The Fourth National Communication of the Republic of Hungary on Climate Change 2005

Hungarian Ministry of Environment and Water
2005

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1. Executive Summary

Hungary signed the Framework Convention on Climate Change at the United Nations Conference on Environment and Development held in Rio de Janeiro in June 1992. In 1994 Hungary ratified the UN FCCC and acceded to the Kyoto Protocol on 21 August 2002. Under the Protocol Hungary is obliged to reduce greenhouse gas emissions from its territory by 6% compared to the average of 1985-87 level during the period of 2008-2012.

1.1 National Circumstances

Hungary is located in the Carpathian Basin between 45°45' and 48°35' North and from 16°05'to 22°58' East. It covers an area of 93 033 km^2, compromising 84% lowlands (under 200 m) 14% (between 200-400 m) hilly regions and 2% "mountainous" area (above 400 m). The highest peak of Mátra Mountains: Kékestető is the highest point of the country as well with 1014 m above sea level. The major rivers in the country are the Danube and Tisza. Lake Balaton is the largest lake.

The dominant climate is continental, but the Sub-Atlantic and Sub-Mediterranean influence also bring about rapid changes and considerable differences in the various parts of the country. Characteristic climatic figures are shown in Table 1.1.

Climatic characteristics	Average	Range
Precipitation (mm/year)	560	400-900
Temperature (°C)	11.9	-20 - +38
Sunny hours (hour/year)	1850	1700-2000

Table 1.1 Main characteristics of the climate of Hungary

At the beginning of year 2004, the population of the country was 10.1 million, of which 6.7 million people lived in towns. The density of population was 108.5 inhabitants/km^2. Between 1970 and 2004 the population decreased by about 225 thousand people. Figure 3.1 shows the changes between 1920 and 2001. The area of the country is 93 033 km^2, out of which 63% is agricultural area (48.5% arable land, 3.1% garden, orchard and vineyard, 11.4% grassland), 19.1% forest, 1.1% reed and fish-pond, 16.9% uncultivated land area. 41.0% of the area is managed by business organisations, 44.7% by farmers, 14.3% is of other organisational, institutional and public goals.

The country has market economy. A structural economic recession began in the second half of the 80's, which was followed by the transformation of the whole economic and political system around 1990. The economic depression lasted till 1995. Since then the economy began to develop and the growth rate of the Hungarian economy exceeded the average of the EU. The main economic indicators are shown in Table 1.2.

	1990	1993	1995	2000	2001	2004
GDP growth rate	-3.3	-0.8	1.5	5.2	3.8	4.2
Unemployment rate	2.1	12.1	10.4	6.4	5.7	7.2
Inflation rate	28.9	22.5	28.2	9.9	9.3	6.8
Central budget/ GDP	0.8	-5.5	-6.0	-2.8	-2.8	-4.2

Table 1.2 Main economic indicators of Hungary in 1990-2004 (%)

Energy

The domestic utilisation was 1090 PJ, an increase of 31 PJ compared to 2002. The increase in energy demand was caused mainly by comparatively more severe weather conditions.

In the overall energy consumption, electricity consumption amounted to 39 985 GWh, which indicates an 1.6% increase compared to that of 2002. In 2003, the disposable energy sources accounted for 1 208.9 PJ, that is 47.1 PJ or 4% higher than that in 2002.

In 2003 the share of imported energy – considering electricity produced from nuclear energy domestic – increased from 61% (2002) to 64%. Import dependency would be 75% if imported nuclear fuel would also be considered as non-domestic energy carrier.

The share of coal and coal-type fuels in the source structure of energy demand was 158.5 PJ in 2003 or 13.0% of the total energy consumption, and 149.6 PJ in 2002, or 12.8% of the total.

Due to the maintenance problems in Paks NPP, the electricity produced from nuclear energy utilisation fell back with 21%, and only amounted to 9.9% of the total primary energy consumption.

Coal mining produced 274 kt more coal in 2003 compared to 2002. Deep cultivation and surface cultivation decreased with 696 kt, while the lignite production in the Mátraalja region increased with 990 kt.

Share of carbohydrates from total primary energy was 72.1% (879.1 PJ) in 2003, 70.2% (822.8 PJ) in 2002. Gas production and import altogether accounted for 42.0% of the total primary energy supply.

The capacity enlargement of the power system in the 90's was undertaken with gas fired units, thus increasing gas demand significantly. The capacities are satisfactory, the necessary reserves were installed.

In 2003 the balance of imported electricity amounted to 6 939 GWh compared to the respective amount of 4 256 GWh in 2002, substituting partly the production decrease of Paks NPP (the increase in import was mainly caused by the opening of the power market in January, 2003).

The average heat loss of district heating systems in East European countries is 30-70%, while the West-European average is hardly 20%. This suggests significant efficiency reserves in the Hungarian district heating systems, as well.

70% of domestic district heating is produced in power plants, mostly co-generated with electricity. The ratio of heating plants, mostly in municipalities is declining; their ratio presently is around 30%. The installation of low capacity co-generating gas motors has showed an outstanding acceleration in the recent years. These motors usually take over consumers of old heating plants.

Natural gas is the most preferred fuel to be combusted in this sector, coal is declining, oil dropped dramatically. The number of residential sites supplied with district heating is limited, and the number of districts that can be efficiently supplied is decreasing exponentially with distance.

Waste management

Domestic waste management policy is laid down in the National Waste Management Plan (NWMP) approved by the Parliament. This plan determines the waste management goals of the regularly prepared National Environmental Program. A short-term projection (through 2008) was prepared on the basis of this plan. The realisation of the goals of the plan is going to have an essential influence on GHG emission. These goals and the awaited trends are as follows.

The total amount of waste should be reduced to the quantity of year 2000 by means of preventive action. To achieve this, the application of low-waste technologies, the production of re-usable and long-life products and a campaign to change the consumption behaviour of the population shall be supported. This means that the total amount of waste generated in 2008 shall not exceed 68.4 Mt, of which municipal solid waste accounts for 5.2 Mt.

Landfills not complying with the standards should be stopped or re-constructed by 2009. Appropriate technical conditions should be ensured for waste incineration, by the re-construction or closure of non-complying incinerators. Starting from 2009, waste disposal is supposed to be totally anaerobe along national landfill regulations. The amount of collected and utilised or flared-off methane will increase significantly.

The amount of biodegradable waste disposed ot at landfills should be gradually reduced to 50% by 2007 and to 35% by 2014. The mostly affected fractions of municipal waste is organic waste from kitchens, gardens and parks and paper. To achieve this target organic waste has to be separately collected and treated, mostly recycled.

Transport sector

Most of transport sector emissions come from road transport. There is a linear correlation between CO_2 emission and the amount of fuel consumed by transport. CH_4 and N_2O also show a linear correlation to fuel consumption, but these emissions are influenced by the composition and technical condition of the vehicle park as well. GHG emission forecast is based on projected fuel consumption by the sector.

The change of the passenger car stock shows a close (99.6%) correlation with GDP growth from 1995 through 2003. Projection was based on this correlation. The stock of gasoline-fuelled buses exponentially declines with a 99.9% correlation with GDP growth between 1995-2003. The youngest gasoline-fuelled buses are 3-5 years old. Other fuel types (e.g. gas) represent a very low ratio. Stock changes of trucks also show a decline of gasoline-fuelled vehicles. Unit fuel consumption per kilometre is predicted to decrease as a result of technology improvement.

Agriculture and land use change

The Hungarian agricultural production has practically developed in accordance with the country's ecological and economic capabilities till mid-1980, several branches have reached world standard. In the second half of the '80s production started to decrease, and during the '90s a dramatic fallback occurred. Between 1990 and 1995 as well as 2003, the number of agricultural production units decreased by more than 30%, the employees in agriculture by more than 60%, the volume index of gross production of agricultural products by more than 30% and livestock by almost 50%. Simultaneously, the production efficiency of several branches has decreased. Production per one hectare agricultural land has decreased both in plant production and animal breeding.

In 2003 the proportion of agriculture in the GDP was 2.9%, and 5.7% together with food industry. (HCSO 2004, Table 1.2, 17.p.) The proportion of the employees in the agriculture is 5.5% (9.4% together with food industry) projected to all the employees of the Hungarian economy. (HCSO 2004, Table 1.4, 19.p.)

The size of plough-land utilised for corn cultivation is expected to grow by 10% in a few years. The reason for that is EU subsidy for a certain land size accompanied by an additional national subsidy. No significant change is foreseen in the yields of crops, though weather extremities can have an influence.

Fertiliser use dropped significantly after the collapse of the East-European markets. Fertiliser use mostly depends on the profitability of the sector and fertiliser prices. Fertiliser use is expected grow.

The GHG emission of animal husbandry is in close connection with the number of animals, the amount of manure generated and the technologies applied for manure treatment, variables considered in the prognosis. Animal husbandry is well subsidised by the EU until 2010, but a new subsidy scheme is planned after 2005 or 2007 the latest. In the new scheme the subsidised unit is not the number of animals but the average income level of the farm. This will probably decrease the temper for animal husbandry, with a limited scope to regard size of the animal population. It is assumed that Hungary keeps 50% of the current subsidy system to balance the negative effect of the changing subsidy scheme.

Forestry

Forests and forestry in Hungary are traditionally important for people both from economic, as well as social and environmental points of view. Managing forests has been changing for the last decades, and especially for the last few years.

Due to its natural circumstances, Hungary used to be a forested country with a high forest ratio. This ratio fell down to 12 per cent, or 1.1 million hectare by the end of the 19th century. Later, as a result of the large scale national afforestation, the forested area of the country increased by more than 600 000 hectare. The annual afforestation ratio declined in the 1990s, but increased again in the last few years. This increase shows the commitment of the country to sustainable land use, and to the desire to combat environmental, social and economic problems.

While forest management planning remained obligatory and professional, planned wood harvests became more dependent on the wood market, which shows considerable fluctuations. Moreover, the countries' joining the EU meant even more cooperation, but also more dependence on the international situation.

One such consequence is the change of the inner market. Due to climate change considerations, more and more biomass is required for energy production. This favours forest managers, because they can sell, at a relatively good price, fuel wood-quality broadleaves timber, which was sold earlier, to the particle-board based industry, at a low price. This even created tension between the forest managers and the former buyers, because temporary shortages and higher prices considerable changed their production conditions.

1.2 Emission Inventories

Direct greenhouse gases are carbon-dioxide, methane, and nitrogen-oxide, more recently also the fluoride gases (HFCs, PFCs and SF_6). On top of these the followings also have an effect on atmospheric warming:

- precursor gases (CO, NO_x, NMVOC), which help the creation of ozone;
- sulphur-dioxide, which is fostering aerosol creation and thus reduces warming.

Emission inventories concentrate on "direct" gases, which have the most marked effect on atmospheric warming. In the last few years precursor gases have also been included in inventories.

The emission of direct gases is summarized in Table 1.3 with data based on yearly emission inventories. The data shows the emission of each greenhouse gas in Hungary in CO_2 equivalent units as well as the net emission – which takes into account the effect of removal by forests – and the total emission. The percentage values show that Hungary's emission is below the commitment level of 94%. In Chapter 3. more details are provided on the above emission data as well as on the trends of changes.

1.3 Policies and measures

It can be stated that the support of energy efficiency measures were not satisfactory in the past, only after the millennium were greater steps taken. In the 90's a well outlined subsidy system could have helped a great deal, operating with tax reduction and lower VAT rates could have given a competitive advantage of renewable and alternative sources' developers, and energy efficiency managers.

GREENHOUSE GAS EMISSIONS	Base years	1988	1989	1990	1991	1992	1993	1994
	CO_2 equivalent (Gg)							
CO_2 (without LUCF)	84 776	80 326	78 102	72 278	68 440	61 974	62 733	61 595
CH_4	13 290	13 707	13 571	11 870	11 423	10 780	10 057	9 903
N_2O	23 816	23 127	22 380	18 895	15 243	12 294	12 001	13 214
HFCs	-	-	-	-	-	0.1	0.1	1
PFCs	268	264	285	271	234	135	146	159
SF_6	81	84	25	40	53	49	52	68
Total (with net CO_2 emissions/ removals)	120 884	117 115	114 111	100 983	93 856	82 941	81 669	79 522
Total (without CO_2 from LUCF)	122 232	117 508	114 363	103 353	95 392	85 231	84 989	84 940
Limit, %	----	103.1	100.4	88.9	82.6	73.0	71.9	70.0

GREENHOUSE GAS EMISSIONS	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)								
CO_2 (without LUCF)	60 870	62 220	60 478	60 139	60 015	57 803	59 360	57 703	60 461
CH_4	10 051	10 168	10 074	10 388	10 024	10 102	10 356	9 765	9 523
N_2O	12 397	13 330	13 205	13 203	13 066	12 583	13 500	12 621	12 434
HFCs	2	2	45	125	347	206	281	393	478
PFCs	167	159	161	172	189	211	199	203	190
SF_6	70	69	68	68	127	140	107	120	162
Total (with net CO2 emissions/ removals)	78 235	81 212	79 060	79 105	78 993	76 669	79 261	78 440	79 283
Total (without CO_2 from LUCF)	83 557	85 947	84 031	84 095	83 768	81 046	83 803	80 805	83 248
Limit, %	68.9	71.5	69.6	69.6	69.5	67.5	69.8	69.0	69.8

Table 1.3 Total greenhouse gas emissions

The market provided solutions partially, by developing cheap and efficient lighting devices, however it would still be advisable to have a beneficial, lower VAT rate for environment friendly products and services. This applies for solar units, the solar cells and solar thermal units. Lower tax burden could be a highly efficient and „budget-friendly" solution for household penetration of renewables.

Thermal insulation and energy efficiency measures still pose a great burden for a large proportion of the households, for these households a negative income effect also stems from the price escalation on the energy carrier markets.

Concerning renewables, the Hungarian regulation is investment friendly, the penetration of renewables is beneficiary from many aspects: energy strategy, import dependence, environment, social and employment aspects.

Potentials are constrained mostly by financial barriers, the required financial investment for reaching 5.5% share of renewables in the total energy balance sum up to 400M euros, of which around 140M euros should be state subsidies.

It would be important to start a forestation subprogram in the National Environmental Program, which would promote the development of sinks, and provide reinforcement for the complex ecological system and enforce sustainability.

On the short run the following measures would be necessary:

- A separate National Renewable Program should be started to promote the utilisation of renewables with the participation of the relevant Ministries, and an Inter-ministerial Committee has to be founded for its management.
- An Agro-energy Program should be started by the competent Ministry of Agriculture and Rural Development to examine and utilise arable lands for biomass production (energy forests, etc.). This wide range would be vital to further increase domestic renewables utilisation, and to fulfil the EU's expectations towards us.
- The state budget should include the necessary resources to support the development of EE and RES programs until 2010, this budget should be managed by the above mentioned Committee.

- In the field of renewable energy, a regulation considering the power systems characteristics and constraints should be developed, special attention should be paid to the tradable green certificates system.

In the middle range the followings should be considered.

- International participation in the respective programs should be considered, and definite support for renewables has to arise.
- Common interministerial program has to be worked out, from 2006 a detailed annual schedule should be developed for the necessary activities.

Calculated energy savings and emission reduction from policies and measures

The calculation of energy savings and the resulting CO_2 emission reduction was done based on the total energy use and total CO_2 equivalent emissions, using the data from 2002 (TPES 1066 PJ, CO_2 emission 55.75 Mt).

The emission intensity used is 52.3 tCO_2/TJ. This means that estimates used are not always precise, but this error is not significant and balances up on the long run. The summarised results can be seen in Annex 2.

General macro-economic forecasts were considered, and the official macro-economic projection of the Ministry of Finance was applied. The results were published, and all sectors provided feedback, lot of stakeholders suggested corrections. The final version of the national GHG forecast as follows, was approved by the Ministry of Environment and Water.

The "with measures" and "with additional measures" scenarios were developed with the following two basic differentiating factors: changes in agricultural and forestation policies, application of previously mentioned policies and measures, improved utilisation of renewable energy sources, and different transportation policies.

The "with measures scenario" includes a higher penetration rate of renewables in electricity generation, increased afforestation ratio and a more effective transportation policy change.

The effects and differences are presented for each sector if applicable. At the end of the chapter a comprehensive outline of the scenarios and their graphic representation is given.

Figure 1.1 gives a comprehensive overview of the effects of policies and measures and other mitigating options.

1.4 Projections

The projection presented herewith is based on an extensive research project to forecast the national greenhouse gas emissions. The research project was prepared for the Ministry of Environment and Water by a large community of researchers in 2004. This research was updated in 2005, and the effects of policies and measures and other assumed mitigating factors were presented in two additional scenarios.

Sectoral studies were almost exclusively based on official statistical data collected and published by government offices, national authorities and designated agencies. The method of projections was to first identify relevant market goods, the production of which results in GHG emissions. Then production changes of the relevant goods were explained by robust statistical models. Explanatory variables were chosen from sector specific and general economic factors. Models were improved until observed variations in production and in relevant activities could be reliably estimated. Eventually, GHG emissions were calculated form combustion and process emissions of the technology in each sector along the guidelines of IPCC, wherever possible.

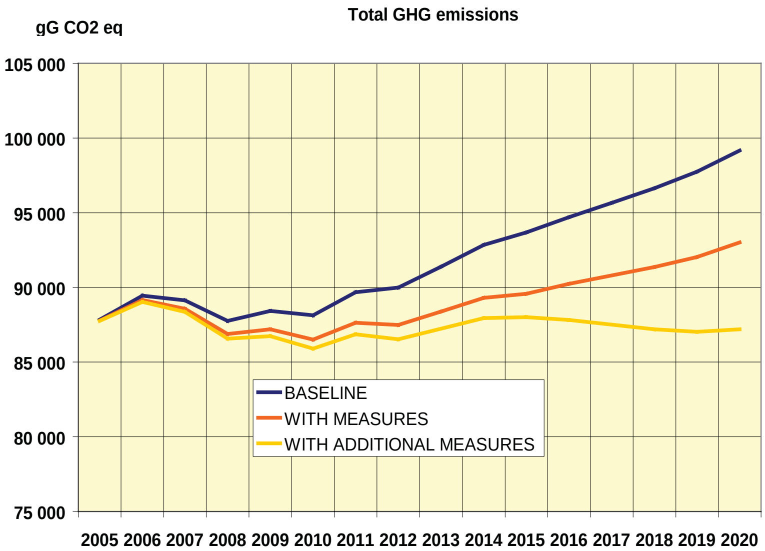

Figure 1.1 Total GHG emissions in scenarios

1.5 Vulnerability and adaptation

The monetised value of the impacts of unfavourable meteorological and environmental events is significant, with a high annual variance. In Hungary, taking the average of many years of damage and necessary defence, the value is between 600M and 720M euros, around 1% of the GDP. Global climate change can change the frequency of certain extreme events, and increase the damage costs, besides the not monetisable impacts on human health and natural-environmental values.

This makes the development of a comprehensive climate policy necessary in Hungary. This policy should be characterised by reduction of anthropogenic emissions and adaptation to the harmful effects by proactive and preventive measures.

To tackle the increasing risk stemming from global climate change, and to support the founding of the domestic climate policy the Ministry of Environment and Water together with the Hungarian Academy of Sciences launched a common research programme named VAHAVA, "The domestic effects of global climate change, and the answers to be given to the challenge". Primary aim of this project was the preparation to the potential negative and positive effects of climate change, harm reduction, prevention and advancement of restoration.

Methodological characteristics of the project was the complex system synthesis, interdisciplinary and multi-sectoral approach, and wide range partnership.

The synthesis takes into consideration results from the relevant international research, the National Research Programmes, the National Environmental Programme, the National Environmental-Health Action Programme, and some published results in the domestic literature.

The expected final report of the project comes in 2006 spring.

It will summarise the unfavourable effects of meteorological events of varying frequency and intensity from global climate change; the main elements of the national strategy on adaptation to climate change and atmospheric protection (preparation, mitigation, harm reduction, restoration) and suggested measures for the future to mitigate and adapt to harmful events .

1.6 Research and Systematic Observation

Hungary has become an EU member state since the Third National Communication, and this has had a noticeable influence on climate change related research, environmental and climate change literacy, environmental education and training.

R&D governance involves three main levels in Hungary: governmental bodies, the Hungarian Academy of Sciences (HAS), and research institutes. Around half of the total R&D expenditure originates from the central budget. Funding of university research groups is largely through normative research support and various governmental funds and programs. Further income is ensured through R&D activities according to contracts from private companies and national and international grants.

The Hungarian Meteorological Service (HMS) was extensively introduced in the NC3. Its role and function in climate research is still to serve as the largest meteorological and climatic information provider of the country. The Meteorological Department of the Eötvös Loránd University is also active in climatic, air pollution and meteorological observations. Both of them cooperate with numerous other smaller groups, as well as with each other. The information collected and provided by the two main meteorological organizations covers the past (trends, changes, analyses), the present (measured and observed meteorological and environmental data), and the future (forecasts on meteorological and climatic time-scales).

Mesoscale atmospheric modeling has been a key issue in weather prediction for about a decade at the Hungarian Meteorological Service. A large step taken since the NC3 was that in 2004 a new application of these models and the corresponding knowledge basis started, namely a trial to compute local climatic effects of the changes in the atmospheric composition and land use. At present, four models are checked in parallel for their climate reproduction ability.

The Department of Meteorology at the Eötvös Loránd University has been involved in several regional climate projects. The Department operates three national projects in connection with climate change under the Research and Technology Innovation Fund and the Hungarian Scientific Research Fund Program.

In Hungary Hegyhátsál station was assigned responsible for vertical measurements of CO_2 concentration and other important parameters (wind, temperature, humidity). With the help of EU financial support, monitoring was extended to the investigation of GHG distribution in the lower troposphere. Hegyhátsál will be one of the three main sites of GHG measurements in Europe.

Research projects are present on several other areas, including paleoclimatic studies, impact of various ecosystems, water and soil, human life as well as on various aspects of mitigation.

1.7 Education, training and public awareness

Awareness on climate change is growing in Hungary according to opinion polls. It is promoted by wide-spread tools of awareness raising and built into the curriculum of education from elementary to university level.

2. Introduction

Hungary signed the Framework Convention on Climate Change at the United Nations Conference on Environment and Development held in Rio de Janeiro in June 1992. In 1994 Hungary ratified the UN FCCC and acceded to the Kyoto Protocol on 21 August 2002. Under the Protocol Hungary is obliged to reduce greenhouse gas emissions from its territory by 6% compared to the average of 1985-87 level during the period of 2008-2012.

In response to UNFCCC requirement Hungary has prepared since 1994 every year National Inventory Reports and three National Communications. The current Fourth National Communication covers GHG inventories of the years 1985 to 2003 including also the years for which inventories have been reported earlier but have been recalculated. The purpose of all recalculations was to improve the accuracy and completeness of the inventory.

Examining the emissions trends as a whole it is ascertainable that compared to the base year, emissions in Hungary show a significant decrease. At the beginning of the period – corresponding to national economic performance – a fast decline took place, then, since the mid 1990's it has been fluctuating around 83 000 Gg per annum. The favourable trend is mainly due to the restructuring of the economy and political measures. Considering emission trends and projections is certain that Hungary can fulfil its emission reduction obligations under the Kyoto Protocol for its first commitment period.

3. National Circumstances Relevant to GHG Emissions

3.1 Political profile

The effective constitution of Hungary is the Constitution of 1949 together with its amendments. Since the amendment to the Constitution proclaimed on 23 October 1989 the form of the Hungarian state has been a parliamentary republic. The President of the Republic of Hungary is elected, with a secret ballot by a two-third majority vote, by the National Assembly for a term of five years.

The Head of State has the following powers: he signs and promulgates laws; he may adjourn the sessions of or dissolve the National Assembly, he sets the date for parliamentary elections; he has a one-time veto power over an Act of Parliament before signing it if he disagrees with it; he has wide-ranging powers to initiate measures; he gives the mandate to form the cabinet and the Prime Minister is elected by the National Assembly upon his proposal; he appoints ministers, undersecretaries, generals, judges of courts of law; he has the power of individual pardon.

Executive power – government functions and the highest-level control of public administration – is exercised by the government, in which the Prime Minister plays a dominant role. The National Assembly elects the Prime Minister on the basis of the principle of parliamentary majority, concurrently approving the government programme. The government is constituted upon the appointment of ministers and their ministerial oath.

Citizens exercise local governance at their places of residence in the villages, towns, cities, boroughs, in the capital and the 23 districts of the capital – through an assembly of representatives elected by them or directly, for instance by way of local referenda.

The local assembly is headed by the mayor and the vice mayor. The mayor is elected directly by the voters. In municipal matters the assembly passes regulations and performs administration independently, it may receive subsidies from the central government in addition to its own revenues, and may adopt local by-laws. The obligations of municipalities include elementary education, the provision of health care and basic social benefits, the enforcement of the rights of national and ethnic minorities, establishment of local titles and awards, etc.

3.2 Population

According the preliminary data, the Hungarian population was estimated 10 006 835 persons by the end of 2004. The mortality markedly exceeds the number of live births in recent years, though the two indicators have to some extent converged in the last years compared to the late 90's. The life expectancy at birth rose by 1 year between 2000 and 2003, but the 77 (female) and 68 (male) years life expectancy is one of the lowest among the developed countries.

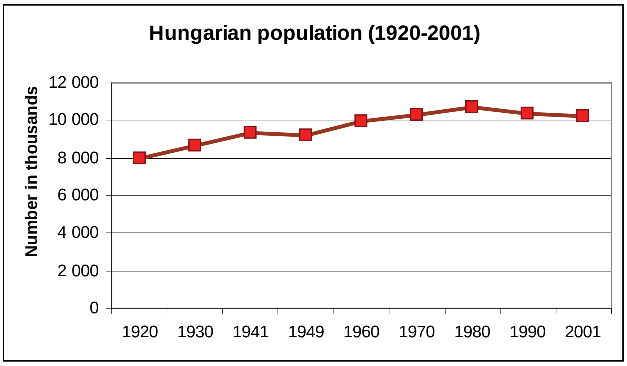

Figure 3.1 Population of Hungary between 1920 and 2001 (HCSO)

Census figures indicate that the population grew until 1980 (with the exception of 1949), but it has been continuously declining since 1981. After the first decade following the Second World War fertility dropped, then stabilised at a low level. In the 1990s there was a further decline in the number of live births, and in 1999 the number was below 95 000. The total fertility ratio was 1.33 in the year 2000.

Table 3.1 shows some important demographic rates, and Figure 3.1 the changes of the population between 1920 and 2001.

Population	10 006 835
Median age	total: 38.57 years male: 36.1 years female: 41.24 years
Population growth rate	-0.26%
Birth rate	9.76 births/1 000 population
Death rate	13.19 deaths/1 000 population
Sex ratio	at birth: 1.06 male(s)/female under 15 years: 1.06 male(s)/female 15-64 years: 0.97 male(s)/female 65 years and over: 0.57 male(s)/female total population: 0.91 male(s)/female
Infant mortality rate	8.57 deaths/1,000 live births
Life expectancy at birth	total population: 72.4 years male: 68.18 years female: 76.89 years
Total fertility rate	1.32 children born/woman

Table 3.1 Demographic rates, estimated for 2005

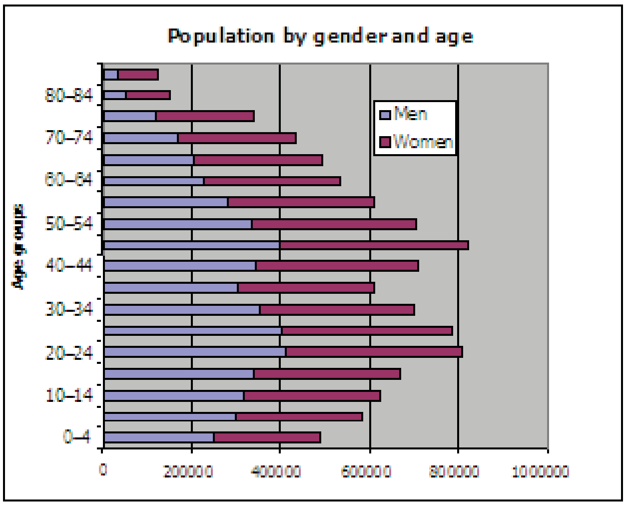

Figure 3.2 Age structure of the Hungarian population in 2001 (HCSO)

Hungary, with its 109.6 persons/square kilometer population density (31 January 2001), is a densely populated country by global standards. Figure 3.2 shows the age structure of the Hungarian population. The most densely populated region of the country is Central Hungary, especially Budapest (3 381.3 persons/square kilometer) having the highest density figure.

3.3 Geography

Hungary is located in the Carpathian Basin between 45°45' and 48°35' North and from 16°05' to 22°58' East. It covers an area of 93 033 km^2, compromising 84% lowlands (under 200 m) 14% (between 200-400 m) hilly regions and 2% "mountainous" area (above 400 m). The highest peak of Mátra Mountains: Kékestető is the highest point of. the country as well with 1014 m above sea level. The major rivers in the country are the Danube and Tisza, furthermore Hungary has three major lakes. Lake Balaton is the largest. It is 78 kilometers long and from 3 to 14 kilometers wide, with an area of 598 square kilometers. It is Central Europe's largest freshwater lake and an important recreation area. Smaller bodies of water are Lake Velence (26 square kilometers surface area) and Lake Fertő (322 square kilometers surface area, of which Hungarian part has 82 square kilometers surface area).

Out of the whole area of the country 63% is agricultural area (48.5% arable land, 3.1% garden, orchard and vineyard, 11.4% grassland), 19.1% forest, 1.1% reed and fishpond, 16.9% uncultivated land area. 41.0% of the area is managed by business organisations, 44.7% by farmers, 14.3% is of other organisational, institutional and public goals.

3.4 Climate profile

Hungary is situated in the orographical zone between the 45°45'N and 48°35'N. Almost half of the country area is below 200 m (ASL), and only 2% is higher than 400 m. The country is located in the temperate zone affected by three large climatic zones, namely oceanic, continental and mediterranean.

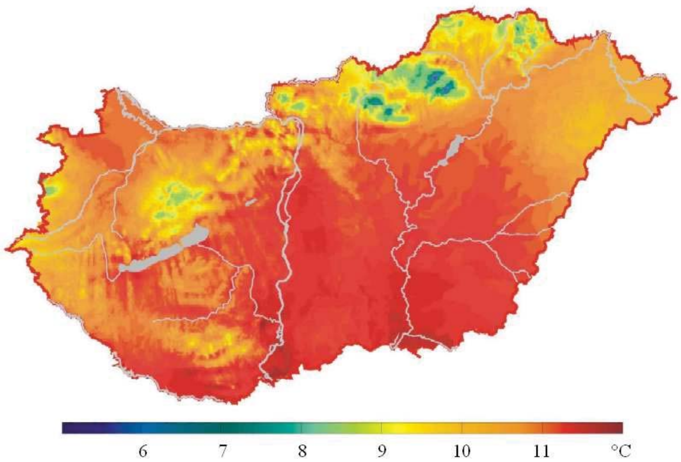

Figure 3.3 The annual mean temperature in Hungary

Due to the given geographical location and topography of the country four season could be separated. The temperature and the precipitation characteristics vary from season to season. Winter has less precipitation than summer. The water requirement is covered moderately by the annual precipitation.

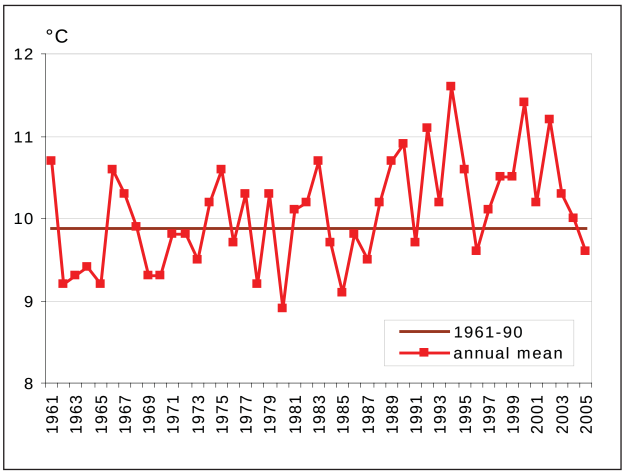

Figure 3.4 Mean temperature and the climatic mean of the period of 1961-1990

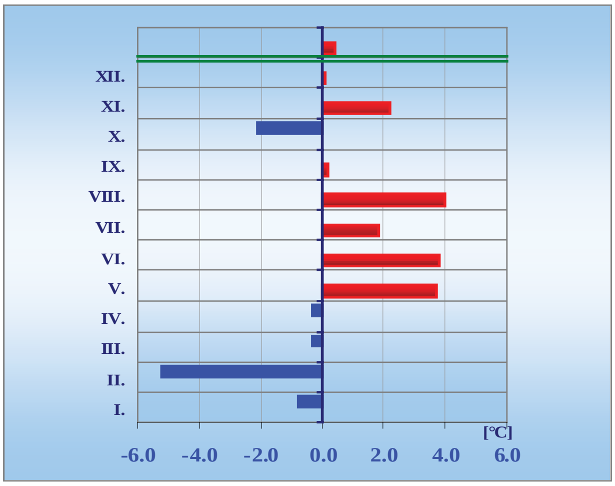

Figure 3.5 Anomaly of the countrywide monthly mean temperatures (°C) in Hungary, 2003

The annual mean temperature is 10°C in Hungary. The dominant features are the zonality and the effect of the altitude. The coldest part of the country is the mountain region in the North (Kékestető: 5.7°C).,The cooling effect of Alps is appreciable in the Western part of Hungary, where the annual mean temperature is 9.5°C. The warmest countryside with 11.5°C is situated in South (Szeged) and in the basin of the Danube south from Budapest. The coldest month is January. The temperature decreases in two direction: from South to North (because of the zonality) and from West to East (due to the continentality). The southwestly (Genova) warm air stream and the north eastly cold air often influence the weather. The winter is highly variable, strongly differ year by year. The coldest January had less than -10°C and the warmest had more than 6°C mean temperature. The warmest month is July. The temperature increases in two directions: from North to South (zonality) and from West to East (continentality). The coolest part of Hungary is the NW and N region with about 19°C, the warmest is SE with more than 22°C. The warmest temperature even measured in Hungary is 41.7°C (Békéscsaba), while the coldest is -35°C (Miskolc-Görömbölytapolca). The biggest temperature change between two months is in the transition seasons, the rate of change is 5-7°C.

The precipitation pattern depends on the distance from the Atlantic Ocean and influenced by the altitude (+35mm/100m). The annual mean precipitation is 600 mm in Hungary, but the inter-annual variation could exceed 30 percent.

The most humid region is located in SW with about 800 mm annual precipitation, the most arid region is the middle of the Great Hungarian Plain with about 500 mm annual precipitation. In the central part of the Great Plain the annual average rainfall varies between 470-550 mm, while in the mountainous areas 700-800 mm.

There is a tendency for droughts, especially on the Great Plain. The number of days when the land is covered with snow is relatively few. During the winter time, a specific synoptic situation, so called “cold air pad” often caused foggy and extremely cold weather Convective thunderstorms dominate during summer months.

The number of sunny hours (sunshine duration) varies between 1700-2200 hours per year. The area between the rivers Danube and Tisza being the most sunny, while the regions with the least amount of sunshine are the Alpokalja (Lower Alps) and the Northern mountains. The annual average wind speed is 2.4 m/sec.

During the past century the climate became warmer in Hungary (Fig. 3.4) similar to the global tendencies, but the extent of annual warming is slightly higher than the global average.

