOC protocol and updated for 1993*

TABLE 1B2 ENERGY: Fugitive Emissions from Fuels (Oil and Natural Gas) Year 1993

SOURCE AND SINK CATEGORIES		ACTIVITY DATA	EMISSION ESTIMATES			AGGREGATE EMISSION FACTORS		
		A Fuel Quantity (PJ)	B (Gg)			C=B/A (kg/GJ)		
			CH4	CO2	NMVOC	CH4	CO2	NMVOC
I B 2 a Oil			***0.1***	***0.0***	***17.3***			
I B 2 a ii Production of Crude Oil		3.4	0.0	0.0		0.0027		
I B 2 a iii Transport of Crude Oil		133.4	0.0	0.0	17.3	0.0000		0.1297
I B 2 a iv Refining/Storage		133.4	0.1	0.0		0.0007		
I B 2 a vi Other	(Qnty.consumed)	133.4	0.0	0.0	0.0			
I B 2b Natural Gas			***81.9***	***0.0***	***4.2***			
I B 2 b i Production/Processing	(Qnty.produced)	11.6	0.8	0.0	3.3	0.0670		0.2855
I B 2 b ii Distribution-pipeline	(Qnty.transfer.)#	2,617.2	13.1	0.0	0.3	0.0050		0.0001
I B 2 b iii Other Leakage	(Qnty.consumed)	200.0	68.0	0.0	0.6	0.3400		
Total Fuels			**82.0**	**0.0**	**21.5**			

TABLE 1B2 ENERGY: Fugitive Emissions from Fuels (Oil and Natural Gas) Year 1994

SOURCE AND SINK CATEGORIES		ACTIVITY DATA	EMISSION ESTIMATES			AGGREGATE EMISSION FACTORS		
		A Fuel Quantity (PJ)	B (Gg)			C=B/A (kg/GJ)		
			CH4	CO2	NMVOC	CH4	CO2	NMVOC
I B 2 a Oil			***0.1***	***0.0***	***17.9***			
I B 2 a ii Production of Crude Oil		3.1	0.0	0.0	0.0	0.0027		
I B 2 a iii Transport of Crude Oil		137.9	0.0	0.0	17.9	0.0000		0.1297
I B 2 a iv Refining/Storage		137.9	0.1	0.0	0.0	0.0007		
I B 2 a vi Other	(Qnty.consumed)	137.9	0.0	0.0	0.0			
I B 2b Natural Gas			***80.5***	***0.0***	***3.0***			
I B 2 b i Production/Processing	(Qnty.produced)	9.5	0.6	0.0	2.7	0.0670		0.2855
I B 2 b ii Distribution-pipeline	(Qnty.transfer.)#	2,477.0	12.4	0.0	0.2	0.0050		0.0001
I B 2 b iii Other Leakage	(Qnty.consumed)	198.4	67.5	0.0	0.0	0.3400		
Total Fuels			**80.6**	**0.0**	**20.8**			

TABLE 1B2 ENERGY: Fugitive Emissions from Fuels (Oil and Natural Gas) Year 1995

SOURCE AND SINK CATEGORIES		ACTIVITY DATA	EMISSION ESTIMATES			AGGREGATE EMISSION FACTORS		
		A Fuel Quantity (PJ)	B (Gg)			C=B/A (kg/GJ)		
			CH4	CO2	NMVOC*	CH4	CO2	NMVOC
I B 2 a Oil			***0.1***	***0.0***	***18.2***			
I B 2 a ii Production of Crude Oil		4.4	0.0	0.0	0.0	0.0027		
I B 2 a iii Transport of Crude Oil		140.0	0.0	0.0	18.2	0.0000		0.1297
I B 2 a iv Refining/Storage		140.0	0.1	0.0	0.0	0.0007		
I B 2 a vi Other	(Qnty.consumed)	140.0	0.0	0.0	0.0			
I B 2b Natural Gas			***82.8***	***0.0***	***5.6***			
I B 2 b i Production/Processing	(Qnty.produced)	18.8	1.3	0.0	5.4	0.0670		0.2855
I B 2 b ii Distribution-pipeline	(Qnty.transfer.)#	2,700.0	13.5	0.0	0.3	0.0050		0.0001
I B 2 b iii Other Leakage	(Qnty.consumed)	200.0	68.0	0.0	0.0	0.3400		
Total Fuels			**82.9**	**0.0**	**23.8**			

 # preliminary data
For CH4 default emission factors "rest of world" are used (IPCC, 1995)
Activity data according statistical yearbook 1990, 1995, 1996
**NMVOC emissions were estimated in 1990 for VOC protocol and updated for 1993*

TABLE 2 Industrial Processes **Year 1990**

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES								AGGREGATE EMISSION FACTORS							
	A Production Quantity (kt)	B Full Mass of Pollutant (Gg)								C=B/A Mass of Pollutant per tone of Product (t/t)							
		CO	CO2	CH4	N2O	NOx	NMVOC	CF4 *	C2F6*	CO	CO2	CH4	N2O	NOx	NMVOC	CF4	C2F6
A Iron and Steel		***127.0***		***6.4***		***31.0***	***1.6***										
Pig Iron	3,561			3.2								0.0009					
Crude steel	3,982			2.0								0.0005					
Coke	2,340			1.2								0.0005					
B Non-Ferrous metalals		***4.7***	***108***	***0.0***	***0.0***	***0.0***	***0.2***	***74.2***	***0.1***								
Aluminia production	67	4.7	108					74.2	0.1	0.07	22.8083					0.0011	0.00003
Copper production							0.2										
C Inorganic Chemicals					***2.1***	***0.9***											
Nitric Acid	411				2.1	0.5							0.005	0.0012			
Ammonia											1.6000			0.0027	0.00480		
Fertilisers	269					0.4								0.0015			
Urea																	
D Organic Chemicals				***0.5***			***6.4***										
Ethylene	219			0.2								0.0010					
Dichlorethylene	34			0.0								0.0004					
Styrene	55			0.2								0.0040					
Methanol	15			0.0								0.0020					
E Non-Metallic Mineral Products			***3,167***														
Cement	3,781		1,885								0.4985						
Lime	1,076		845								0.7850						
Magnesite	428		437								1.0220						
F Other			***280***				***4***										
Beer #	460,700		230				0				0.0005						
Grape vine #	58,067		48				0				0.0008						
Bread	218		1				0				0.0049						
Total		**131.7**	**3,554**	**6.8**	**2.1**	**31.8**	**12.3**	**74.2**	**0.1**								

** unit of emissions is Mg*
Production quantity according the Statistical yearbook 1995, 1996
Emission factors (except for Al production) form IPCC guidelines 1995
 # unit of production is thous. lit.
CO2 from coke production is included in "Energy emissions"
VOC emissions were estimated within "National Programme of Non-Methane Volatile Organic Compounds Reduction" (1995)

TABLE 2 Industrial Processes

Year 1991

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES								AGGREGATE EMISSION FACTORS							
	A Production Quantity (kt)	B Full Mass of Pollutant (Gg)								C=B/A Mass of Pollutant per tone of Product (t/t)							
		CO	CO2	CH4	N2O	NOx	NMVOC	CF4 *	C2F6*	CO	CO2	CH4	N2O	NOx	NMVOC	CF4	C2F6
A Iron and Steel		***125.3***		***6.0***		***29.0***											
Pig Iron	3,163			2.8								0.0009					
Crude steel	4,107			2.1								0.0005					
Coke	2,173			1.1								0.0005					
B Non-Ferrous metalals		***4.6***	***106***	***0.0***	***0.0***	***0.0***	***0.0***	***99.0***	***2.5***								
Aluminia production	66,274	4.6	106					99.0	2.5	7E-05	22.7742					0.0011	0.00003
C Inorganic Chemicals					***1.5***	***0.6***											
Nitric Acid	291				1.5	0.3							0.0050	0.0012			
Ammonia											1.6000			0.0027	0.0048		
Fertilisers	178					0.3								0.0015			
Urea																	
D Organic Chemicals				***0.0***													
Ethylene				0.0								0.0010					
Dichlorethylene				0.0								0.0004					
Styrene				0.0								0.0040					
Methanol				0.0								0.0020					
E Non-Metallic Mineral Products			***2,490***														
Cement	2,680		1,336								0.4985						
Lime	819		643								0.7850						
Magnesite	500		511								1.0220						
F Other			***227***				***0***										
Beer #	408,200		204				0				0.0005						
Grape vine #	26,489		22				0				0.0008						
Bread	208		1				0				0.0049						
Total		**129.9**	**2,823**	**6.0**	**1.5**	**29.6**	**0.0**	**99.0**	**2.5**								

** unit of emissions is Mg*
Production quantity according the Statistical yearbook 1995, 1996
Emission factors (except for Al production) form IPCC guidelines 1995
 # unit of production is thous. lit.
CO2 from coke production is included in "Energy emissions"

TABLE 2 Industrial Processes

Year 1992

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES								AGGREGATE EMISSION FACTORS							
	A Production Quantity (kt)	B Full Mass of Pollutant (Gg)								C=B/A Mass of Pollutant per tone of Product (t/t)							
		CO	CO2	CH4	N2O	NOx	NMVOC	CF4 *	C2F6*	CO	CO2	CH4	N2O	NOx	NMVOC	CF4	C2F6
A Iron and Steel		***104.3***		***5.6***		***27.7***											
Pig Iron	2,952			2.7								0.0009					
Crude steel	3,789			1.9								0.0005					
Coke	2,040			1.0								0.0005					
B Non-Ferrous metalals		***4.3***	***98***	***0.0***	***0.0***	***0.0***	***0.0***	***99.0***	***2.5***								
Aluminia production	62	4.3	98					99.0	2.5	0.0700	22.8072					0.0011	0.00003
C Inorganic Chemicals					***1.4***	***0.3***											
Nitric Acid	275				1.4	0.3							0.0050	0.0012			
Ammonia											1.6000			0.0027	0.0048		
Fertilisers	200					0.3								0.0015			
Urea																	
D Organic Chemicals				***0.0***													
Ethylene				0.0								0.0010					
Dichlorethylene				0.0								0.0004					
Styrene				0.0								0.0040					
Methanol				0.0								0.0020					
E Non-Metallic Mineral Products			***2,869***														
Cement	3,374		1,682								0.4985						
Lime	616		484								0.7850						
Magnesite	688		703								1.0220						
F Other			***213***				***0***										
Beer #	368,600		184				0				0.0005						
Grape vine #	33,534		28				0				0.0008						
Bread	150		1				0				0.0049						
Total		**108.6**	**3,180**	**5.6**	**1.4**	**28.1**	**0.0**	**99.0**	**2.5**								

** unit of emissions is Mg*
Production quantity according the Statistical yearbook 1995, 1996
Emission factors (except for Al production) form IPCC guidelines 1995
 # unit of production is thous. lit.
CO2 from coke production is included in "Energy emissions"

TABLE 2 Industrial Processes

Year 1993

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES								AGGREGATE EMISSION FACTORS							
	A Production Quantity (kt)	B Full Mass of Pollutant (Gg)								C=B/A Mass of Pollutant per tone of Product (t/t)							
		CO	CO2	CH4	N2O	NOx	NMVOC	CF4 *	C2F6*	CO	CO2	CH4	N2O	NOx	NMVOC	CF4	C2F6
A Iron and Steel				***5.8***			***1.6***										
Pig Iron	3,205			2.9								0.0009					
Crude steel	3,922			2.0								0.0005					
Coke	1,876			0.9								0.0005					
B Non-Ferrous metalals		***2.7***	***62***	***0.0***	***0.0***	***0.0***	***0.5***	***83.5***	***2.2***								
Aluminia production	39	2.7	62					83.5	2.2	0.0700	22.8132					0.0011	0.00003
Copper production							0.5										
C Inorganic Chemicals					***1.1***	***0.6***											
Nitric Acid	228				1.1	0.3							0.0050	0.0012			
Ammonia											1.6000			0.0027	0.0048		
Fertilisers	250					0.4								0.0015			
Urea	150																
D Organic Chemicals				***0.0***			***3.5***										
Ethylene				0.0								0.0010					
Dichlorethylene				0.0								0.0004					
Styrene				0.0								0.0040					
Methanol				0.0								0.0020					
E Non-Metallic Mineral Products			***2,610***														
Cement	2,656		1,324								0.4985						
Lime	727		571								0.7850						
Magnesite	700		715								1.0220						
F Other			***221***				***4***										
Beer #	369,700		185				0				0.0005						
Grape vine #	42,860		36				0				0.0008						
Bread	144		1				0				0.0049						
Total		**2.7**	**2,893**	**5.8**	**1.1**	**0.6**	**5.7**	**83.5**	**2.2**								

** unit of emissions is Mg*
Production quantity according the Statistical yearbook 1995, 1996
Emission factors (except for Al production) form IPCC guidelines 1995
 # unit of production is thous. lit.
CO2 from coke production is included in "Energy emissions"
VOC emissions were estimated within "National Programme of Non-Methane Volatile Organic Compounds Reduction" (1995)

TABLE 2 Industrial Processes

Year 1994

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES								AGGREGATE EMISSION FACTORS							
	A Production Quantity (kt)	B Full Mass of Pollutant (Gg)								C=B/A Mass of Pollutant per tone of Product (t/t)							
		CO	CO2	CH4	N2O	NOx	NMVOC	CF4 *	C2F6*	CO	CO2	CH4	N2O	NOx	NMVOC	CF4	C2F6
A Iron and Steel		***130.1***		***5.9***		***29.5***											
Pig Iron	3,330			3.0								0.0009					
Crude steel	3,974			2.0								0.0005					
Coke	1,735			0.9								0.0005					
B Non-Ferrous metalals		***2.3***	***52***	***0.0***	***0.0***	***0.0***	***0.0***	***47.5***	***1.2***								
Aluminia production	33	2.3	52					47.5	1.2	0.07	22.807					0.0011	0.00003
C Inorganic Chemicals					***0.8***	***1.4***											
Nitric Acid	150				0.8	0.2							0.0050	0.0012			
Ammonia	200					0.5					1.6000			0.0027	0.0048		
Fertilisers	250					0.4								0.0015			
Urea	100					0.3											
D Organic Chemicals				***0.0***													
Ethylene				0.0								0.0010					
Dichlorethylene				0.0								0.0004					
Styrene				0.0								0.0040					
Methanol				0.0								0.0020					
E Non-Metallic Mineral Products			***2,770***														
Cement	2,879		1,435								0.4985						
Lime	765		601								0.7850						
Magnesite	718		734								1.0220						
F Other			***295***				***0***										
Beer #	497,400		249				0				0.0005						
Grape vine #	54,858		46				0				0.0008						
Bread	125		1				0				0.0049						
Total		**132.4**	**3,117**	**5.9**	**0.8**	**30.8**	**0.0**	**47.5**	**1.2**								

** unit of emissions is Mg*
Production quantity according the Statistical yearbook 1995, 1996
Emission factors (except for Al production) form IPCC guidelines 1995
 # unit of production is thous. lit.
CO2 from coke production is included in "Energy emissions"
VOC emissions were estimated within "National Programme of Non-Methane Volatile Organic Compounds Reduction" (1995)

TABLE 2 Industrial Processes

Year 1995

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES								AGGREGATE EMISSION FACTORS							
	A Production Quantity (kt)	B Full Mass of Pollutant (Gg)								C=B/A Mass of Pollutant per tone of Product (t/t)							
		CO	CO2	CH4	N2O	NOx	NMVOC	CF4 *	C2F6*	CO	CO2	CH4	N2O	NOx	NMVOC	CF4	C2F6
A Iron and Steel		***130.1***		***5.8***		***29.5***											
Pig Iron	3,207			2.9								0.0009					
Crude steel	3,958			2.0								0.0005					
Coke	1,854			0.9								0.0005					
B Non-Ferrous metalals		***2.3***	***52***	***0.0***	***0.0***	***0.0***	***0.0***	***47.5***	***1.2***								
Aluminia production	30	2.3	52					47.5	1.2	0.077	22.807					0.0011	0.00003
C Inorganic Chemicals					***1.1***	***1.4***											
Nitric Acid	220				1.1	0.3							0.0050	0.0012			
Ammonia	350					0.9					1.6000			0.0027	0.0048		
Fertilisers	200					0.3								0.0015			
Urea	100					0.3											
D Organic Chemicals				***0.0***													
Ethylene				0.0								0.0010					
Dichlorethylene				0.0								0.0004					
Styrene				0.0								0.0040					
Methanol				0.0								0.0020					
E Non-Metallic Mineral Products			***2,832***														
Cement	2,981		1,486								0.4985						
Lime	803		630								0.7850						
Magnesite	700		715								1.0220						
F Other			***258***				***0***										
Beer #	436,900		218				0				0.0005						
Grape vine #	46,928		39				0				0.0008						
Bread	171		1				0				0.0049						
Total		**132.4**	**3,142**	**5.8**	**1.1**	**30.8**	**0.0**	**47.5**	**1.2**								

** unit of emissions is Mg*
Production quantity according the Statistical yearbook 1995, 1996
Emission factors (except for Al production) form IPCC guidelines 1995
 # unit of production is thous. lit.
CO2 from coke production is included in "Energy emissions"
VOC emissions were estimated within "National Programme of Non-Methane Volatile Organic Compounds Reduction" (1995)

TABLE 3 Solvent and Other Product Use — Year 1990 and 1993

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES				AGGREGATE EMISSION FACTORS			
1990	A Quantity Consumed (kt)	B Full Mass of Pollutant (Gg)				C Mass of Pollutant per tone of Product (t / t) C=B/A			
		CO2	N2O	HFCs	NMVOC	CO2	N2O	HFCs	NMVOC
A Paint and Glues Application	56.9				32.8				0.577
B Degreasing and Dry Cleaning	6.7				6.7				1.000
C Chemical Products Manufacture / Processing *									
D Other					8.3				
cosmetics and household products					8.3				
Total					**47.8**				

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES				AGGREGATE EMISSION FACTORS			
1993	A Quantity Consumed (kt)	B Full Mass of Pollutant (Gg)				C Mass of Pollutant per tone of Product (t / t) C=B/A			
		CO2	N2O	HFCs	NMVOC	CO2	N2O	HFCs	NMVOC
A Paint and Glues Application	35.3				19.3				0.548
B Degreasing and Dry Cleaning	3.4				3.4				1.000
C Chemical Products Manufacture / Processing *									
D Other					8.3				
cosmetics and household products					8.3				
Total					**31.0**				

** 21 relevant sources; data provided by operators*
NMVOC emissions occurring by solvent use were estimated only for year 1990 and updated for 1993 within "National program of VOC emission reduction" (1995)

TABLE 4A&B AGRICULTURE: Enteric Fermentation & Manure Management   Years 1990-1995

SOURCE AND SINK	ACTIVITY DATA						EMISSION ESTIMATES						EMISSION ESTIMATES						EM. FACTOR	
	A Number of Animals (thousands)						B1=A*C1 Enteric Fermentation (Gg CH4)						B2=A*C2 Manure Management (Gg CH4)						C1 Ent.Fer. (kg CH4/head)	C2 Man.M.
Year:	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**		
1 Cattle	1,593	1,397	1,182	993	916	929	101	93	79	68	63	63	45	41	35	30	28	28		
a Dairy	549	501	429	386	359	355	55	50	43	39	36	36	25	23	20	18	17	16	100.00	46.00
b Non-Dairy	968	896	753	607	557	574	47	43	36	29	27	28	19	18	15	12	11	11	48.04	20.00
3 Sheep	600	531	572	411	397	428	5	4	5	3	3	3	0	0	0	0	0	0	8.00	0.28
4 Goats							0	0	0	0	0	0	0	0	0	0	0	0	5.00	0.12
6 Horses	600	531	572	411	397	428	11	10	10	7	7	8	1	1	1	1	1	1	18.00	1.40
8 Swine	2,521	2,428	2,269	2,179	2,037	2,076	4	4	3	3	3	3	20	19	18	17	16	17	1.50	8.00
9 Poultry	16,487	13,866	13,267	12,234	14,246	13,382	0	0	0	0	0	0	2	2	2	1	2	2		0.12
	Emission Est. (Ent. Ferm. & Manure M.)																			
Total (Gg CH4)	**187**	**172**	**151**	**130**	**121**	**122**	**121**	**111**	**97**	**82**	**76**	**77**	**66**	**61**	**54**	**48**	**45**	**45**		