The characteristic features of our climate are the large variability of meteorological variables, and frequently occurrence of extreme events. In Hungary one of the most dangerous phenomenon is the drought, which affects the sensitive regions (e.g. Great Plain) almost in each second year. On the other hand heavy precipitations are not rare events in summer time. The biggest daily precipitation sum in our data set is 180 mm (in Erdőtelek 10.07.1999). Number of hot days increased, and number of frost days decreased during the last few years. Figure 3.5 illustrates the monthly temperature anomaly of an extremely hot year 2003.

3.5 Economic profile

In Hungary almost two thirds of the GDP is produced by the service sector. Within this, financial intermediation, real estate, renting and business activities as well as public services (administration, education, health, social work)

Gross output by industries, 2002-2004						
	2002		2003		2004	
	at current prices		at current prices		at current prices	
	HUF million	%	HUF million	%	HUF million	%
Agriculture, hunting, forestry and fishing	1 718 632	4.9	1 646 666	4.3	1 833 304	4.4
Mining and quarrying	87 304	0.2	88 568	0.2	96 687	0.2
Manufacturing	13 526 833	38.3	14 979 556	39	16 411 650	39
Electricity, gas, steam and water supply	1 203 750	3.4	1 378 217	3.6	1 646 438	3.9
Construction	1 986 485	5.6	2 042 447	5.3	2 316 005	5.5
Wholesale and retail trade; repair	3 563 550	10.1	3 758 781	9.8	3 967 860	9.4
Hotels and restaurants	609 778	1.7	634 864	1.7	726 698	1.7
Transport, storage and communications	2 248 486	6.4	2 378 713	6.2	693 678	6.4
Financial intermediation	1 026 267	2.9	1 151 483	3	1 210 539	2.9
Real estate, business activities	4 184 481	11.9	4 619 156	12	5 052 841	12
Public administration and defense, compulsory social security	1 824 534	5.2	1 998 187	5.2	2 147 649	5.1
Education	1 027 213	2.9	1 210 259	3.2	1 294 447	3.1
Health and social work	1 119 710	3.2	1 309 161	3.4	1 364 508	3.2
Other community, personal service activities	1 148 501	3.3	1 215 200	3.2	1 338 046	3.2
Gross output total	35 275 524	100	38 411 258	100	40 100 350	100

Table 3.2 Gross output by industries 2002-2004 (HCSO)

play a prominent role. Agriculture and construction have a relatively low share in recent years (agriculture 3.3%, industry 31.4%, services 65.3% estimated for 2004).

The growth rate of GDP exceeded that of the EU-15 by 1.5-2 percentage points in the past years. In 2004 per capita GDP in Hungary was EUR 8 025. On the other hand, the Hungarian growth rate is rather low among the new EU member states. After a trend of weakening growth from 2001, in 2004 an upsurge took place, due to the favourable external conditions. Aside from the outstanding growth (36%) of agricultural value added, industry and construction were the main driving forces of this upsurge (with growth rates about 5% for both branches), while most of the service branches lagged behind (except of transport and storage).

In 2001, Hungary changed its exchange rate regime, from the former crawling peg to a floating with 15% band. In line with this, the full liberalisation of the exchange rate market took place and the National Bank of Hungary adopted the inflation targeting monetary regime. As a result of this as well as the favourable external tendencies the growth of consumer prices reduced by 4.7% by the year 2003. However, partly because of the pass through of international price hikes, partly because of harmonisation of administered prices and increase of VAT, CPI has temporarily increased markedly last year, but from the last third of 2004 disinflation factors have prevailed again.

Per capita gross domestic product (GDP)					
Denomination	2000	2001	2002	2003	2004
Value, HUF	1290014	1457639	1665116	1841225	2019707
1990=100.0	109.7	114.2	118.6	122.9	128.9
Previous year=100,0	105.5	104.1	103.8	103.7	104.9
Value, EUR*	4 961	5 679	6 853	7 263	8 025

* at the official exchange rate of the National Bank of Hungary

Table 3.3 Per capita gross domestic product, GDP (HCSO)

By the year 2000, the government managed to reduce the deficit to 3%, a value fulfilling the respective Maastricht criterion. Then in 2001-2002 the deficit increased significantly, to the remarkably high 9.2% in 2002. In 2003-2004 overall government deficit fell. But the pace of decreasing of the deficit is slower than it was scheduled by the budget targets.

	1990	1993	1995	2000	2001	2004
GDP growth rate	-3.3	-0.8	1.5	5.2	3.8	4.2
Unemployment rate	2.1	12.1	10.4	6.4	5.7	7.2
Inflation rate	28.9	22.5	28.2	9.9	9.3	6.8
Central budget/ GDP	0.8	-5.5	-6.0	-2.8	-2.8	-4.2

Table 3.4 Main economic indicators of Hungary in 1990-2004 (%)

Exports and imports of goods and services*					
Denomination	**2000**	**2001**	**2002**	**2003**	**2004**
Exports					
Goods	8 145.8	8 902.5	8 943.1	9 739.2	11 331.6
Services	1 674.5	2 010.5	1 905.4	1 951.1	2 077.8
Total	9 820.3	10 913.0	10 848.5	11 690.3	13 409.4
Imports					
Goods	8 974.3	9 544.4	9 476.5	10 473.8	11 941.7
Services	1 352.9	1 588.1	1 768.9	2 054.0	2 106.5
Total	10 327.2	11 132.5	11 245.4	12 527.8	14 048.2
Export (+), import (-), surplus					
Goods	-828.5	-641.9	-533.4	-734.6	-610.2
Services	321.5	422.4	136.5	-102.9	-28.7
Total	-507.0	-219.5	-396.9	-837.5	-638.9
	* at current prices, billion HUF				

Table 3.5 Exports and imports of goods and services (HCSO)

By the year 2000, also the gross national debt came under the Maastricht reference value of 60% of the GDP. The 53.4% in 2001 meant the minimum value for that indicator in the post-transition years. Because of the higher government deficits also the debt/GDP ratio started to grow, and this trend continued even during the recent years of gradual deficit easing. In 2004, the rate of national debt to GDP crossed the Maastricht threshold at least, if the funded pension scheme is not taken into account.

Also the current account deficit shows an ever-growing tendency in the last three years. In 2003 the deficit/GDP ratio rose to 8.7% (from 6.2% in 2001), and in 2004 it rose further although marginally and in part due to some accession-related accounting issues. The main economic indicators are shown in Table 3.4.

After 2000 there was a backslide in the growth rates of export and import volumes, but from 2003 a new upsurge began. Remarkably, in 2004 the growth of export exceeded that of the imports again, and as a result of this, the trade balance improved somewhat, despite the slight deterioration in the terms of trade.

According to the data of the National Employment Office, 344.6 thousand unemployed persons were registered at the end of September 2001, 0.4 thousand fewer than in the previous month and 24 thousand fewer than a year before. Among the registered unemployed, the number of blue-collar workers dropped by 5.9%, while that of white-collar workers decreased by 9.2% against previous year figures. Unemployment among university or college graduates fell by 1.4% in one year. According to the most recent data, there were 18.2% fewer long-term unemployed in the register than a year earlier.

3.6 Energy

The source structure of the domestic energetics in 2003 is shown in Tables 3.6-3.7. The domestic utilisation was 1090 PJ, an increase of 31 PJ compared to 2002. The increase in energy demand was caused mainly by comparatively more severe weather conditions.

In the overall energy consumption, electricity consumption amounted to 39 985 GWh, which indicates an 1.6% increase compared to that of 2002. In 2003, the available energy sources was

Balance of Energy (terajoule)					
Denomination			**2002**	**2003**	**2004**
Production			462 739	434 729	422 066
Of which:	**Coal**		112 329	113 402	91 360
	Hydrocarbons		161 137	162 681	160 392
	within it:	**crude oil**	43 045	46 504	45 012
		PB gas from mining	9 071	9 729	10 105
		natural gas	98 624	95 696	96 204
		natural gasoline	10 397	10 752	9 071
Electricity generated by nuclear power station			152 088	120 042	129 874
Electricity generated by hydroelectric power station			698	616	756
Firewood			36 487	37 988	39 684
Imports			716 471	786 448	783 800
Of which:		**coal**	39 497	45 096	51 247
		crude oil	206 310	220 431	229 190
		crude oil products	90 885	79 753	88 419
		natural gas	364 457	416 188	388 045
		electricity	15 322	24 980	26 899
Sources, total			1 179 210	1 221 177	1 205 866
Exports			105 971	108 172	120 481
Change is stocks			6 441	21 470	-2 672
Energy consumption			1 066 798	1 091 535	1 088 057

Table 3.6 Energy Balance (HCSO)

Structure of energy sources (%)*						
Denomination		2000	2001	2002	2003	2004
All kinds of coal		15.2	14.3	12.9	13.0	11.8
Hydrocarbons		67.2	68.1	69.8	72.0	71.8
Of which:	crude oil and crude oil product	31.4	30.9	30.5	30.1	31.7
	natural gas	35.7	37.2	39.3	41.9	40.2
Electricity generated by nuclear power station		13.4	13.3	12.9	9.8	10.8
Imported electricity		1.1	1.0	1.3	2.0	2.2
Other fuels		3.1	3.3	3.2	3.2	3.4
Total		100	100	100	100	100
Of which:	ratio of imports, percent	57.8	58.5	60.8	64.4	65.0
		* on the basis of calorific value				

Table 3.7 Structure of energy sources (HCSO)

1 218.9 PJ, an amount higher than that of 2002 with 47.1 PJ, or 4%. In the same year the share of imported energy – considering electricity produced from nuclear energy domestic – increased from 61% (2002) to 64%. Import dependency would amount to 75% if imported nuclear fuel would also be considered as non-domestic energy carrier.

Share of coal and coal-type of fuels in the source structure of energy demand was 158.5 PJ in 2003 or 13.0% of the total energy consumption, and 149.6 PJ in 2002, or 12.8% of the total. Coal mining produced 274 kt more coal from 2002 to 2003. Deep cultivation and surface cultivation decreased by 696 kt, while the lignite production in the Mátraalja region increased by 990 kt.

Due to the maintenance problems in Paks Nuclear Power Plant, the electricity produced from nuclear energy utilisation fell back by 21%, and only amounted to 9.9% of the total primary energy consumption.

3.6.1 Energy balance

The share of domestic production and import and the structure of energy sources are shown in Tables 3.5-3.6.

Share of carbohydrates from total primary energy was 72.1% (879.1 PJ) in 2003, 70.2% (822.8 PJ) in 2002. Gas production and import altogether accounted for 42.0% of the total primary energy supply.

The capacity enlargement of the power system in the 90's was undertaken with gas fired units, thus increasing gas demand significantly. The capacities are satisfactory, the necessary reserves were installed.

In 2003 the balance of imported electricity amounted to 6 939 GWh compared with the respective amount of 4 256 GWh in 2002, substituting partly the production decrease of Paks Nuclear Power Plant (the increase in import was mainly caused by the opening of the power market in January, 2003).

3.7 Transport

A total of 19 airline companies operate services from 48 cities in 32 countries to Budapest. Hungary has a road network of over 30 000 kilometres. All Hungarian municipalities are accessible via hard surface roads. There are 4 motorways and 8 main roads.

There are direct railway connections between Budapest and the capital cities of 16 European countries. Most of the international express trains depart from and arrive in Budapest.

Most of sector emissions come from road transport. There is a linear correlation between CO_2 emission and the amount of fuel consumed by transport. CH_4 and N_2O also show a linear correlation to fuel consumption, but these emissions are influenced by the composition and technical condition of the vehicle park as well. GHG emission forecast is based on projected fuel consumption by the sector.

The change of the passenger car stock shows a close (99.6%) correlation with GDP growth from 1995 through 2003. Projection was based on this correlation. The stock of gasoline-fuelled buses exponentially declines with a 99.9% correlation with GDP growth between 1995-2003. The newest gasoline-fuelled buses are 3-5 years old. Other fuel types (e.g. gas) represent a very low ratio. Stock changes of trucks also show a decline of gasoline-fuelled vehicles. Unit fuel consumption per kilometre is predicted to decrease as a result of technology improvement.

Number of transport vehicles by type 2000-2004					
	2 000	2001	2002	2003	2004
Motorcycle	91 169	93 060	97 588	103 488	114 033
Passenger car	2364 158	2 481 921	2629 485	2777 187	2828 401
Bus	17 846	17 811	17 869	17 874	17 427
Van, trucks	341 925	355 117	369 276	377 092	378 069
Tractors	24 420	25 215	26 786	29 752	32 397

Table 3.8 Number of transport vehicles by type 2000-2004 (HCSO)

Rail transport accounted for 2.12% of the total emission of the transport sector in 2002. The emission is the result of operating diesel engines and space heating in stations. GHG emission in this sub-sector is in direct propor-

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Lignite	5.0	4.9	6.6	6.8	6.7	7.1	7.5	8.0	7.6	7.7	7.8	8.0	7.5	8.5
Sub-bituminous coal	11.5	11.0	8.3	7.1	6.0	6.8	6.9	7.1	6.5	6.4	5.6	5.3	4.5	4.0
Bituminous coal	1.9	1.8	1.3	0.9	1.0	0.8	0.9	0.9	0.8	0.7	0.7	0.6	0.6	0.6
Total coal	18.5	17.7	16.3	15.0	13.7	14.8	15.4	16.17	15.0	14.9	14.2	14.0	12.8	13.2

Table 3.9 Coal production (Mt) in Hungary

tion with the fuel consumed. The average passenger km (757.8 km) declined below the EU-15 average in 2001. Based on the communication with the national railway company (MÁV Rt.) present trends are supposed to keep on in the next period. The ratio of electric traction increases, technological level of diesel engines improves; the volume of rail shipping increases, the volume of passenger transport stagnates.

National ship and air transport accounted for 0.13% of the total GHG emission of the sector. The volume of water transport was significantly reduced by the Balkan war, which blocked the Danube, the most important transport route for years. National air transport is not considerable and is not expected to grow, 1% increase of fuel consumption is foreseen.

3.8 Industry

Hungary is poor in the natural resources essential for heavy industry and relies strongly on imported raw materials. In 1993, industrial production was only two-thirds of the 1985 level. In 1997, industrial output increased in the manufacture of road vehicles, consumer electronics, insulated cables, office equipment and computers, steel products, aluminium metallurgy, household chemical products and cosmetics, rubber and plastic products, and paper and pulp production

Since 1990, Hungary has developed industrial strength in the automotive field as well as an expanding automotive sourcing industry in plastics and electronics.

3.8.1 Coal Mining Industries

At the beginning of 2000, the registered coal stock of Hungary was 198,7 Mt of bituminous coal, 206.8 Mt of sub-bituminous coal, 1421.1 Mt of lignite. There are billions of tonnes of low quality lignite at the feet of Mountain Mátra and Bükk. Based on the economic conditions today the only increase foreseen in domestic coal mining is the growing use of the lignite stock. In 2003 and 2004 a number of mines were closed or stopped. Only 3 surface (12 in 2002) and 1 subsurface (9 in 2002) mine is going to operate after 2005. In a longer term, the only one to survive among the group of small surface mines seems to be the Nógrád-mine. Imported amounts of high quality coal with low sulphur content may increase in the future as a number of Hungarian power plants are planning to mix high sulphur domestic coal with imported coal.

The most important competitor of domestic coal is natural gas, but even if natural gas prices rise in the future domestic coal would be crowded out by imported coal because of their good combustion characteristics, constantly low market price and the huge production capacity of the large coal exporting countries. In the future, as a result of the environmental regulation for air pollutant emission, industrial combustion facilities shall only use low sulphur imported coal.

The domestic power plants, the most significant consumers of the coal industry, have been designed to fit local coal reserves. Thus their furnace parameters firmly tie the future of power plants to mining of local coal reserves. With respect to the stricter environmental regulation and the relatively bad quality of Hungarian coals, power plants have had to decide whether to implement investments for air pollution reduction or switch to a different fuel.

The share of coal has dropped in the residential sector as a result of the spread of natural gas heating. Table 3.9 shows observed coal production in Hungary. Though some data show that one-sixth of the households have kept their coal boilers, the only case when returning to coal combustion is probable is a drastic rise in natural gas prices. This means that closure of power plant-integrated mines and non-integrated mines are inevitable alike. Exceptions are the surface lignite mines, the Nógrád-surface mine and the subsurface mine of Márkushegy.

Data of the Hungarian Mining Office show fugitive methane emissions for sub-bituminous coal of Márkushegy at a rate of 0.954 m^3 CH_4/t coal, measured in 1999. The Vértes Power Plant data for in situ CH_4 content is 0.93 m^3 CH_4/t coal. Methane recovery is 0 m^3/year. The emission of the de-gasification system is 0 m^3/year. Average carbon content of the mining waste-pile is 1-2%, the recovery of which is not feasible.

3.8.2 Oil Industry

Oil production and refining is highly concentrated in Hungary, there is no real chance of competition.

The industry comprises two basic activities: production (with CO_2 and CH_4 emissions) and refining (with CO_2, CH_4 and N_2O emissions).

Due to the depletion of oil stocks domestic production is gradually decreasing. MOL Rt. (Hungarian Oil and Gas Company) attempts to slow down this trend, as a result production has stabilised in the recent years. Nevertheless, 2002 production was only 63% of the 1995 level. The amount produced is not influenced by the oil market price.

MOL Rt. has three plants in Hungary, the major GHG emitter being the crude oil refinery plant (Duna Refining Plant). MOL has five product groups, of which the most important are: gasoline, gas/diesel oils and residual fuel oils (or heavy fuel oils). Besides these products the impotency of asphalt and paraffin are pretty high. The product ratios were more or less constant until 2001. After 2001 the gasoline, gas/diesel oils, residual fuel oils production ratios have changed. The production of residual fuel oil with high sulphur content was stopped as a result of environmental regulation. Along the large drop in residual fuel oil production petroleum coke production has been started, which has been mostly exported but its domestic market is expected to grow.

Refined oil products are used by the whole national economy as fuels for vehicles and for combustion facilities. Motor gasoline products are mostly used by household and small enterprise vehicles, naphtha is processed as feedstock by the petrochemical industry. Diesel oil is mostly consumed by transport activities characterised by the demands of the transport sector, agriculture sector and the household sector. Besides, diesel oil consumption of the chemical industry is also significant.

Domestic production of crude has not been influenced by the oil market price, and no significant change in domestic production is expected to be induced by price. Oil production and refining has rather been influenced by the geological possibilities; all the accessible diminishing reserves are cultivated.

According to the prognosis of the Hungarian Geological Service the industrial oil stock was 22 Mt in 2002. Based on the 2003 statement of MOL about its research and production activities the amount of oil produced in the proceeding 8 years is going to level at app. 1000 kt/year.

The total refined amount in 2002 was 5.9 Mt crude oil and 1.3 Mt other raw material, altogether 7.2 Mt. The capacity of the Duna Refining Plant can be increased only by less than 10%. In the next 10 years the nominal refining capacity can slightly be increased but the effective production capacity barriers are different for all products.

3.8.3 Natural Gas Industry

In the past the consumptions trend showed a slight increase with an exponential but almost linear curve with an average 2% growth per year. The annual deviation was between 8-10% possibly caused by interim drops in sectors or changes in market structure. The most important exogenous factor is the fluctuation of the daily temperature, which has a different influence on residential and industrial consumption.

Three main segments are distinguished to be forecast in this sector: households, municipal and industrial consumers. Industrial consumers are characterised by food, chemical, non-metal mineral products and energy industry.

After 1996-97, the rate of increase in the number of households supplied with natural gas has started to slow down. The ratio of households connected to the supply system was close to 80% in the ‘90s. As it is not feasible to supply all the potential residential consumers, the number of settlements that can be connected to the natural gas distribution system is close to saturation. Residential consumption is forecasted to be close to equal of the annual amounts used in the recent years.

The two major sectors in the group of industrial consumers are processing industry and the energy sector.

The sub-sectors of processing industry with much GHG emissions of natural gas use are food industry, chemical industry, the production of non-metal mineral products. The natural gas use of food industry depends on the level of real wages of consumers. As food is a necessity good, income elasticity of demand is less than 1 (in 2002 estimated to be 0.6). Predicting that real wages increase at the same rate as gross domestic product in the next decade ($\approx$ 3.5%) this would mean an app. 2%/year increase for the food industry.

Natural gas consumption by the chemical industry is fluctuating. This is mainly caused by some developing and some declining sub-sectors. Some aggregated prognoses predict a higher industry increase than the GDP growth (6-8%). In this projection the growth rate for this sector was assumed to equal that of the GDP growth ($\approx$ 3.5%).

Natural gas use in the non-metal mineral products sector is app. equally distributed among glass-, brick-, tile- and other sectors: cement, lime and gypsum production. Based on the inventory data of the previous years and with a linear trend variable (R2=0.84) the past consumption trend could be estimated well, so the linear model was used to forecast the future trend.

The most dynamic growth can be seen in the energy sector. The twelve-year average of natural gas consumption by the energy sector shows a clear trend of growth the magnitude of which is 3.8%/year. This trend seems to characterise future consumption levels for the following reasons:

- economic growth causes an even more accelerated increase of electricity consumption,
- at present, the installation of natural gas combusting power plants seems to be the most feasible investment to increase capacities,
- economic growth is not going to reach a "saturation point".

In the next 10 years relatively low natural gas price is expected, contributing to a cheap electricity production. The deregulation of the natural gas market will further enhance this trend by leading to a price reduction as a result of international gas price competition. The exact projection of natural gas consumption by domestic power plants was based on the electricity sector forecast, resulting a significant growth of gas consumption.

3.8.4 Electricity industry

A recent feature of electricity consumption is that increase of demand in the hot months is higher than in the winter or transition months, an effect caused by spreading use of air-conditioning equipments. The excess summer consumption generated by the spread of air-conditioning leads to the smoothing of the annual load curve.

The national model for the deregulated electricity sector was laid down by legislation in 2001. After 2003 big consumers, after 2004 all non-household users and after 2007 all consumers are eligible to buy electricity from the supplier of their choice. Producers can get access to the national transmission grid by regulated codes, consumers shall pay standardised grid charges.

Another feature of this sector is that the transmission capacity of the cross-border interconnectors is limited. Accessible cross-border capacities are allocated to market participants by annual and monthly capacity-auctions.

To improve supply in the open market segment power plant capacity auctioning was introduced (virtual plant auction). The role of this annual or half a year auction is to liberate unused production capacities contracted by power plants and MVM Rt (the national electricity transmission and wholesale monopoly) so that the open market may allocate those to the highest bidders.

Captive consumers are supplied along a single buyer model. A captive consumer can buy electricity from the designated local monopoly supplier, only. Suppliers in the single buyer segment must purchase from MVM Rt exclusively.

The most important barriers for the strengthening of the deregulated segment of the electricity sector are the long-term power purchase agreements between the largest power plants and MVM Rt. These contracts cover 80% of the production capacity, which is thus un-available for the consumers eligible to the open market. The policy instruments designed to deregulate the monopolistic electricity utilities have proved to be weak. The negotiations, aimed at the reduction of the contracted capacity, failed as the interest of power plants is the opposite, as they achieve significantly higher income in this system than they could in an open market. It seems to be a real threat that MVM Rt. will be interested in holding back supply in a longer-term.

In 2003 the EU accepted the new directive for the regulation of the internal electricity market (2003/54/EK). As a result, Hungarian regulations will have to be modified. One of the basic principles of the new EU regulation is that monopolistic rights shall only prevail in exceptional cases, the opposite of the current domestic situation. In a few years time the present "double-segment" electricity sector will have to be properly deregulated.

As the current stranded cost regulation is not providing incentives for the breaking or re-negotiation of the present portfolio of power purchase agreements by the wholesale monopoly, the sector forecast is based on the assumption that the concentrated supply structure and the high ratio of import remains intact.

3.8.5 District-heating

70% of domestic district heating is produced in power plants, mostly co-generated with electricity. The ratio of heating plants, mostly in municipalities is declining; their ratio presently is around 30%. The installation of low capacity co-generating gas motors has showed an outstanding acceleration in the recent years. These motors usually take over consumers of old heating plants.

Natural gas is the most preferred fuel to be combusted in this sector, coal is declining, oil dropped dramatically. The number of residential sites supplied with district heating is limited, and the number of districts that can be efficiently supplied is decreasing exponentially with distance.

The trend of district heating supply and consumption is highly influenced by regulation. The reason for that is the extent of authority intervention, the dominance of authority prices, the obligation of municipalities to supply and regulate, the feed-in obligation of co-generated electricity. In 1998 a new law was added to the regulation of district heating mostly to halt or slow the loss of the district heating consumers' market.

3.9 Waste

Domestic waste management policy is laid down in the National Waste Management Plan (NWMP) approved by the Parliament. This plan determines the waste management goals of the National Environmental Program regularly prepared. A short-term projection was prepared on the basis of this plan. The realisation of the goals of the plan is going to have an essential influence on GHG emission. These goals and the expected trends are as follows.

The total amount of waste should be reduced to the quantity of year 2000 by means of preventive action. To achieve this, the application of low-waste technologies, the production of re-usable and long-life products and a campaign to change the consumption behaviour of the population shall be supported. This means that the total amount of waste generated in 2008 shall not exceed 68.4 Mt, of which municipal solid waste accounts for 5.2 Mt.

The amount of biodegradable waste disposed of at landfills should be gradually reduced to 50% by 2007 and to 35% by 2014. The waste fractions of municipal waste mostly affected are organic waste from kitchens, gardens and parks and paper. To achieve this target organic waste has to be separately collected and treated, mostly recycled. The amounts predicted for 2007 are 960 thousand tonnes of biomass waste and 470 thousand tonnes of paper, and 1340 and 650 thousand tonne of biomass and paper for 2014. From GHG emission point of view the most important target is that of recycling of biomass waste, the baseline projection is based on this strategy.

Direct material consumption of production units is characterised by the Direct Material Consumption Index (DMCI). This index for Hungary shows that GDP growth has been separated from the growth of primary natural resources consumption. DMCI has shown a slow rise far below GDP growth. As material use is in close connection with waste generation, this trend indicates the reduction of waste generation. The amount of waste produced in the EU is 3.8 tons/year/capita. This value in Central- and Eastern Europe is 4.4 tons/year/capita. This index is composed of an industrial waste amount component, which is higher, and a municipal waste component, which is lower than that of the EU. This clearly indicates that this region has an intensive industrial waste production, but the population generates a lower amount as consumption habits are different from those of the EU population. Supposing that the region follows the EU trend, the quantity of industrial waste is going to decrease, while the amount of municipal waste will grow in the future. As the absolute amount of industrial waste is much higher than the total municipal, the overall value is predicted to decrease.

3.10 Agriculture and land use change

According to the current data, out of the area of the country 63% is agricultural area (48.5% arable land, 3.1% garden, orchard and vineyard, 11.4% grassland), 19.1% forest, 1.1% reed and fish-pond, 16.9% uncultivated land area. 41.0% of the area is managed by business organisations, 44.7% by farmers, 14.3% is of other organisational, institutional and public goals.

In 2003 the proportion of agriculture in the GDP was 2.9%, and 5.7% together with food industry. The proportion of the employees in the agriculture is 5.5% projected to all the employees of the Hungarian economy.

The size of plough-land utilised for corn cultivation is expected to grow by 10% in a few years. The reason for that is EU subsidy for a certain land size accompanied by an additional national subsidy. No significant change is foreseen in the yields of crops, though weather extremities can have an influence.

The most important industrial crops are oil seeds plants (sunflower, rape), sugar beet and potato. The overall profitability of crop growing is predicted to increase, caused by the rising EU subsidies and domestic price increase. Environmental programs are expected to extend, another factor to enhance bio-cultivation. No considerable change is expected in the yields or the size of plough-land for industrial plants. These products are supported by the EU and their cultivation is inevitable because of the alternation of crops, as well. The other reason for the projection is the potential of these plants to be used as renewable energy sources (e.g., bio diesel, ethanol, pellet).

The cultivation of sugar beet is regulated by a production quota system, the overall volume of which was not exhausted by the country in the previous years. Moreover,

Calendar year		1930	1950	1960	1970	1980	1990	2003
Forest area	1000 ha	1091	1167	1306	1471	1587	1657	1821
	%	11.8	12.5	14.0	15.8	17.1	18.4	19.6

Table 3.10 Expansion of the forest area until 2003

there is cheap import from Poland, the volume of which increased ten times in 2003 over imports of previous years.

The average yield for potato is predicted to increase from the present 18 tons/hectare to 30 tons/hectare as a result of increasing market competition. Achieving this yield is assumed to be inevitable in order to stay in the market.

The whole territory of vegetable plough-land is authorised for EU subsidy, but does not receive a national top-up. Processing subsidies have been terminated and could not be replaced by EU sources. This led to the reduction of the profitability of this sub-sector, which is balanced by the improvement of yields and the efficiency of cultivation. Yields can grow to reach 30 tons/hectare, but land size is predicted to stagnate.

No considerable change is expected in the size or yields of rice.

Fertiliser use dropped significantly after the collapse of the East-European markets. Fertiliser use mostly depends on the profitability of the sector and fertiliser prices. Fertiliser use is expected to grow.

Forest planting is expected to accelerate in forestry. 9 000 hectare/year forest is expected to be planted in 2005-2006; this value is predicted to rise to 15 000 hectare/year between 2007-2013. These forests are predicted to be planted on low and medium quality plough-lands, as most of the grass lands are under protection. On top of that, an additional 762 000 hectares of forest plantations are expected for ecological purposes by the end of the decade. EU subsidies for foresting are competitive with ploughing subsidies, so there is no danger of keeping low yield plough-lands in cultivation just to draw more support than from switching over to forestry. The annual wood felling is expected to stagnate around app. 8 million cubic meters of harvested wood.

Land use change and alteration of cultivation methods affects the biomass content of land. Two scenarios were developed for these conversion processes; an intensive and an extensive land use change scenario.

The GHG emission of animal husbandry is in close connection with the number of animals, the amount of manure generated and the technologies applied for manure treatment, variables considered in the prognosis. Animal husbandry is subsidised by the EU until 2010, but a new subsidy scheme is planned after 2005 or 2007 the latest. In the new scheme the subsidised unit is not the number of animals but the average income level of the farm. This will probably decrease the temper for animal husbandry, with a limited scope to regard size of the animal population. It is assumed that Hungary keeps 50% of the current subsidy system to balance the negative effect of the changing subsidy scheme.

The Hungarian agricultural production has practically developed in accordance with the country's ecological and economic capabilities till mid-1980, several branches have reached world standard. In the second half of the '80s production started to decrease, and during the '90s a dramatic fallback was registered. Between 1990 and 1995 as well as 2003, the number of agricultural production units decreased by more than 30%, the employees in agriculture by more than 60%, the volume index of gross production of agricultural products by more than 30% and livestock by almost 50%. Simultaneously, the production efficiency of several branches has decreased. Production per one hectare agricultural land has decreased both in plant production and animal breeding. (HCSO 2004, Table 1.2, 1.3, 1.4 17-19.p.)

3.11 Forestry

Forests and forestry in Hungary are traditionally important for people both from economic, as well as social and environmental points of view. Managing forests has been changing for the last decades, and especially for the last few years. The information in this part of the report is based on sources from relevant ministries, the National Forest Service and research organizations.

Due to its natural conditions, Hungary used to be a forested country with a high forest ratio. This ratio fell down to 1.1 million hectare, or 12% by the end of the 19th century.

Time (year)	1980	1993	2003
Primary objective	Forest area in thousand hectares		
Productive forest	1 287.3	1 348.4	1 175.0
Seed crop stands	2.8	5.6	2.9
Game Management	1.9	25.0	7.1
Protective and protection forest	198.3	245.1	605.8
Recreation	54.9	45.6	25.8
Other forest	33.6	39.0	4.1
Total	1 618.8	1 708.7	1 820.7

Table 3.11 Distribution of forest area (thousand hectares) by primary management objectives

Later, as a result of the large scale national afforestation, the forested area of the country increased by more than 600 000 hectare. The annual afforestation ratio declined

Species	Age class											Total	Species ratio (%)
	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-		
Quercus robur	15.7	20.7	16.8	11.2	26.6	14.7	11.7	8.8	8.1	9.1	6.8	150.1	8.9
Quercus petraea	8.9	12.3	11.1	13.9	11.3	19.5	28.2	23.2	20.3	13.8	13.5	175.9	10.4
Quercus cerris	10.6	14.6	16.5	16.9	14.5	24.1	32.3	26.6	18.6	10.2	9.0	193.8	11.4
Other Quercus	1.8	2.7	4.9	3.8	2.2	1.7	2.4	2.7	3.0	2.2	4.2	31.5	1.9
Fagus silvatica	4.1	5.9	4.6	4.8	5.3	9.7	12.6	11.5	12.7	12.1	20.5	103.7	6.1
Carpinus betulus	1.1	6.2	9.3	8.6	7.8	14.4	17.0	13.3	9.4	5.1	4.3	96.5	5.7
Robinia pseudoacacia	88.7	119.1	81.5	48.0	32.5	7.5	1.6	0.4	0.1	0.0	0.0	379.5	22.4
Acer sp.	0.8	2.2	2.8	2.5	2.8	1.1	0.6	0.5	0.4	0.2	0.6	14.4	0.9
Ulmus sp.	0.9	0.7	0.5	0.5	0.6	0.2	0.1	0.0	0.0	0.0	0.0	3.6	0.2
Fraxinus sp.	2.7	4.8	5.0	4.4	7.0	5.8	5.5	3.9	2.9	1.7	2.3	45.9	2.7
Populus x euramericana hybrids	41.7	46.1	16.9	9.5	3.2	0.4	0.1	0.0	0.0	0.0	0.0	117.8	7.0
Populus alba and tremula	13.1	15.1	10.8	6.5	6.1	2.3	1.0	0.3	0.1	0.0	0.0	55.4	3.3
Salix sp.	0.8	5.0	6.8	5.5	2.8	1.1	0.5	0.2	0.0	0.0	0.0	22.7	1.3
Alnus sp.	2.9	8.8	11.3	9.8	9.3	4.5	1.5	0.5	0.1	0.0	0.0	48.7	2.9
Tilia sp.	0.3	1.4	2.9	3.2	2.1	2.4	2.2	1.4	1.1	0.7	0.9	18.5	1.1
Pinus silvestris	2.5	16.0	45.6	30.6	23.1	7.8	5.5	3.4	2.3	1.1	0.7	138.6	8.2
Pinus nigra	5.6	13.8	15.6	13.5	12.6	2.1	2.0	1.3	1.0	0.7	0.4	68.7	4.1
Picaea abies	0.6	5.1	8.7	3.4	2.2	0.7	0.5	0.3	0.2	0.2	0.1	21.9	1.3
Larix europea	0.2	0.9	0.7	0.5	0.7	0.2	0.1	0.1	0.1	0.1	0.1	3.7	0.2
Other conifers	0.1	0.2	0.4	1.0	0.5	0.2	0.1	0.0	0.0	0.0	0.0	2.5	0.1
Total	203.0	301.5	272.6	198.0	173.1	120.3	125.5	98.1	80.4	57.5	63.3	1693.4	100.0
Age class ratio (%)	12.0	17.8	16.1	11.7	10.2	7.1	7.4	5.8	4.7	3.4	3.7		

Table 3.12 Forest area by species and age class (in thousands of hectare and in %, as of 1 Jan 2003)

in the 1990s, but increased again in the last few years (Table 3.10). This increase shows the commitment of the country to sustainable land use, and to the desire to combat environmental, social and economic problems.

By 2003, the total forest area in Hungary increased to 1 821 thousand hectares. This area includes the stocked forests and the temporarily unstocked areas, but excludes the roads, alleys, rides, clearings, fields, water surfaces and buildings, which are all integrated parts of forest holdings (133 thousand hectares, together with which the land under forest management amounts to 1 954 thousand hectares). The distribution of the forest area by primary management objectives is shown in Table 3.11.

About 25% of Hungarian forests are located at the border area of the forest cover in the dry continental climate zone where the relative air humidity in July is under 50%. Therefore, water is the major factor for the trees on these areas, i.e., it determines forest conditions and limits tree growth.

The most common bedrocks in Hungary are loess, sand, lime stone, dolomite, andesite and basalt. As a consequence of the great variety of bedrocks and the variable climatic conditions, a wide range of soil types developed. Forest areas are dominated by brown and dark forest soils, as well as by sandy soils with low humus content, but soils vary from alcalic on lowlands to podzolic and acidic soils in the hilly regions. Sites in the flooded belts along the two big rivers (the Danube and the Tisza) or with high water table represent favourable conditions for forests, but are heavily affected by the water management activities. All this explains why the diversity of tree species and forest types is so high, and why so many methods must be applied in the management of these forests.

In Hungary, unlike in most countries in Europe, an overwhelming majority of the forests is covered by broad-leaved species (Table 3.12). Conifers are mainly considered as introduced species, but a fairly high proportion of the broad-leaved forests also consists of introduced species, such as black locust and improved poplars. The most characteristic feature of the Hungarian forests is the big variety of mixed, sometimes multistoried stands of broad-leaved species. There are altogether some 150 species, varieties and clones registered in the Hungarian forests.

Almost all forests in Hungary are considered as even-aged and established artificially. Some experts distinguish

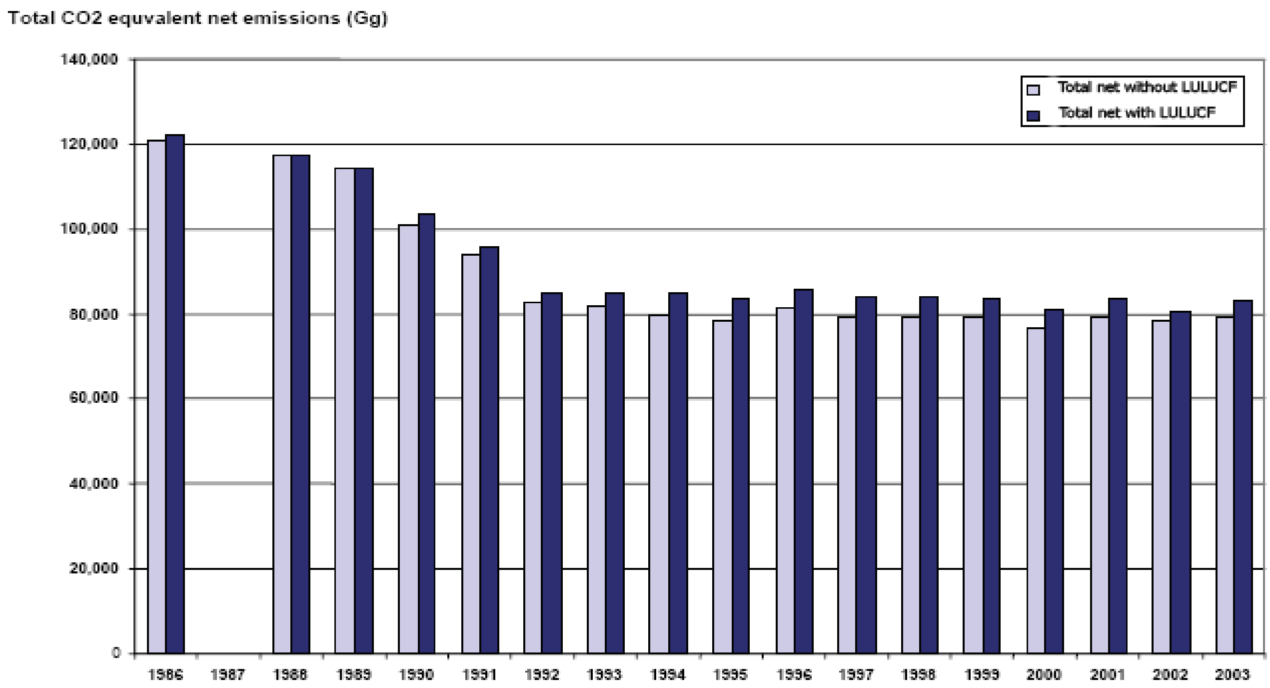

Figure 3.6 Trends of net emissions in the country that can be extrapolated with high probability at least for the next decade

plantations and natural types of forests. The existence of virgin forests in the country is questionable. Therefore, all forests are considered managed.

An important feature of the forests is that the length of the rotation period can vary between 15 and 120 years. Because of this, and because of the history of the forests, the age structure is uneven. It is to be noted, however, that, although less stands were cut in the last two decades than before, young forests dominate the landscape. This is also due to the fact, which was already mentioned above, that a lot of afforestations took place in the last century, the majority of which was done after World War II, and most stands from these afforestations have not reached their rotation age, rather, they fall in the young age class categories (Table 3.12).

As for the origin of the stands, coppices occupy some 40% of the area. After felling, the natural regeneration process is preferred wherever it has a fair chance. The rate of stands regenerated in a natural way (coppice and regeneration cuts combined) amounts to about 50%.

The total growing stock of the productive forests amounts to 333.2 million m^3, and the majority of the current annual increment, 12.3 million m^3, is also being produced in these forests.

The mean net specific current annual increment (relative to the currently stocked area) is 7.3 m^3/hectares. This relatively intensive growth can be ascribed partly to the relatively favourable site and climatic conditions and partly to the relatively high proportion of tree-species of fast growth and of short rotation period. About 29% of the forests are covered with fast growing species providing 32% of the total current increment. The health condition of trees has not changed recently; it can be considered as acceptable.

It must be noted that both the net increment, as well as the growing stock has been increasing for decades in Hungary, resulting in a net sink effect. This is a result of the uninterrupted increase of forest area, change of species for faster growing ones, improved silviculture, and effective regulation. It can be projected with high probability that these trends will continue in the future for at least a decade (Figure 3.6).

Hungary's present domestic use of wood products is larger than her forests' wood production capacity. Therefore, Hungary is reduced to importing. There is, however, no considerable pressure on the forests because of the structure of the forests, i.e. that broad-leaves predominate, and because industry mainly requires conifers.

Considerable political, economic, and legal changes took place both in general in the country, and specifically in the forestry sector since 1989. An important milestone was marked in 1996 when the new Laws on Forests and Forestry, Nature Conservation, and Hunting and Game Management were passed. These new laws strengthened but redefined the goals and functioning of the management. While forest management planning remained obligatory and professional, planned wood harvests became more dependent on the wood market, which shows considerable fluctuations. Moreover, the countries' accession to the EU meant even more cooperation, but also more dependence on the international situation.

One such a consequence is the change of the inner market. Due to climate change considerations, more and more biomass is required for energy production. This favours forest managers, because they can sell, at a relatively good price, fuel wood-quality broad-leaves timber, which was sold earlier, to the particle-board based industry, at a low price. This even created tension between the forest managers and the former buyers, because temporary shortages and higher prices considerable changed their production conditions.

4. Greenhouse Gas Inventory Information

4.1 Introduction and Methodology

As previously mentioned, Hungary produced its first National Communication in 1994, when it joined the UN Framework Convention on Climate Change. The greenhouse gas emission inventories have accordingly been prepared since. Initially the reports were prepared according to the published IPCC "Draft Guidelines for National Greenhouse Gas Inventories," which regulated the inventories and reports of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) gas emissions. Until 1997, Systemexpert Limited Liability Co. prepared the inventory. From 1998, the Ministry of Environment commissioned the Institute of Environmental Management's Institute for Environmental Directorate (IEM) to prepare the inventories. IEM is owned by the Ministry. Since the submission of the inventory for 1998 in 2000, IEM has prepared the inventories using the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories" (further referenced to as Revised Guidelines), published by IPCC as an amendment to the "Draft Guidelines…". The new software prepared by IPCC was introduced in parallel with the new methodology. In 1999, the Secretariat of UNFCCC published the software "Common Reporting Format (CRF)," which harmonized the formatting of the emission reports. Also in 1999, the IPCC published a "Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories" handbook (further referred to as "Good Practice Guidance"), parts of which were already used for the preparation of the 1999 inventory.

The Revised Guidelines further improved the methodology of the draft version for the preparation of the national greenhouse gas emissions. It provided more specific default emission factors for several further technologies, or means to obtain these values. At the same time it included the "newer" greenhouse gases (i.e. partially fluorised hydrocarbons (HFCs), fully fluorised hydrocarbons (PFCs) and sulfur hexafluoride (SF_6)). Furthermore, the preparation of the inventory also included the precursor gases /(nitrogen oxides (NO_x), carbon monoxide (CO), non-methane volatile organic hydrocarbons (NMVOC))/, and sulfur dioxide (SO_2). The inventory of these gases has been prepared in Hungary since 1980 according to the LRTAP convention, so we have taken the relevant data from this source.

The Good Practice Guidance introduces the concept of key source category, which includes the technologies contributing to 95% of national emissions. The application of this concept facilitates the analysis of the sources and the examination of the inventory. In the last few years we have performed the Level and Trend analysis using Tier 1 methodology and identified the key source categories.

In 2004 National Directorate for Environment, Nature and Water (OKTVF), the successor of IEM, has taken over the responsibilities for the preparation of the inventory, under the same conditions: unfortunately, the resources required for the preparation of the emission inventories are not fully available – neither in funding nor in terms of staff. Two full time staff members and a few contractors need to prepare the inventory at OKTVF. As a result for years we did not get the chance to review the inventories prepared for years prior to 1998 according to the Revised Guidelines, and as such there was no consistency in the data, and major discrepancy was observed in some cases between 1997 and 1998 data points.

In the last few years we have gradually revised and modified the inventories, according to reviews by the UNFCCC Secretariat, especially the in-depth review in 2002. As a result emission trends are became more accurate.

The base year for Hungary was determined in the first inventory report. The choice of 1990 as the base year for comparison in the Framework Convention did not seem appropriate, as during the transition from a centrally planned to a market economy Hungary's economic performance showed a strong decline. It would have been

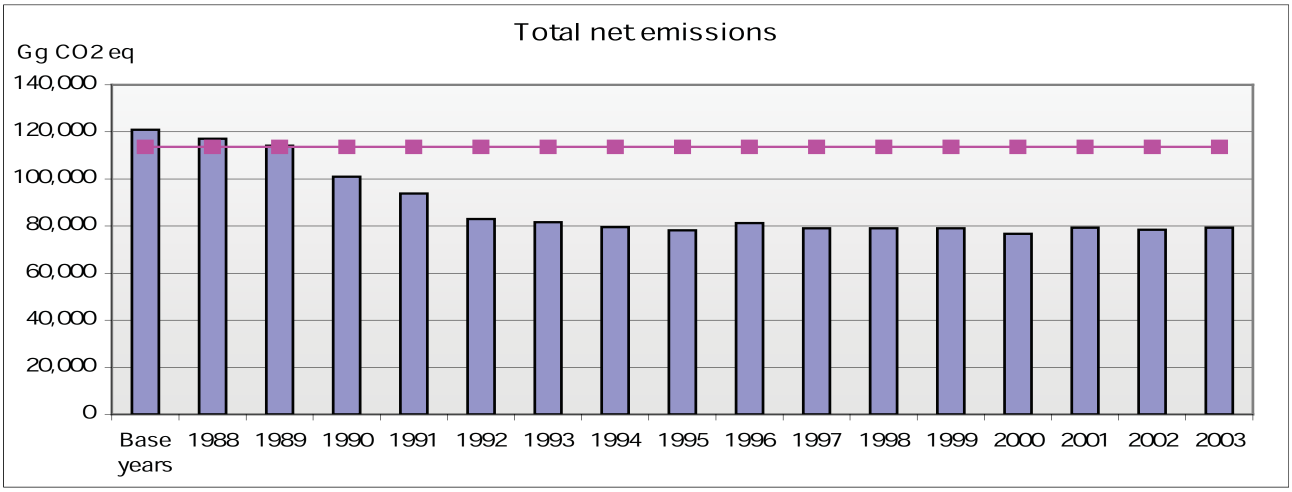

Figure 4.1 Trends of GDP and total GHG emissions

disadvantageous for Hungary to select a year of such deep economic decline as the base year. See Figure 4.1. (1960=100 %)

For this reason the average of the years 1985-1987 was suggested as the base period for Hungary, which represented a relative period of economic stability. The COP accepted this period as the base year.

With the admission of new greenhouse gases into the system, it has become necessary to determine the base year with respect to these gases. (This was especially crucial in the case of HFCs, which have been used extensively since the mid-nineties to replace freon type gases, which contribute to the destruction of the ozone layer.) Hungary has not yet determined the base year for these gases.

As the method to develop the inventories was refined over the years, more and more sources of information were used to determine the values. The emission data are based chiefly on the energy balance collected by the Energy Centre Non-profit Co. and the yearbooks of the Hungarian Statistics Office. We have also used specific data in relation with agriculture, forestry and various industrial sectors. As such the Tier 1 methodology initially used was gradually replaced by the more accurate Tier 2 and Tier 3 methods. To determine the emission of fluoride gases import data provided by the National Customs and Excise Office was used (since these gases are not produced domestically), and this was gradually replaced by data collected directly from importers and their clients.

The Hungarian statistical system in the 1990's was different from the one required by the Revised Guidelines. Therefore in many cases the data available could not be used and estimates had to be made to modify the data and obtain the required values. This has naturally lowered the reliability of the inventory. The new statistical classification system introduced at the end of the last decade was in line with international standards, but a few years were necessary for the changes to trickle through the entire economy. It needs to be noted that in the statistical system the coke manufacturing and oil refinery are still classified in the energy sector, and as a result we cannot place the data as required by the IPCC categories in the inventory.

The lack of factor values adapted to Hungary's idiosyncrasies in most sectors used to be another source of problems. In the majority of calculations we used the default values recommended by the Revised Guidelines and Good Practice Guidelines for Eastern European technologies. However, in sectors where more developed technology has been adapted, we used the corresponding default values from the Guidelines. In the case of a few technologies (aluminum production, CF_4 emission etc.) we determined the factor emission values for Hungary based on the recommendations in the Revised Guidelines.

Also, as the experience of the professionals preparing the inventories has increased in collecting and using the data over the years, the levels of completeness and thus the quality of the inventories have also improved. This improvement at the same time led to discrepancies between subsequent years, but these have been remedied in parallel with the provision of consistence data sets. Naturally, the accuracy and completeness of the values for the early years does not match the level of the most recent years.

Since 2003 the Ministry for Environment and Water (KvVM) has provided resources for the recalculation of inventories of the early years. This work was completed in the spring of 2005. As the first step, we have revised the methodology for the calculation of base year data (1985-1987) as well as for 1990. We then prepared the inventories for the missing 1988-1989 periods and recalculated the inventories for 1991-1997. At the same time correction were made to ensure consistency in the time line for each data type. This was necessary where new data was found for a particular activity or emission factor or when the calculation methodology was altered. Besides the tight resources available, what also made this task

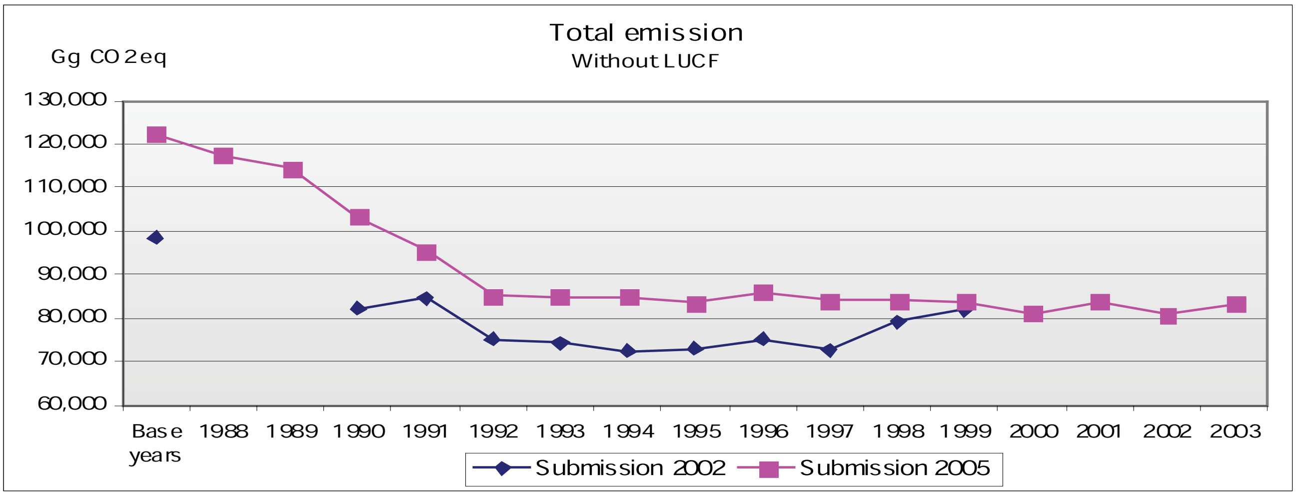

Figure 4.2 The changes since the submission of NC3 in CO_2eq values

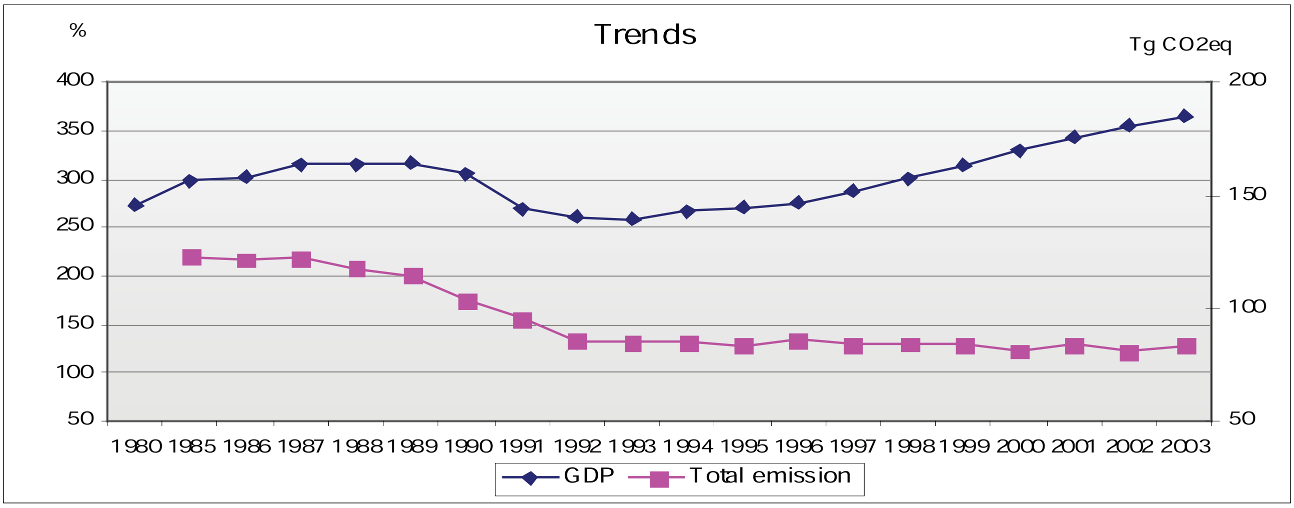

Figure 4.3 Net emission values from the base year until the last year for which inventory has been completed, taking into consideration the effects of greenhouse gas removal

hard is that unlike for other countries we needed to ensure consistency in the inventories of 20 years (base year + 19 years), due to Hungary's derogation in the selection of the base year.

During the data revision national factor values were determined in the case of several technologies and then applied these consistently for the entire period. At the same time in many cases we switched from the top-bottom method to the more accurate bottom-top approach. In such cases we were able to use country or plant specific factor values.

In addition to the general changes just mentioned, the following main alterations have taken place since the preparation of the previous, third national inventory:

1. Energy:
    - 1.1. detailed calculation of CH_4 and N_2O emission;
    - 1.2. calculation method for fugitive methane emission;
2. Industrial Processes:
    - 2.1. calculation for Metal Production CO_2 emission;
    - 2.2. calculation for Chemical Industry CH_4 and N_2O emission;
3. Solvent and Other Product Use: calculation of CO_2 and N_2O as well as NMVOC emission;
4. Agriculture:
    - 4.1. methodology to determine total animal numbers;
    - 4.2. calculation methodology for Enteric Fermentation CH_4 and N_2O emission;
    - 4.3. calculation methodology for Agricultural Soils;
    - 4.4. calculation methodology for plant cultivation;
5. LUCF: calculation methodology for soil;
6. Waste:
    - 6.1. Solid Waste Disposal on Land: calculation methodology for CO_2 and CH_4 emission;
    - 6.2. calculation methodology for Waste-water Handling CH_4 emission;
    - 6.3. calculation methodology for Waste Incineration CO_2 emission.

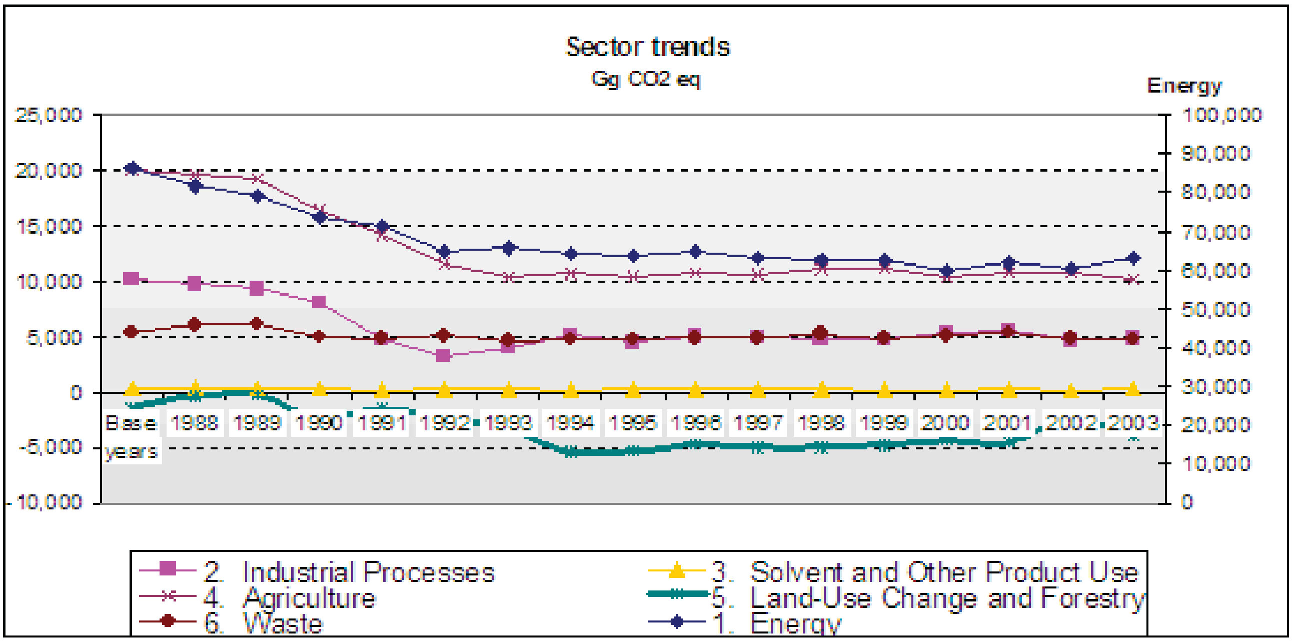

Figure 4.4 The changes in precursor and SO_2 gases emissions over time

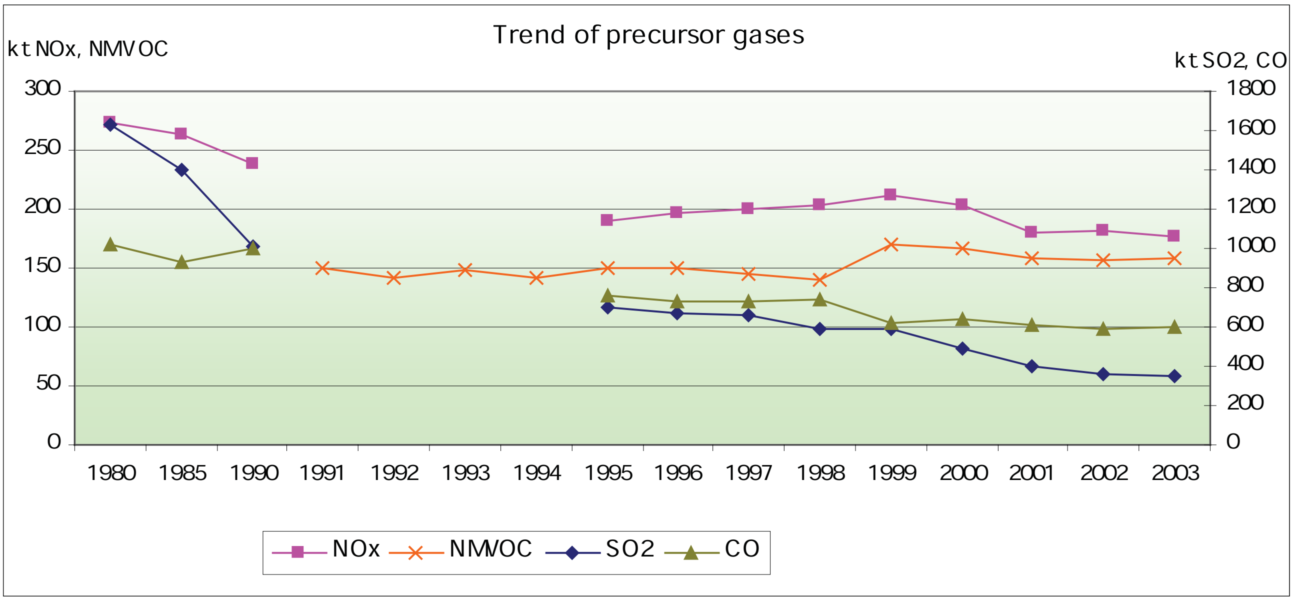

Figure 4.5 Trands of precursor gases

4.2 Aggregated Emissions

Hungary has committed to the reduction of greenhouse gas emission by 6% under the Kyoto Protocol. The straight line on the Figure shows the reduced value. The collapse of the centrally planned economy meant a major decline in economic production, and in line with this decline the emission of greenhouse gases also fell until the mid-nineties and then stabilized at around 83 000 Gg. By 1999 Hungary's GDP again reached the value of the late eighties (see above, Figure 4.3), but at the same time emission levels remained significantly lower. Thus, Hungary is expected to be able to fulfill the commitment it made under the Kyoto Protocol.

Figure 4.4 shows the change in the emission of various sources as well as removals, broken down into sectors. Emissions by the Energy and Agriculture sectors have the most significant impact on total emission.

The decline in gas emissions related to heating is the result of a decrease in the use of fuels. In the case of CO, but especially NO_x this decline has been somewhat counter-balanced by the increase in transport fuel use. The more robust decline in sulphur-dioxide emissions is due to the introduction of desulphurization plant at coal-fired power plants as well as the substantial decline in sulphur content of heating and transport fuel oils.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	NO_x	CO	NMVOC	SO_2
	Emissions /removals									
	CO_2 equivalent (Gg)					(Gg)				
Total National Net Emissions	56 496	9523	12434	478	190	162	208	600	165	348
1. Energy	57 592	2715	2936				207	543	112	345
2. Industrial Processes	2 688	10	1324	478	190	162	0.09	46.6	24.1	2.96
3. Solvent and Other Product Use	81		193						29	
4. Agriculture	0	2153	7977				0	0	0	0
5. Land-Use Change and Forestry	-3965	26	3				0.3	10.7	0	0
6. Waste	99	4619	0				0	0	0	0
International Bunkers	592	0.04	0.08				0.26	0.11	0.08	0.02
Biomass	2120									

Table 4.1 Summary data of the inventory of 2003

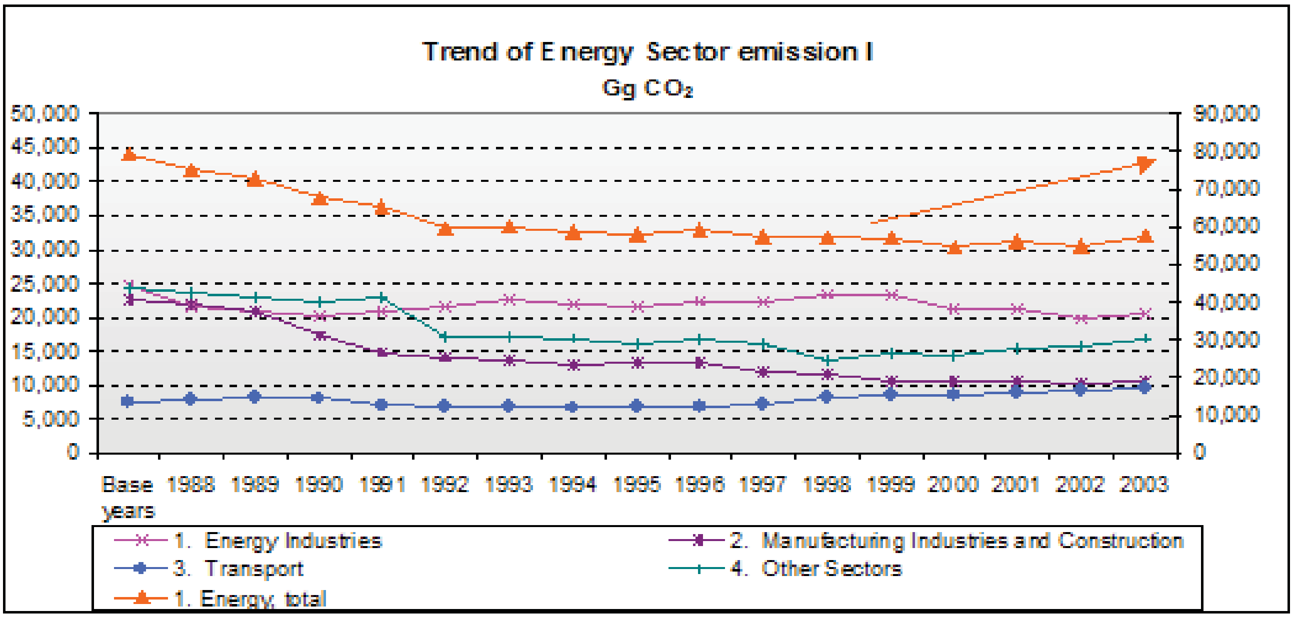

Figure 4.6 Emission trends in the energy sector

4.3 Emissions by Sectors

The most important data for Hungary's 2003 emission inventory are summarized in Table 4.1 above. SO_2 and precursor gas emissions are also included.

Summaries of trends for each sector and each gas are provided below.

4.3.1 Energy sector

The carbon-dioxide emission of the energy sector nationwide is the largest item in the inventory. The amount of emission, however, has fallen since the base year (Figure 4.6) despite a constant, or only slightly decreasing energy production during the same period. The emission decline in the Energy Sector is due especially to the industrial and communal (Other Sectors) combustion, while transport-related emissions are slightly on the rise. While the emission of the former has declined every year, the latter began showing an increase in recent years.

Figure 4.7 shows the breakdown of the various subcategories within the Energy sector.

Concerning the methane output of the energy sector (Figure 4.8), a slight downward trend with some fluctuation becomes apparent. The effects of shrinking coal mining activities and an increase in oil and natural gas consumption are clear. The largest decline is in the communal and industrial sectors. The emission marked as "Other" contains a peculiar to Hungary: on the Great Plain in eastern Hungary a significant amount of methane

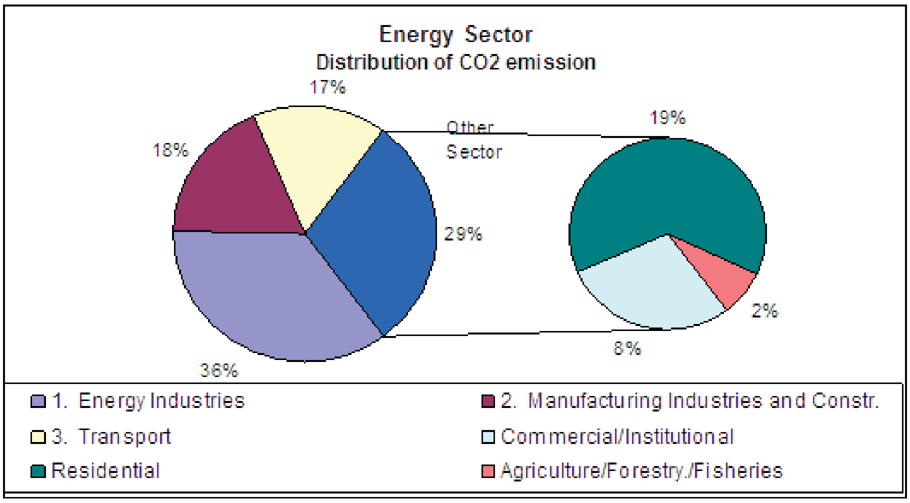

Figure 4.7 The breakdown of the various subcategories within the Energy sector

spouts to the surface along with thermal and spring water. The methane content is usually allowed to escape during the airing of the water. We have adopted the value of an earlier expert estimate, which determined the emission at 20 Gg. More detailed calculations for this methane emission are under way, though there is no regular monitoring in place.

Before 1998 no emission estimates were made in several subsectors. These have now been provided during the recalculation process.