TABLE 4D AGRICULTURE: Agricultural Soils

Years 1990-1994

	ACTIVITY DATA				EMISSION ESTIMATES						
	A	B	C	D	E=	F=	G=	H=	I	J	K
	Area	Ammount of N applied			A*I	A*J	A*K	(E+F+G)/3	EF=0.0005*	EF=0.0036*	EF=0.039*
	cult.	mineral	organic	Fbnf					(B+C+D)	(B+C+D)	(B+C+D)
Year	(k ha)	(kg N/ha)	(kg N/ha)	(kg N/ha)	(Gg N2O)	(Gg N2O)	(Gg N2O)	(Gg N2O)	(kg N2O/ha)	(kg N2O/ha)	(kg N2O/ha)
1990	2,448	75.3	62.8	33.0	0.33	2.37	25.67	**9.46**	0.13	0.97	10.49
1991	2,449	63.6	56.6	33.0	0.29	2.12	22.99	**8.47**	0.12	0.87	9.39
1992	2,447	36.5	47.2	33.0	0.22	1.62	17.50	**6.45**	0.09	0.66	7.15
1993	2,445	23.3	33.8	33.0	0.17	1.25	13.50	**4.97**	0.07	0.51	5.52
1994	2,444	31.2	33.8	33.0	0.19	1.35	14.68	**5.41**	0.08	0.55	6.01

TABLE 5 A LAND USE & FORESTRY: Managed Forest - Temperate

Tree species		Annual roundwood increment (m3/ha)	Biomass conv./ expan factor	Annual biomass increment (t/ha)	Area (kha)	Carbon fraction	Total Carbon Increment (kt C)	Commerc. Harvest (1000 m3) roundwood)	Biomass Conv. Factor (t dm/m3)	Tot. biomass Removed in Comm. Harv. (kt dm)	Carbon Fraction	Annual Carbon Release (kt C)	Annual C Uptake and Release (kt C)	Annual CO2 Emission or Removal (GgCO2)
1990														
Picea abies	Spruce	3.7	0.6	2.22	518.1	0.5	575.1	1,656.0	0.4	662.4	0.5	411.92	163.17	598.30
Abies alba	Fir	3.9	0.6	2.34	87.3	0.5	102.2	466.4	0.4	186.6	0.5	110.81	-8.66	-31.75
Pinus sp.	Pine	2.6	0.8	2.08	141.6	0.5	147.3	303.6	0.5	151.8	0.5	97.50	49.77	182.49
Larix decidua	Larch	2.8	0.8	2.24	41.9	0.5	46.9	42.0	0.6	25.2	0.5	17.32	29.61	108.59
Other coniferous		1.6	0.6	0.96	0.7	0.5	0.3	0.0	0.4	0.0	0.5	0.00	0.35	1.27
Quecus robur, petı	Oak	2.6	1.3	3.38	215.7	0.49	357.2	188.8	0.65	122.7	0.49	96.27	260.89	956.61
Fagus sylvatica	Beech	3.2	1.2	3.84	563.2	0.49	1,059.7	1,120.8	0.68	762.1	0.49	606.53	453.19	1,661.69
Carpinus betulus	Hornbeam	1.9	1.1	2.09	106.1	0.49	108.7	54.2	0.8	43.3	0.49	60.82	47.83	175.39
Acer sp.	Maple	2.5	1.1	2.75	30.0	0.49	40.5	36.1	0.63	22.7	0.49	18.26	22.19	81.38
Fraxinus excelsior	Ash	2.8	1	2.8	20.6	0.49	28.2	23.0	0.63	14.5	0.49	13.62	14.61	53.56
Ulmus sp.	Elm	2.6	1	2.6	0.9	0.49	1.2	16.4	0.65	10.7	0.49	5.23	-4.02	-14.73
Quercus cerris	Pubescent oak	2.5	1.3	3.25	49.5	0.49	78.9	49.2	0.65	32.0	0.49	27.51	51.39	188.43
Robinia pseudoac.	Robinia	2	1.2	2.4	35.8	0.49	42.1	42.7	0.8	34.1	0.49	32.36	9.79	35.90
Betulus sp.	Birch	1.1	0.8	0.88	24.3	0.49	10.5	18.1	0.6	10.8	0.49	11.36	-0.90	-3.31
Alnus sp.	Alder	1.7	0.9	1.53	12.6	0.49	9.4	6.6	0.6	3.9	0.49	3.32	6.10	22.37
Tilia sp.	Linden	2.1	0.8	1.68	6.1	0.49	5.0	0.5	0.5	0.3	0.49	0.00	5.02	18.40
Breeding poplars		3.5	0.6	2.1	7.4	0.49	7.6	77.1	0.4	30.8	0.49	21.98	-14.35	-52.62
Populus sp.	Poplar	3.9	0.6	2.34	11.9	0.49	13.7	16.4	0.4	6.6	0.49	5.08	8.60	31.54
Salix sp.	Willow	2.3	1	2.3	2.4	0.49	2.7	4.9	0.6	3.0	0.49	2.42	0.25	0.93
Other broadleaves		1.3	1.1	1.43	3.9	0.49	2.7	4.9	0.7	3.4	0.49	3.16	-0.44	-1.60
Total 1990					**1,884.0**		**2,639.9**	**4,127.5**		**2,126.9**		**1,545.45**	**1,094.41**	**4,012.84**
1994														
Picea abies	Spruce	3.6	0.6	2.16	530.6	0.50	573.05	1,890	0.40	756.00	0.50	415.80	157.25	576.58
Abies alba	Fir	3.9	0.6	2.34	89.4	0.50	104.60	469	0.40	187.60	0.50	103.18	1.42	5.20
Pinus sp.	Pine	2.6	0.8	2.08	145.0	0.50	150.80	240	0.50	120.00	0.50	66.00	84.80	310.93
Larix decidua	Larch	2.8	0.8	2.24	42.9	0.50	48.05	23	0.60	13.80	0.50	7.59	40.46	148.35
Other coniferous		1.5	0.6	0.90	0.7	0.50	0.32	0	0.40	0.00	0.50	0.00	0.32	1.16
Quecus robur, petı	Oak	2.5	1.3	3.25	271.5	0.49	432.36	375	0.65	243.75	0.49	131.38	300.98	1,103.60
Fagus sylvatica	Beech	3.1	1.2	3.72	576.8	0.49	1,051.39	1,465	0.68	996.20	0.49	536.95	514.44	1,886.28
Carpinus betulus	Hornbeam	1.9	1.1	2.09	108.6	0.49	111.22	140	0.80	112.00	0.49	60.37	50.85	186.45
Acer sp.	Maple	2.5	1.1	2.75	30.7	0.49	41.37	48	0.63	30.24	0.49	16.30	25.07	91.92
Fraxinus excelsior	Ash	2.8	1.0	2.80	21.1	0.49	28.95	35	0.63	22.05	0.49	11.88	17.06	62.57
Robinia pseudoac.	Robinia	2.0	1.2	2.40	36.7	0.49	43.16	52	0.80	41.60	0.49	22.42	20.74	76.03
Populus sp.	Poplar	3.9	0.6	2.34	12.2	0.49	13.99	100	0.40	40.00	0.49	21.56	-7.57	-27.76
Other broadleaves		1.2	1.1	1.32	59.2	0.49	38.29	73	0.70	51.10	0.49	27.54	10.75	39.41
Total 1994					**1,925.4**		**2,637.54**	**4,910**		**2,614.34**		**1,420.98**	**1,216.56**	**4,460.71**

TABLE 5 C LAND USE CHANGE & FORESTRY: Temperate Forest

Afforestation and regrowing - carbon uptake in soils

	20 year Total Area Afforested (ha) 1	Annual Rate of Uptake of C in Soils (kt C/ha) 2	Annual C Uptake in Soils (kt C) 1 x 2 3	Total Area Afforested more than 20 Years (ha) 4	Annual Rate of Uptake of C in Soils (kt C/ha) 5	Annual C Uptake in Soils (kt C) 4 x 5 6	Total C Uptake from Afforested Lands (kt C) 3 + 6 7	Total CO2 Uptake (kt CO2) 7 x 44/12 8
Coniferous	60,000	0.0012	72	139,000	0.0012	166.8	238.8	875.6
Broadleaves	40,000	0.0018	72	93,000	0.0018	167.4	239.4	877.8
TOTAL 1990	100,000		144	232,000		334.2	478.2	**1753.4**
Coniferous				200,408	0.0012	240.5	240.5	881.8
Broadleaves				134,994	0.0018	243.0	243.0	891.0
TOTAL 1994	0		0	335,402		483.5	483.5	**1772.8**

TABLE 5 B LAND USE CHANGE & FORESTRY: Temperate Forest

CO2 emission from grassland conversion between 1965-1990 (Gg)

Area converted (in 25 years) (1000ha) A	Average C Content in Soil (tC/ha) B	Annual Rate of C Release from Soil C	CO2 Emission (Mg/25 year) D=E*25	CO2 Emission (Mg/year) E =A*B*44/12*C	Average Emission Factor (Mg/ha/year) F=E/A
90	70	0.02	11,550	462	5.13

TABLE 5 D LAND USE CHANGE & FORESTRY: Temperate Forest

On site burning and forest fires

	Annual loss of Biomass by burning (km3/year)	Biomass conv. / exp. Factor	Annual loss of Biomass by burning (kt dm/y)	Fraction of Biomass Oxidized on site	Quantity of Biomass Oxidized on site (kt dm)	Carbon Fraction of Abovegr. Biomass (burned on site)	Quantity of C Released (kt C)	Total CO2 Released (kt CO2)	Trace Gas Emissions from Burning CH4 Emiss. Ratio 0.012 (kt CH4)	Trace Gas Emissions from Burning CO Emiss. Ratio 0.1 (kt CO)	N/C Ratio	Trace Gas Emissions from Burning N2O Emiss. Ratio 0.007 (kt N2O)	Trace Gas Emissions from Burning NOx Emiss. Ratio 0.121 (kt NOx)
Coniferous	123.30	0.70	86.31	0.9	77.68	0.49	38.06	139.56	0.61	8.88	0.02	0.01	0.19
Broadleaves	293.50	1.20	352.20	0.9	316.98	0.50	158.49	581.13	2.54	36.98	0.02	0.04	0.83
Forest Fires			5.32	0.9	4.79	0.50	2.39	8.78	0.14	2.05	0.02	0.00	0.01
Total 1990			443.83		399.45		198.95	**729.47**	**3.29**	**47.91**		**0.04**	**1.03**
Coniferous	103.25	0.70	72.28	0.9	65.05	0.50	32.52	119.25	0.52	7.59	0.02	0.01	0.16
Broadleaves	210.60	1.20	252.72	0.9	227.45	0.49	111.45	408.65	1.78	26.00	0.02	0.02	0.58
Forest fires			1.57	0.9	1.41	0.50	0.71	2.59	0.04	0.60	0.02	0.00	0.00
Total 1994			326.57		293.91		33.23	**530.49**	**2.35**	**34.20**		**0.03**	**0.75**

TABLE 5 E LAND USE CHANGE & FORESTRY: Temperate Forest

Forest clearing - CO2 release from decay

	Annual Area Cleared Average 10y. (ha/rok)	Net Change in Biomass (t dm/ha)	Average Annual loss of Biomass (kt dm)	Fraction Left to Decay	Quantity of Biomass to Decay (kt dm)	Carbon fraction in Aboveground Biomass	Portion C Released as CO2 (kt C)
Forests Total 1990	1080	71	76.68	1	76.68	0.5	**38.34**
Forests Total 1994	970	71	68.87	1	68.87	0.5	**34.435**

TABLE 6 A WASTE: Solid Waste Disposal on Land — Years 1990-1995

SOURCE/SINK CATEGORIES	ACTIVITY DATA		EMISSION ESTIMATI	AGGREGATE EF
Waste type	A MSW Total (Gg)	B=k*A MSW Landfilled (Gg)	C=B*D Emissions CH4 (Gg)	D EF (kg CH4/ kg MSW Ld)
A Landfills/Open Dumps				
1988	1208	1108	**50**	0.0449
1990	1324	1175	**53**	0.0450
1991	1427	1277	**57**	0.0449
1992	1592	1442	**65**	0.0449
1993	1438	1288	**58**	0.0449
1994	1340	1190	**53**	0.0449
1995	1291	1141	**51**	0.0449

k - share of Municipal solid waste landfilled

TABLE 6C WASTE: Waste Incineration — Years 1992-1993

SOURCE/SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATE*			AGGREGATE EMISSION FACTORS		
	A Waste total (Gg)	N2O	NMVOC (Gg)	NOx	N2O	NMVOC (kg/t)	NOx
C Waste Incineration							
1992	307	0.02			0.07	0.00	0.00
1993	335	0.03	1.26	0.43	0.08	3.76	1.27
1994	331	0.03	1.26	0.43	0.08	3.81	1.30

** preliminary results*

TABLE 6B WASTE: Wastewater treatment

Years 1990-1995 average

SOURCE AND SINK CATEGORIES	ACTIVITY DATA			EMISSION ESTIMATE			AGGREGATE EMISSION FACTORS			
	Population (1000 persons)	A BOD Generated (Gg BOD5)	B Quantity of BOD Terated Anaerobically (Gg BOD5)	C Release CH4 (Gg)	D CO2 (Gg)	E N2O (Gg)	F CH4	G CO2	H N2O	I Methane Recovery (Gg CH4)
WW plants	2,740			5.293	100	0.2				4.55
Municipal WW-individuals	2,580	47	42	11.187	50					0
Industrial WW -non treated		51		0.285	50					
Total	**5,320**			**16.765**	**200**	**0.2**				**4.55**
Net CH4 emissions				**12.215**						

Waste water of 2740 thousand population is treated in waste water treatment plants.
Emissions are based on operation data from 1990.
Waste water of 2580 thousand population is collected in septic tanks, retention tanks, dry toilets or is directly discharged to streams.
CH4 emissions are based on IPCC methodology, N2O emissions are estimated by CORINAIR methodology.
Wastewater outflow and BOD generated data from statistical yearbook for 1993

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES Year 1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 (Gg) Emission	CO2 (Gg) Removals	CH4 (Gg)	N2O (Gg)	NOx (Gg)	CO (Gg)	NMVOC (Gg)	SO2 (Gg)
Total National Emissions	**60,032**	**5,766**	**409**	**12.5**	**229**	**537**	**149**	**543**
Net Emissions	**55,774**							
1 All Energy (Fuel Combustion+Fugitive)	**56,585**		**147**	**0.6**	**227**	**489**	**80**	**526**
A Fuel Combustion [b]	***56,585***		***25***	**0.6**	***227***	***489***	***54***	***526***
1 Energy & Transformation Activities	11,970		0	0.2	62	34	11	248
2 Industry (ISIC)	25,398		2	0.2	84	128		157
3 Transport	5,168		1	0.0	69	156	42	4
4 Commercial / Institutional	6,370		1	0.1	5	27		38
5 Residential	6,622		15	0.1	7	144		79
6 Agriculture / Forestry	821		1	0.0				
7 Other (non specified elswhere)	234		0					
Biomass	[1 806]		5	0.0				
B Fugitive Fuel Emissions	***0***		***122***	***0.0***	***0***	***0***	***26***	***0***
1 Coal Mining			34					
2 Oil and Natural Gas Systems			88				26	
2 Industrial Processes [a]	**3,447**		**7**	**2.1**	**in 1A2**	**in 1A2**	**12**	**17**
A Iron and Steel			6				2	
C Inorganic Chemicals							0	
D Organic Chemicals			0	2.1			6	
E Non-Metallic Mineral Products	3,167							
F Other	280						4	
3 Solvent Use							**48**	**0**
A Paint Application							33	
B Degreasing and Dry Cleaning							7	
C Chemical Products Manufacture/Processing							8	
4 Agriculture	**0**		**187**	**9.5**	**0**	**0**		**0**
A Enteric Fermentation			121					
B Animal Wastes			66					
D Agricultural Soils				9.5				
5 Land Use Change & Forestry **	**1,509**	**5,766**	**3**	**0.0**	**1**	**48**		**0**
A Managed Forest		4,013						
B Grassland conversion	462							
E Forest clearing	317							
C Afforestration and regrowing		1,753						
D On-site Burning of Cleared Forest	730		3	0.0	1	48		
6 Waste	**0**	**0**	**65**	**0.3**	**0**	**0**	**9**	**0**
A Landfils			53					
B Waste water #			12	0.2				
C Waste Incineration				0.1	0		9	

[a] CO2 emissions from Iron and Steel , Coke, and Aluminia production are included in 1A category
[b] CO2 from fuel combustion activities is estimated by IPCC reference approach
Bunkers are negligible (< 0.5 %) comaparing to other fuel combustion emissions
Emissions of PFCs and HCFs are not estimated,
Consumption of CFCs and HCFC controlled by Montreal protocol is estimated (data available at MoE SR)
 # Emission estimates are based on data averaged for 1990 - 1993
CO2 emissions from biomass combustion are not included in totals, CH4 and N2O emissions are included in totals

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES Year 1991

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 (Gg) Emission	CO2 (Gg) Removals	CH4 (Gg)	N2O (Gg)	NOx (Gg)	CO (Gg)	NMVOC (Gg)	SO2 (Gg)
Total National Emissions	**52,755**	**5,766**	**381**	**10.9**	**212**	**487**	**131**	**445**
Net Emissions	**48,498**							442
1 All Energy (Fuel Combustion+Fugitive)	**50,038**		**131**	**0.6**	**211**	**439**	**70**	**445**
A Fuel Combustion [b]	***50,038***		***17***	**0.6**	***211***	***439***	***53***	***445***
1 Energy & Transformation Activities	45,612		17	0.6	135	161	53	347
2 Industry (ISIC)								
3 Transport	4,426				66	148		3
4 Commercial / Institutional					5	27		38
5 Residential					5	103		57
6 Agriculture / Forestry								
7 Other (non specified elswhere)								
Biomass								
B Fugitive Fuel Emissions	***0***		***114***	***0.0***	***0***	***0***	***17***	***0***
1 Coal Mining			29					
2 Oil and Natural Gas Systems			85				17	
2 Industrial Processes [a]	**2,717**		**6**	**1.5**	**in 1A2**	**in 1A2**	**12**	**0**
A Iron and Steel			6				2	
C Inorganic Chemicals							0	
D Organic Chemicals			0	1.5			6	
E Non-Metallic Mineral Products	2,490							
F Other	227						4	
3 Solvent Use							**48**	**0**
A Paint Application							33	
B Degreasing and Dry Cleaning							7	
C Chemical Products Manufacture/Processing							8	
4 Agriculture	**0**		**172**	**8.5**	**0**	**0**		**0**
A Enteric Fermentation			111					
B Animal Wastes			61					
D Agricultural Soils				8.5				
5 Land Use Change & Forestry **	**1,509**	**5,766**	**3**	**0.0**	**1**	**48**		**0**
A Managed Forest		4,013						
B Grassland conversion	462							
E Forest clearing	317							
C Afforestration and regrowing		1,753						
D On-site Burning of Cleared Forest	730		3	0.0	1	48		
6 Waste	**0**	**0**	**69**	**0.3**	**0**	**0**	**1**	**0**
A Landfils			57					
B Waste water #			12	0.2				
C Waste Incineration				0.1	0		1	

[a] CO2 emissions from Iron and Steel , Coke, and Aluminia production are included in 1A category

[b] CO2 from fuel combustion activities is estimated by IPCC reference approach

Bunkers are negligible (< 0.5 %) comaparing to other fuel combustion emissions

Emissions of PFCs and HCFs are not estimated,

Consumption of CFCs and HCFC controlled by Montreal protocol is estimated (data available at MoE SR)

 # Emission estimates are based on data averaged for 1990-1993

*** Emisions from 1990*

CO2 emissions from biomass combustion are not included in totals, CH4 and N2O emissions are included in totals