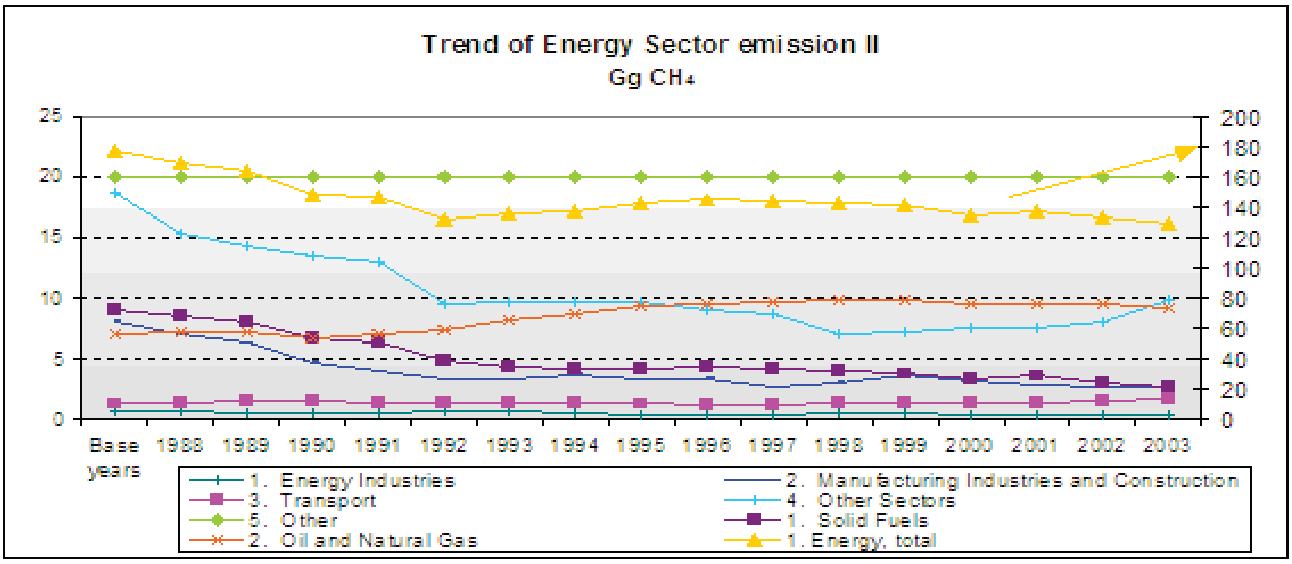

Figure 4.8 Emission trends of methane in the energy sector

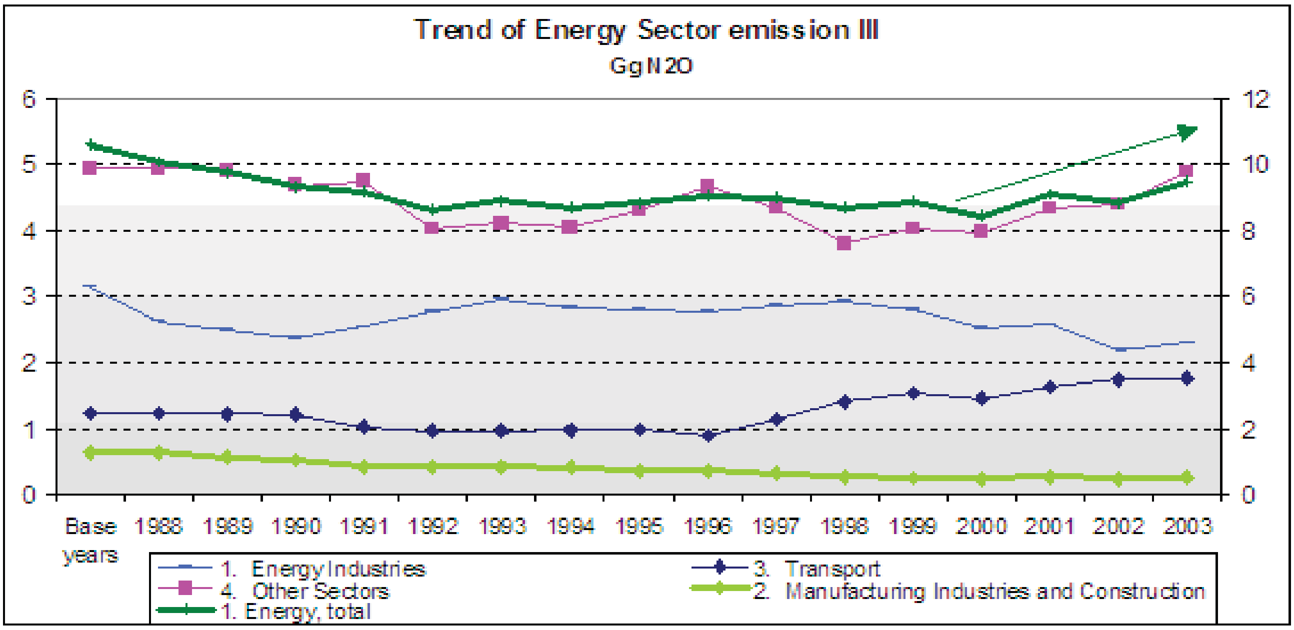

Figure 4.9 Emission trends of nitrous-oxide in the energy sector

The emission values for nitrous-oxide show a continuous decline (Figure 4.9), which is the net result of a decrease in heating fuel use and the increase in the use of transport fuels. It needs to be noted that this is the data that is the least reliable in the inventory, primarily due to the uncertainty in factor values. There have been no measurements to determine the factor values, so literature values are used, which are very scattered. (The Good Practice Guidance estimates the uncertainty of the factor values to be around 50%-100%). Prior to 1998 the data of several subsectors was missing from the inventory. These have now been provided during the recalculation process.

The emission of several technologies did not get included in earlier years.

Methane emission in the Industrial sector is particularly low, displaying a trend of slight increase. Its value in the base year was 0.37 Gg, which has risen to around 0.50 Gg in recent years. The production of active carbon and soot are confidential technologies, and as such their methane emissions could not be tabulated. However, its magnitude is within the values mentioned.

Nitrogen-dioxide emissions were previously not considered in the Industry sector. Since 2000 the emission related to nitric acid production is included. Due to lack of detailed data (nitric acid production used to be a confidential technology) we have calculated with the factor value of an average technology. During the second step of the recalculation process, emission measurements were introduced, leading to the realization that the actual emission values are far higher than those previously estimated. This is due to the use of an older technology in nitric acid production. At the same time we have obtained annual production data back to 1985, so we could calculate emission levels. The 14.65 Gg emission value in the base year has fallen to 4.27 Gg due to the general decline in industrial production.

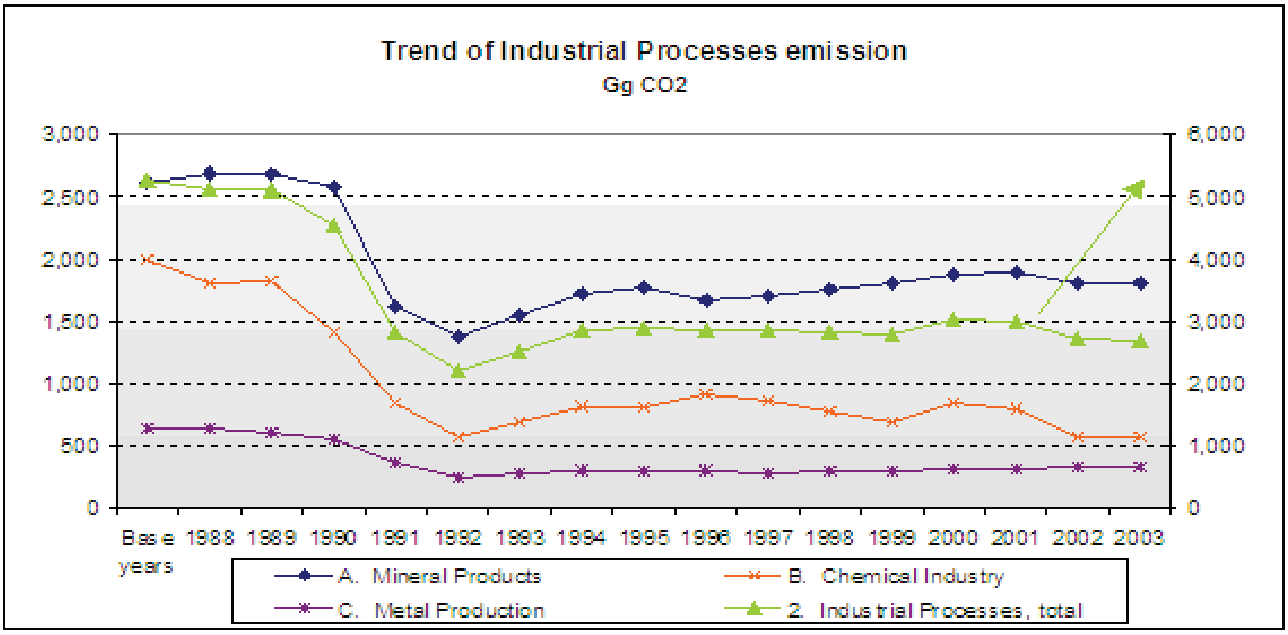

Figure 4.10 Trends of industrial process emissions

4.3.2 Industrial Processes

Carbon-dioxide emission in general well reflects the economic trends of the last decade. The early nineties saw a sharp fall compared to the base year, but as industrial production slowly picked up, so did carbon-dioxide emission (Figure 4.10). However, even in 2003 the emission level is far below base year levels.

Mineral Products especially cement production, make up the largest share of Industrial emissions. Since the previous report we have determined the amount of emission during ammonia production for the entire period. These values are listed in the Chemical Industry category. While initially the emission level was similar to that of Mineral Products, by 2003 it has receded to a much lower rate. Besides the general fall in production, this is due to a switch of CO_2 free technology at one of the factories. With respect to the Metal Production subsector it is worth noting that due to the peculiarities of statistical data gathering in Hungary, only some of the emission caused by iron and steel production is tabulated here, with the rest included in the Energy sector. Ferroalloy production was wound up in 1990.

The amount of fluoride gases was first calculated in 1998. In the case of HFCs we could not follow the Revised Guidelines, due to the lack of available statistical data. Given that HFCs are not produced in Hungary, we initially determine the potential and actual emission values based on import data, but have since gradually switched to collecting data from importers and users of HFCs. However, we have been forced to make estimates

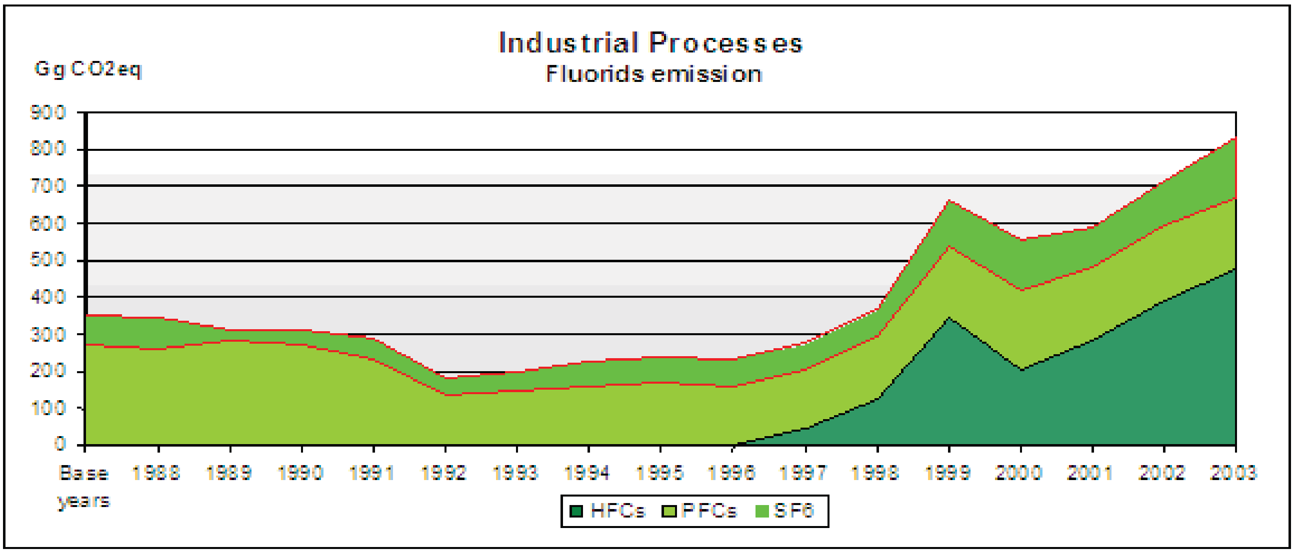

Figure 4.11 Fluoride emission from industrial processes

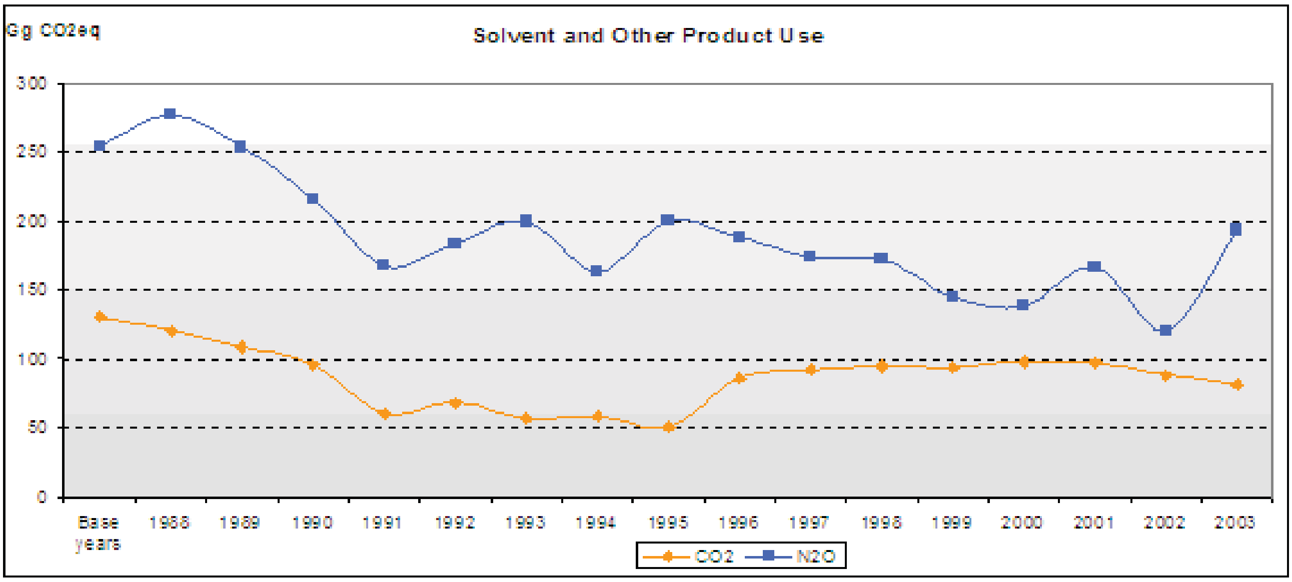

Figure 4.12 Emission from solvent and other product use

in several areas, particularly concerning the method of HFCs use. This began in 1992, initially in household refrigerators, but this use has since been on the decline due to a switch to technology using R600 (iso-buthane) coolant, which does not have any greenhouse effects. At the same time the use of HFCs – and the accompanying emission – is rising intensively in commercial refrigerators and air conditioning equipment.

In the case of PFCs the amount produced during aluminum manufacturing was calculated according to the Revised Guidelines. We obtained the activity values directly from the manufacturers.

In case of SF_6 we obtained the (electrical) consumption data chiefly directly from industry players. However, for the early years only one of the manufacturers could provide data, so we estimated the rest using general industrial production trends. Estimates were used to fill in gaps in the data series: when a company could not provide data for a particular year.

Figure 4.11 shows the trend of fluoride gases emissions.

The use of HFCs began in 1992, but remained insignificant until 1996. Since then, however, it has been sharply on the rise. The emission of PFCs follows the trend of aluminum production, though to a small extent is also used in cooling agents. The use of SF_6 has been increasing even though as an industrial gas one would expect it to follow the general decline in industrial production.

4.3.3 Solvent and Other Product Use

The sector contains mostly carbon-dioxide emission data due to the use of paints and solvents. Technologies using N_2O also fall into this category.

Carbon-dioxide emission was calculated based on the NMVOC content of paints, varnishes and their solvents, using factor values corresponding to their composition. As illustrated on Figure 4.12 the emission values show a

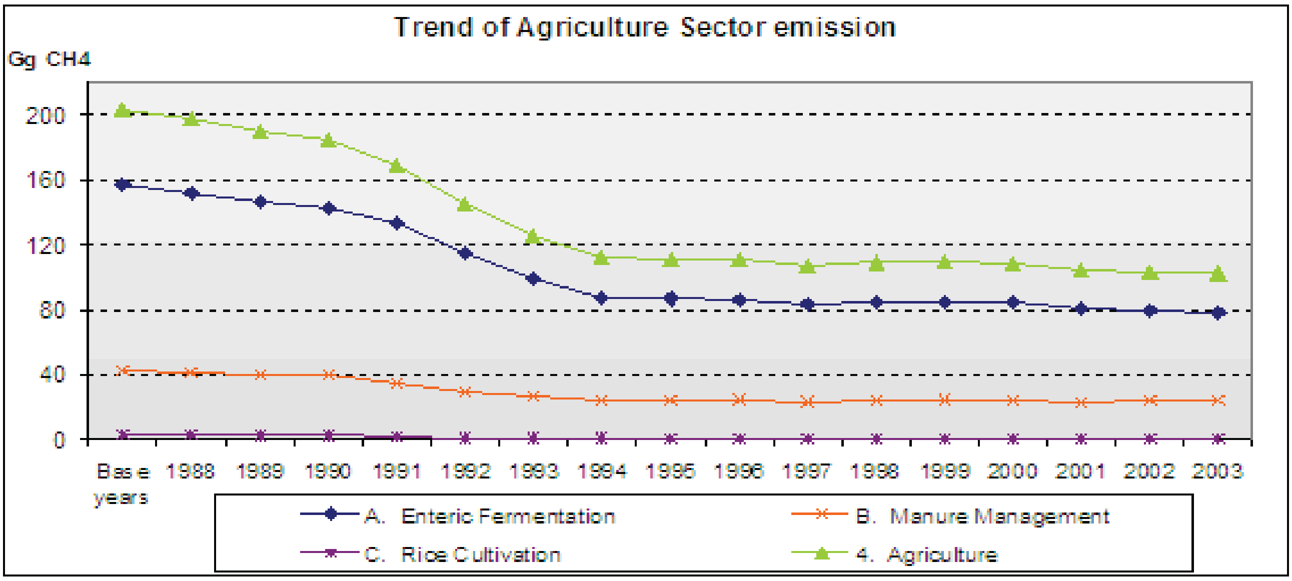

Figure 4.13 Methane emisions from agriculture

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
4. Agriculture, Gg				49.88	49.05	40.56	34.20	27.57	24.84	26.85
B. Manure Management, Gg				7.34	7.15	6.93	6.35	5.48	4.70	4.23
D. Agricultural Soils, Gg				42.49	41.87	33.63	27.85	22.09	20.14	22.62
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1995	1996	1997	1998	1999	2000	2001	2002	2003	
4. Agriculture, Gg	26.16	27.12	27.05	28.33	28.39	25.90	27.62	27.45	25.73	
B. Manure Management, Gg	4.18	4.13	4.05	4.11	4.07	4.16	4.02	3.98	4.00	
D. Agricultural Soils, Gg	21.98	22.99	23.00	24.23	24.32	21.74	23.60	23.48	21.73	

Table 4.2 Nitrous-oxide emissions

declining trend, due not only to the decrease in paint use, but also to the spread of water-based paints. The sudden increase in 1996 is due to the statistical reclassification of several products as paint.

Nitrous-oxide emission is the result of only partially known technologies that use N_2O itself. One of such technologies is its use as an anesthesia. Its other use is in household whipped cream production. This is done in cream-makers, where the cream is whipped using N_2O-filled cartridges. This technology has been traditionally popular in Hungary, but is now on the decrease.

Usage data was obtained from manufacturers. Most of the whipping cartridge production is for export, so we included only production values for domestic use. We have used 1 as the emission factor value, because according to information provided by manufacturers, the gas is emitted from the human body unaltered. The emission data fluctuates, but shows an overall declining trend, due mostly to the decline in whipping cartridge use.

4.3.4 Agriculture

No carbon-dioxide emissions were calculated for agriculture. The emission values for transportation and machinery use are included in the Energy sector.

The values for methane emission are shown on Figure 4.13.

The decline since the base year is apparent. Since methane emission is mostly a result of animal husbandry, the shape of the curve clearly indicates the state of this sector in Hungary. Rice production, which used to be significant, was reduced significantly already by the base year. The small production that was left before 1990 has declined or at most remained constant from each year to the next. Field Burning has been banned since 1986, so it has been included in the calculations only through 1990, at gradually receding values, but these values are so small (0.1-1 Gg) that they do not show on the Figure.

Data for nitrous-oxide emission are summarized in Table 4.2. The emission is due mostly to the usage of manure as fertilizer, but is influenced by N-fixing plants as well as

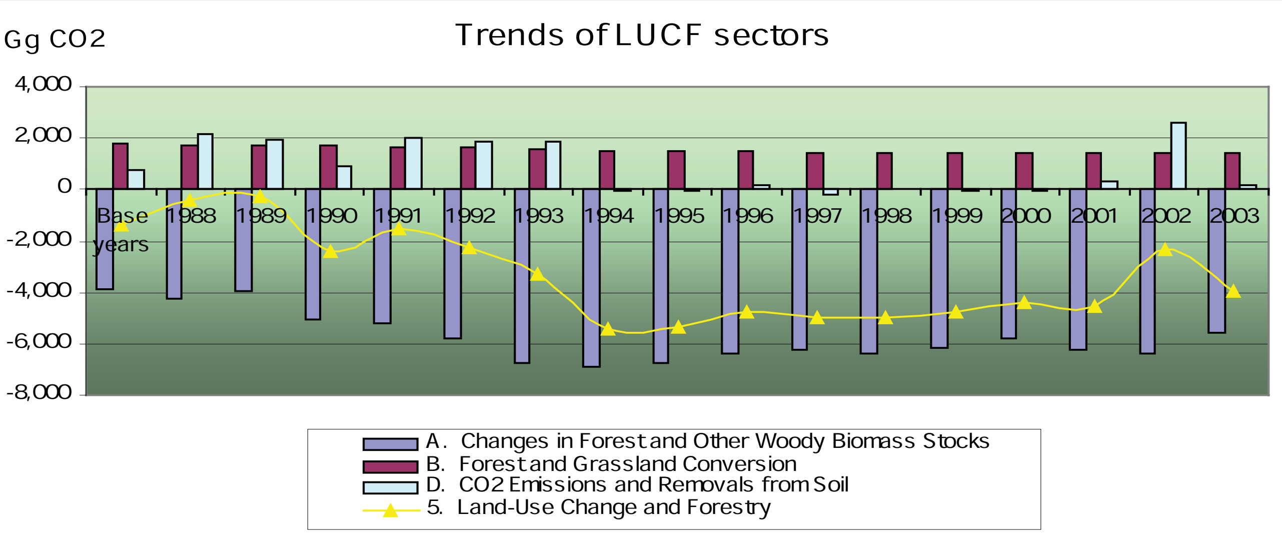

Figure 4.14 Trends of LUCF sector

the oxidation processes in the atmosphere. The decline since 1989 is due to the decline in animal husbandry and thus manure production. For the rest of the period the value shows a slight increase, not following the continuing decline in of the sector apparent in the methane emission figures. This is likely due to changes in plant cultivation. Since 1999 the emission figures have again decreased. Note that, as discussed before, of all the factor values, it is the values for N_2O that show the highest uncertainty.

4.3.5 Land Use Change and Forestry

The sector shows CO_2 removal by forests and the CO_2 removal or emission resulting from the change in organic carbon content of the soil.

For carbon-dioxide the sector is showing negative emissions – or removal. As Figure 4.14 shows there is emission in the subcategories Forest and Grassland Conversions and CO_2 Emission or Removals from Soil, while the removal of carbon-dioxide by forests shows up in the Changes in Forest and Other Woody Biomass Stocks subcategories. Forests always result in negative emission values, the value of which fluctuates around 6% to 8% of the total CO_2 emission. In the early years removal was on the rise, as a result of a gradual increase in the overall forest size. Since 1994, however, the removal level shows a slightly falling trend.

In the early nineties around a third of forests were privatized and ended up mostly in the hands of small landowners, and there is very little data available about the status and composition of these forests. Since there is no available data, we think the filling of this sector is the least sufficient.

The results show that in 2000 little carbon addition to soils can be detected, however, if we consider the uncertainty of initial data, especially that of soil type, this does not implicate any real change in the organic matter composition of soils. Increasing carbon content can be explained with the increasing addition of organic matters like fertilisers, or with the expanding areas of abandoned land. Less pastureland in comparison with the past 20 years explains decreasing carbon content of soils. The main reason of change is that grazing has been stopped on those lands and their classification changed into successional meadow. Another important change is that the extent of land cultivation is declining. 2002 shows extreme results compared to the preceding year and to 2003. It is conceivable that a measurement error skipped into statistical data and significantly influenced the result in such a manner that it produced this extreme value. And, the statistical measurement error in turn may have been caused by a faulty declaration (e.g., submitted by a farmer who was not obliged to do so, or a downtown area was taken into account in the declarations etc.). This by all means points out that fluctuations due to large statistical errors may occur and estimated errors of original data may not be disregarded either.

In the autumn of 1993, a large part of arable land of Hungary (mainly plough-lands and nursery-gardens) was reclassified into downtown area. By this, the basis of data supply changed, therefore the results of two intervals (1987-1993 and 1994-2003) cannot be compared, and trends can only be examined separately from each other. As a consequence of reclassification, statistical data and calculations are related to a much smaller area.

For the first period (between 1987 and 1993) we have very low values for the removal of carbon-dioxide, which was presumably caused by intensive cultivation methods typical of the direct neighborhood of settlements. This removal of carbon-dioxide did not cease after 1994, but these areas are not reported any more among agricultural land due to their reclassification into downtown area. At

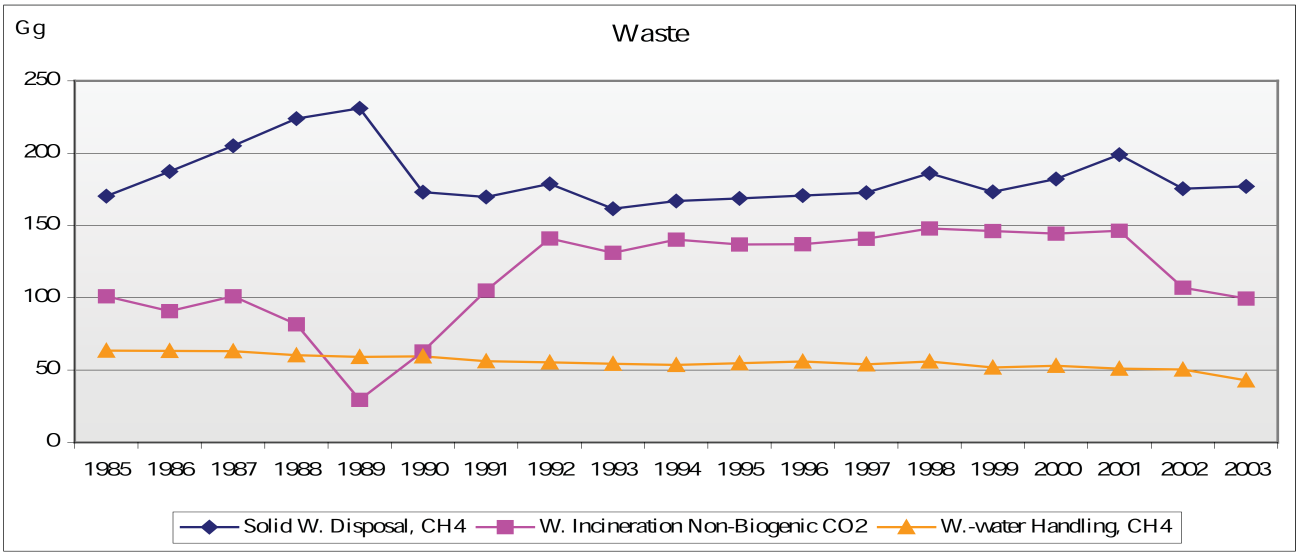

Figure 4.15 Emissions from treatment of waste

the beginning of the second period, from 1994, emission can be considered zero. The results of the calculations for the various years show an equal number of small emission and removal values.

4.3.6 Waste

The sector includes emission from solid waste (CH_4), from household and industrial waste water treatment (CH_4) as well as from waste combustion (CO_2, CH_4, N_2O). Some of the carbon-dioxide emitted in from biogenic source, and as such its emission is not considered greenhouse gas.

The activity and composition data have been obtained from publications by the authorities and experts. To estimate missing data we used the average values recommended by the Good Practice in order to achieve the most accurate results possible. During the beginning of the period examined there was no unified procedure for waste registration. Data is based on filings by waste producers, and it has been processed to varying degrees and at varying levels of professional quality. This is due to the difference in legal and technical specifications provided for different types of waste. There was no registration of industrial by products at the time, as this was not required by law. Even for solid municipal waste, only partial information is available, based on transport and treatment volume figures.

In the early years municipal waste collection was not a universal municipal service, so not all waste was collected and transported in an organized manner. As a result only estimates can be made as to the total volume of solid municipal waste. The calculations here are based on the data of organized waste transport.

Statistical data about the composition of waste collected is available for Budapest only. We have extrapolated this data to obtain national figures.

There has been no central data collection for the treatment of waste water and sludge (the relevant decree came into effect only last year). As a result we were forced to make estimates in emission calculations. Household and industrial waste water volume data have been provided by the regional environmental inspection agencies. The data are based on measurements by the agencies themselves as well as by the waste producers. No information is available about the amount of sludge created during the treatment process or about the division of decaying material between the water and the sludge. Thus we included the entire methane emission amount under waste water treatment.

Figure 4.15 shows the emission changes resulting from the treatment of solid and liquid waste.

The jump between 1989 and 1990 on the Solid W. Disposal, methane curve is due not only to the uncertainty in determining total waste volume but also to the change in waste density (from 0.3 t/m^3 to 0.22 t/m^3). For combustion, we estimated the CO_2 emission of the waste incinerator in Budapest. It is used close to 100% capacity year after year, except around 1989 and since 2002 due to reconstruction. The change in carbon-dioxide emission is due to the change in the volume of incinerated waste.

The decline in methane production during waste water treatment is the result of a decline in industrial waste water volume.

Nitrous-oxide figures have been included for incineration only, but the volume is so low that its analysis can be neglected.

Previously the emission of this sector was not calculated for the 1985-1990 period, but we have now filled in this gap.

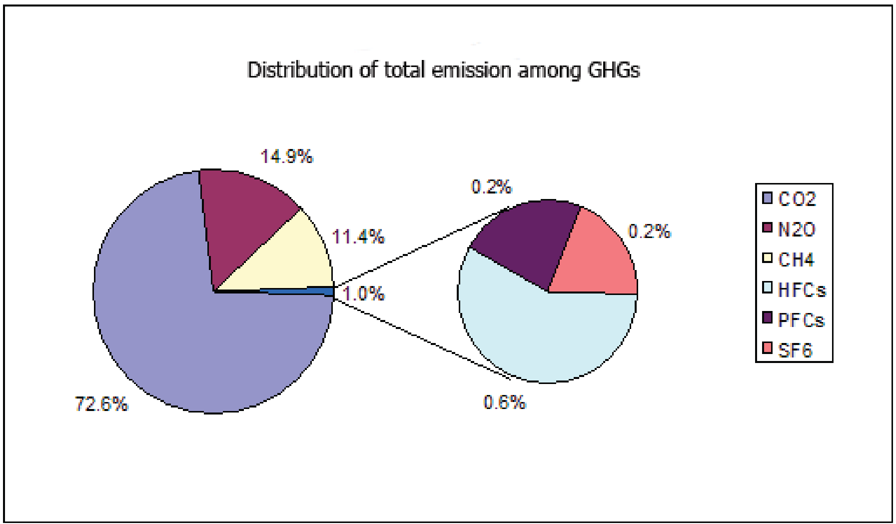

Figure 4.16 Distribution of total emission among GHGs

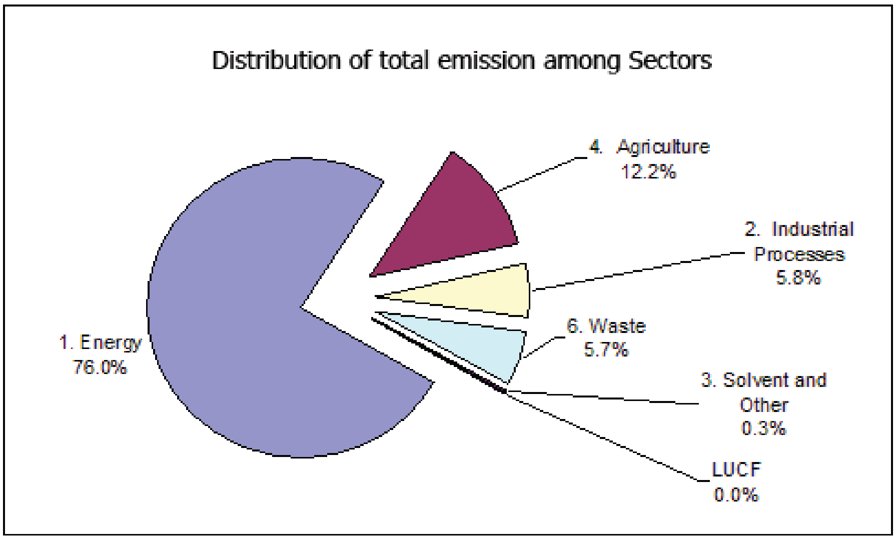

Figure 4.17 Distribution of total emission among sectors

total emission value when using the methods (LEVEL: 16, TREND: + 2 sources). Stationary Combustion Gas technology represents the largest single category, accounting for 33%. The second most important source is coal com-bustion of the same technology, with 18%. In the case of sources other than those of CO_2 Industry is the largest for N_2O (5%), and solid waste landfills for methane (4%). Of the subsectors emitting fluoride gases only HFCs, accounting for just 0.6% is included among the key sources (TREND). Since the use of HFCs began only in 1992, compared to the zero emission in the base year, the change is "significant" by 2003 despite the low absolute value.

Figures 4.16 and 4.17 show the breakdown of total emission values (in CO_2eq) among gases and categories. Of the gases the share of the "older" gases was 99%, and among them, as expected, carbon dioxide has the highest share at 72.6%. Looking at total emissions be sector, Energy alone is responsible for 76%, followed by Agriculture (12.2%), Industrial Processes (5.8%), Waste (5.7%), Solvent and Other Product Use (0.3%) and Land Use Change and Forest (LUCF, less than 0.001%).

4.4 Key Sources Categories

To improve the quality of the prepared inventories, the Good Practice Guidance introduces the notion of "key source categories" – referring to sources that have a major impact on the total emissions. By paying special attention to the data of these categories, the quality and reliability of the inventories increases substantially. Following the Good Practice Guidance we determined these categories in recent years. Because sufficient estimates for uncertainty values are not available, we have used TIER 1 methodology to determine the categories. We have considered the various sectors according to the breakdown provided by UNFCCC. The key source categories for the 2003 inventory are presented in Appendix 3.2.

Due to the different nature of the gases, the comparisons were based on GWP. Calculations were performed both according to the LEVEL and TREND methods. The value of total emissions (not taking into consideration any removal) is 83 225 Gg CO_2 equivalent. Calculations show that 18 source categories are responsible for 95% of this

4.4.1 Uncertainties

EIT countries have received a two-year extension for the implementation of reliability measures described in the Good Practice Guidelines. Hungary did indeed need this grace period, because the resources available for the preparation of the inventory have been very tight. Despite this problem several aspects of the Guidelines were implemented as early as in the 1999 inventory. The reliability values of the categories were calculated using the Good Practice Guidelines, especially in the case of key source categories. Where this was not possible we provided a textual explanation and an estimate of the uncertainty's magnitude. Regardless of the actual values, it appears that – just like before – the CO_2 emission data was found the most reliable, while estimates for nitrous-oxide emission from combustion were the least reliable. The total emission uncertainty of the 2003 inventory is estimated to be below 10%. By considering the entire time period available by 2005 (1985-2003), the uncertainty and the calculation errors of the inventories have been further reduced.

5. Policies and Measures

5.1 Notes on the methodology of policy effect forecasts

In order to give a clear and quantified picture of the mechanism of how the individual policies and measures result in GHG emission reduction, the input data and the method of calculation is explained one-by-one in the "Effects and impacts" section of the relevant chapters. The origin of the input data is diverse and it is due to the different nature of the individual policies, often either the baseline or the method of calculating the emission reduction is different, too. These differences and the applied methodologies are therefore described in each case.

As a consequence the resulting emission savings may not be directly added up in order to receive a cumulative GHG emission reduction value. Taking into account the overall effect of the measures requires a rather complex transformation of values, which was incorporated in the national emission forecast.

As to the methodology of the national forecast, a separate chapter explains its basic principles and assumptions.

The reliability of data of the forecasts is determined by the reliability of the inventory data of the recent years and the uncertainties of the forecast itself.