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES **Year 1992**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 (Gg) Emission	CO2 (Gg) Removals	CH4 (Gg)	N2O (Gg)	NOx (Gg)	CO (Gg)	NMVOC (Gg)	SO2 (Gg)
Total National Emissions	**48,725**	**5,766**	**359**	**9.0**	**193**	**430**	**125**	**354**
Net Emissions	**44,467**							
1 All Energy (Fuel Combustion+Fugitive)	**45,616**		**121**	**0.8**	**192**	**382**	**64**	**354**
A Fuel Combustion [b]	***45,616***		***18***	**0.8**	***192***	***382***	***50***	***354***
1 Energy & Transformation Activities	41,500		17	0.6	127	133	12	269
2 Industry (ISIC)								
3 Transport	4,116		1	0.2	55	143	38	3
4 Commercial / Institutional					5	27		38
5 Residential					5	79		44
6 Agriculture / Forestry								
7 Other (non specified elswhere)								
Biomass								
B Fugitive Fuel Emissions	***0***		***102***	***0.0***	***0***	***0***	***14***	***0***
1 Coal Mining			25					
2 Oil and Natural Gas Systems			78				14	
2 Industrial Processes [a]	**3,109**		**7**	**1.4**	**in 1A2**	**in 1A2**	**12**	
A Iron and Steel			6				2	
C Inorganic Chemicals							0	
D Organic Chemicals			1	1.4			6	
E Non-Metallic Mineral Products	2,896							
F Other	213						4	
3 Solvent Use							**48**	**0**
A Paint Application							33	
B Degreasing and Dry Cleaning							7	
C Chemical Products Manufacture/Processing							8	
4 Agriculture	**0**		**151**	**6.5**	**0**	**0**		**0**
A Enteric Fermentation			97					
B Animal Wastes			54					
D Agricultural Soils				6.5				
5 Land Use Change & Forestry **	**1,509**	**5,766**	**3**	**0.0**	**1**	**48**		**0**
A Managed Forest		4,013						
B Grassland conversion	462							
E Forest clearing	317							
C Afforestration and regrowing		1,753						
D On-site Burning of Cleared Forest	730		3	0.0	1	48		
6 Waste	**0**	**0**	**77**	**0.3**	**0**	**0**	**1**	**0**
A Landfils			65					
B Waste water #			12	0.2				
C Waste Incineration				0.1	0		1	

[a] CO2 emissions from Iron and Steel , Coke, and Aluminia production are included in 1A category
[b] CO2 from fuel combustion activities is estimated by IPCC reference approach
Bunkers are negligible (< 0.5 %) comaparing to other fuel combustion emissions
Emissions of PFCs and HCFs are not estimated,
Consumption of CFCs and HCFC controlled by Montreal protocol is estimated (data available at MoE SR)
 # Emission estimates are based on data averaged for 1990-1993
*** Emisions from 1990*
CO2 emissions from biomass combustion are not included in totals, CH4 and N2O emissions are included in totals

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES Year 1993

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 (Gg) Emission	CO2 (Gg) Removals	CH4 (Gg)	N2O (Gg)	NOx (Gg)	CO (Gg)	NMVOC (Gg)	SO2 (Gg)
Total National Emissions	**46,415**	**5,766**	**331**	**7.1**	**185**	**456**	**117**	**325**
Net emissions	**42,157**							
1 All Energy (Fuel Combustion+Fugitive)	**43,584**		**122**	**0.7**	**184**	**408**	**75**	**325**
A Fuel Combustion [b]	***43,584***		***16***	***0.7***	***184***	***408***	***53***	***325***
1 Energy & Transformation Activities	39,555		15	0.5	122	164	11	246
2 Industry (ISIC)								
3 Transport	4,029		1	0.2	53	151	42	2
4 Commercial / Institutional					5	23		38
5 Residential					4	70		39
6 Agriculture / Forestry								
7 Other (non specified elswhere)								
Biomass								
B Fugitive Fuel Emissions	***0***		***106***	***0.0***	***0***	***0***	***22***	***0***
1 Coal Mining			24					
2 Oil and Natural Gas Systems			82				22	
2 Industrial Processes [a]	**2,831**		**6**	**1.1**	**in 1A2**	**in 1A2**	**10**	**0**
A Iron and Steel			6				2	
C Inorganic Chemicals							1	
D Organic Chemicals				1.1			4	
E Non-Metallic Mineral Products	2,610							
F Other	221						4	
3 Solvent Use							**31**	**0**
A Paint Application							19	
B Degreasing and Dry Cleaning							3	
C Chemical Products Manufacture/Processing							8	
4 Agriculture	**0**		**130**	**5.0**	**0**	**0**		**0**
A Enteric Fermentation			82					
B Animal Wastes			48					
D Agricultural Soils				5.0				
5 Land Use Change & Forestry **	**1,509**	**5,766**	**3**	**0.0**	**1**	**48**		**0**
A Managed Forest		4,013						
B Grassland conversion	462							
E Forest clearing	317							
C Afforestration and regrowing		1,753						
D On-site Burning of Cleared Forest	730		3	0.0	1	48		
6 Waste	**0**	**0**	**70**	**0.4**	**0**	**0**	**1**	**0**
A Landfils			58					
B Waste water #			12	0.3				
C Waste Incineration				0.1	0		1	

[a] *CO2 emissions from Iron and Steel , Coke, and Aluminia production are included in 1A category*

[b] *CO2 from fuel combustion activities is estimated by IPCC reference approach*

Bunkers are negligible (< 0.5 %) comaparing to other fuel combustion emissions

Emissions of PFCs and HCFs are not estimated,

Consumption of CFCs and HCFC controlled by Montreal protocol is estimated (data available at MoE SR)

 # Emission estimates are based on data averaged for 1990-1993

*** Emisions from 1990*

CO2 emissions from biomass combustion are not included in totals, CH4 and N2O emissions are included in totals

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES **Year 1994**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2 (Gg) Emission	CO2 (Gg) Removals	CH4 (Gg)	N2O (Gg)	NOx (Gg)	CO (Gg)	NMVOC (Gg)	SO2 (Gg)
Total National Emissions	**43,454**	**6,234**	**315**	**7.3**	**171**	**443**	**116**	**238**
Net Emissions	**38,338**							
1 All Energy (Fuel Combustion+Fugitive)	**40,389**		**120**	**0.7**	**170**	**409**	**74**	**238**
A Fuel Combustion [b]	***40,389***		***15***	***0.7***	***170***	***409***	***53***	***238***
1 Energy & Transformation Activities	36,200		14	0.5	50	4	11	105
2 Industry (ISIC)					58	162		77
3 Transport	4,189		1	0.2	53	185	42	3
4 Commercial / Institutional					5	11		32
5 Residential					4	47		21
6 Agriculture / Forestry								
7 Other (non specified elswhere)								
Biomass								
B Fugitive Fuel Emissions	***0***		***105***	***0.0***	***0***	***0***	***21***	***0***
1 Coal Mining			24					
2 Oil and Natural Gas Systems			81				21	
2 Industrial Processes [a]	**3,065**		**6**	**0.8**	**in 1A2**	**in 1A2**	**10**	**0**
A Iron and Steel			6				2	
C Inorganic Chemicals					1		1	
D Organic Chemicals				0.8			4	
E Non-Metallic Mineral Products	2,770							
F Other	295						4	
3 Solvent Use							**31**	**0**
A Paint Application							19	
B Degreasing and Dry Cleaning							3	
C Chemical Products Manufacture/Processing							8	
4 Agriculture	**0**		**121**	**5.4**	**0**	**0**		**0**
A Enteric Fermentation			76					
B Animal Wastes			45					
D Agricultural Soils				5.4				
5 Land Use Change & Forestry	**1,118**	**6,234**	**3**	**0.0**	**1**	**34**		**0**
A Managed Forest		4,461						
B Grassland conversion	462							
E Forest clearing	126							
C Afforestration and regrowing		1,773						
D On-site Burning of Cleared Forest	530		2	0.0	1	34		
6 Waste	**0**	**0**	**65**	**0.4**	**0**	**0**	**1**	**0**
A Landfils			53					
B Waste water #			12	0.3				
C Waste Incineration				0.1	0		1	

[a] CO2 emissions from Iron and Steel , Coke, and Aluminia production are included in 1A category

[b] CO2 from fuel combustion activities is estimated by IPCC reference approach

Bunkers are negligible (< 0.5 %) comaparing to other fuel combustion emissions

Emissions of PFCs and HCFs are not estimated,

Consumption of CFCs and HCFC controlled by Montreal protocol is estimated (data available at MoE SR)

 # Emission estimates are based on data averaged for 1990-1993

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES Year 1995

preliminary results

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 (Gg) Emission	CO_2 (Gg) Removals	CH_4 (Gg)	N_2O (Gg)	NO_x (Gg)	CO (Gg)	NMVOC* (Gg)	SO_2 (Gg)
Total National Emissions	**48,516**	**6,234**	**316**	**7.8**	**191**	**438**	**153**	**262**
Net Emissions	**43,400**							
1 All Energy (Fuel Combustion + Fugitive)	**45,426**		**122**	**0.8**	**190**	**404**	**111**	**262**
A Fuel Combustion [b]	***45,426***		***15***	**0.8**	***190***	***404***	***87***	***262***
1 Energy & Transformation Activities	23,641		14	0.5	118	169	45	189
2 Industry (ISIC)	9,479				in 1A1	in 1A1		in 1A1
3 Transport ##	4,216		1	0.3	49	181	42	2
4 Commercial / Institutional	3,293				18	11		50
5 Residential	3,880				5	43		21
6 Agriculture / Forestry	917							
7 Other (non specified elsewhere)								
Biomass								
B Fugitive Fuel Emissions	***0***		***107***	***0.0***	***0***	***0***	***24***	***0***
1 Coal Mining **			24					
2 Oil and Natural Gas Systems			83				24	
2 Industrial Processes [a]	**3,090**		**6**	**1.1**	**in 1A2**	**in 1A2**	**10**	**0**
A Iron and Steel			6				2	
C Inorganic Chemicals					2		1	
D Organic Chemicals				1.1			4	
E Non-Metallic Mineral Products	2,832							
F Other	258						4	
3 Solvent Use							**31**	**0**
A Paint Application							19	
B Degreasing and Dry Cleaning							3	
C Chemical Products Manufacture / Processing							8	
4 Agriculture	**0**		**122**	**5.4**	**0**	**0**		**0**
A Enteric Fermentation			77					
B Animal Wastes			45					
C Agricultural Soils ***				5.4				
5 Land Use Change & Forestry * **	**1,118**	**6,234**	**3**	**0.0**	**1**	**34**		**0**
A Managed Forest		4,461						
B Grassland conversion	462							
C Forest clearing	126							
C Afforestration and regrowing		1,773						
D On-site Burning of Cleared Forest	530		2	0.0	1	34		
6 Waste	**0**	**0**	**63**	**0.4**	**0**	**0**	**1**	**0**
A Landfils			51					
B Waste water #			12	0.3				
C Waste Incineration				0.1	0		1	