In preparing the inventory, the reliability of source category was calculated according to Good Practice Guidelines, mainly for the key source categories. Where no such possibility was available, the level of uncertainty was judged by the experts working on the inventory calculations. Regardless of the actual values, it can be generally stated that the lowest uncertainty is associated with CO_2 emissions, and the highest uncertainty is related to N_2O emissions from fuel combustion.

By following the instructions provided in Good Practice Guidelines the report tries to determine the uncertainties associated with each activity.

The most reliable calculation is the emissions of CO_2 and its weight within the emissions is by far the largest (in CO_2 equivalent is above 70%). The highest uncertainty is associated with the calculations of N_2O, which represents some 15% in overall emissions. The same weight is attached to the emissions of CH_4 that features medium uncertainty (about 11%). Fluoride gases have no significance from this aspect, as their contribution to the emissions is only 1%. By these considerations the estimated uncertainty of emission of each gas is as follows:

CO_2	+/-2-4 %
CH_4	+/-15-25 %
N_2O	+/-80-90 %

As a consequence, the overall uncertainty of the total inventory emissions is estimated below 10%.

The uncertainty of the forecast itself is estimated as the double of that of the inventory.

5.2 Policy-making process

The Hungarian Ministry of Environment and Water is responsible for national environmental policy including climate change. It has the responsibility to develop acts, and amendments to existing legislation. Act LIII of 1995 codifies the general principles of environmental protection and creates the legal basis for all the subsequent regulations that are related to the environment.

Hungary acceded to the Kyoto Protocol on 21 August 2002 and the basic strategic elements to meet its commitments under the Protocol incorporated into the second National Environmental Programme as stipulated already in 2001 (Government Resolution 1117/2001 (X.19.) Korm. on the concept for the second planning period (2003-2008) of the National Environmental Programme. The specific tasks together formed the "Thematic action programme (TAP) on climate change" under the NEP-II. The basic priorities were as follows: the reduction of GHG emission through mitigation measures in the energy sector, industry, transport and agriculture, enhancing sink capacities, strengthening the institutional basis to meet the monitoring and reporting requirements, raising public awareness among others. These tasks were formulated as part of an overall environmental strategy and also within the framework of the preparation for Hungary's accession to the European Union. The national climate change strategy set the overall objective for the domestic mitigation measures i.e., the net Hungarian global warming potential (for the gases covered by the Kyoto Protocol) has to remain below 94% of the average emission level in the base period of 1985-87. Hungary joined the European Union in 2004 and since then on the one hand it takes part in formulation of Community climate change related policies and legal instruments, on the other hand, it fulfils the relevant Community programmes and regulations.

5.2.1 The Inter-Ministerial Committee for meeting the Kyoto commitments

In order to ensure a coordinated approach to meet Hungary's commitments under the Kyoto Protocol, the Government Resolution 2045/2003. (III. 27.) Korm. made provisions to set up an Inter-ministerial Committee. The task of the Committee is to identify and co-ordinate the various tasks related flexible mechanisms under the Kyoto Protocol; to supervise the approval of Joint Implementation (JI) project proposals; to be instrumental in creating the country's standpoint on the trading of GHG emission rights and allowances.

5.2.2 The Energy Centre

By the Government Resolution 1031/2000. (IV. 7.) Korm. the Hungarian Government created the Energy Efficiency, Environment and Energy Information Agency (Energy Centre for short) with the primary aim of creating the institutional framework for the implementation of the Energy Saving and Energy Efficiency Action Programme (ESEEAP) that is the key instrument in meeting the Kyoto targets within the energy sector, primarily in demand side energy use. The founders and owners of the Energy Centre are the Ministry of Economic Affairs and Transport (60%), the Ministry of Environment (25%) and the Hungarian Energy Office (15%). The basic tasks of the Energy Centre are:

- to manage the annual energy saving programmes (named as SZT-EN or NEP in the different years);
- to manage other energy efficiency funds (such as EHA, EHP, UNDP-GEF);
- to operate the national level energy statistics system;
- to co-operate in the development of national energy policy;
- to be instrumental in information exchange on energy-related matters between Hungary and the international community, primarily the European Union;
- non-profit based information dissemination on energy and energy efficiency;
- to manage international energy efficiency and environmental programmes.

The Energy Centre was also assigned in the past some JI project management tasks.

5.2.3 The Inter-Ministerial Committee for Energy Efficiency

The Government Resolution 1031/2000. (IV. 7.) Korm. also made provisions for setting up the Inter-Ministerial Committee for Energy Efficiency, whose task is to make decisions on financial supports for energy efficiency projects within the framework of the different supports schemes managed by the Energy Centre. The Ministries responsible for economic affairs, environmental protection, finance, internal affairs, agriculture and rural development, transport, water management and the Hungarian Energy Office form the Committee. This way it is ensured that the supports would serve best the national strategies, the interest of all parties affected would be represented and overlapping supports could be avoided. As an observer an NGO is also invited to the Committee.

Hungary's greenhouse gas mitigation policies are all based on a set of basic legislation which establishes a legal and /or financial framework for more concrete, targeted policy tools. Although these pieces of legislation have no direct, quantifiable emission reduction effects, they are worth to be provide a brief description of them in order to better illustrate Hungary's efforts under the UNFCCC and the Kyoto Protocol is to be provided. The scope of this legislation covers areas far broader than GHG mitigation; in the following sections only those aspects are discussed that are directly related to the subject matter of this report.

5.3 Overview of policies and measures to reduce GHG emissions

5.3.1 Cross sectoral measures

Act on Electricity

Act CX of 2001 on Electric Energy declares among its general provisions, that production distribution, commerce and utilisation of electric power must be conducted by taking into account the aspects of, among others, environmental protection, nature conservation, energy saving and protection of human health. Through these provisions the Act provided basis for several further pieces of legislation and measures that supports GHG mitigation. The Act also defined what is considered renewable energy, introduced the concept of IPPs.

Besides the general provisions, the Electricity Act also laid down the principles of support for renewables and cogeneration and tasked the Minister of Economy do develop the details of support mechanism.

National Development Plan and National Rural Development Plan

In preparing for the utilisation of the EU Structural Funds, Hungary has prepared the National Development Plan (NDP). On the basis of a thorough analysis of economic and social conditions, NDP identified the priorities that are to be supported by using finance from the Structural Funds.

Improved quality of the environment is among the three major objectives of the Plan. Low level of renewable energy utilisation is identified as a major problem, and increasing the share of renewables within overall energy use is considered as key element of achieving the long-term goals of the NDP.

The specific goals of the Plan are to be achieved through five operative programmes, three of which has relevance from the aspect of GHG mitigation (Environment and Infrastructure Operative Programme – KIOP; Agriculture and Rural Development Operative Programme – AVOP; Regional Development Operative Programme – RFOP) and will be referred to in the current document.

The National Rural Development Plan (NRDP) was developed in order to identify priorities for the utilisation of support provided by the European Agricultural Orientation and Guarantee Fund. The general objectives of NRDP are

- to improve income and safeguard employment in rural areas;
- to ensure environment-friendly development of agriculture, rationalisation of land-use;
- and to encourage landscape management.

The specific objectives include the improvement of the quality of the environment and increasing forest cover and thereby improve the ecological conditions.

Energy Saving and Energy Efficiency Action Programme

Based on the principles of Business Model of the Energy Sector and related policy decisions, the government adopted the new Energy Saving and Energy Efficiency Action Programme (ESEEAP) (Resolution of the Government 1107/1999.(X.8.) Korm.) that began in 2000 and is to run until 2010. The overall goals of the Action Programme are: 3,5% /year reduction of energy intensity; the saving of 75 PJ/year of primary energy use; reduction of 50 kt/year of SO_2 and 5 Mt/year of CO_2 emissions, increase of renewable energy production. The Action Programme lists 15 specific policy measures, the most relevant of which are the following:

Improving energy awareness

The purpose of this measure is to assist reaching the overall objectives of the ESEEAP by providing state-of-the-art information and training via the educational system and the organisation and operation of advisory networks and consumer offices, as well as via advertisements, the media etc. Another specific point of action is the promotion of energy efficiency labels. The resolution set an overall 10 PJ energy saving until 2010 via energy awareness raising tools.

R&D for energy efficiency and renewables

This action of the ESEEAP aims at encouraging the participation of Hungarian experts in foreign research, as well as the incorporation of energy saving and environmentally friendly technologies is the Hungarian R&D, including demonstration projects. According to the ESEEAP, the priority of energy efficiency within R&D has to be ensured with legal instruments and with preferential credits.

Energy audits in industry

It is widely recognised that demand side energy efficiency actions can only be effective if they are preceded by energy audits that can identify the most efficient course of action. Therefore energy audits have been supported through various tools, one of them being that energy audits in industry were one important item of the Energy Saving and Energy Efficiency Action Programme (ESEEAP). The program allocated financial support to such audits in the form of a soft loan. In practice, during the implementation phase of the Programme the audits were supported mainly through grants.

Improvement of municipality energy management

Municipalities and their institutions represent serious share in the total energy consumption. It is recognized that the Hungarian municipalities often lack expertise to properly address energy related projects, therefore support was to be provided in form of soft loans for the elaboration of energy supply concepts, energy audits.

Least-cost planning, demand side management programmes

The aim of this action was to make the operators of large energy supply systems interested in reducing energy demands by recognised the related costs as justified costs and reflect them in the energy prices. The quantitative target was around 5 PJ saving of primary energy by 2010.

- Energy conservative organisation of transport and transportation
- Incentives were provided for organisational measures that would moderate the increase of road transportation and shift it to railways, waterways and combined way, as well as to moderate the use of passenger cars and switch traffic to public transport.
- Reduction of industrial energy use

The objectives of the action were

- modernisation of energy processes of industrial production,
- improving thermal insulation,
- improving the efficiency of energy consuming equipment and
- -improving the efficiency of energy generating equipment.

The objectives were to be achieved through providing preferential loans, but no concrete amount was allocated. The expected target reduction of industrial energy use was 8.5 PJ until 2010.

Modernisation of the transport

The action was aimed at the promotion of energy saving and environmentally friendly transport alternatives (railway, water) and public transport, as well as improving the technical level and replacement of existing vehicle stock. 4.5 PJ primary energy saving was foreseen till 2010.

Modernisation of technology in agriculture

Preferential loan was to be provided for implementing energy conserving equipment and technology in agriculture in order to achieve 0.5 PJ saving by 2010.

Residential and communal energy saving projects

Besides the reducing industrial energy consumption the ESEEAP also put emphasis on the support of residential and communal energy efficiency projects. This action of the ESEEAP focused on the improvement of thermal insulation and upgrading of building envelopes (facades, roofs, cellars, doors and windows) and the improvement the secondary heating systems of district-heated homes (primarily control and metering).

The foreseen tool of support was direct subsidies (grants) and the saving target was 10 PJ/year until 2010.

Increasing the share of alternative space heating modes

In order to reduce natural gas consumption and the related GHG emissions biomass-based heat supply modes were to be promoted through preferential loans (communal end-users) or grants (residential end-users).

Support for local renewable power generation and end-user renewable energy use

The purpose of the action is to increase the use of biomass, geothermal energy, organic waste, especially electricity generation from these renewable sources. Its bother sub-programme, the “Programme for 20000 solar roofs, 2000” is directed at the promotion of solar heat generation and photovoltaic projects.

The general objective of the ESEEAP was to achieve 50 PJ/year renewable energy utilisation by 2010. The other quantitative target within this objective was to have solar collectors on 20 000 homes or public buildings by 2010. The foreseen form of support was direct subsidies (grants).

Modernising district heating systems

District heating plays an important role in space heating and hot water supply in Hungary, especially in the residential sector. There are some 100 district heating schemes in the country, supplying heat to more than 640000 homes. The inefficiency of the systems and the high space heating costs of the district heated buildings are not only a technical problem but also an evergreen political issue. Therefore the modernisation of the district heating systems was included among the priorities of the ESEEAP. The quantitative target was to achieve 10 PJ/year saving till 2010 by providing support for:

- increasing the share of cogeneration within the heat generation capacities of the district heating systems;
- primary side reconstructions including the installation of meters in the substations;
- secondary side modernisation, primarily for better controls and cost allocation.

2nd National Environmental Protection Programme

As the sequel of the First National Environmental Programme (NEP-I) between 1997-2002, on 8 December 2003, the Hungarian Parliament approved its Resolution 132/2003. (XII.11.) OGY, on the National Environmental Programme (NEP-II.) for 2003-2008.

NEP-II relies on the most important Hungarian and international environmental policy principles, which can be classified into three main categories:

- Traditional environmental protection principles, for example, principles of precaution, prevention, reconstruction, liability, co-operation, information, publicity and the 'polluter pays'.
- Additional principles exemplary for Hungary on the basis of the environmental government activities of developed countries (shared responsibility, transparency in planning, decision-making, financing, implementation and control, predictability in regulation and financing, accountability, clear objectives, measurable performance, partnership, subsidiarity, additionality, measures with multiple benefits).
- Taking into account the principles of sustainable development; NEP-II must promote the establishment of social, economic and environmental conditions required for the transition towards sustainable development.

The primary objectives of the NEP-II are the following:

- The protection of the ecosystem
- Provision of a harmonic relationship between society and environment
- Enforcement of environmental criteria in economic development.
- Strengthening of knowledge on, and awareness of environmental processes, impacts, environment and nature conservation and co-operation

These primary aims are broken down to individual concrete objectives, which are planned to be achieved through nine specific Thematic Action Programmes of:

1. Raising Environmental Awareness
2. Climate Change
3. Environmental Health and Food Safety
4. Urban Environmental Quality
5. Biodiversity Conservation and Landscape Protection
6. Rural Environmental Quality, Land-area and Land Use
7. Protection and Sustainable Use of Water
8. Waste Management
9. Environmental Security.

The relevant foreseen actions will be referred to in the current document. It is noted that tasks within the Thematic Action Programmes of NEP-II are divided into two groups. NEP-II partly includes interventions which are currently working (existing tasks), they are present separately or in other programmes and in this framework their necessary resources are also targeted. Incorporating these tasks into NEP-II is justified because environmental problems are dealt in a complex way. At the same time there are new elements among the goals and tasks, which have not belonged to the tasks of any programme but are indispensable for the solution of a given environmental problem.

<u>The Climate Change Operative Programme of the NEP-II</u>

The wording of the Climate Change Operative Programme of the NEP II concretely introduces the fact of climate change due to human activity into the Hungarian legislation. It is recognised that the dangerous consequences of climate change can only be avoided thorough international co-operation. The primary objective of this action programme is the regulation and reduction of emissions from domestic economic activities. The action programme is aimed at the reduction of greenhouse gas emission, its contribution to anthropogenic climate change and at the same time at improvement of local and regional air quality. In addition, it contributes to the dissemination of environmentally friendly consumption habits and improvement of the quality of settlement environment.

Implementation of the comprehensive goal of the action programme is realized through specific objectives. It is recognized in the text of the legislation that main sources of the emission of the affected gases are power generation, transport, certain industrial activities and intensive agriculture. Accordingly, contribution to the reduction of the risk of climate change can be ensured primarily by pollution-decreasing development of the energy- transport infrastructure and of the production-agricultural systems permeating the national economy.

The specific and operative objectives of the Action Programme are:

- Promoting the reduction of atmospheric emissions from energy management activities
  a) Modernization of energy production, conversion and transportation
  b) Improvement of the energy conservation and energy efficiency of the consumers
- Development and dissemination of technologies related to the utilization of renewable energy sources (to subsidize investments)
  a) Application of alternative fuels
  b) Utilization of landfill gas
  c) Other biomass utilization, replacement of gas fuel used currently for local goals with local biomass, and development of simultaneous heating systems
  d) Application of solar, wind energies and geothermal energy
  e) Price preference for electric energy generated from renewable energy sources
- Reduction of pollution emission from transport

a) Accelerating the modernization rate of the vehicle stock
b) Reduction of the environmental impact of freight transportation: supporting the propagation of environmentally friendly transportation ways, shifting freight transportation from trucks to railway
c) Support for environmentally sustainable means of transport

- Reduction of greenhouse gases from agriculture and waste by strengthening carbon dioxide sink capacities
  a) Reduction of methane emission form animal breeding and cultivation
  b) Support for cultivation aimed at power generation and increasing the binding potential
- Stratospheric ozone depletion and prevention of atmospheric acidification
  a) Reduction of gas emissions depleting the stratospheric ozone layer, compliance with relevant international conventions
  b) Prevention of atmospheric acid deposition
  c) Launching a halon treatment programme
- Research-development, horizontal measures
  a) Research-development relating to climate change (researches on direct and indirect impacts of air pollution, climate change, on their abatement, causes and reduction)
  b) Attitude forming, information (tasks in relation to technological switchover, consumption habits) educational and raising awareness tasks aimed at the development of information systems

5.3.2 Energy

Limitation of SO_2 emissions from power plants

Objectives and description: The general and primary objective of the relevant legislation was to significantly reduce air pollution from stationary sources, especially that caused by SO_2. The Decree 22/1998 (VI.26) KTM and a sequel Decree of the Minister for Environment and Water 10/2003. (VII.11.) KvVM which is replacing it have set more strict emission limits than those in force earlier and offered two alternatives for the operators of the emission sources: either provisions are made to reduce emissions below the limit (e.g. FGD units are installed) or the operation has to be stopped. The deadline for the measures for large power stations was January 1st, 2005, for other plants it is (mainly industrial) 31st December, 2008.

Within the energy industry the new regulation affected primarily those power stations that used low quality, mainly domestic coals with high sulphur content.

The secondary objective of the policy is to reduce GHG emissions by the fuel switch and technology improvement projects stemming form the policy.

Policy instrument type: Regulatory.

Status of implementation: Implemented.

Implementing entity: Regional Environmental Inspectorates, via the construction and operation licensing procedures.

Monitoring indicators: The achieved emission reduction can be monitored through the electric power production and fuel use data of the affected power plants. These can be evaluated against the theoretical emissions that correspond to the same quantity of electric power generated from coal in the same plants. The data are available from MAVIR.

The national GHG inventories (LRTAP, UNFCCC) can also be used for monitoring.

Effects and impacts: As the direct result of the policy several mitigation measures were put in place, including the installation of FGDs and a series of fuel switch projects:

FGD unit installation:

- Mátra Power Plant: Installation of a wet SO_2 scrubber in 2000.

Besides, other modernization measures were/are being taken:

- Mining retrofit program finished.
- Plans exist to increase the capacity of the plant by installing a new unit with mixed fuel combustion after 2008. The purpose of this is to achieve a 1000 MWe capacity by the end of 2010, instead of the current 836 MW. However, the Capacity Plan of the system operator does not calculate with the planned increase until 2015.
- Experiments have also started with adding woodchips to the fuel mix. It is planned that the share of renewables will exceed 10% in the fuel use by 2006.
- Vértes Power Plant: The installation of an FGD has been completed. The mine of this plant (Márkushegy Mine) is the only subsurface mine viable in the future. Its planned production after the investment is 1500-2000 kt/year.

Fuel switch projects:

- Borsod Power Plant: has decided to switch two of its boilers to biomass fuel with a planned 260GWh electricity production and the combustion of 316 kt of biomass. This replaces the 700 kt sub-bituminous coal from the Lyukóbánya Mine, which was closed. The rest of the boilers have been switched to natural gas.

- Tiszapalkonya Power Plant: it has switched to co-firing of wood-chips and sub-bituminous coal.
- Pécs Power Plant: The plant accomplished a major reconstruction project by converting all but one of its units to natural gas in place of coal. The remaining 50 MW unit was converted to wood-chip firing.
- Ajka Power Plant: In order to meet the emission limits the plant was modified so that adding woodchips to the coal fired would be possible.
- Tatabánya Plant: Switched to natural gas and installed gas engines to improve efficiency.

Stop operation:

- Inota Power Plant: Its owners have temporarily suspended the operation of the plant. Plans exist to install a natural gas fired CCGT unit, but no concrete steps have been made as yet.
- Bánhida power plant: Stopped operation from the beginning of 2005. Various plans exist for the utilisation, but no concrete projects have been so far initiated.

Regardless, how important is the reduction of SO_2 emissions from the aspect of Hungary's international commitments, this alone would not qualify this measure to be included in the current report on GHG emissions. It must be noted however, that as result of the implementation of the policy its secondary aims, i.e. the indirect reduction of GHGs is also fulfilled through the following benefits:

- Through the fuel switch projects coal was substituted by natural gas (with more than 40% less specific CO_2 emissions) and biomass (zero net CO_2 emission).
- Due to the falling demand for domestic coal the mining-related direct (energy use) and fugitive emissions are reduced.
- Stop of operation of the Inota plant may also reduce overall GHG emissions, although this effect is questionable, as the power production of the plant is obviously substituted by other sources such as increased output form other plants and/or imports.

It is important to emphasize, that as a special benefit this policy combined with the subsidies for renewable based power generation (discussed separately) resulted the first biomass-power projects in Hungary (Pécs, Borsod, Tiszapalkonya, Ajka). This, besides the direct CO_2 emission reduction significantly contributed to

- increasing awareness through the wide media coverage
- creating markets for wood fuel and eventually energy crops.

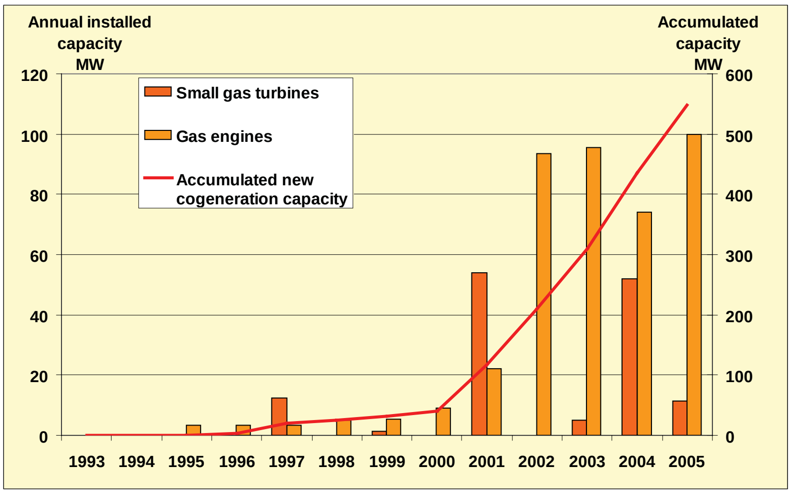

Figure 5.1 Growth of small-scale CHP in Hungary

The quantitative effects can be forecast using the monitoring method described above. It is noted that in the calculation allowance is made for the eventual improvement of plant efficiencies due to the conversion projects. Thus the savings are calculated by comparing the forecast emissions against the emissions calculated with the specific emissions normalised to power generation of the individual plant before the measures. It is also assumed that the – as no further increase of capacity of the plants in question is planned, the yearly power production and fuel use in 2010 and 2015 will be the same as forecast for 2005. Thus the reduction of CO_2 emissions achieved is 980 kt in each year examined.

Support of cogeneration

Objectives and description: The objective of this policy item is to promote combined heat and power (CHP) production as a highly efficient form of energy generation and tool of GHG emission reduction. The relevant legislation (Decree of the Minister of Economic Affairs and Transport 56/2002(XII.29) GKM.) adopts two ways of support:

- Stipulates the mandatory purchase of co-generated electric power
- Provides financial support for the operators of CHP plants in the form of regulated and subsidised feed-in tariff.

Finance for the subsidies is provided by a small earmarked fraction of the regulated end-user electricity prices.

The mandatory purchase of co-generated power created a safe market for primarily small-scale CHP plants and the subsidised feed-in tariff ensured attractive economic performance. As a consequence rapid growth of small-scale CHP capacity has been experienced. By the end of 2005, it is estimated that the installed capacity of small-scale CHP, (practically all of them use the natural gas fuelled gas engine technology or gas turbines, smaller than 50 MW) exceeded 500 MW. It is to be noted that in relation to the installation of CHP plants in district heating systems, considerable modernisation has taken place in the primary systems, and the heat sources.

However, the rapid growth of small scale CHP capacities created some problems in the control of the national power system, therefore limitations were included in the legislation that are expected to considerably slow down further growth:

- Yearly and monthly overall efficiency criteria are set as a condition of subsidy
- Bigger than 6 MWe capacity plants can only receive subsidy if their heat is used in district heating
- •The latest feed-in tariffs provide lower economic attractiveness.
- The GHG-emission reduction benefits of the policy are the following:
- •The new natural gas fired CHP units replace some of the fossil (coal and oil) power generation capacity of the Hungarian power system, as well as some of the heat-only thermal plants.
- •The overall efficiency of the CHP plants is higher than the combined efficiency of conventional power generation and heat only plant, resulting in net fuel saving and hence emission reduction.

Policy instrument type: Economic and regulatory

Status of implementation: Implemented

Implementing entity: Hungarian Energy Office

Monitoring indicators: Monitoring is through the yearly energy production and fuel use data of the individual CHP plants. These data are mandatorily provided to the Hungarian Energy Office on a monthly and to MAVIR on a yearly basis. The emission reduction can be calculated by comparing the energy production data to a baseline scenario, where the same amount of electricity is generated in the Hungarian Power system and the heat in gas fired heat only plants.

Effects and impacts: The mandatory purchase of co-generated power created a safe market for primarily small-scale CHP plants and the subsidised feed-in tariff ensured attractive economic performance. As a consequence rapid growth of small-scale CHP capacity has been experienced. By early 2005, the installed capacity of small-scale CHP exceeded 500 MW, with a net production capacity of more than 400 MW.

However, the rapid growth of small scale CHP capacities created some problems in the control of the national power system, therefore some limitations were included in the legislation that are expected to considerably slow down further growth:

- Yearly and monthly overall efficiency criteria are set as a condition of subsidy
- Bigger than 6 MWe capacity plants can only receive subsidy if their heat is used in district heating
- The latest feed-in tariffs provide lower economic attractiveness.

The GHG-emission reduction benefits of the policy are the following:

• The new natural gas fired CHP units replace some of the fossil (coal and oil) power generation capacity of the Hungarian power system, as well as some of the heat-only thermal plants.

• The overall efficiency of the CHP plants is higher than the combined efficiency of conventional power generation and heat only plant, resulting in net fuel saving and hence emission reduction.

The forecast of the quantitative effects follows the monitoring method. As to the baseline values for power generation, they are based on the values and methods developed by the Ministry of Environment and Water for the calculation of reference CO_2 emission factors used for baseline calculations of JI projects[2]. As these values are developed for 2008-2012 only, using their linear trends between 2008-2010, and 2010-2012, extrapolations are made to 2005 and 2015.

In the forecast it is assumed that due to the limitations built in the regulations the growth of CHP capacities will be slower than in the recent years. The forecast also assumes a slight increase in overall equipment efficiencies with regard to technological development.

Input data forecast		2005	2010	2015
Power output	TWh	1.51	1.65	2.06
Heat sales	PJ	6.40	7	10
Primary fuel use	PJ	14.6	16	21.2
CO2 emission total	kt	817	893	1183
Baseline				
Heat baseline				
Fuel use	PJ	7.1	7.8	11.1
CO2 emission heat	kt	396.9	434.2	620.2
Power baseline				
Specific CO2 emission	kt/TWh	698	714	664
CO2 emission power	kt	1053	1178	1368
CO2 baseline emission total	kt	1450	1612	1989
Reduction achieved	**kt**	**634**	**719**	**805**

Support of renewable-based power generation

Objectives and description: Similarly to the support of CHP power generation from renewable energy sources is supported by both the mandatory purchase of such power by either the national transmission company or by the distribution companies and through subsidised feed-in tariffs.

The primary objective of the policy and the relevant legislation (Act LXXIX of 2005 on the amendment of Act CX of 2001 on electricity; Decree (XII.29) GKM.) is to ensure that Hungary can comply with its international commitments to increase the share of renewable based power generation to 3.6%, and the share of overall renewable energy to 5% by 2010, as a part of the general GHG mitigation policy of the European Union.

With these deadlines approaching some further incentives were incorporated in Hungary's renewable support policy such as technology-specific increased feed-in tariffs.

Policy instrument type: Economic and regulatory

Status of implementation: Implemented

Implementing entity: Hungarian Energy Office

Monitoring indicators: Monitoring is through the yearly energy production and fuel use (where applicable, such as biomass plants) data of individual plants. These data are provided mandatory to the Hungarian Energy Office on a monthly and to MAVIR on a yearly basis.

The emission reduction can be calculated by comparing the energy production data to a baseline scenario, where the same amount of electricity is generated in the Hungarian Power system. The specific CO_2 emission of the JI projects referred to earlier can be used as basis.

Effects and impacts: The implementation of this policy item increases the attractiveness of renewable power projects by providing a safe market and subsidised revenues. However, due to the large variety of the available technologies the forecast of the realised CHG mitigation requires a short review of the feasibility of the major options.

Wind power

Hungary has limited endowments in terms of wind power: the typical potential ranges between 70-200 W/m^2, the highest values reaching 260 W/m^2 in the north-western part of Hungary. In the long term, the total installed wind power capacity is also limited by load control considerations of the national power system: roughly the 50% of the total electricity demand covered by the Paks nuclear plant, the fossil fuel plants need to provide hot stand-by capacities for wind power.

Due to the limited subsidies and insufficient wind potential, so far only a few wind-power plants with relatively small unit sizes have been commissioned (Kulcs: 600 kW, Inota: 200 kW, Mosonszolnok: 2 x 600 kW, Mosonmagyaróvár 2 x 600 kW.) The most recent changes in the renewable policy however gave a boost to wind-power project ideas: there are investor initiatives for some

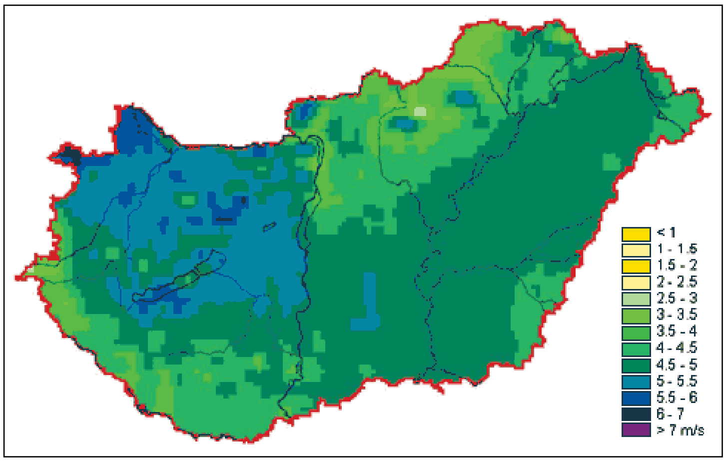

Figure 5.2 Average wind velocities at 50 m height in Hungary

200 projects with the installed capacity exceeding 1000 MW. Such a rapid increase, compared to the actual peak demand of Hungary (forecast to increase from 6270 MW in 2005 to some 7500 MW in 2015), with the specialities of the Hungarian power system (high share of nuclear energy and fossil fired plant to provide system control) in mind, is clearly unrealistic. Therefore, adopting the conservative forecast of MAVIR the actual installed wind power capacity is expected to reach 100-200 MW by 2010 and some 220-440 MW by 2015 maximum. In the calculations the following forecast is used:

	Installed capacity (MW)	Electricity output (TWh)
2005	3.2	0.005
2010	170	0.250
2015	245	0.375

Biomass

In terms of renewable potential, Hungary is best endowed with biomass, owing to the importance of agriculture and forestry within the economy, the high level of forestation and the farming traditions in some large regions. The share of biomass is estimated to be more than 70% within the technical potential. For power generation purposes hard-wood provides the best opportunities in the short term due to its favourable combustion characteristics. In the long term herbaceous plants, such as energy grass, can have high importance, when some current technical problems with their combustion at high temperatures necessary for efficient power generation, are resolved.

Beside the already implemented fuel switch projects referred to in section "Limitation of SO_2 emissions from power plants" new biomass (woodchip-fired) capacities will have to be created before 2010 if Hungary is to meet its international commitments. These can either be co-firing biomass with coal in the existing plants (e.g. Mátra, Tiszapalkonya) or preferably some green-field projects. This, however, can be limited by the quantity of the available fuel from the existing forests, thus simultaneous development of energy forests is of high importance (see it discussed in the relevant section).

In pursuing the renewable targets biomass is not only preferred due to its high potential and availability but also for the spin-off effects of such projects, such as infrastructure development, job creation or the general regional development.

The forecast biomass-based power generation data – excluding those referred to in the fuel switch projects – are the following:

	Installed capacity MW	Electricity output TWh
2005	24	0.11
2010	175	0.937
2015	210	1.128

Geothermal energy

Hungary is richly endowed with geothermal energy, in the estimation of renewable energy potential geothermal is considered to be the second most important after biomass. This, however is not true is power generation potential is considered. Due to the relatively low geothermal well temperatures (typically 40-95°C) the cycle efficiency of the possible ORC plants is low, and the net power output is small. With respect to the high investment costs this feature, together with the problems created by the salt content of the waters geothermal based power generation is considered to have small significance in the time span investigated.

Hydro power

Hungary being mainly flat, hydropower has little potential within the overall electricity balance. The currently installed total capacity is 55 MW, the annual power generation is around 195 GWh, depending on the weather. Although the theoretical hydropower potential is 7500 GWh, whose 72% is provided by the Danube mainly due to historical and political reasons a large scale hydropower project is not planned in the medium term. The theoretical potential of the small rivers and streams is 338 GWh/year, which indicates that considerable increase is unlikely. Plans however exist, including, among others, a 5 MW small hydro plant for the utilization of the cooling water from the Paks nuclear plant.

The forecast data for hydropower are the following:

	Installed capacity MW	Electricity output TWh
2005	55	0.195
2010	60.1	0.250
2015	70.1	0.285

Solar power

Although Hungary has relatively high number of sunny hours, there is an agreement between the experts that the major field of solar energy utilization is and will be primarily hot water generation in the medium term. Solar electric power generation, due to the high expenses of the technology and the low output of the currently available solar cells is unlikely to play a decisive role in the time-span investigated. Still, there are pilot projects, but the capacity of even the largest solar energy plant, just recently commissioned in the Gödöllő University, is only 10 kW. At any rate, with the improvement of the technology some modest increase of installed solar power capacity is forecast, in particular for those special applications where autonomous power supply is pursued. The following contribution of solar power to the overall power balance is foreseen:

	Installed capacity MW	Electricity output TWh
2005	0	0
2010	14	0.001
2015	30	0.002

Biogas

It is noted that the utilisation of biogas is not considered here, as such projects are typically either cogeneration projects or heat-only applications. The cogeneration projects were accounted for in the chapter on power generation. The heat-only use of biogas is taken into account in forecast of agriculture.

With all the forecast data the CO_2 emission reduction to be achieved calculated using the principle of the monitoring and the specific CO_2 emissions of the JI projects referred to earlier. It is noted here that since the effect of the support policy is to be evaluated, only the increase of installed capacities and power production shall be taken into account, in relation to the capacities that existed before the policy was implemented, i.e. practically before 2003. This is particularly important when hydropower is considered, where all major plants existed already before 2003. Thus the forecast savings of all the renewable power projects are the following:

	Installed additional capacity (MW)	Electricity output GWh	Emission reduction achieved (kt)
2005	27	115	80
2010	419	1447	1033
2020	555	1808	1201

Land-based support for energy crops and forests

Objectives and description: In line with the priorities of National Rural Development Plan, Decree 28/2005. (IV. 1.) FVM provides for financial support for various agricultural activities that are entitled for support from the European Agricultural Orientation and Guarantee

Fund. For these purposes additional national support may be obtained. The decree allocates EUR 946 000 for the production of energy crops (both wood and herbaceous plants). The detailed regulation of the support is codified by 74/2005. (VIII. 22.) FVM. The latter decree defines which plant classifies ad energy crop, maximises the area that can obtain financial support and the obtainable finance: for wheat, corn, rape and sunflower together it is 16 000 ha and EUR 27/ha, for energy grass 10 000 ha and 32 EUR/ha and for energy forest 2 500 ha and 194.13 EUR/ha.