[a] CO_2 emissions from Iron and Steel , Coke, and Aluminia production are included in 1A category
b CO_2 from fuel combustion activities is estimated by IPCC reference approach except transport
emissions from transport are estimated according COPERT method
Bunkers are negligible (< 0.5 %) comparing to other fuel combustion emissions
Emissions of PFCs and HCFs are not estimated,
Consumption of CFCs and HCFC controlled by Montreal protocol is estimated (data available at MoE SR)
** NMVOC emissions are figures from 1993*
*** Emission estimates for 1993*
**** Emission estimates for 1994*
 # Emission estimates are based on data averaged for 1990-1993

TABLE 8A Overview Table for National Greenhouse Gas Inventories

GREENHOUSE GAS	CO2		CH4		N2O		NOx		CO		NMVOC		HFCs		PFCs		Dokumen-	Disaggre-
SOURCE AND SINK CATEGORIES	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	Estimate	Quality	tation	gation
Total National Emission and Sink													NE		NE			
1 All Energy (Fuel Combustion+Fugitive)																		
A Fuel Combustion	ALL	H	ALL	L	ALL	L	ALL	M	ALL	H	ALL	L					H	3
B Fugitive Fuel Emission	PART	L	PART	M							PART	L					M	2
2 Industrial Processes	PART	M	PART	M	PART	L	PART	L	PART	L	PART	M					L	2-Mar
3 Solvent use											PART	M					M	2
4 Agriculture																		
A Enteric Fermentation			ALL	M													H	3
B Animal Wastes			ALL	M													H	3
D Agricultural Soils					ALL	L											M	1
5 Land Use Change & Forestry					NE													
A Managed forests - temporal	ALL	H															H	3
B Grassland conversion	ALL	M															M	1
C Afforestation and regrowing	ALL	H															H	2
D On site burning and forest fires	ALL	H	ALL	L			ALL	L	ALL	L							H	2
E Forest clearing, CO2 release from decay	ALL	H															H	2
6 Waste																		
A Solid waste disposal on Land			ALL	M													H	1
B Wastewater treatment			PART	L	PART	L											H	1
D Waste incineration					PART	L	PART	L									M	1

Note: PART = Partial Estimate

ALL = Full Estimate of All Possible Sources

IE = Estimated but Included Elsewhere

H, M, L = High, Medium, Low Confidence in Estimation

H, M, L = High, Medium, Low Amount of Documentation Included

3 = Sub-sectoral split

2 = Sectoral split

Worksheet: CO2 from Energy Sources (Reference Approach) Year 1990

			Production	Imports	Exports	Bun.	Stock.Ch.	Cons.	Conv.fact.	Ap.Cons.	EF			C stor.	Net C em.	C oxid.	C	CO2
Fuel types			(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)		(GJ)	(kgC/GJ)	(tons C)	(Gg C)	(Gg)	(Gg)		(Gg/year)	(Gg/year)
Liquid Fossil	Primary fuels	Crude Oil	3,042	256,927	0		871	259,098	1,000	259,098,000	20.47	5,303,736	5,304	0	5,304	0.99	5,251	19,253
		Natural Gas Liquids		0	0		0	0	1,000	0	15.20	0	0	0	0	0.99	0	0
	Secondary fuels	Gasoline		0	1,589		-817	-772	1,000	-772,000	19.73	-15,232	-15	0	-15	0.99	-15	-55
		Kerosene		0	0		0	0	1,000	0	20.09	0	0	0	0	0.99	0	0
		Jet Kerosene		334	6,133		-214	-5,585	1,000	-5,585,000	20.09	-112,203	-112	0	-112	0.99	-111	-407
		Residual Fuel Oil		515	31,143		1,775	-32,403	1,000	-32,403,000	21.09	-683,379	-683	0	-683	0.99	-677	-2,481
		LPG	182	0	941		37	-796	1,000	-796,000	17.56	-13,978	-14	0	-14	0.99	-14	-51
		Naphta		0	27,113		1,497	-28,610	1,000	-28,610,000	20.28	-580,211	-580	581	-1,161	0.99	-1,150	-4,215
		Bitumen		0	0		3	-3	1,000	-3,000	22.00	-66	0	439	-440	0.99	-435	-1,596
		Lubricants		0	0		0	0	1,000	0	20.00	0	0	19	-19	0.99	-19	-70
		Petroleum Coke		0	0			0	1,000	0	27.50	0	0	0	0	0.99	0	0
		Refinery Feedstocks		0	0		0	0	1,000	0	20.00	0	0	205	-205	0.99	-203	-744
		Other Oil		6,894	505		564	5,825	1,000	5,825,000	20.00	116,500	117	0	117	0.99	115	423
Liquid Fossil Totals			**3,224**	**264,670**	**67,424**		**3,716**	**196,754**		**196,754,000**		**4,015,168**	**4,015**	**1,245**	**2,771**	**0.99**	**2,743**	**10,057**
Solid Fossil	Primary fuels	Coking Coal	0	86,950	0		-124	87,074	1,000	87,074,000	28.95	2,520,792	2,521	87	2,434	0.98	2,385	8,745
		Steam Coal	0	72,297	0		-233	72,530	1,000	72,530,000	25.58	1,855,317	1,855		1,855	0.98	1,818	6,667
		Lignite	54,046	102,537	3,651		-12,356	165,288	1,000	165,288,000	27.39	4,527,238	4,527		4,527	0.98	4,437	16,268
		Sub-bituminous	0	0	0		0	0	1,000	0	26.20	0	0		0	0.98	0	0
		Tar	0	0	0		0	0	1,000	0	22.20	0	0		0	0.98	0	0
	Secondary fuels	BKB&Patent Fuel		4,937	0		-197	5,134	1,000	5,134,000	25.16	129,171	129		129	0.98	127	464
		Coke		12,348	0		-967	13,315	1,000	13,315,000	29.12	387,733	388		388	0.98	380	1,393
Solid Fossil Totals				**279,069**	**3,651**		**-13,877**	**343,341**		**343,341,000**		**9,420,252**	**9,420**	**87**	**9,333**	**0.98**	**9,147**	**33,538**
Gaseous Fossil		**Natural Gas (Dry)**		**235,193**	**551**		**25,260**	**223,810**	**1,000**	**223,810,000**	**16.07**	**3,596,627**	**3,597**	**65**	**3,532**	**1.00**	**3,514**	**12,886**
Biomass		Solid Biomass					8	16,814	1,000	16,814,000	27.59	463,898	464	0	464	0.98	455	1,667
		Liquid Biomass					0	0	1,000	0	20.00	0	0	0	0	0.99	0	0
		Total Biomass					8	16,814		16,814,000	27.59	463,898	464	0	464	0.98	455	1,667
TOTAL (without biomass)				**778,932**	**71,626**		**15,099**	**763,905**			**t C=**	**17,032,047**	**17,032**	**1,396**	**15,639**	**0.99**	**15,407**	**56,481**

Worksheet: CO2 from Energy Sources (Reference Approach)

Year 1991

			Production	Imports	Exports	Bun.	Stock.Ch.	Cons.	Conv.fact.	Ap.Cons.	EF			C stor.	Net C em.	C oxid.	C	CO2
Fuel types			(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)		(GJ)	(kgC/GJ)	(tons C)	(Gg C)	(Gg)	(Gg)		(Gg/year)	(Gg/year)
Liquid Fossil	Primary fuels	Crude Oil	2,978	206,098	0		-1,831	210,907	1,000	210,907,000	20.00	4,218,140	4,218		4,218	0.99	4,176	15,312
		Natural Gas Liquids		0	0		0	0	1,000	0	15.20	0	0		0	0.99	0	0
	Secondary fuels	Gasoline		0	5,051		767	-5,818	1,000	-5,818,000	19.73	-114,789	-115		-115	0.99	-114	-417
		Kerosene		0	0		0	0	1,000	0	20.09	0	0		0	0.99	0	0
		Jet Kerosene		66	3,807		-120	-3,621	1,000	-3,621,000	20.09	-72,746	-73		-73	0.99	-72	-264
		Residual Fuel Oil		0	13,644		-7,770	-5,874	1,000	-5,874,000	21.00	-123,354	-123	0	-123	0.99	-122	-448
		LPG	2,298	0	872		11	1,415	1,000	1,415,000	17.56	24,847	25	0	25	0.99	25	90
		Naphta		0	25,523		1,002	-26,525	1,000	-26,525,000	20.28	-537,927	-538	468	-1,006	0.99	-996	-3,651
		Bitumen		0	0		12	-12	1,000	-12,000	22.00	-264	0	354	-354	0.99	-350	-1,285
		Lubricants		0	0		0	0	1,000	0	20.00	0	0	16	-16	0.99	-16	-57
		Petroleum Coke		0	0			0	1,000	0	27.50	0	0		0	0.99	0	0
		Refinery Feedstocks		0	0		0	0	1,000	0	20.00	0	0	185	-185	0.99	-183	-672
		Other Oil		188	0		-44	232	1,000	232,000	20.00	4,640	5		5	0.99	5	17
Liquid Fossil Totals			**5,276**	**206,352**	**48,897**		**-7,973**	**170,704**		**170,704,000**		**3,398,547**	**3,399**	**1,022**	**2,376**	**12.87**	**2,352**	**8,626**
Solid Fossil	Primary fuels	Coking Coal	0	79,895	0		-81	79,976	1,000	79,976,000	28.95	2,315,305	2,315	80	2,235	0.99	2,213	8,115
		Steam Coal	0	61,085	0		-5,874	66,959	1,000	66,959,000	25.58	1,712,811	1,713		1,713	0.99	1,696	6,218
		Lignite	47,000	87,522	1,021		-341	133,842	1,000	133,842,000	27.39	3,665,932	3,666		3,666	0.99	3,629	13,307
		Sub-bituminous	0	0	0		0	0	1,000	0	26.20	0	0		0	0.99	0	0
		Tar	0	0	0		0	0	1,000	0	28.90	0	0		0	0.99	0	0
	Secondary fuels	BKB&Patent Fuel	0	3,652	0		-5	3,657	1,000	3,657,000	25.16	92,010	92		92	0.99	91	334
		Coke	0	12,343	951		-124	11,516	1,000	11,516,000	29.12	335,346	335		335	0.99	332	1,217
Solid Fossil Totals			**47,000**	**244,497**	**1,972**		**-6,425**	**295,950**		**295,950,000**		**8,121,405**	**8,121**	**80**	**8,042**	**6.93**	**7,961**	**29,191**
Gaseous Fossil		**Natural Gas (Dry)**	**10,190**	**202,139**	**551**		**-729**	**212,507**	**1,000**	**212,507,000**	**16.07**	**3,414,987**	**3,415**	**48**	**3,367**	**0.99**	**3,333**	**12,222**
Biomass		Solid Biomass	13,782					13,782	1,000	13,782,000	27.59	380,245	380		380	0.99	376	1,380
		Liquid Biomass	11,043					11,043	1,000	11,043,000	20.00	220,860	221		221	0.99	219	802
		Total Biomass	24,825					24,825		24,825,000		601,105	601		601	0.99	595	2,182
TOTAL (without biomass)			**62,466**	**652,988**	**51,420**		**-15,127**	**679,161**			**t C=**	**14,934,940**	**14,935**	**1,150**	**13,785**		**13,647**	**50,038**