The primary objectives of the measure are to improve the competitiveness of agricultural production and food processing; to promote environment-friendly development of agriculture; rationalisation of land use and to assist to the realignment of rural areas.

Policy instrument type: Economic

Status of implementation: Implemented.

Implementing entity: Ministry of Agriculture and Rural Development and Office for Agriculture and Rural Development (MVH)

Monitoring indicators: Implementation is monitored via the support system managed by MVH. All supports are allocated via a regulated application process, that provides enough data about the lands and planned energy plants for the monitoring of the impact of the measure. Thus the main indicators of monitoring are of land, type of energy crop, expected yield.

Effects and impacts: Although the energy crops act as short-term carbon sinks, due to the short rotation it is not considered as GHG mitigation effect. The major impact of the measure is all plants grown on the supported lands will be used either directly as fuel (energy grass, wood) or indirectly as raw material for automotive fuel or biogas.

Besides the direct impact, this tool is also of utmost importance because it enables the implementation of further bio-energy projects, by providing excess fuel at lower prices.

The quantitative effects of the measure, however are not evaluated separately, but they are included in the forecasts for biomass, biogas and bio-ethanol utilisation.

Life extension of the Paks nuclear plant

Objectives and description: In the Resolution 85/2005 (XI.23) OGy. of the Parliament, the life extension and capacity increase of the Paks nuclear power plant was approved. The rationale of the project identifies the environmental commitments related to the Kyoto protocol and its foreseen sequel among the most important objectives.

The four units of the Paks plant were commissioned between 1982-87. Currently the total capacity of the four units is 1866 MW. The Paks plant is the base power station of the Hungarian power system supplying about 40% of the total power production at low costs with no GHG emissions. The planned technical lifetime of the units ends between 2012-17, but all investigations show that the operation can safely be extended by at least 20 years. In the framework of the retrofits needed for the life-extension, the capacity of the plant will be increased by same 150 MW, chiefly through the improvement of control systems and use of upgraded fuel cells.

Thus the objective of the project is to ensure the availability of some 2040 MW nuclear capacity until at least 2032-2037, thus improving the safety of supply and save considerable GHG emissions.[3]

Although the project, as it will require neither finance nor guarantees from the government, first appears as a general development project by an enterprise, it may still classify as part of the national policy, partly because the Paks plant is state owned, partly due to its sheer size that has long-time impact on the national energy strategy, thus requiring governmental approval.

Policy instrument type: Other: technical

Status of implementation: Adopted

Implementing entity: The Paks Nuclear Plant

Monitoring indicators: The amount of generated power.

Effects and impacts: The measure has no impact on CO_2 emission reduction before the end of the originally planned lifetime of the individual units, since it may be well assumed that they would remain in operation until then, as they are at present. However, from then on, all the generated power of the individual units will substitute power that should be generated in other (fossil) power plants or imported, if the life extension did not take place.

It is very difficult to establish a baseline for calculation the actual emission reduction as there is practically no alternative to the life extension:

- natural gas based capacity developments are limited by the capacity of the gas supply system (almost utilised up to 100% even now);
- imports are also limited by the capacity of the transmission system;

- susbstituting 1860 MW by renewable is rather unrealistic.

Still, for the sake of estimating the emission savings, it is assumed, that in case the life extension did not happen, some combination of the above choices would be implemented, however costly they would be.

The forecast applied rests on then following assumptions:

- If the life extension did not happen, 50% of the so missing power would be covered by fossil plants, partly utilising some existing reserve capacities (e.g. in the Dunamenti plant) partly from new fossil, most likely natural gas fired CCGT plants. The average specific CO_2 emission is assumed as 0.4 kg/kWh, on the basis of the average value of the most modern capacities of the Hungarian power system.

- The other 50% of the power would come mostly from imports and a much smaller share from renewable sources. Neither of them generate national level CO_2 emissions, hence the specific emission is zero.

- The emission savings due using nuclear power before the end of the lifetime of the Paks units are not considered as the result of the measure, so they are not shown here.

- The reconstruction and upgrading of the nuclear units will be finished by the same year when their original lifetime would end (commissioning + 30 years), i.e. in 2012, 2014, 2016 and 2017.

Thus the savings are the following:

	Installed additional capacity (MW)	Electricity output GWh	Emission saving kt
2005	0	0	0
2010	0	0	0
2015	1020	7385	1477

Emission Trading System

Objectives and description: In compliance with the relevant Community acts (2003/87/EC; 2004/156/EC) the Hungarian Parliament approved the Act XV of 2005 on the trading system of greenhouse gas emission units. This created the official framework for the allocation, trade, utilisation of GHG emission units and also codified those activities that are subject to emission licences.

The creation of the Act was preceded by some two years of intensive preparatory work, which resulted not only in the Act, but also in the preparation of all the necessary documents and procedures that were necessary to launch the trading system in Hungary. This included the detailed rules of the emission rights allocation and trading which were set forth in detail in the implementation decree of the Act, Government Decree 143/2005. (VII. 27.) Korm., and also the National Allocation Plan and the detailed Allocation List. The preparation work included a wide range public discussion about these documents.

The ultimate objective of the entire trading system is to reduce the risk of climate change. This is to be achieved by creating incentives for GHG emission-conscious behaviour an emission reduction measures, implemented by the biggest polluters.

The system is ready and operative for the first trading period (2005-2007) and preparation for the second period (2008-12) has started. The draft of the allocation principles for the second period has been written and disseminated and a series of public consultations have been announced.

Policy instrument type: Regulatory, economic

Status of implementation: Implemented.

Implementing entity: Ministry of Environment and Water Management

Monitoring indicators: Quantity of traded emission rights

Effects and impacts: The indirect impacts of the ETS on GHG emission reduction are not yet possible to measure or forecast. It is commonly agreed, however, that the first and most important impact of the ETS is that it considerably increases the awareness of the large companies – this has been strongly confirmed by their feedback during and since the preparation of the legislation. The companies rather soon realised the fact that they can generate extra revenues by reducing their GHG emissions. At the same time the limited availability of "free" emission rights for new entrants puts a constraint of energy use reduction on new developments.

However, quantitative forecasts will only be possible to make when the experience of the first trading period will be available.

Energy tax and environmental levy

Objectives and description: A high level regulation (Act LXXXVIII of 2003) introduced the energy tax on the sales and imports of electric power and natural gas.

Sales to residential consumer are exempt for the duty of paying the tax. The amount of the tax currently is HUF 186/MWh of electricity, and HUF 56/GJ of natural gas.

The primary objective of the tax is to incorporate some of the external costs of energy use in the price of energy, and to create incentive for energy saving and improving energy efficiency, in order to meet the general objectives of environmental protection and energy conservation.

Act. LXXXIX of 2003 introduced the environmental levies, in order to reduce the burden of the environment, protect nature, promote environmental awareness, and – not in the least - to provide funds for nature conservation. The objectives also include the use of best available technologies.

The levy is to be paid by the users of the environment in proportion to the quantity of pollutants emitted to the atmosphere, surface waters and soil. The amount of the levy is pollutant-specific. Residential users of the environment are exempt from the air pollution levy. The following pollutants are levied:

Air: SO_2, NO_x, solid, non-toxic particles

Water: COI, phosphor, inorganic nitrogen, mercury, cadmium, chrome, nickel, lead and copper.

Soil-related levy is not pollutant-specific, its amount based on the quantity of waste waters.

The two measures are discussed together because their working principle is very similar. The effect of both measures on GHG mitigation is indirect, and they work through fiscal incentives.

Policy instrument type: Regulatory / Fiscal

Status of implementation: Implemented.

Implementing entity: For the energy tax: Hungarian Customs and Finance Guard (VPOP), for the environmental levy: State Tax Authority (APEH)

Monitoring indicators: The effects of the measure are monitored directly through the amount of tax and levy, and/or the actual quantity of energy sales / pollutants the tax and levies are based on.

Effects and impacts: The direct effects i.e. the amount of tax and levy collected or the amount accumulated for the financing of environmental projects may easily be quantified. This volume is well demonstrated by the relevant lines of the state budget:

Line code	Item	Million HUF
2004		
19.7.1	Energy tax	10 921.8
19.7.2	Environmental levy	6 482.2
2005		
1.7.1	Energy tax	10 700.0
1.7.2	Environmental levy	9 000.0

The effects of these policy items on GHG emission reduction, however, are rather indirect (GHGs are not levied), as they act through the following mechanisms:

Energy tax

- Increasing energy awareness
- Improving the feasibility of energy efficiency projects
- Creating incentive for energy efficiency measures or for the substitution of gas/electricity with other types of energy

Environmental levy

- Creating incentive for reducing energy use or for modernizing equipment
- Creating incentive for reducing polluting activity

There are some ways of assigning measurable quantities, such as comparing the amount of energy tax with energy prices as to show how strong the incentive for improving energy efficiency (see the following table), but the actual GHG mitigation effect is not possible to quantify, since any mitigation may be the result of several incentives and policies together.

	Typical communal	Small enterprise	Industry
Electricity			
Price, HUF/ kWh	20.7	12.9	11.29
Energy tax	0.90%	1.44%	1.65%
Gas			
Price, HUF/MJ	1.069	1.610	1.643
Energy tax	5.24%	3.48%	3.41%

Energy audits in industry and the communal sector

Objectives and description: It is widely recognised that demand side energy efficiency actions can only be effective if they are preceded by energy audits that can identify the most efficient course of action. Therefore energy audits have been supported through various tools:

- Energy audits in industry is an important item of the Energy Saving and Energy Efficiency Action Programme (ESEEAP). The program allocated financial support to such audits in the form of a soft loan. In practice, during the implementation phase of the Programme the audits were supported mainly through grants. First 75% then 50% of the total audit cost was provided as grant, in the framework of the “Széchenyi plan”.
- Communal (municipality) energy audits were supported in the framework of both the UNDP-GEF Municipal Energy Efficiency Programme and Széchenyi Plan.
- Energy audits were also encouraged by including

them as a precondition of several financial support mechanisms for energy efficiency projects (e.g. Energy Efficiency Credit Fund, Phare Co-financed Loan Programme).

The objectives of these measures were:

- to identify energy saving opportunities in the industrial and communal sector and to found the base for further projects
- to ensure that expenditures on energy efficiency measures are efficiently made
- to increase energy awareness

Recognizing that the audits alone do not generate direct energy savings, the original legislation did not set any quantitative targets.

Policy instrument type: Economic

Status of implementation: Implemented/suspended

The original resolution (ESEEAP) that was the basis for all these measures is in effect till 2010. The main tools of its implementation were the annually revised energy efficiency programmes: the energy chapters of the Széchenyi Plan (SZT-EN 2001; SZT-EN 2002), the National Energy efficiency Programme (NEP 2003; NEP 2004). While SZT-EN 2001 and SZT-EN 2002 opened application possibilities for the support of energy audits, this opportunity was not offered in NEP 2003; NEP 2004, basically due to lack of funds.

Still, ESEEAP is effective and its most recent review by the Energy Efficiency, Environment and Energy Information Agency (Energiahatékonysági, Környezetvédelmi És Energia Információs Ügynökség Közhasznú Társaság - Energy Centre for short) recommends that energy audits are to be supported. Therefore it is expected that energy audits will receive further support before 2010, and possibly onwards.

Implementing entity: Energy Efficiency, Environment and Energy Information Agency (Energy Centre)

Monitoring indicators: Number of energy audits conducted; energy saving potential identified

Effects and impacts: In the past years when support was available the following results were achieved:

Source of support	Total project cost [M HUF]	Support [M HUF]	Number of projects
Industry			
SZT-EN 2001	187.1	118.8	32
SZT-2002-EN	8.5	4.3	1
NEP 2003	Not supported		
NEP 2004	Not supported		
Municipalities / Communal			
SZT-EN 2001	215.7	106.7	58
SZT-2002-EN	0	0	0
NEP 2003	Not supported		
NEP 2004	Not supported		
UNDP-GEF (between 2002-2004)	72.3	47.6	117

The effect of the audits on energy use or GHG emissions were not quantified by the implementing agency. It is also not possible to make well-founded forecasts as to the achievable GHG mitigation because:

- savings depend on how much of the audits' recommendations are the actually implemented;
- the future of available supports is uncertain, especially after 2010;
- much of the industrial audits do not use the available support but financed directly by the industry owners.

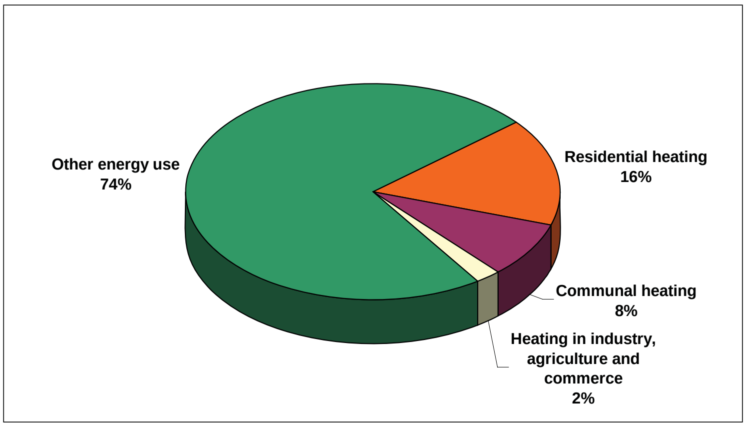

Figure 5.3 Importance of space heating in total energy end-use

New legislation for the energy efficiency of buildings

Objectives and description: In line with the principles of the Directive 93/76/EEC of European Commission that is aimed reducing the GHG emission through energy efficiency measures and the related Directive 2002/91/EC on the energy efficiency of buildings, the Hungarian

Government acknowledges the potential of improving energy efficiency of buildings in GHG emission mitigation and puts emphasis on taking appropriate actions in this field. As regards setting out appropriate provisions on the minimum energy performance requirements, especially regarding new buildings, the relevant Hungarian legislation is under preparation and the newly adopted regulations are planned to be effective from the beginning of 2006. The regulation will introduce new standards for the energy performance of buildings. Both the methodology of evaluation (thermal calculations) and some key parameters (e.g. U-values and normalised heat loss) are prescribed. Meeting with these prescribed values will be the precondition for the issuance of licences for construction or major refurbishment of buildings. The objective is considerable savings through the more strict performance requirements.

	Number of new homes	Number of modernised or partially modernised homes			CO2 emission saving kt
		Detached houses	Multi-flat housing	Housing estates	
2010	40 000	40 000	25 000	10 000	97
2015	40 000	40 000	30 000	10 000	108

As for the use of energy efficiency certificates, and regular inspection of boilers and HVAC systems as major energy consumer equipments within the buildings, unfortunately due to the lack of qualified and accredited experts, the application of these instruments suffers delays. Due to these problems, the Hungarian Government intends to avail itself of the possibility of having some additional period for the implementation of these provisions, while making every effort to make such a system is operational as early as possible.

Policy instrument type: Regulatory

Status of implementation: Adopted.

Implementing entity: Authorities for construction licences (municipalities), National Office for Housing and Construction (OLÉH)

Monitoring indicators: Number of issued Building Energy Certificates, number / heated volume of new or reconstructed housing.

Effects and impacts: The importance of heating in buildings is high: according the background study of OLÉH for their "Long-term Sustainable Building Energy Concept" it represents more than 26% of the total energy end-use and the related primary energy demand is 314 PJ per year. Having in mind the fuel mix of space heating the associated CO_2 emissions almost reach 19 000 kts. The measure has also impact on cooling, however, there are no reliable information as to the cooling energy demand, only estimations exist. According to those, approximately 1.05 PJ primary energy use can be associated to space cooling, that can be considered insignificant as compared to heating.

It is difficult to forecast the actual effect of the new legislation on GHG emission reduction, as there are no reliable forecasts available regarding the number of new housing to be constructed. Still, there are scenarios which were drafted on the basis of past experience. The concept foresees some subsidies for the improvement energy performance of buildings, but also some "spontaneous" saving that is due to those modernisation efforts that happen without support. Besides, the forecast calculates with the effect of the more strict standards.

For the purposes of the current document the foreseen subsidy of building modernisation is not taken into account so as to achieve a more conservative estimation. With this the following forecast is made for 2010 and 2015 (as the measure is planned to become effective from 2006):

Improving energy awareness

Objectives and description: One important action of the ESEEAP is to assist reaching its overall objectives by providing state-of-the-art information and training via the educational system and the organisation and operation of advisory networks and consumer offices, as well as via advertisements, the media etc. Another specific point of action is the promoting the use of energy efficiency labels. The relevant legislation set an overall 10 PJ energy saving until 2010 via energy awareness raising tools.

Policy instrument type: Information, education

Status of implementation: Implemented.

Implementing entity: Energy Efficiency, Environment and Energy Information Agency (Energy Centre), through a application system.

Monitoring indicators: Number of project applications, information outreach indicators.

Effects and impacts: Similarly to the support of energy audits, this action was also mainly implemented through the annually revised energy efficiency programmes (SZT-EN 2001, SZT-EN 2002). In 2001 14 of 46 projects were approved and supported with altogether HUF 42.5 million. In 2002 only 8 of the 13 applications were approved. From 2002 onwards the annual energy efficiency programmes (NEP2003, NEP2004) did not include awareness raising components.

Still, the implementation of action is not suspended, as there have been other sources and tools such as the

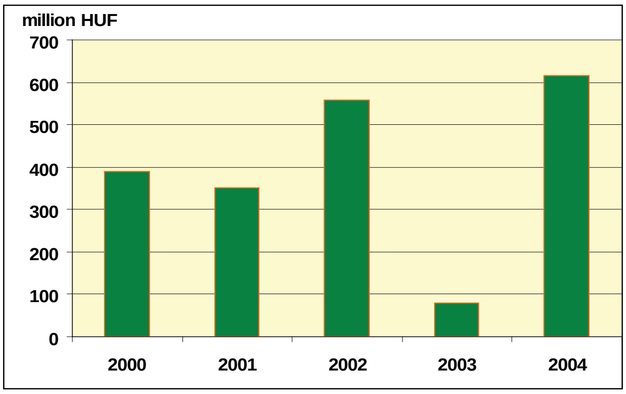

Figure 5.4 Energy related R&D expenditures

Environmental Protection Fund of the Ministry of Environment and Water Management, that provided an almost HUF 200 million support for 163 civil projects for energy awareness campaigns and projects. [4] Besides the UNDP-GEF programme for Municipal Energy Conservation, managed by the Energy Centre also included several educational components, from organising training course for municipal officials to publishing best practice guides. Even the creation of the Energy Centre in 2000 (see resolution 1031/2000) was done with educational objectives in mind, and the Centre still fulfils several awareness raising and educational duties, by providing energy efficiency information on-line, publishing energy efficiency manuals and guides, operating their specialised library.

Even if the ESEEAP set a concrete target of 10 PJ saving, it is not possible to quantify the effects of energy awareness actions, due to their very indirect nature. However, it may well be stated, that these activities were rather successful. This certainly shows in large number of applications for support for energy efficiency projects, the increasing number of events targeted at energy efficiency, large number of inquiries the Energy Centre, the customer offices of energy distribution companies and advisory agencies receive.

R&D for energy efficiency and renewables

Objectives and description: This action of the ESEEAP aims at encouraging the participation of Hungarian experts in foreign research, as well as the incorporation of energy saving and environmentally friendly technologies is the Hungarian R&D, including demonstration projects. According to the ESEEAP, the priority of energy efficiency within R&D has to be ensured with legal instruments and with preferential credits.

Besides the ESEEAP, other strategies, strategy documents also address R&D. Thus the 2002. Governmental Program, or the Mid-term Economic Policy Program adopted in August 2002., all identify R&D as key element.

The support of energy efficiency and renewable energy related R&D was administered through the National Research and Development Programmes (NKFP), The Central Technical Development Base Program (KMÜFA) and the GVOP sub-program of the National Development Plan. NKFP supports large, long term complex programmes, the other sources aid smaller (less than HUF 100 million budget) projects. The form of support is mainly grants, or – to a lesser extent – preferential (zero interest) loans. Each of the three sources identified energy efficiency and renewable energy utilisation as top priorities within their energy chapters.

Besides the above sources the annual energy efficiency programs (SZT-EN and NEP) also included R&D related targets.

Due to the nature of R&D projects no concrete quantitative target was set for energy saving or GHG mitigation.

Policy instrument type: Economic

Status of implementation: Implemented.

Implementing entity: Ministry of Education (earlier), National Office for Research and Technology (from 2004), Energy Centre

Monitoring indicators: Supported project budgets, number of projects.

Effects and impacts: From the different sources altogether almost HUF 2 billion was spent on energy efficiency and renewable research and development, HUF 1.4 billion of which was spent on renewable energy. [4]

The forecast, however difficult, as the expenditures on this purpose largely varied from year to year. The figures, however reflect the priority of the field therefore it is foreseen that the average level of support will be maintained in the medium term. It is not possible though to identify the quantitative effects of R&D on GHG mitigation. It is obvious that much of the results appear in the development of renewable energy generation (e.g. the availability of Hungarian-developed energy crops, energy grass) the bioethanol programme and in other areas but these effects are indirect and are incorporated in the forecasts that are relevant for those sectors.

Support for the improvement of industrial energy efficiency

Objectives and description: One of the actions of the ESEEAP was aimed at reducing industrial energy consumption. The objectives of the action were

- modernisation of energy processes of industrial production,
- improving thermal insulation,

	Total project cost	Support	Energy saving	Number of projects
	[M HUF]	[M HUF]	[TJ]	
EHA 2000...2003				
Gas engine cogeneration	1 034	400	298	5
Heat supply modernisation	2 185	1 124	484	34
Process modernisation	214	163	37	7
Wind power project	330	145	30	2
Complex refurbishment	107	67	57	2
EHA total	3 870	1 899	906	50
SZT-EN 2001				
Heat supply modernisation	189	55	24	19
Waste heat recovery	35	8	9	1
Building envelope modernisation	4	1	1	1
Process modernisation	53	14	11	3
Thermal insulation	19	6	1	1
Complex refurbishment	133	37	26	9
SZT-EN 2001 total	432	121	72	34
SZT-2002-EN				
Space heating and indoor lighting modernisation	53	16	10	1
Building envelope and space heating modernisation	5	1	0	1
Thermal insulation	5	1	0	1
Process modernisation	53	16	6	1
SZT-EN 2002 total	116	35	16	4
NEP 2003	386	95	72	17
Heat supply modernisation	55	15	12	3
Building envelope modernisation	39	12	2	4
Thermal insulation	3	1	0	1
Process modernisation	75	22	22	3
Two processes combined	39	9	10	3
Three processes combined	149	30	25	1
Four processes combined	26	7	1	2
NEP 2003 total	386	95	72	17
NEP 2004	93	26	14	7
Phare 2000...2003				
Gas engine cogeneration	1 100	133	254	3
Heat supply modernisation	740	135	220	5
Waste recovery	28	5	7	1
Phare 2000...2003 total	1 868	273	481	9
TOTAL	6 765	2 449	1 561	121

- improving the efficiency of energy consuming equipment and
- improving the efficiency of energy generating equipment.

The form of support foreseen was preferential loans, but no concrete amount was allocated. The expected target reduction of industrial energy use was 8.5 PJ until 2010.

Similarly to other actions of the ESEEAP the primary tools of implementation were the annually revised energy efficiency programs (SZT-EN, NEP), but similarly important was that preference was given to industrial energy efficiency in other existing support schemes, such as the Energy Saving Loan Fund (EHA) or the Phare Co-financed Loan Programme.

Policy instrument type: Economic

Status of implementation: Implemented

Implementing entity: The Energy Centre as the manager of energy efficiency funds, under the supervision of an inter-ministerial committee.

Monitoring indicators: Achieved energy saving.

Effects and impacts: The implementation of the policy required the following resources and resulted in the savings in Table 5.1.

It is apparent from the figures that the majority of the savings come from space heating related (heat supply modernisation, thermal insulation, building envelope modernisation etc.) and cogeneration /wind-power projects. The latter are not considered in the further calculations, as they were accounted for in the among the supply side measures. Considering the fuel mix of industrial space heating, the total emission reduction achieved by saving 754 TJ energy earlier used for this purpose results in 53 000 tons CO_2 emission reduction.

There are no forecasts available about the potential of further industrial energy saving, therefore the following assumptions are made in order to estimate the future effect of the policy:

- The technical lifetime of the already implemented projects is more than 10 years, therefore the generated savings will still be generated in 2010 and 2015.
- The support mechanism will stay in place after 2010.
- The average level of subsidy will be somewhat lower as there will be no Phare resources. In the meantime the investment costs will grow, therefore the subsidy can "buy" less projects.
- The efficiency of subsidy will also be lower as the best projects have been implemented already.
- The effect of projects implemented until 2010 will still be present in 2015.

With these assumptions the following emission reductions are forecast:

	CO_2 emission saving (kt)
2005	53
2010	63
2015	73

Residential and communal energy saving programmes

Objectives and description: Besides the reducing industrial energy consumption the ESEEAP also put emphasis on the support of residential and communal energy efficiency projects. This action of the ESEEAP focused on the improvement of thermal insulation and upgrading of building envelopes (facades, roofs, cellars, doors and windows) and the improvement the secondary heating systems of district-heated homes (primarily control and metering).

The foreseen tool of support was direct subsidies (grants) and the saving target was 10 PJ/year until 2010. Similarly to industrial energy efficiency improvement and other actions of the ESEEAP the primary tools of implementation were the annually revised energy efficiency programs (SZT-EN, NEP), but similarly important was that residential/communal energy efficiency projects were included in other existing support schemes, such as the Energy Saving Loan Fund (EHA) or the Phare Co-financed Loan Programme.

Policy instrument type: Economic

Status of implementation: Implemented/suspended

Implementing entity: The Energy Centre as the manager of energy efficiency funds, under the supervision of an inter-ministerial committee.

Monitoring indicators: Achieved energy saving.

Effects and impacts: The key figures of the related programmes were the following:

	Total project cost	Support	Energy saving	Number of projects
	[M HUF]	[M HUF]	[TJ]	
EHA 2000...2003	1 530	863	210	28
SZT-EN 2001	5 637	1 558	239	4 086
SZT-2002-EN	9 888	2 655	448	7 554
NEP 2003	7 840	1 951	403	4 736
Phare	1 223	269	155	11
Total	26 118	7 297	1 454	16 415

Of which residential projects:

	Total project cost	Support	Energy saving	Number of projects
	[M HUF]	[M HUF]	[TJ]	
EHA 2000...2003	0	0	0	0
SZT-EN 2001	4 456	1 214	142	3 989
SZT-2002-EN	8 396	2 335	283	7 500
NEP 2003	5 478	1 519	186	4 665
Phare	0	0	0	0

The EHA fund – with the exception of one small gas engine project – supported the modernisation of heat supply or thermal insulation in public buildings. As to the Phare source, roughly 50% support was spent on space heating modernisation, the remaining projects dealt with waste water and landfill-gas utilisation. The early residential projects included several complex heat supply modernisation measures, while the later years the vast majority of support was spent on the replacement of windows and doors.

The GHG emission saving is estimated on the basis of the achieved energy saving and the fuel average fuel mix of the residential and communal sector. Thus the 1.45 PJ saving resulted in 81 kt CO_2 reduction.

	Number of projects	Total project cost	Support	Energy saving
		M HUF	M HUF	[TJ]
Heat generation type				
Geothermal and heat pumps	27	428	123	25
Woodchip firing	12	1000	92	194
Biogas utilisation	2	261	71	104
Other biomass	9	137	41	12
Other renewables	6	181	46	31
Power generation type				
Photovoltaic	6	222	19	0,43
Wind power	5	1 120	182	93
Hydro	1	137	37	41
Photovoltaic + wind power	1	1	0	0,03
Miscellaneous technologies	4	20	1	0,1
“20000 solar roofs”				
Solar collector	437	768	198	15
Solar collector + biomass	12	26	6	2
Total	**522**	**4 302**	**816**	**518**

Table 5.2 Most important energy saving data regarding end-user energy efficiency

In order to forecast the effect of the measure, similarly to those of the industrial energy efficiency measures, the following assumptions are adopted.

- The technical lifetime of the already implemented projects is more than 10 years, therefore the generated savings will still be generated in 2010 and 2015.
- The support mechanism will stay in place after 2010.
- The key area of projects will be space heating related measures (boiler replacement, thermal insulation, window replacement etc.)
- The average level of subsidy will be lower. (In 2005 the support of residential and communal energy efficiency was suspended. Due to the low support intensity other areas were preferred, but with the introduction of energy tax it is hoped that some level of support will be maintained.) The basis of forecast will be the SZT-EN and NEP figures, as Phare is likely to be discontinued and the criteria of EHA are too strict to support considerable number of residential/communal projects.
- In the meantime the investment costs will grow, therefore the subsidy can ”buy” less projects.
- The effect of projects implemented until 2010 will still be present in 2015.

With these assumptions the following emission reductions are forecast:

	CO_2 emission saving (kt)
2005	81
2010	97
2015	112

Support for end-user renewable energy

Objectives and description: Promoting the use of renewable energies is one of the priorities of the ESEEAP. Two of its sub-programmes address this area:

- Promoting alternative (primarily biomass fuelled) firing systems and
- Increasing the utilisation of renewables in general.

The general objective of the ESEEAP was to achieve 50 PJ/year renewable energy utilisation by 2010. The other quantitative target within this objective was to have solar collectors on 20 000 homes or public buildings by 2010 (“20 000 solar roofs programme”). The foreseen form of support was direct subsidies (grants).

The instruments of implementation were also the SZT-EN and NEP programmes and support was also provided from the EHA and Phare funds or from the Environmental Fund (KAC).

Policy instrument type: Economic

Status of implementation: Implemented.

Implementing entity: The Energy Centre as the manager of energy efficiency funds, under the supervision of an inter-ministerial committee., Ministry of Environment and Water

Monitoring indicators: Achieved energy saving.

Effects and impacts: Detailed information is available about the SZT-EN and NEP programmes only that can serve as basis for impact forecasts. The most important figures were listed in Table 5.2.

The related CO_2 emission reduction is calculated differently for the two basic project types:

- For power generation type projects those specific reference CO_2 emission factors are used that were developed for baseline calculations of JI projects. It is noted, however, that the indicated savings are primary energy savings, therefore – although the projects in question are end-user projects – the factors of the generation type projects are used, disregarding distribution losses. In order to calculate the electricity generation related to the given primary energy uses, the forecast average plant efficiencies of the big power plants (without the Paks nuclear) is used.
- For the fossil heat replacement type projects (heat generation and solar) the emission reduction is calculated with the fuel mix of the residential and communal sector.

Thus the total GHG emission reduction achieved by the above projects is 29 kt CO_2, of which 8 kt is from power generation type projects, 21 kt from heat generation type ones.

For the forecast of impacts of the measure the same set of assumptions are used as in case of the residential and communal programmes, with the following additional consideration:

- Power generation type projects are not considered, as the related forecasts are included in the chapter on supply side promotion of renewables.

With these assumptions the following emission reductions are forecast:

	CO_2 emission saving (kt)
2005	29
2010	38
2015	46

Modernising district heating systems

Objectives and description: District heating plays an important role in space heating and hot water supply in Hungary, especially in the residential sector. There are some 100 district heating schemes in the country, supplying heat to more than 640 000 homes. The inefficiency of the systems and the high space heating costs of the district heated buildings are not only a technical problem but also an evergreen political issue. Therefore the modernisation of the district heating systems was included among the priorities of the ESEEAP. The quantitative target was to achieve 10 PJ/year saving till 2010 by providing support for:

- increasing the share of cogeneration within the heat generation capacities of the district heating systems;
- primary side reconstructions including the installation of meters in the substations;
- secondary side modernisation, primarily for better controls and cost allocation.

Similarly to the other ESEEAP actions, the support was provided through the SZT-EN and NEP programmes and the EHA and Phare funds.

Policy instrument type: Economic

Status of implementation: Implemented

Implementing entity: The Energy Centre as the manager of energy efficiency funds, under the supervision of an inter-ministerial committee.

Monitoring indicators: Achieved energy saving.

Effects and impacts: In the following tables and calculations only those projects are considered that are not co-generation related, as the effects of cogeneration were accounted for in the relevant chapter.

The support proved and the achieved savings are summarised in the following table:

	Number of projects	Total project cost	Support	Energy saving
		M HUF	M HUF	[TJ]
EHA (2001-2003)	1656	966	346	19
SZT-EN 2001	2668	773	557	32
SZT-EN 2002	566	167	69	8
NEP 2003	1613	475	281	22
Phare	874	60	220	1
Total	7377	2441	1473	82

The emission reduction savings achieved through the energy saving realised can be calculated with the actual fuel mix of district heating. Thus the specific emission factor is 63.9 that results in a 94 kt CO_2 emission reduction by all the non-cogeneration projects of the three years investigated.

The forecast of further emission reduction is based on similar assumptions as those of the residential energy efficiency programmes. However, a stronger degradation of subsidy intensity is assumed, as due to the low number of DH schemes the replicability of projects is lower. The so forecast emission reductions are the following:

	CO_2 emission saving (kt)
2005	94
2010	114
2015	129

Energy efficiency support schemes

Objectives and description: In the previous chapters several references were made to various financial support schemes, energy efficiency programmes. In the current chapter a general overview of these policy tools is given in order to provide a complete picture of their background and objectives. The order of reviews does not reflect priority.

UNDP energy efficiency programme for Municipal Energy Conservation

The aim of the assistance programme is to reveal the possibilities of rational use of energy; to reduce CO_2 emission by financing energy audits and the compilation of feasibility studies at the municipal institutions. The programme is open for municipalities, county governments, district notaries and organisations in total or partial municipal ownership as well as for legal entities or business organisations dealing with issues of municipal energy use (such as the auditors themselves.) The form of support is direct subsidy (grant). In 2005 the following conditions of subsidy apply:

- 40% of the total costs of the audit or the feasibility study can be covered directly from the support;
- A further 40% can be granted (altogether maximum 80 per cent), if an investment into energy efficiency is initiated by 31 October 2006. (i.e. some or all of the recommendations of the audits are actually implemented.)

The total size of the funds available for the purposes of the programme is 1.535 million USD. The programme is planned to remain operative until the end of 2005.

EHA - Energy Saving Loan Fund (German Coal Aid)

The Government of Federal Republic of Germany offered Hungary DEM 50 million specially for the acquisition of coal in 1991. Sixty per cents of the HUF equivalent of the original aid, working as a revolving fund, are still used for the financial support of energy efficiency projects and the reduction of energy demand. The support can be obtained in the form of discounted repayment loan through an open application procedure.

The Fund finances the implementation of developments for achieving energy saving which contribute to the reduction of the energy demand and the energy costs of the national economy efficiently, reduction of pollution of the environment as well as dependence upon energy import. The aims are to substitute the traditional sources of energy with renewable energy sources and energy from waste, to establish the conditions of efficient management of energy sources and the reduction and termination of energy losses at the least possible cost. Supported measures include:

- Reduction of energy losses of energy generation, distribution and use.
- Procurement and use of modern, lower energy consumption process equipment.
- Heat recovery and the utilisation of renewable energies.
- Cogeneration
- Thermal insulation projects
- Better space heating control, especially in district heating.