Worksheet: CO2 from Energy Sources (Reference Approach) Year 1992

			Production	Imports	Exports	Bun.	Stock.Ch.	Cons.	Conv.fact.	Ap.Cons.	EF			C stor.	Net C em.	C oxid.	C	CO2
Fuel types			(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)		(GJ)	(kgC/GJ)	(tons C)	(Gg C)	(Gg)	(Gg)		(Gg/year)	(Gg/year)
Liquid Fossil	Primary fuels	Crude Oil		179,954	0		741	182,274	1,000	182,274,000	20.00	3,645,480	3,645		3,645	0.99	3,609	13,233
		Natural Gas Liquids		0	0		0	0	1,000	0	15.20	0	0		0	0.99	0	0
	Secondary fuels	Gasoline		0	6,092		-50	-6,042	1,000	-6,042,000	19.73	-119,209	-119		-119	0.99	-118	-433
		Kerosene		0	0		0	0	1,000	0	20.09	0	0		0	0.99	0	0
		Jet Kerosene		0	2,724		550	-3,274	1,000	-3,274,000	20.09	-65,775	-66		-66	0.99	-65	-239
		Residual Fuel Oil		0	5,690		75	-5,765	1,000	-5,765,000	21.00	-121,065	-121	0	-121	0.99	-120	-439
		LPG		0	769		0	121	1,000	121,000	17.56	2,125	2	0	2	0.99	2	8
		Naphta		0	19,783		-2,300	-17,483	1,000	-17,483,000	20.28	-354,555	-355	404	-759	0.99	-751	-2,755
		Bitumen		0	0		0	0	1,000	0	22.00	0	0	306	-306	0.99	-303	-1,111
		Lubricants		0	0		0	0	1,000	0	20.00	0	0	13	-13	0.99	-13	-49
		Petroleum Coke		0	0			0	1,000	0	27.50	0	0		0	0.99	0	0
		Refinery Feedstocks		0	0		0	0	1,000	0	20.00	0	0	181	-181	0.99	-179	-657
		Other Oil		240	399		-120	-39	1,000	-39,000	20.00	-780	-1		-1	0.99	-1	-3
Liquid Fossil Totals				**180,194**	**35,457**		**-1,104**	**149,792**		**149,792,000**		**2,986,221**	**2,986**	**905**	**2,082**	**12.87**	**2,061**	**7,556**
Solid Fossil	Primary fuels	Coking Coal		73,935	0		-206	74,141	1,000	74,141,000	28.95	2,146,382	2,146	74	2,072	0.99	2,052	7,523
		Steam Coal		60,764	0		-3,500	64,264	1,000	64,264,000	25.58	1,643,873	1,644		1,644	0.99	1,627	5,967
		Lignite		73,995	0		-800	114,699	1,000	114,699,000	27.39	3,141,606	3,142		3,142	0.99	3,110	11,404
		Sub-bituminous		0	0		0	0	1,000	0	26.20	0	0		0	0.99	0	0
		Tar		0	0		0	0	1,000	0	28.90	0	0		0	0.99	0	0
	Secondary fuels	BKB&Patent Fuel		580	0		0	580	1,000	580,000	25.16	14,593	15		15	0.99	14	53
		Coke		8,189	350		-85	7,924	1,000	7,924,000	29.12	230,747	231		231	0.99	228	838
Solid Fossil Totals				**217,463**	**350**		**-4,591**	**261,608**		**261,608,000**		**7,177,200**	**7,177**	**74**	**7,103**	**6.93**	**7,032**	**25,784**
Gaseous Fossil		**Natural Gas (Dry)**		**199,755**	**351**		**-890**	**213,794**	**1,000**	**213,794,000**	**16.07**	**3,435,670**	**3,436**	**54**	**3,382**	**0.99**	**3,348**	**12,276**
Biomass		Solid Biomass						12,500	1,000	12,500,000	27.59	344,875	345		345	0.99	341	1,252
		Liquid Biomass						11,043	1,000	11,043,000	20.00	220,860	221		221	0.99	219	802
		Total Biomass						23,543		23,543,000		565,735	566		566	0.99	560	2,054
TOTAL (without biomass)				**597,412**	**36,158**		**-6,585**	**625,194**			**t C=**	**13,599,091**	**13,599**	**1,033**	**12,566**		**12,441**	**45,616**

Worksheet: CO2 from Energy Sources (Reference Approach) Year 1993

			Production	Imports	Exports	Bun.	Stock.Ch.	Cons.	Conv.fact.	Ap.Cons.	EF			C stor.	Net C em.	C oxid.	C	CO2
Fuel types			(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)		(GJ)	(kgC/GJ)	(tons C)	(Gg C)	(Gg)	(Gg)		(Gg/year)	(Gg/year)
Liquid Fossil	Primary fuels	Crude Oil	2,770	187,456	666		-11,316	178,244	1,000	178,244,000	20.00	3,564,880	3,565		3,565	0.99	3,529	12,941
		Natural Gas Liquids	0	0	0		0	0	1,000	0	15.20	0	0		0	0.99	0	0
	Secondary fuels	Gasoline	0	294	9,992		167	-9,531	1,000	-9,531,000	19.73	-188,047	-188		-188	0.99	-186	-683
		Kerosene	0	0	3,564		4	-3,560	1,000	-3,560,000	20.09	-71,520	-72		-72	0.99	-71	-260
		Jet Kerosene	0	0	0		0	0	1,000	0	20.09	0	0		0	0.99	0	0
		Diesel Oil	0	1,401	25,622		444	-23,777	1,000	-23,777,000	20.28	-482,198	-482		-482	0.99	-477	-1,750
		Residual Light Fuel Oil	0	325	2,427		-917	-3,019	1,000	-3,019,000	21.02	-63,459	-63	155	-219	0.99	-217	-795
		Residual Heavy Fuel Oil	0	198	13,343		-848	-13,993	1,000	-13,993,000	20.93	-292,873	-293		-293	0.99	-290	-1,063
		Residual Fuel Oil Total	0	523	15,770		-1,765	-17,012	1,000	-17,012,000		-356,333	-356	155	2,311	7.92	2,288	8,390
		LPG	108	582	1,671		112	-869	1,000	-869,000	17.56	-15,260	-15		-15	0.99	-15	-55
		Naphta	0	0	0		0	0	1,000	0		0	0	375	-375	0.99	-371	-1,362
		Bitumen	0	0	0		0	0	1,000	0	22.00	0	0	157	-157	0.99	-156	-571
		Lubricants	0	0	0		0	0	1,000	0	20.00	0	0	10	-10	0.99	-10	-36
		Petroleum Coke	0	0	0		0	0	1,000	0	27.50	0	0		0	0.99	0	0
		Refinery Feedstocks	0	0	0		0	0	1,000	0	20.00	0	0		0	0.99	0	0
		Other Oil	0	925	1,118		-6	-199	1,000	-199,000	20.00	-3,980	-4		-4	0.99	-4	-14
Liquid Fossil Totals			**2,878**	**191,181**	**58,403**		**-12,360**	**123,296**		**123,296,000**		**2,447,543**	**2,448**	**698**	**1,750**	**14.85**	**1,732**	**6,351**
Solid Fossil	Primary fuels	Anthracite	0	0	0		0	0	1,000	0	26.66	0	0		0	0.99	0	0
		Coking Coal	0	72,567	0		611	73,178	1,000	73,178,000	28.95	2,118,503	2,119	73	2,045	0.99	2,025	7,425
		Steam Coal	0	62,880	0		3,973	66,853	1,000	66,853,000	25.58	1,710,100	1,710		1,710	0.99	1,693	6,208
		Lignite	40,552	71,417	223		-1,856	109,890	1,000	109,890,000	27.39	3,009,887	3,010		3,010	0.99	2,980	10,926
		Sub-bituminous	0	0	0		0	0	1,000	0	26.20	0	0		0	0.99	0	0
		Tar	0	0	0		0	0	1,000	0	22.21	0	0		0	0.99	0	0
	Secondary fuels	BKB&Patent Fuel	0	1,334	1		6	1,339	1,000	1,339,000	25.16	33,689	34		34	0.99	33	122
		Coke	0	5,123	1,012		1,069	5,180	1,000	5,180,000	29.12	150,842	151		151	0.99	149	548
		Other Solid Fuel	7,185	0	0		0	7,185	1,000			0	0		0	0.99	0	0
Solid Fossil Totals			**47,737**	**213,321**	**1,236**		**3,803**	**263,625**		**256,440,000**		**7,023,021**	**7,023**	**73**	**6,950**	**8.91**	**6,880**	**25,228**
Gaseous Fossil		**Natural Gas (Dry)**	**8,267**	**180,096**	**420**		**20,517**	**208,460**	**1,000**	**208,460,000**	**16.07**	**3,349,952**	**3,350**	**43**	**3,307**	**0.99**	**3,274**	**12,005**
Biomass		Solid Biomass	0	0	0		0	0	1,000	0	27.59	0	0	0	0	0.98	0	0
		Liquid Biomass	0	0	0		0	0	1,000	0	20.00	0	0	0	0	0.98	0	0
		Total Biomass	0	0	0		0	0	1,000	0		0	0	0	0		0	0
TOTAL (without biomass)			**58,882**	**584,598**	**60,059**		**11,960**	**595,381**	**1,000**	**588,196,000**	**t C=**	**12,820,516**	**12,821**	**814**	**12,007**	**0.99**	**11,887**	**43,584**