Phare Co-Financed Energy Efficiency Loan Construction

A 10-year energy efficiency loan construction established within the frame of European Union's Phare programme and supported by Phare Revolving Fund is operated via the Commercial and Credit Bank plc. and Raiffeisen Unicbank plc. The aim of the loan construction is to provide the financial incentive for developments focusing on the improvement of energy efficiency. The soft loan is open for private enterprises, municipalities or municipal institutions and independent public institutions. A precondition of the loan is that the energy efficiency project is based on an energy audit or feasibility study. The amount of the loan is based on the actual project cost that may include feasibility planning, engineering, commissioning, training of operators, hardware.

National Energy Saving Programme (SZT-EN, NEP)

The Programme is the sequel of the Energy Chapter of the Széchenyi Plan, starting in 2001. The conditions of support are reviewed annually according to changing emphases in the energy policy, but the major strategic goal are based on the priorities of the Energy Saving and Energy Efficiency Action Programme. The key objectives of the NEP in 2004 were the following:

- Support of domestic energy saving for private individuals
- Reduction of energy utilisation and energy cost of municipal, governmental and other institutions
- Support of the modernisation of street lighting (of small settlements)
- Modernisation of the district heating on the customer side
- Extension of the utilisation of renewable energy sources for municipalities and private individuals
- Extension of the utilisation of renewable energy sources for business organisations
- Support of R+D type of energy efficiency developments of small and medium size business organisations with low capital and the reduction of energy utilisation of production sector to reduce energy expenditures.
- Support of energy saving investments for enterprises with the involvement of third party financing.

In 2005 the due to the disproportion between the demand for support and the size of available funds the NEP was temporarily suspended but is planned to be continued in 2006.

KIOP-2004-1.7.0.f (Operative Programme for the Environment and Infrastructure Environmental friendly development of energy management for 2004-2006)

KIOP is one of the five operative programmes of the National Development Plan.On of the actions set forth

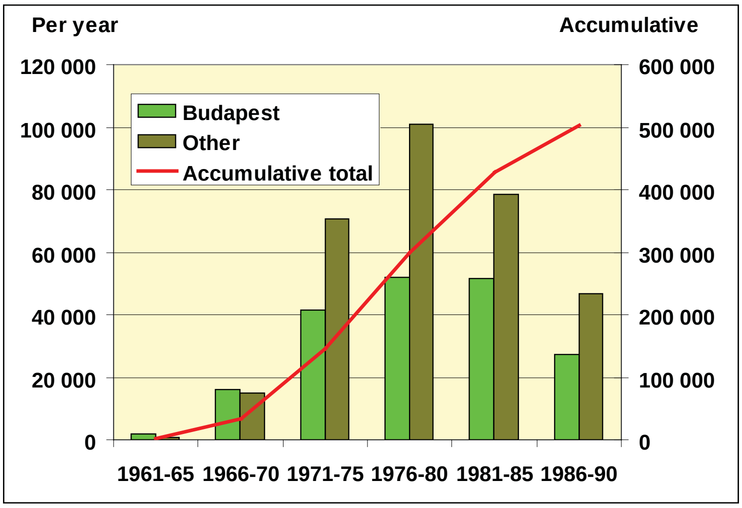

Figure 5.5 Number of "panel" buildings constructed

within KIOP was the Environmental friendly development of energy management. The key objectives of the action is the

- increased utilisation of renewable energies
- improved energy efficiency.

The tool of meeting the objectives is direct subsidies covering 25-75% of the justified costs of renewable projects and 30-75% of energy efficiency projects. The support cannot exceed HUF 300 million per project. The funds for the support is prided from the European Regional Development Fund (75%) and from national resources (state and municipal budgets) (25%).

This tool is designed for large projects: the minimum projects size is HUF 125 million. The support is available for governmental and municipal institutions, municipality-owned enterprises, non-profit NGOs, churches and SMEs.

Support for the energy efficient reconstruction or modernisation of pre-fab technology buildings ("Panel Programme" Code: LKFT-2005-LA-2)

Due to their large number, age and the technology used in their construction, the buildings constructed from prefabricated concrete elements between the end of the 1960s and 1990 ("panel" buildings) represent large potential in residential energy saving. The same applies to the "mass-produced" housing constructed with some other technologies. In order to realise some of this saving potential support is provided for the energy efficient reconstruction or modernisation of such buildings. The supported measures are primarily:

- thermal insulation of building envelope;
- replacement of windows and doors
- modernisation of heating, water supply, sewage and ventilation systems.

Maximum 33% of the total project cost or 400 000 HUF/home, whichever is the lower, can be provided in the form of grant. The support system is managed by the National Office for Housing and Construction (OLÉH).

Hungarian Energy Efficiency Co-Financing Programme (HEECP)

The purpose of the Programme is to provide assistance in the financing of energy efficiency within the financial sector. Three forms of assistance is offered:

- Guarantee Fund: By providing guarantees HEECP is instrumental in promoting the energy efficiency services of financing institutions, in the financial and technical preparation of projects.
- Technical assistance: HEECP is ready to cover the 50% of the personnel costs of one person who is working on preparation or monitoring of energy efficiency related projects, or on energy efficiency marketing. HEECP can also provide up-front financing for project preparation.
- Operation: Financing is available for information exchange, conferences, workshops, or work of experts.

Policy instrument type: Economic

Status of implementation: Implemented

Implementing entity: Please refer to the description of the individual tools.

Monitoring indicators: Number of projects, energy savings achieved.

Effects and impacts: Included in the forecasts for the different measures and projects discussed in the other parts.

5.3.3 Transport

National targets and support for renewable automotive fuels

Objectives and description: The Directive 2003/30/EC of the European Parliament and the European Commission requires that the member states would increase the share of automotive bio-fuels to 2% until 2005 an then establish a growth rate of 0.75%/year in order to reach 5.75% share by 2010.

In order to address these targets, Government Decree 18/2003. (II. 19.) Korm. introduced a subsidy system for bio-diesel and also provided a safe market for such products. This attempt proved to unsuccessful1, therefore the system was abandoned.

As in several EU member states, the use of bio-ethanol (ethanol) and ETBE produced from bio-ethanol, as well as the use of bio-diesel produced from vegetable oils is considered feasible in Hungary. Due to professional and financial considerations, direct blending of bio-ethanol in engine fuel is not preferred, however, technically, there is no restriction on the blending in of ETBE produced by the addition of isobutylene, a by-product of oil-refineries.

Thus in order to meet Hungary's international commitments, however, the Government in the Government Resolution No. 2233/2004. (IX. 22.) Korm. agreed that the share of renewable fuels (bio-diesel and ETBE produced from bio-ethanol) within the total automotive fuel consumption shall reach 2% by 2010. The decree also provided a tool for achieving the target by installing a excise-duty refund system until 2010.

Some further details of the use and commerce of bio-fuels are regulated by Government Decree 42/2005. (III. 10.) Korm., primarily by providing adequate definitions for the various types of bio-fuels.

Policy instrument type: Fiscal

Status of implementation: Implemented.

Implementing entity: Ministry of Economic Affairs and Transport, Ministry of Environment and Water Management, Ministry of Agriculture and Rural Development, Ministry of Finance

Monitoring indicators: Quantity of bio-fuels sold/used. The Government Decree 42/2005. (III. 10.) Korm makes it obligatory for all traders of bio-fuels to make a detailed report every year for the ministry responsible for transport.

Effects and impacts. One of the obstacles before the faster bio-fuel production is the lack of ETBE production capacities. At the time when the current targets were set, production capacity for bio-ethanol required for 40 thousand tons of ETBE was available. Subsequent to the new decree in late 2004, MOL Hungarian Oil and Gas Company plans to make investments in their Tiszai refinery, so that the total ETBE production capacity is expected to be over 100 000 tons from 2007. The bio-ethanol necessary for ETBE production is to be procured through tender procedures that triggers competition for the construction of ethanol production capacities. The first tender for was launched in the summer of 2005.

It is difficult to make statements as to the quantitative impacts of the policy as yet, because the first results are about show in 2006. According to the background studies of the Government's renewable strategy the 2% share target is realistic if the excise-duty refund (or zero excise duty) system is in place. All estimations are based on this quantitative target figure. The absolute value of renewable energy consumption in transport through the use bio-fuels is thus expected to be 3 PJ in 2010. After 2010 the 2-2.5% share is thought to be maintained.

It is even more difficult to quantify the GHG emission reduction effect of the measure as there is no commonly agreed estimation regarding the impact of bio-fuels on overall GHG balance. Some scientists, for example, even argue that the energy balance of alcohol production is negative, i.e. the production requires more energy (typically produced from fossil fuels) than the final product contains. Other authors in a more recent study claim that owing to modernised methods of farming and the optimisation of the conversion process the balance turned positive in recent years, presenting 8-15 MJ/litre energy gain, depending on the feedstock and the technology used for conversion. It is clear that converting the estimated energy gains to GHG emission savings is even more difficult and site-dependent, as it much depends the fuel used in the plant and the fuel mix of power generation in the given region. According to the study the achievable GHG reduction ranges from 0.3 to 1.8 kg CO_2 eq. depending on the feedstock and the fuels used. The wide range well shows that it would be irresponsible to make any statements regarding Hungary's emission reductions as yet, since the construction of the production capacities are in the preparation phase. Still, just to illustrate the order of magnitude, using the above range, it is calculated that the use of the expected quantity of bio-fuels in 2010 may result in saving of 0.04-0.26 kt per year.

General transport related policies and measures

Objectives and description: An important specific and operative objective within the Action Programme of Urban Environmental Quality is the reduction of urban environmental problems that are due to the traffic, particularly in densely populated areas of towns. This objective is planned to be achieved through:

- Comprehensive transport plans, organization and management to reduce traffic in inner-city areas, particularly centres of towns (constructing by-pass roads, planning and establishing P+R systems, constructing a network of bicycle paths)
- Development of urban and agglomeration public transport, considerable improvement of its quality (including the integration of urban public transport, establishment of traffic associations; development of intermodal junctions; modernization, replacement of vehicles; development of capital, local and suburban traffic)
- Protective investments to prevent the propagation of harmful impacts, among them the construction of noise protection structures, noise abatement elements

NEP-II. does not set concrete quantitative targets to these actions.

The Action Programme of Climate Change also includes a transport related operative objective, i.e. the reduction of pollution emission from transport, that is to be achieved by:

- Accelerating the modernization rate of the vehicle stock
- Moderation of the environmental impact of freight transportation: supporting the propagation of environmentally friendly transportation ways, shifting freight transportation from trucks to railway
- Support for environmentally sustainable means of transport.

In order to implement the planned measures an ambitious Action Programme is being developed with concrete individual measures. The planned measures include

- Yearly updated promotion / support scheme for environmentally friendly vehicles
- Establishing a carbon trading system for heavy vehicles, later for lorries then for passenger cars.
- Improving the efficiency of regular emission tests of the vehicles by utilising the Internet; by providing improved technology for the tests,; by random on-the-road tests.

The target emission reduction to be achieved by the measures of the Action Programme is the following:

CO_2	15%
NO_x	70%
CO	60%
CH	50%
Particles	70%

Plans also exist for balancing the various ways of cargo transport by

- limiting the use of heavy road transport through more stringent regulation, limits on the time frame and lengths when and where such transportation is allowed, offering bonuses, combined discounts if transport is shifted to railways of waterways;
- supporting the construction of infrastructure and equipment, vehicles for combined transport (new terminals, loading technologies, Ro-Ro types ships etc.)
- ensuring that costs of transportation would be related to the load by introducing differentiated road tolls, review of vehicle tax system.

Training and information dissemination measures will also be instrumental in achieving the targets. The planned measures include:

- information system of transportation will be established (incorporation information on the environmental impacts of transportation in the curriculum of schools, cooperation between governmental bodies and NGOs)
- legislation that reflects the environmental benefits of modern, state-of-the-art vehicles;
- labelling and other type of information about the environmental impacts of the vehicles.

Policy instrument type: Mainly economic.

Status of implementation: Adopted.

Implementing entity: Various

Monitoring indicators:

- share of local and interurban public transport within modes of transport;
- changes in passenger-km of local and interurban public transport;
- changes in the length of local and interurban public transport network detailing the transport modes (railway, road);
- occupancy indicators of local and interurban public transport;
- share of bicycle transport within modes of transport;
- changes in the length of bicycle paths;

Effects and impacts: The impacts of the planned actions are rather indirect therefore it is not possible to forecast the emission reductions achieved by these. Some sort of forecast will be possible only for some of the individual actions when the concrete targets will be clear and input data according to the monitoring indicators are available. Still, in the course of modelling and forecasting Hungary's GHG emissions some assumptions were made with all the planned measures in mind and with respect to expected growth rate of the economy, the forecast increase of the road network system, the average distance travelled by the different vehicles (primarily lorries and heavy transport vehicles), the price elasticity of automotive fuels and the expected growth of vehicle stock. With all these the forecast GHG emission reduction achieved, as compared to the also forecast baseline are shown in the following table. It is, however, noted, that the forecast emissions, compared to the transport emission levels of 2005 the absolute values show increase, shown in the third column of the table.

	CO_2 emission saving against baseline (kt)	Emission increase relative to 2005 (kt)
2005	0	0
2010	925	583
2015	2 118	1 176

5.3.4 Industry

Objectives and description: The process-related industrial GHG emissions are basically determined by the production levels that are dependent on the general development of the national economy, the market conditions, owbership changes, acquisition etc. The major developments in selected industries are shortly listed below:

Mining industry

Due to the low economic performance of coal mining and the strong competition in the coal market a number of mines were closed or stopped in 2003 and 2004. Demand for coal also dropped due to the fuel switch project of some power plants, but the share of coal has also dropped in the residential sector as a result of the widespread use of natural gas.

As to domestic oil and gas mining, due to the gradual depletion of domestic sources its importance in GHG emission is lower than earlier.

Cement production

The main consumer of cement is construction industry, so its prosperity is the figure of the improvement of construction industry. Cement is mostly used for concrete production. There is a very strong price competition in this sector. Holcim and the Heidelberg group own the main plants in Hungary. One of the Holcim plants, Hejőcsaba operates dry technology and has 2 times greater capacity than the size it operates presently. The other Holcim plant, Lábatlan runs wet technology. The 2 plants belonging to the Heidelberg group is Beremend, with dry technology, planned to be modernised and Vác, with a modern, dry technology having one line permanently out of operation because of the low demand. The overall utilisation of cement production capacities in Hungary is just 60%.

Lime production

Lime production is highly concentrated, the capacity is composed of 3 factories. The capacity of these can be increased in the coming years by app. 25%, so the capacity barrier is not expected to show. With the reduction of national production the ratio of import began to rise, the source of which is mainly Slovakia and Austria. The reason for the increase of import is not a more competitive price, but the growing demand for quality lime. The relatively quick appearance of lime import was the result of the closure of national factories (mainly the Dunaferr Lime Plant). As the capacity of the operating plants can be increased, export is predicted to reduce.

Consumption is stabilised. Increase can emerge in the paper industry for the production of quality paper, presently supplied from import. The prosperity and changes in the applied technologies of the construction industry can also raise demand. New consumption can appear in the environmental protection and agriculture.

Ceramics and porcelain industry

The product structure, and hence the market for the products in this sector is quite heterogeneous. No typical trends can be identified, as, for example, no significant relationship can be found between the production volume of building material ceramics and the volume index of the construction industry. However, a slowly growing trend of production is foreseen.

Paper industry

Paper consumption in Hungary is app. 80 kg/person, which is far below the EU average. The average consumption of the EU-5 is 2.5 times higher, 200 kg/person. Based on this fact a dynamic improvement of production is expected.

Chemical industry

Chemical industry probably is the most concentrated sector of processing industry, contributing to the total production of processing industry by 75-80%, which is produced by only 15-20 companies. An important, sector-specific tendency is that in many cases the national production of raw materials and intermediers is going to cease, companies are going to import these materials then. The big company size is also the result of a significant vertical integration, which is extremely true for the petrol-chemistry sub-sector (mineral oil processing, plastic production). Though the concentrated structure is a general characteristic of the sector, there are huge differences between sub-sectors. Coke production and mineral oil processing is shared by 2 company groups (Dunaferr and MOL Rt.) as there are only a few actors in the plastic raw material, fertilizer, pharmaceutical and rubber industry. Petrol-chemistry sub-sector (including plastic manufacture, mineral oil processing and plastic fibre production) has a cyclic character. Fertiliser and pesticide industry was the loser of the evolution of the previous period of chemical industry as a result of the decline of the Hungarian intensive agriculture, the accelerated import. In the future demand level for fertiliser is predicted to fix at a relatively stable value, which is considerably lower than in the previous period. Hungarian pharmaceutical industry is one of the most competitive sectors of the whole economy even abroad. Therefore a strong growth rate is predicted. Rubber and plastic manufacture has shown a very dynamic improvement since 1990. Experts foresee an even 4 times higher growth than the GDP increase here.

Coke-, pig iron and steel production

The production side of the national steel market has a few actors, which can significantly be influenced by the periodical or final disappearance, modification or technology change of an actor. The national demand is influenced mainly by construction activities, but overall production heavily depends on what happens in the world market, such as how China's demand will change. Predictions show a dynamic growth in the construction sector. Coke in Hungary is produced by only by one plant, and the demand for coke is determined by the steel production.

The above described situation well reflects how the production of the industry is exposed to a wide range of factors. It must also be noted that the vast majority of the industrial GHG emissions are due to energy generation, combustion or other energy conversion processes. The direct process-related emissions represent a small fraction only.

Therefore there are no industry specific mitigation policy: the general policies and measures described elsewhere in the current document influence the emissions of the industry. The most important such measures are:

- The introduction of the Emission Trading System. This creates a strong incentive for the biggest emitters of the industry for reduction measures.
- General environmental protection measures, such as emission limits of combustion equipment. These force the industries to modernise their equipment, that usually results in efficiency improvement and hence GHG emission reduction.
- Energy tax and environmental levy.
- Waste management legislation and programmes. These have the highest effect in the industry (such as reduction in packing materials) beside the agriculture.
- Support programs for cogeneration.
- Support on energy efficiency measures (audits, projects, awareness raising).

Policy instrument type: Regulatory, economic, fiscal

Status of implementation: Various

Implementing entity: Various

Monitoring indicators: Only indirect effects can be monitored, as the data appearing in emission inventories reflect the effect of a host of various influencing factors other than the measures. However, some monitoring method (discussed at the individual measures) allow differentiation between the industries and other emitters. (An example is the support of energy efficiency measures, where each supported project can be evaluated individually.)

Effects: The quantifiable effects are included in the forecasts for the individual measures in the relevant chapters of the current document.

5.3.5 Agriculture

Objectives and description: The key elements of GHG emission mitigation policy within agriculture are the following:

- Modernisation of animal husbandry including the application of foddering technologies that reduce the products of enteric fermentation
- switching the manure management technology from liquid to semi-liquid; application of less methane intensive manure management and leak-free storage technologies
- Promotion of natural farming methods with much less chemicals, organic fertilisers (manure) and energy use.
- Change of land use.

There is a wide range of legal measures and policies to support such changes.

National Agri-environment Programme

The NAEP, a sub-programme of the National Environmental Programme, approved by the Government Resolution 2253/1999 (X.7.) Korm, includes several horizontal and zonal targets. One of them is to increase the territorial proportion of semi-natural forest management. NAEP also looks at afforestation as a tool of implementing some of its measures, such a forest plantation on flood areas in order to protect wetland habitat.

The NAEP objectives were integrated into the agri-environmental measures of the National Rural Development Plan (NRDP) in 2004.

Environmentally beneficial extensification, especially the reduced, optimised use of fertilisers and pesticides, the considered (limited) application of dangerous substances and other accompanying benefits for the environment are among the main priorities for agricultural practice. Integrated farming is based on the internationally approved principles and practices of integrated pest management (IPM, IOBC guidelines). This production system should be targeted as a future standard for market oriented agricultural production due to the economical and efficient production that it facilitates, its environmental merits and its food safety aspects. The Integrated Crop Management System (ICMS) was introduced in Hungary in 2002, also under the National Agri-environment Programme. (A detailed summary of the NAEP is given in Hungary's 3rd National Communication for the UNFCCC, 2002.)

The SAPARD Plan of Hungary (2000 – 2006)

Decree No. 53/2001. (VIII. 17.) FVM identified Hungary's priorities in agriculture and rural development in order to prepare for the optimum use of the EU's SAPARD funds. This decree (SAPARD Plan for short) was based on, among others the NAEP. Reducing the negative impacts of agriculture on the environment is listed among the

SAPARD Plan's specific objectives and the emphasis on environmental considerations is an integral part of the proposed strategy. The latter is planned to be put into practice by promoting natural farming methods.

Of the measures prescribed in the SAPARD Plan, the activities involved in the measures entitled, "Protection of agri-environment" and „Technical Assistance" provided the basis for some corresponding measures with GHG mitigation aims or effects.

Nitrate Action Programme

Government Decree 49/2001. (IV. 3.) Korm on protection against the nitrate contamination of waters from agricultural sources (Nitrate Decree for short) contains provisions in line with Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources. In a manner similar to the directive, the Nitrate Decree, which came into effect in 2001, contains the list of settlements in nitrate sensitive areas, the rules of "Good Farming Practice in manuring" that farmers are obliged to keep and the time-schedule of implementation in the form of an action plan. The Action Programme was launched on 1 January 2002 and extends to 31 December 2013. Along with nitrate sensitivity, its priorities include the requirements applicable to the manure storage systems of animal keeping sites that use semi-liquid manure technology.

Agriculture and Rural Development Operative Programme (AVOP)

AVOP is the part of the National Development Plan, which identifies the environmentally friendly agriculture and the rational use of land among the general objectives of rural development and sets forth the following specific objectives:

- Environment-conscious and sustainable land use
- Improvement of the status of the environment
- Increasing afforestation.

Second National Environmental Programme - Thematic Action Programme of Climate Change

Among the specific and operative objectives of the Climate Change Action Programme, the following objectives are included:

"3.2.4 Reduction of greenhouse gases from agriculture and waste by strengthening carbon dioxide sink capacities

c) Reduction of methane emission form animal breeding and cultivation

d) Support for cultivation aimed at power generation and increasing the binding potential"

These policies are implemented by, among others, various support schemes. The most important ones, that affect GHG mitigation are the following:

Entry Level Scheme (ELSs): Entry level schemes promote environmentally friendly farm management in each land use type to provide broad scale opportunity to farmers to enter commitments to reach environmental achievements in their farming practice. Elements of the ELS have already been introduced in Hungary in 2002-2003 under Government Resolution 2253/1999 (X. 7.) on the introduction of the National Agri-environment Programme. ELSs are designed to encourage farmers to use farming methods adapted to the local environmental and agricultural conditions, to target production systems suitable to soil and climate conditions and natural environment, with special attention to relevant environmental protection aspects.

Organic Farming Scheme: The OFS is designed to encourage farmers using conventional farming methods to convert their production systems to organic production as prescribed by Regulation 2092/91 (as amended). Conversion to organic farming systems provides gains in terms of soil health and fertility, benefits for bio-diversity and wider landscape benefits through the use of organic soil cultivation, crop rotation and the absence of synthetic pesticides, herbicides and fertilisers. Besides organic farming contributes to reduced GHG emissions through the use of manure as fertiliser and the limited energy use.

All farmland in the land use concerned must be entered into the scheme, parallel farming (both organic and conventional) is not allowed. Any farmer who is controlled by any organic production certification organisation approved under Article 9 of Regulation 2092/91 is eligible for aid under the OFS regardless that he/she is in conversion or already converted. For areas in conversion period the higher payment rates apply, this is 2 years for annual crops and 3 years for permanent crops.

Environmentally beneficial extensification, especially the reduced, optimised use of fertilisers and pesticides, the considered (limited) application of dangerous substances and other accompanying benefits for the environment are among the main priorities for agricultural practice. Integrated farming is based on the internationally approved principles and practices of integrated pest management (IPM, IOBC guidelines). This production system should be targeted as a future standard for market oriented agricultural production due to the economical and efficient production that it facilitates, its environmental merits and its food safety aspects. The (Integrated Crop

Management System (ICMS) was introduced in Hungary in 2002, on the introduction of the National Agri-environment Programme

The ICMS is designed to encourage farmers to use integrated farming methods of production in compliance with higher environmental standards, to optimise the use of fertilisers and pesticides and to apply all available means (equipment and know how) of sound farming. The application of integrated farming systems provides benefits in terms of soil conservation, water protection and bio diversity through the use of environmentally friendly crop patterns, cultivation techniques, nutrient management, crop rotations, as well as the optimised, limited use of synthetic pesticides, herbicides and fertilisers

Support for meeting standards: The general purpose of the support is to ensure that the requirements of the valid standards animal husbandry are met. Within the support a separate "sub-measure" covers the area of environmental protection. The aim of this type of support is to ensure the adequate on-site placement and management of the organic manure and the storage in line with the environmental requirements. The form of support is provided by providing subsidy for the investment costs. In the framework of this support mechanism assistance is also provided for compliance with provisions concerning keeping and foddering technology, although reduction of enteric fermentation is not identified as a target.

Policy instrument type: Various

Status of implementation: Continuous

Implementing entity: Ministry of Agriculture and Rural Development

Monitoring indicators: Number of projects supported; Number of events; Fund spent on projects; Specific quantitative indicators of projects (e.g. number and type of animals foddered, quantity of manure managed)

Effects: The above discussed measures obviously have GHG mitigation effects, although, due to either their indirect nature or the lack of adequate data the impacts are very difficult to quantify. The more so because the overall GHG emissions of agriculture are much more influenced by other, stronger factors, such as the market mechanisms and demand for animals of organic products. There are other adverse effects, too. For example, considerable decrease in the use of fertilisers is highly unlikely, as in the past years the problem of Hungarian soils is not the excess of fertilisers, but rather – due to the negative balance of nutritive elements - the degradation of soil quality.

In the modelling process some assumptions were made as to the effect of the planned measures. It is strongly emphasized, however, that the following figures do not reflect the impact of measures only, but rather the result of complex processes, whose part are the measures. As to the possible effect of mitigation measures, however a good indication is the difference between the "with measures" and "with additional measures" scenarios, because the latter is based on the spread of more natural modes of farming, a reduced fertiliser use, and a farming practice that complies with the requirements of the agro-environmental program. This scenario also assumes the strongest afforestation scenario through supports and other significant measures are taken in the agricultural sector.

	with measures		with additional measures	
	CO_2 emission saving against baseline kt	Emission change relative to 2005 kt	CO_2 emission saving against baseline kt	Emission change relative to 2005 kt
2005	0	0	0	0
2010	57	1 828	353	1 531
2015	123	2 527	751	1 899

5.3.6 Land use change and forestry

Afforestation

Objectives and description: Increasing the area of forests is in the national interest for several reasons. Afforestation within the scope of alternative land use primarily furthers the objectives of agricultural policy as it is considered environment-friendly land use and produces environment-friendly raw materials while contributing to the GHG mitigation effort of Hungary. Afforestation aimed at meeting the complex social requirements applicable to forests play ecological, economic and social functions that all promote rural development and the improvement of the standard of living of the rural population. Afforestation is also of key importance in areas affected by water and wind erosion as well as the region of the Great Plain that is often covered by internal water and floods. Therefore massive afforestation efforts were made in the past and afforestation is among the key priorities of rural development.

The Third National Communication of Hungary outlined an estimation of the possible future carbon sequestration scenarios of the country by assuming several afforestation scenarios. The effects of „declining afforestations" (scenario I), „measures" (which was more or less equal to scenario II, i.e. the „realistic" scenario) and those of „with additional measures" (which are equal to the „technical potential" scenario or scenario III), too, were analysed. Since that analysis it became obvious that, fortunately, the „declining afforestations" scenario will not happen, and it seems sure that even higher afforestation rates will be sustainable than those assumed in scenario II. However, it is still unsure whether the technical potential can be fully exploited.

The legal and policy background of these efforts are summarised below.

National Afforestation Programme

Based on the considerations of agricultural land utilisation concepts, the national long-term afforestation concept was completed in 1996. According to the concept, 778 thousand hectares is a realistic estimate of the quantity of agricultural land suitable for afforestation, and the afforestation of that area would raise the forest rate of Hungary to the optimum level of 27%. optimal. This concept provided the basis for the National Afforestation Programme drafted in 1997. Due to limited resources available, changes of land ownership and lack of information for the new land owners, however, the set targets were not met.

National Rural Development Plan and AVOP

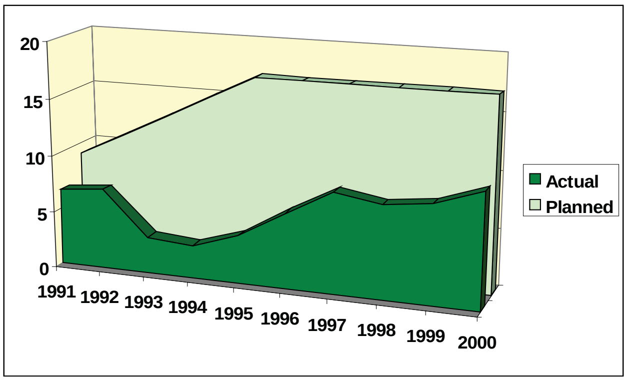

Figure 5.6 Planned and actual afforestation in Hungary

Afforestation is among the top priorities and measures of the NRDP. NRDP –in order to avoid overlapping measures – is in close relation to AVOP, the operative programme of the National Development Plan, which identifies the environmentally friendly agriculture and the rational use of land among the general objectives of rural development and sets forth the following specific objectives:

- Environment-conscious and sustainable land use
- Improvement of the status of the environment
- Increasing afforestation.

National Agri-environment Programme

The NAEP, a sub-programme of the National Environmental Programme, approved by the Government Resolution 2253/1999 (X.7.) Korm, includes several horizontal and zonal targets. One of them is to increase the territorial proportion of semi-natural forest management. NAEP also looks at afforestation as a tool of implementing some of its measures, such a forest plantation on flood areas in order to protect wetland habitat.

Act LIV of 1996 on the forests and their protection

Hungary has a very elaborate legislative framework for the protection of the forests, that ensures that forestry would be sustainable. The legislative framework is based upon the Act LIV of 1996 and the Decree 29/1997. (IV.30) FM on its implementation. Forestry activities are conducted in accordance with a regularly updated 10-year plan that is broken down into individual one-year operative plans. Both types of planning are approved by independent bodies.

The quantitative targets of the policies are based on the draft of the National Afforestation Programme, but learning from the experience of the past years, they are somewhat reduced and an escalating schedule is foreseen. In practice, according to financing targets of the National Rural Development Plan, the following afforestation schedule is set: in 2005: 10 000 ha, in 2006: 11 000 ha, and then this value is predicted to rise to 15000 hectare/year between 2007-2013. These forests are predicted to be planted on low and medium quality arable lands, as most of the grasses are under protection. EU subsidies for afforestation are competitive with ploughing subsidies, so there is no danger of any barriers before turning arable land into forests. The annual wood felling is expected to stagnate around app. 8 million cubic meters of harvested wood.

The above described policy is implemented through a set of support schemes:

- Plantation: direct support for the afforestation of agricultural land, and, in justified cases, supplementary aid for certified additional activities performed in conjunction with the plantation. The amount of subsidy depends on the type (topography) of land and the type of trees planted. The additional activities also supported are the following:
  - Protection of the soil of afforested areas
  - Protection of the afforestation against grazing animals, game and trampling damage
  - Protection of afforested areas against inundation/flood damage
  - Protection of afforested areas against fire
- Maintenance: protection and fill-in planting of newly planted forests, disbursed for a maximum period of 5 years. This support aims at the maintenance of forests established in agricultural areas, including measures required or protection against harmful biotic effects, for five years following the establishment. This includes the annual mainte-

nance (machine weeding, hoeing, sickle cutting, removal of young shoots, etc.) of forests along with their pest protection and the ploughing and cleaning of fire protection strips. The cost of additional maintenance and protection after establishment is determined for each target type as a lump sum, which applicants will receive in the third and fifth years after plantation.

- Premium for loss of income for the afforested area, disbursed for a maximum period of 20 years. The aim of this support is to provide compensatory payment to farmers for the loss of revenue or income caused by the afforestation of their agricultural land. Pursuant to paragraph 1of Article 31 of Council Regulation (EC) n°1257/1999 , support will be granted annually to cover loss of income due to the afforestation of agricultural land for a maximum period of 20 years.

Policy instrument type: Economic

Status of implementation: Implemented.

Implementing entity: Ministry of Agriculture and Rural Development

Monitoring indicators: Increase of afforested area; type of forests (CO_2 sequestration capability)

Effects and impacts: It is apparent from the past history of the National Afforestation Programme, that the actual results are much dependent on political decisions. Therefore in order to however roughly, but realistically the CO_2 sequestration potential the following three scenarios were used:

- Baseline scenario: It assumes that the afforestation rate is equal to the lowest one in the past few decades (~4 000 ha/year).
- “With measures” scenario: it is assumed that average afforestation rates in the past several years (~8 000 ha/year) are maintained until 2050,
- “With additional measures” scenario: this is the technical potential scenario that involves afforesting 773 000 ha of former agricultural land in 50 years.

Thus the CO_2 emission saving against the baseline will be the following:

	with measures	with additional measures
		CO_2 emission saving against baseline (kt)
2005	55	82
2010	630	945
2015	1 857	2 800

5.3.7 Waste management

Objectives and description: The basis of Hungary’s waste management policy is the Act XLIII of 2000 on waste management and the National Waste Management Plan (NWMP) that was codified by the Resolution No. 110/2002. (XII. 12.) OGY of the Hungarian Parliament.

The basic purpose of the Act XLIII of 2000 was to create a framework for waste management that serve

- sustainable development and providing adequate conditions for the future generations;
- reduction of energy and raw materials consumption by improving efficiency and reducing the volume of waste;
- reduction of loads caused by waste on human health and the natural environment.

The Act put on emphasis on preventing the production of wastes, on recycling and the environmentally friendly treatment of wastes, and adopts the “polluter pays” principle. It codifies the rights and duties of manufacturers (producers), traders and consumers, identifies who is responsible for the treatment, collection, transport, recycling and treatment of wastes and the basic principles of all these activities. Among other provisions it stipulates that a national waste management plan then specific regional waste management plans have to prepared. The different authorities of the local and regional governments and the Environmental Inspectorates are also identified. Two more provisions of the Act need also be mentioned: it creates the legal background for waste management fines and prescribes that a Waste Management Information System would be established.

The NWMP identifies concrete tasks in the following fields:

- Regulation and standards
- Development if institutional background
- Information dissemination, awareness raising
- Training, education
- Research and Development
- Prevention and treatment

The major quantitative targets of the NWMP are:

- Through prevention measures it should be achieved that by 2008 the quantity of waste produced would not exceed the level in 2000.
- The share of organic matters within the landfilled waste shall be reduced to the 50% of the 1995 level by 2007.
- By 2008 some 50% of the non-biomass type wastes shall be re-used either as raw material or in energy generation.

- Landfilling of any biomass type organic waste shall be stopped by 2008, they shall be utilised for biogas production.
- The utilisation of effluent sludge shall be increased to 55% from the current 40% by 2008.

These targets are to achieved by a set of specific programmes:

- Program for the non-hazardous wastes of the industry, commerce and services
  - o Prevention and recycling programme of industrial wastes
  - o Industrial waste treatment programme
  - o Program for improving the waste management performance of SMEs
- Program for wastes from agriculture, food processing and biomass
- Program for municipal wastes
  - o Program for the management of municipal solid waste

    Establishing complex regional collection and treatment systems

    Selective waste collection

    Recultivation of old landfills.