Worksheet: CO2 from Energy Sources (Reference Approach)

Year 1994

			Production	Imports	Exports	Bun.	Stock.Ch.	Cons.	Conv.fact.	Ap.Cons.	EF			C stor.	Net C em.	C oxid.	C	CO2
Fuel types			(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(TJ)		(GJ)	(kgC/GJ)	(tons C)	(Gg C)	(Gg)	(Gg)		(Gg/year)	(Gg/year)
Liquid Fossil	Primary fuels	Crude Oil	2,794	198,078	0		589	200,283	1,000	200,283,000	20.00	4,005,660	4,006		4,006	0.99	3,966	14,541
		Natural Gas Liquids	0	0	0		0	0	1,000	0	15.20	0	0		0	0.99	0	0
	Secondary fuels	Gasoline	0	501	8,531		-385	-7,645	1,000	-7,645,000	19.73	-150,836	-151		-151	0.99	-149	-548
		Kerosene	0	0	6,857		297	-7,154	1,000	-7,154,000	20.09	-143,724	-144		-144	0.99	-142	-522
		Jet Kerosene	0	0	0		0	0	1,000	0	20.09	0	0		0	0.99	0	0
		Diesel Oil	0	0	33,350		-1,332	-32,018	1,000	-32,018,000	20.28	-649,325	-649	375	-1,024	0.99	-1,014	-3,719
		Residual Light Fuel Oil	0	0	1,920		-919	-1,001	1,000	-1,001,000	21.02	-21,041	-21		-21	0.99	-21	-76
		Residual Heavy Fuel Oil	0	0	17,727		-697	-17,030	1,000	-17,030,000	20.93	-356,438	-356		-356	0.99	-353	-1,294
		Residual Fuel Oil Total	0	0	19,647		-1,616	-18,031	1,000	-18,031,000		-377,479	-377	375	2,309	7.92	2,286	8,382
		LPG	120	404	1,152		35	-663	1,000	-663,000	17.56	-11,642	-12	0	-12	0.99	-12	-42
		Naphta	0	0	0		0	0	1,000	0		0	0		0	0.99	0	0
		Bitumen	0	0	0		0	0	1,000	0	22.00	0	0	283	-283	0.99	-280	-1,027
		Lubricants	0	0	0		0	0	1,000	0	20.00	0	0	10	-10	0.99	-10	-36
		Petroleum Coke	0	0	0		0	0	1,000	0	27.50	0	0		0	0.99	0	0
		Refinery Feedstocks	0	0	0		0	0	1,000	0	20.00	0	0	167	-167	0.99	-166	-608
		Other Oil	0	447	1,148		-54	-647	1,000	-647,000	20.00	-12,940	-13		-13	0.99	-13	-47
Liquid Fossil Totals			**2,914**	**199,430**	**70,685**		**-2,466**	**134,125**	**1,000**	**134,125,000**		**2,659,714**	**2,660**	**835**	**1,824**	**14.85**	**1,806**	**6,623**
Solid Fossil	Primary fuels	Anthracite	0	0	0		0	0	1,000	0	26.66	0	0		0	0.98	0	0
		Coking Coal	0	75,286	0		-1,953	77,239	1,000	77,239,000	28.95	2,236,069	2,236	77	2,159	0.98	2,116	7,758
		Steam Coal	0	61,448	72		6,279	55,097	1,000	55,097,000	25.58	1,409,381	1,409		1,409	0.98	1,381	5,064
		Lignite	41,647	49,162	263		9	90,537	1,000	90,537,000	27.39	2,479,808	2,480		2,480	0.98	2,430	8,911
		Sub-bituminous	0	0	0		0	0	1,000	0	26.20	0	0		0	0.98	0	0
		Tar	0	0	0		0	0	1,000	0	22.21	0	0		0	0.98	0	0
	Secondary fuels	BKB&Patent Fuel	0	1,232	0		-13	1,245	1,000	1,245,000	25.16	31,324	31		31	0.98	31	113
		Coke	0	6,278	1,133		1,049	4,096	1,000	4,096,000	29.12	119,276	119		119	0.98	117	429
		Other Solid Fuel										0	0		0		0	0
Solid Fossil Totals			**41,647**	**193,406**	**-1,468**		**5,371**	**228,214**		**228,214,000**		**6,275,858**	**6,276**	**77**	**6,199**		**6,075**	**22,274**
Gaseous Fossil		**Natural Gas (Dry)**	**0**	**199,032**	**0**		**0**	**199,032**	**1,000**	**199,032,000**	**16.07**	**3,198,444**	**3,198**	**61**	**3,137**	**1.00**	**3,134**	**11,493**
Biomass		Solid Biomass	0	0	0		0	0	1,000	0	27.59	0	0		0	0.98	0	0
		Liquid Biomass	0	0	0		0	0	1,000	0	20.00	0	0		0	0.98	0	0
		Total Biomass	0	0	0		0	0		0		0	0	0	0		0	0
TOTAL (without biomass)			**44,561**	**591,868**	**-72,153**		**2,905**	**561,371**	**2,000**	**561,371,000**	**t C=**	**12,134,017**	**12,134**	**973**	**11,161**	**15.85**	**11,015**	**40,389**

Worksheet: CO2 from Energy Sources (Reference Approach)

Year 1995

			Production	Imports	Exports	Stock Ch.	Consumption	EF Carbon	Total C	C stored	Net C em.	C oxid.	Total C	Total CO2
Fuel			(TJ)	(TJ)	(TJ)	(TJ)	(TJ)	(kgC/GJ)	(Gg C)	(Gg C)	(Gg C)	-	(Gg /year)	(Gg /year)
Liquid Fossil	Primary Fuels	Crude Oil	3098	223776	0	-11644	215230	20.47	4,406		4,406	0.99	4,362	15,993
		Natural Gas Liquids	0	0	0	0	0	15.2	0		0	0.99	0	0
	Secondary Fuels	Gasoline	0	864	11,940	-899	-11,975	19.73	-236		-236	0.99	-234	-858
		Kerosene	0	0	4,489	-136	-4,625	20.09	-93		-93	0.99	-92	-337
		Jet Kerosene	0	0	0	0	0	19.5	0		0	0.99	0	0
		Diesel oil	0	0	35,462	581	-34,881	20	-698	0	-698	0.00	0	0
		Residual Light Fuel Oil	0	0	765	0	-765	20.28	-16	488.9	-504	0.99	-499	-1,831
		Residual Heavy Fuel Oil	0	0	16,926	604	-16,322	21.02	-343	0	-343	0.99	-340	-1,245
		LPG (propane-butane)	91	256	1,858	3	-1,508	17.56	-26	0	-26	0.99	-26	-96
		Naphta	0	0	0	0	0	20	0	0	0	0.99	0	0
		Bitumen	0	0	0	0	0	22	0	368.70	-369	0.99	-365	-1,338
		Lubricants	0	0	0	0	0	20	0	12.06	-12	0.99	-12	-44
		Petroleum Coke	0	0	0	0	0	27.5	0		0	0.99	0	0
		Refinery Feedstocks	0	0	0	0	0	20	0	191.25	-191	0.99	-189	-694
		Other Oil	0	3	899	8,673	7,777	20	156		156	0.99	154	565
Liquid Fossil Totals			3,189	224,899	72,339	-2,818	152,931	20.59	3,149	1061	2,089	0.99	2,758	10,114
Solid Fossil	Primary Fuels	anthracite	0	0	0	0	0	26.66	0		0	0.98	0	0
		Coking Coal	0	75,816	0	-40	75,776	28.95	2,194		2,194	0.98	2,150	7,883
		Steam Coal	0	54,083	84	10,679	64,678	25.58	1,654		1,654	0.98	1,621	5,945
		Lignite	42,562	39,942	101	195	82,598	27.39	2,262		2,262	0.98	2,217	8,129
		Sub/bituminous coal	0	0	0	0	0	26.2	0		0	0.98	0	0
		tar	0	0	0	0	0	22.2	0	69.32	-69	0.98	-68	-249
	Secondary Fuels	BKB&Patent Fuel	0	139	0	1	140	25.16	4		4	0.98	3	13
		Coke	0	4,602	1,336	-713	2,553	29.12	74		74	0.98	73	267
Solid Fossil Totals			42,562	174,582	1,521	10,122	225,745	27.41	6,188	69	6,119	0.98	5,997	21,988
Gaseous Fossil		Natural Gas (Dry)	11,171	190,000	531	20,000	220,640	16.07	3,546	64.40	3,481	0.995	3,464	12,701
Biomass		Biomass solid	3,196	0	0	53	3,249	29.9	97		97	0.98	95	349
		Biomass liquid	0	0	0	0	0	20	0		0	0.99	0	0
		Biomass total	3,196	0	0	53	3,249	29.9	97	0	97	0.98	95	349
TOTAL (without biomass)							599,316	21.497	12,884	1195	11,689		12,219	44,802

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