    Reconstruction of the Budapest Waste Incinerator Plant
  - o Program for municipal liquid wastes

    Program for achieving that all effluents are collected and treated

    Pre-treatment and utilisation of effluent sludge.
- Program for hazardous wastes
- Program for special waste types (packing materials, batteries, tires, medical wastes, vehicles, asbestos etc.)

The programs of the NWMP are partly implemented by regulatory instruments, a large set of lower-level legislation that codify the details for example of the utilisation of effluent sludge in agriculture (Government Decree 50/2001. (IV. 3.) Korm.), or of technical requirements of municipal solid waste landfills (Decree 5/2002. (X. 29.) KvVM), technical requirements of composting and treatment of biological wastes (Decree 23/2003. (XII. 29.) KvVM), etc.

The implementation of the policy is also aided by allocating finance from various sources:

- in the framework of targeted support HUF 5812 million was provided from the state budget to finance some 45% of the total investment cost of 48 landfills;
- considerable part (typically 20-25%) of the Environmental Fund was used for waste management related projects (this amounted to HUF 2.5 billion between 1996-2001)
- in the Budget of the Ministry of the Interior HUF 4 billion was allocated for waste management projects.

Similarly to these past examples, the NWMP foresees that some 50-60% of the programs will be financed from central (state budget) resources and regional support systems, another 20-30% is planned to be covered from international funds and the remaining 10-20% will have to be paid for by the municipalities. Central support for the operation of the waste treatment systems, however, is not possible as it would contradict the relevant Community acts (2001/C37/03). Thus the operation will need to be financed primarily fro the fees the polluters pay for waste collection and treatment.

Policy instrument type: Regulatory, economic

Status of implementation: Implemented.

Implementing entity: Ministry Environment and Water Management, Regional Environmental Inspectorates, Municipalities

Monitoring indicators: Quantity of wastes, number of projects, budgets used for financing.

Effects and impacts: The results of the NWMP and the lower level legislation stemming from it have started to show. Several municipal landfill projects have been completed, just as the reconstruction of the Budapest Waste incinerator. The Information System on Wastes (HIR) is operative and several information dissemination efforts have been completed (school textbook on wastes for children, training package on wastes for pupils and teachers, specialised web-site, information booklets for households etc.)

5.4 Policies and measures no longer in place

5.4.1 Energy conservation measures 1985-1993

In the past, energy conservation measures were incorporated into five-year economic plans under the central planning system. With the exception of some, all these measures were abolished in the course of the country's political reform. The following measures for energy conservation were previously implemented:

1. System of designation of energy-managed factories: About 4 000 state-run enterprises were designated as such, and were obligated to make reports on energy consumption to the State Energy and Energy Safety Authority (AEEF). System of

energy managers: Factories consuming 10 000 GJ or more annually are obligated to post energy managers.

2. Preferential system for introduction of energy conservation equipment: Hungary had a fund-financing system for investments in energy conservation equipment in factories, under which funds were supplied according to the energy conservation effect. This system was abolished in 1989.

3. Energy diagnosis of factories: AEEF has conducted an energy conservation diagnosis of about 400 enterprises in the past five years.

4. Citation system for energy conservation: The Ministry of Industry and Trade awarded prizes to individual engineers and groups of engineers according to their achievements in energy conservation. The citation system also applied to factories that showed a shorter period of investment recovery than their plan after introducing energy conservation equipment.

5. Promoting and informing activities for energy conservation in the industrial sector: The Ministry of Industry and Trade, jointly with QEEF, held an energy conservation seminar every year for energy specialists in large enterprises as well as in small and medium enterprises.

Furthermore, the Ministry of Industry and Trade held meetings for persons in charge of energy management at factories twice a year to explain the energy situation and exchange information. It also published a specialized magazine and held exhibitions devoted to energy conservation.

Under the new political system the Government decided in June 1990 on the following eight-point energy policy.

1. Improvement of energy efficiency through promotion of energy conservation and the restructuring of industry.
2. Diversification of energy sources and suppliers in order to avoid excessive energy dependence on a single country.
3. Introduction of the principles of a market economy and establishment of a free pricing system reflecting international prices.
4. Reduction of energy cost.
5. Publication of policy information and promotion of social awareness of energy.
6. Establishment of new organizations in response to the introduction of a market economy and abolition of monopoly capital.
7. Reduction of government interference to the minimum necessary level.
8. Raising awareness for environmental problems.

The concrete energy conservation measures are prepared mainly by the Ministry of Industry and Trade in the following basic framework.

- Tax incentives for energy conservation investment.
- Reduction of revenue tax for energy conservation equipment makers.
- Reduction of tariffs on energy conservation equipment.
- Provision of energy conservation information and education.

5.4.2 Energy Efficiency Policy and Programmes 1993-1999

In the Hungarian Energy Policy (1993) some of the basic strategic tasks are related to energy efficiency and environmental protection:

- improved protection of the environment and reduction of pollution;
- increased energy efficiency through the modernisation of supply structures and better management of electricity consumption.

Between 1994 and 1996, three major pieces of legislation were adopted, which created the necessary conditions for privatisation: (i) the Act on Gas Supply (1994), (ii) the Act on Producing, Transmitting and Distributing Electricity (1994), and (iii) the Act on Nuclear Energy. The “Electricity Act”, discussed in the previous section, also established the Hungarian Energy Office, under the authority of the Ministry of Economic Affairs.

Active energy efficiency policies in Hungary started in 1995, when the Government adopted the National Energy Saving and Energy Efficiency Improvement Programme, which was established in the framework of the Energy Policy Concept (Resolution 2399/1995). Major issues addressed by the Programme included:

1. least-cost planning and demand side management, as defined in the Electricity and Gas Laws,
2. cost-based energy pricing in order to motivate energy saving,
3. development of a new energy statistics and information system,
4. introduction of individual metering and regulation in new apartment blocks with district heating supply,
5. implementation of minimum standards for the insulation of new buildings,
6. energy efficiency labelling of household appliances,
7. awareness raising and education on energy saving,

8. improving energy efficiency in municipalities – via the Energy Saving Credit Programme (see below),
9. training for energy professionals,
10. increasing the use of renewable energy and (xi) prioritising energy efficiency in state financed R&D programmes.

Based on this programme, the Energy Saving Action Plan (ESAP) was adopted in 1996, focusing on: (i) the penetration of renewables, (ii) energy efficiency improvements, (iii) energy efficiency labeling and (iv) education, information and technology innovation.

6. Projections and the Total Effect of Policies amd Measures

6.1 Background and methodology

The projections presented are based on an extensive research project to forecast the national greenhouse gas emissions. The research project was prepared for the Ministry of Environment and Water Management by a large community of researchers in 2004. This research was updated in 2005, and the effects of policies and measures and other assumed mitigating factors are presented in two scenarios.

The sector-specific forecasts are based on individual studies, which rely almost exclusively on official statistical data collected and published by government offices, national authorities and designated agencies. The method of projections was to first identify relevant products, whose production results in GHG emissions. Then changes in the production of the relevant goods were forecast by robust statistical models. Explanatory variables were chosen from sector specific and general economic factors. Models were improved until observed variations in production and in relevant activities could be reliably estimated. Eventually, GHG emissions were calculated form combustion and process emissions of the technology in each sector along the guidelines of IPCC, the Monitoring and Reporting Guidelines and data from literature.

General macro-economic forecasts were considered, and the official macro-economic projection of the Ministry of Finance was applied. The results were published, and all sectors provided feedback, number of stakeholders suggested corrections. The final version of the national GHG forecast as follows, was approved by the Ministry of Environment and Water.

The “with measures” and “with additional measures” scenarios were developed with the following two basic differentiating factors: changes in agricultural and forestation policies, application of previously mentioned policies and measures, improved utilisation of renewable energy sources, and different transportation policies.

The effects and differences are presented for each sector if applicable. At the end of the chapter a comprehensive outline of the scenarios and their graphic representation is given.

6.2 Forecast emissions

6.2.1 The scenarios

The “without measures”scenario is treated as the baseline scenario, which is modified with the effects of various policies and measures to arrive at the “with measures” and “with additional measures” scenarios. The emission calculations for the “without measures” scenario already assume that some steps are taken towards energy efficiency, fuel-switch, renewables use, to an extent that this is enforced by existing EU regulation, but no domestic measures have been included.

The “with measures” includes the effect of the currently implemented and adopted policies and measures. It is noted however, that some of the implemented but currently suspended policies whose future in the light of past experience seems uncertain (e.g. support of residential energy efficiency projects) are not included here, since their forecast savings are based on somewhat arbitrary assumptions. These are included among the additional measures.

The scenario “with additional measures” assumes a higher rate of governmental interest in increasing energy efficiency and renewables use, and a higher commitment in transportation and traffic redesign.

The scenario with additional measures differs from the „with measures” scenario regarding the projections in the transport, forestry and agricultural sectors, as well as in the assumption regarding the use of renewables in energy production.

As it can be seen in the following chart, even if additional actions are taken, significant reduction of the emissions can not be achieved, only a stabilisation with a slight drop in the emissions seems realistic.

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Lignite	5.04	4.92	6.63	6.87	6.74	7.11	7.54	8.05	7.63	7.70	7.86	8.04	7.57	8.56
Sub-bituminous coal	11.50	11.03	8.38	7.19	6.00	6.84	6.97	7.19	6.56	6.48	5.67	5.39	4.57	4.04
Bituminous coal	1.95	1.84	1.38	0.97	1.01	0.86	0.96	0.92	0.88	0.74	0.74	0.64	0.66	0.67
Total coal	18.50	17.79	16.39	15.04	13.75	14.80	15.47	16.17	15.07	14.92	14.28	14.07	12.81	13.27

Table 6.1: Observed coal production in Hungary, Mt

6.3 Projections and total effects of policies and measures

6.3.1 ENERGY SECTOR

Coal Mining Industry

The domestic power plants, the most significant consumers of coal, have been designed to utilize local coal reserves. Thus their furnace parameters firmly tie the future of power plants to mining of local coal reserves. With respect to the stricter environmental regulation and the relatively bad quality of Hungarian coals, power plants had to decide whether to invest in air pollution reduction or switch to a different fuel.

The share of coal has dropped in the residential sector as a result of the spread of natural gas heating. Though some data show that one-sixth of the households have kept their coal boilers, the only case when returning to coal combustion is probable is a drastic rise in natural gas prices. This means that closure of both power plant-integrated mines and non-integrated mines is inevitable. Exceptions are the surface lignite mines, the Nógrád surface mine and the subsurface mine of Márkushegy.

Coal consumption by the energy and coking sectors was projected by the relevant market product demand forecasts in the sectoral studies. Other industrial and residential coal consumption is projected as it is indicated in Table 6.2.

Oil Industry

To predict the refining production of this sector a complex time series model was developed. It provides for the possibility of an overall trend change as a result of economic system change in the early 90s, and for another product specific trend change in the early 2000s when heavy residual fuel oil started to be phased-out. The major independent variables are the changes of GDP and population growth. The model shows a slow-down of growth of production from 2003 through 2005 as a result of the decreased growth of GDP and the loss of fuel oil volumes. From 2006 the Ministry of Finance forecasts an acceleration of the GDP growth and lost fuel oil volumes are recovered by changing product ranges. Due to that, total refinery production is predicted to increase in the forecast period.

The forecast model provides total refinery volumes projection through 2020, and then it breaks down into major product groups. Refined product ratios are basically determined by the technical characteristics of the refinery installations. However, motor gasoline and diesel oil production forecast was cross-checked with the domestic transport sector forecast, export and import forecast. Also, the model assumes that a major new petrochemical plant would be fully supplied by domestic crude oil.

Vehicle fuels consumption represents an almost stable ratio in production in the past 20 years, especially in the

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Residential	11.57	11.57	11.57	11.57	11.57	11.57	11.57	11.57	11.57	11.57
Other industrial combustion facilities	3.91	4.02	4.02	4.18	4.29	4.49	4.69	4.88	5.07	5.27
Total	15.48	15.59	15.59	15.75	15.86	16.06	16.26	16.45	16.64	16.84

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Residential	11.57	11.57	11.57	11.57	11.57	11.57	11.57	11.57	11.57
Other industrial combustion facilities	5.49	5.71	5.96	6.19	6.39	6.69	7.01	7.37	7.76
Total	17.06	17.28	17.53	17.76	17.96	18.26	18.58	18.94	19.33

Table 6.2: Coal consumption of residential users and combustion facilities not covered by the rest of the projection, 2002–2020 (PJ)

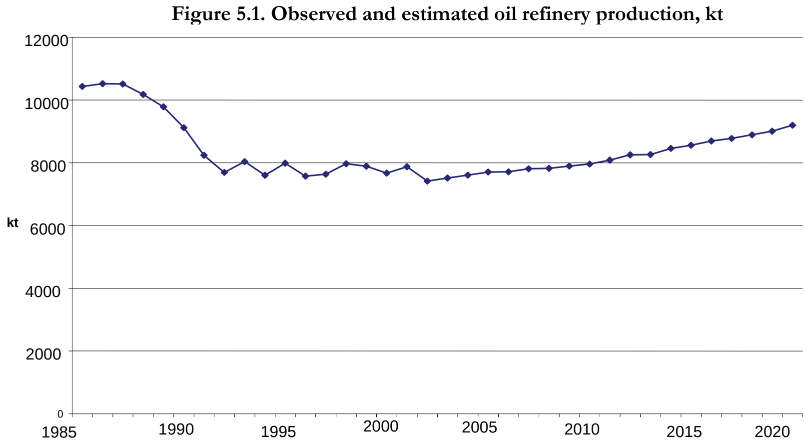

Figure 6.1 Observed and estimated oil refinery production, kt

last 10 years. Export ratios are also predicted to be stable based on previous years statistics. LPG consumption is expected to rise as LPG vehicles are predicted to spread. The demand increase is going to be supplied from import, as in the previous years.

The most significant change is predicted for residual fuel oil, the use of which is going to be diminished in the near future. The total production capacity of the Duna Refining Plant for diesel oil with less than 1% sulphur content is 150-160 thousand tonnes/year. An amount equal to the whole production capacity is predicted to be consumed each year. Total output by the petroleum coke production capacity, app. 240-250 thousand t/year is predicted to be consumed by domestic market. Petrochemical feedstock, crude oil and diesel oil is predicted to be 950 kt/year and 800 kt/year respectively. Lubricants are predicted to stay at 2% of the total refined volume. Bitumen production is predicted by an independent forecast model of construction materials. Increase in product imports is not predicted to cause significant market loss, as the surrounding refining capacities (Slovnaft, INA and, to a lesser extent, OMV) belong to the shareholder group of MOL.

The GHG emission calculations of the oil industries are based on the IPCC methodology (1996). The only exception is calculation of the fugitive methane emission of production, transportation, distribution, processing and consumption of crude oil and natural gas, including fugitive methane emissions from maintenance of equipment and facilities. These fugitive methane emissions were calculated on the basis of projected volumes of crude and gas by the Canadian methodology that has been applied in the Hungarian National Inventory Reports in recent years.

GHG emission of oil refining is influenced by the composition of processed products, the changes of the quality of products, the unit emissions of technological facilities installed to improve product quality. The specific emissions in the oil industry are influenced in particular by Council Directive 1999/32/EC relating to a reduction in the sulphur content of certain liquid fuels, the constraint to fulfil the requirements of the regulation raises the energy demand of fuel production, hence influencing the total amount of CO_2 emitted. Based on the production forecast and the change in specific emissions, CO_2 emission levels are predicted to rise.

Natural Gas Industry

When projecting the future trend for the steeply increasing residential use of natural gas, two factors were distinguished: increase caused by rising individual consumption (intensive factor) and the growth of the number of consumers connected to the gas distribution grid (extensive factor).

The influence of the extensive factor can be projected by the limited number of consumers not yet connected to the gas distribution grid. The projection model forecasts a declining growth in the number of households supplied with natural gas until 2010 followed by stabilisation at 85% of saturation.

The intensive factor depends on the change of volume consumed by an individual household. According to inventory data and supported by econometric analysis no trend in individual household consumption can be identified. The annual fluctuation is the result of weather changes. The projection model assumes that average weather conditions do not change from 1990-2002 to 2004-2013. This leads to the conclusion that no change in individual household consumption is expected. Effects of other economic factors were considered, like average

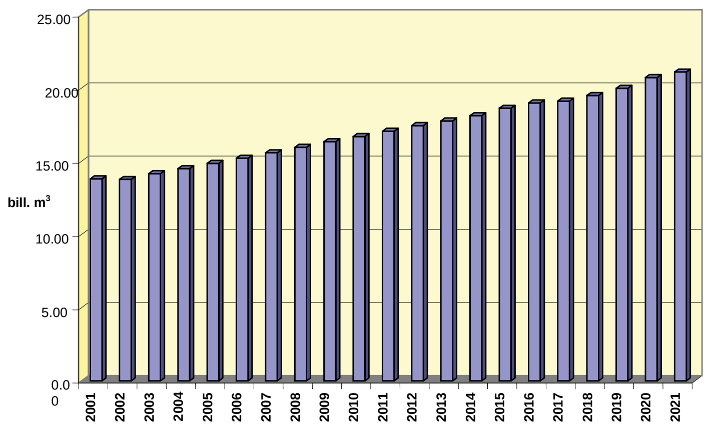

Figure 6.2 Observed and estimated consumption of natural gas in Hungary, billion m^3

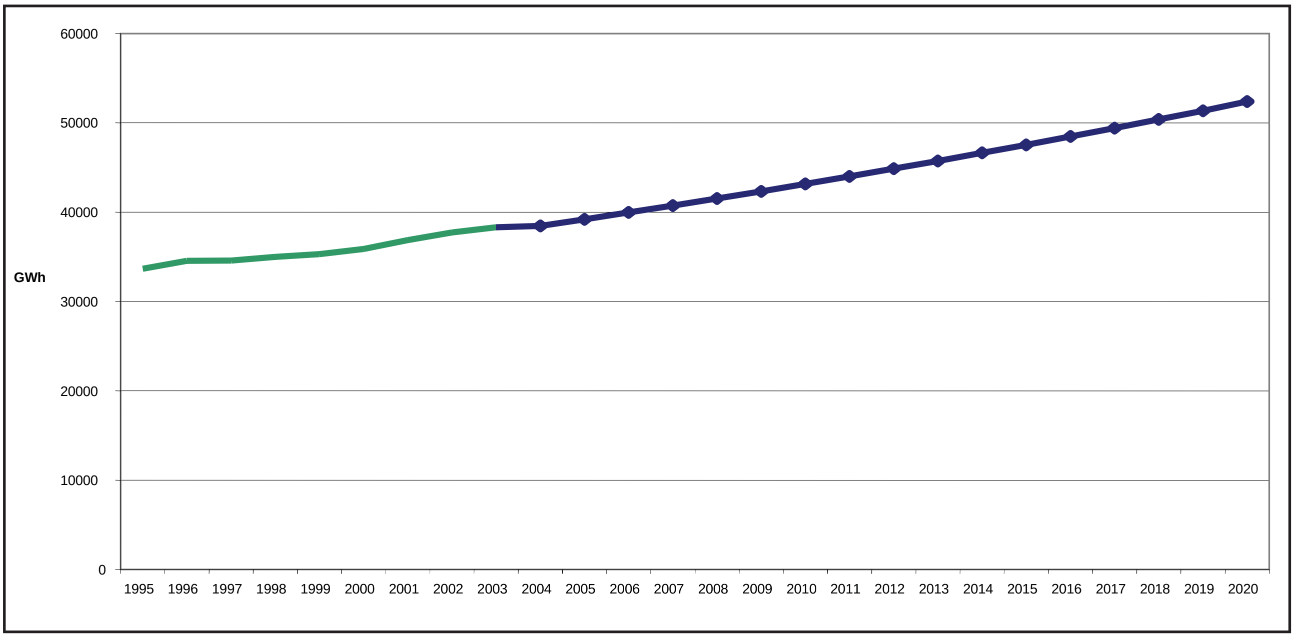

Figure 6.3: Observed and projected gross domestic electricity consumption, GWh
Note: Gross consumption is the sum of net end-use consumption, grid losses and power plant self-consumption

real income per capita and natural gas prices (corrected by CPI). The effect of these factors on the aggregated consumption could not be estimated by econometric terms because of data limitations.

In the household sector natural gas is mostly used for heating, so estimate was further refined by temperature correction. The dependence of consumption on weather conditions is not so explicit in the community and service sectors, and natural gas consumption for space heating could not be projected to saturate in these sectors the way it was projected in the residential sector.

Power sector

The projection model estimates the fuel consumption of power plants by the amount of electric power produced and its distribution among consuming sectors. Demand projection is based on the long-term consumption forecast used by the national system operator (MAVIR) with an overall yearly growth rate of total end use at 1.9 to 2%. The forecast counts on a slower increase of the gross electric power consumption as a result of the decreasing network losses and self-consumption of the producers. The supply forecast is based on the long-term prognosis for capacity planning of domestic electricity production, information provided by the electricity system operator and the Hungarian Energy Office. This is to assume a relatively high import balance, the increase of co-generation and renewable electricity production, and also slightly diminishing role of centralised power plant production. The projection calculates with the installation of 200MWe co-generation gas turbine capacity.

Hungary harmonised the 2001/77/EC directive for renewable energy production with a non-binding target for renewable electricity at 3.6% by 2010, what was assumed to be realised in the forecast model. The co-generation directive (2004/8/EC) does not require more than the obligation to provide feed-in for cogeneration producers, so the forecast assumes reduction of the scope and magnitude of current support for co-generators. However, CCGT installations are forecast to be the competitive choice of the marginal producer.

Detailed forecast of fuel use by individual power plants is provided in the calculations. Authority information regarding ongoing changes in licensed activities was incorporated in the forecast. Common EU environmental regulations have proved to be decisive in terms of power plant investments and choice of fuel in the run up period to 2005, the deadline of the transitory regime provided by the EU Commission with regard to Directives 2001/80/EC (LCP) and 2001/81/EC (NEC). These regulations have dramatically reshuffled the fuel mix of the electricity sector, a change that was perceived first in 2005. Approximately 450 MWe coal based steam generators were phased out, an additional 110 MWe was switched to wood-chips and 70 MWe to natural gas. As a result, coal based electricity capacities were decreased from 1800 MWe to 1170 MWe, out of which an additional 200 MWe is forecast to close down by the end of the decade.

Paks nuclear power plant is forecast to run all four of its 440 MWe blocks, after the temporarily suspended operation in Block II has been resumed in 2004.

For the period 2005 through 2007:

- the forecast nuclear volume is 12800 GWh annually;

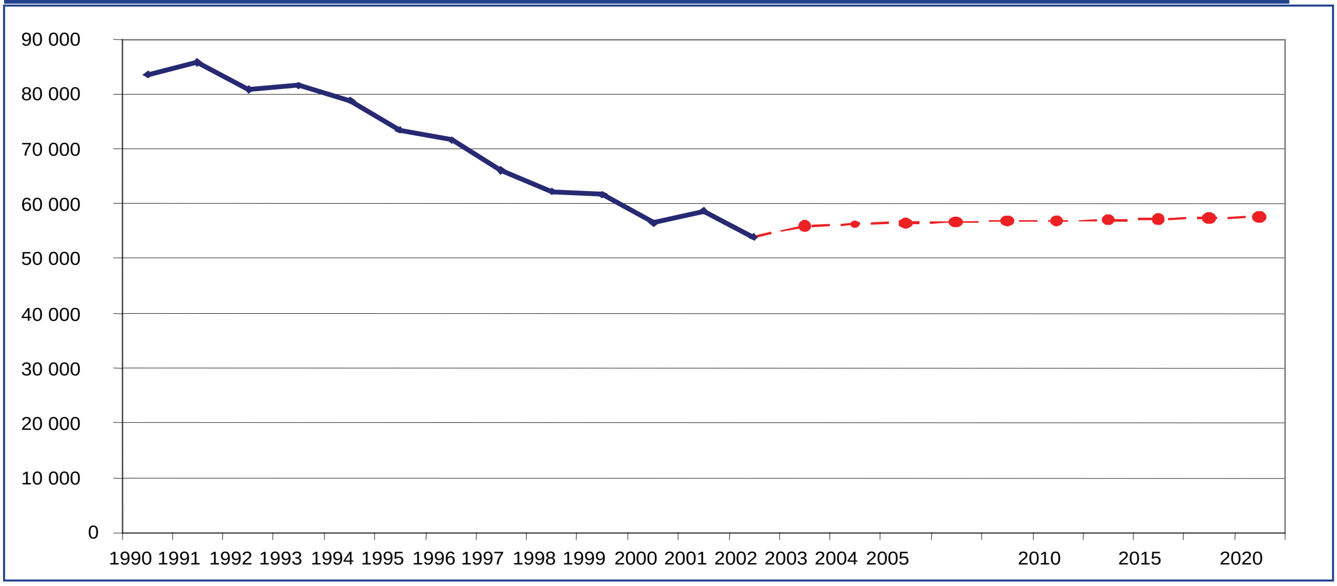

Figure 6.4: Observed and projected district heating consumption, TJ

- the foreseeable volume of imported bituminous coal in the fuel mix of domestic power production is set at 10 PJ;
- net import balance is assumed to be 5500 GWh per year;
- growth rate of end-use electricity consumption is expected to be 2%.

District heating

No significant change in consumption is predicted in the forecast model. No further reduction in industrial use is awaited and residential consumption is also not expected to increase. In the last four years consumption stagnated and was mostly influenced by the average daily temperature changes.

Market opening in the natural gas sector is supposed to improve district heating markets because subsidy on household gas prices will have to be terminated. Market growth is forecast as a result of increasing industrial heat consumption. The prediction counts on the connection of new industrial and municipal users to the system. Their connection to the system is feasible and simple; their heat demand is levelled through the year so they are low-cost users in the system. For the above reasons, the model predicts 1%/year increase in the industrial consumption and stagnation of municipal consumption. Residential use is forecasted to shrink by 1%/year. No change is predicted in other heat consumer segments.

The sector-wise model covers combustion facilities with a rated thermal input higher than 20 MWt. This sector includes industrial, agricultural and other heat generators for own supply. Data was gained from mandatory reports by operators to the economic and environmental authorities. All other greenhouse gas emissions from heat production are covered by fuel-wise models of the national energy balance broken down to coals, oils and natural gas.

6.3.2 Industry

Cement production

Production is determined by demand. For the prediction of cement consumption the forecast model incorporates production data of the previous years, the econometric relationship between cement consumption and macroeconomic variables and other quantifiable impacts of demand changes.

Besides consumption, cement production is characterised by the foreseeable trends of export and import. Import is not limited at all. Export accounts for approx. 10% in value. Import comes mainly from the Ukraine and to a lesser extent from Romania and Slovakia. The main forces behind the Ukrainian import are cheap energy and labour and the currency rate. Import accounts for 15-20% of the domestic cement consumption in Hungary.

In short-term a slight reduction in the import ratio is predicted as a result of increasing cement use in Romania and the Ukraine. As cement exported by these countries is sold at very low prices, rising national demands may divert huge volumes from international markets.

The forecast is based on the observation that cement production follows changes in GDP growth rate very tightly. Firstly, the dependence of the construction industry on GDP and on the number of newly built residential apartments was calculated, in order to forecast the production volume of the construction material industry.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Cement production with unchanged import ratio	3452	3510	3641	3772	3961	4086	4273	4457	4639	4848
Cement production with reduced import ratio				3816	4054	4230	4474	4719	4912	5133
Clinker production	2522	2687	2694	2495	3041	3173	3356	3539	3684	3850
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cement production with unchanged import ratio	5075	5340	5603	5893	6201	6547	6891	7262	7651	8078
Cement production with reduced import ratio	5374	5654	5882	6138	6414	6729	6992	7283	7594	7944
Clinker production	4030	4289	4495	4717	4963	5229	5501	5790	6102	6434

Table 6.3 Observed and projected cement and clinker production, kt

Secondly, the time series data of cement production was estimated by production volumes of the construction materials industry and population growth. The two regression models were used to estimate future volumes of cement production.

Lime production

Domestic consumption can be properly estimated by macroeconomic variables. The first step was to calculate the dependence of the construction industry on GDP and on the number of newly built residential apartments, in order to forecast the production volume of the construction material industry. As a second step, the time series data of lime production was estimated by production volumes of the construction materials industry, by population growth and by a composite growth index of major lime consumer industries (paper, and iron- and steel industries). The two regression models were used to estimate future volumes of cement production.

Ceramics and porcelain industry

The emission model for this sector calculates GHG emissions from fuel combustion (furnaces, driers), and provides estimates for technology process emissions. The relatively complex emission reaction of mineral raw materials can hardly be described by a single series of reaction equation, but process emissions were estimated from industry data. According to expert judgement the process emission of the building ceramics industry counts for app. 35%, those of the fine ceramics sector for app 25% of their total GHG emission.

Based on the NACE codes of sub-sectors three were identified for which two different statistic models were prepared. These are non-building use ceramics and building use ceramics. 2002 inventory data was used as a baseline to forecast production by product categories.

The demand for household ceramics is influenced by a number of aspects, e.g. the number of households, the changes of household income, tendencies for the replacement of ceramics (wearing out, fashion trends), import-export tendencies in connection with the world market

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Domestic consumption	519	420	440	448	422	400	398	385	377	372
Domestic consumption corrected with new demand	519	420	440	448	452	438	443	433	429	427
Export	40	38	27	41	46	52	58	62	68	74
Import	61	94	97	100	72	45	38	12	11	6
Production	498	364	370	389	426	445	463	483	490	495
	2011	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Domestic consumption	374	392	390	410	399	404	407	414	430	428
Domestic consumption corrected with new demand	432	453	443.5	444.5	462.5	460.5	468	470	466.5	477
Export	80	86	98.5	102	106	108	112	115	118	121
Import	12	34	36	49	78	75	84	114	118	111
Production	500	505	506	497.5	490.5	493.5	496	471	466.5	487

Table 6.4 Observed and projected lime production. kt - Notes: Data between 2001-2004 are inventory data. 2005-2020 domestic consumption was estimated by the two regression models. Corrected demand considers emerging demand by soil amelioration and environmental protection.

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Building ceramics	3096	3171	3252	3293	3399	3489	3586	3705	3844
Non-building ceramics	88	93	95	96	98	97	98	102	109
	2012	2013	2014	2015	2016	2017	2018	2019	2020
Building ceramics	4027	4216	4365	4579	4702	4826	5012	5153	5354
Non-building ceramics	120	136	152	167	176	184	191	196	206

Table 6.5 Projected amount of ceramic products, kt

developments (expansion of East-European and Asian products). On the other hand, demand for non-building ceramics depends on the growth of the consuming industries and their purchasing options, export possibilities, market of products alternative product to replace ceramics (e.g. plastic), changes in prices, emerging of new regulation, etc.

All the above aspects cannot be statistically estimated for data limitations. A limited number of independent variables were tested to explain changes in the production the two groups of ceramics. These variables included the domestic GDP growth rate, the number of newly built residential apartments, population change and changes in the EU-15 GDP growth rate, to consider the high export sales of the sector. Eventually, the production volume of non-building ceramics has been proved to depend on the GDP, the number of newly built residential places and population growth. In the case of building ceramics, patterns of observed production variations have been best estimated by domestic population and growth rate of the construction materials industry. The resulting two models project a growing production by the ceramics sector, though the forecast increase rate is lower than that of the 2000-2002 period.

GHG emissions of both sub-sectors were eventually calculated with unchanged fuel structure of the ceramics sector reported by the sectoral breakdown of the National Energy Balance (official authority statistics) as of 2002. This structure of fuels was used to calculate consumption of various types of fuels after production was estimated. Overall fuel need per unit of production was assumed to stay constant at the observed levels of 2002. Potential for fuel switch is limited to low capacity producers often using coal as primary fuel. Most of these companies operate a less modern technology in the rest of the cases, employ cheap manpower and supply their close vicinity. These companies are not predicted to invest in the improvement of their technology. Reduction in coal combustion might happen if they stop production, which seems unlikely as building material industry has been growing steadily.

Glass industry

The GHGs released by the sector is generated mostly by fuel combustion. Process emissions are below one-third of the total emission. Projection is complicated by the fact that glass is not a homogenous product. For prediction of non-homogenous products the volume index of the sector was used. Data was available for the 1986-2002 period. After several modelling attempts the following model was applied. The first step was to calculate the dependence of the construction industry on GDP and on the number of newly built residential apartments, in order to forecast the production volume of the construction material industry. The second step was the estimation of the volume index of the overall glass industry production by growth rate of building materials production, the accumulation of fixed assets and population change. Two regression models were analysed. Model fit is not as good as in the case of cement or paper forecast, but reflects the basic trends properly.

Paper industry

Projection was based on the production of paper and cardboard. Production closely follows GDP and population growth patterns. The applied model fits the 1985-2003 period very well, explaining much of the production changes.

Significant capacity increase by new installations is not foreseen by the Hungarian market and general economic growth trends. Not much room is anticipated for new export markets either, paper industry has been developed in the surrounding countries and there are abundant production capacities.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Quantity	509	504	512	510	524	521	544	556	622	686
Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Quantity	833	991	1144	1305	1451	1609	1759	1940	2107	2291

Table 6.6: Observed and projected amount of melt glass, kt

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Thousand tonnes	501	512	539	536	565	584	626	667	706	747	791
2001=100	100.0	102.2	107.6	107.1	112.8	116.6	124.9	133.2	141.0	149.1	157.8

	2012	2013	2014	2015	2016	2017	2018	2019	2020
Thousand tonnes	842	909	946	1015	1074	1156	1237	1316	1397
2001=100	168	168.1	177.5	175.5	189.4	190.1	197.9	197.6	197.3

Table 6.7 Observed and projected paper and cardboard production, kt

Chemical industry

The projected products are mostly raw materials. This means that significant production volumes may be shifted eastwards from Hungary in the medium to long term. The other characteristic considered was the concentrated structure of the sector. Statistic trends were calculated for the main products based on observed industrial data. Projections were checked and further elaborated after direct communication with the major companies about their ongoing and forthcoming investments in production facilities. CO_2, CH_4 and N_2O emissions were estimated in each product group along the IPCC guidelines.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Ammonia	394	289	282	385	396	414	443	470	475	475
Nitrous acid	454	295	306	447	458	453	496	542	559	548
Ethylene	359	365	353	372	620	620	620	620	620	620
Dichloro-ethane	342	310	283	306	402	515	550	550	550	550
Styrene	0	0	0	0	0	0	0	0	0	0
Methanol	0	0	0	0	0	0	0	0	0	0
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Ammonia	475	475	482	500	516	510	499	506	524	540
Nitrous acid	561	562	547	580	616	623	602	587	620	656
Ethylene	620	620	620	620	620	620	620	620	620	620
Dichloro-ethane	550	550	550	550	550	550	550	550	550	550
Styrene	0	0	0	0	0	0	0	0	0	0
Methanol	0	0	0	0	0	0	0	0	0	0

Table 6.8 Observed and projected production of relevant chemical materials, kt

Coke-, pig iron and steel production

GHG emissions were calculated on the basis of forecast production of pig-iron, sinter, hot rolling and coke. GHG emissions were calculated from the fuel structure forecast along the IPCC Guideline. Methane emissions of coke production are forecast accordingly.

Year	2002	2003	2004	2005	2006	2007	2012	2020
Quantity	2052	1989	1942	1 972	1 992	2 002	2002	2 002

Table 6.9 Observed and projected steel production, kt

Year	2003	2004	2005	2006	2007	2012	2020
Quantity	593	615	800	1 020	1 020	1 020	1 020

Table 6.10 Projection for coke production, kt

6.3.3 Waste treatment

The projection for this sector covers municipal and industrial solid wastes (excluding selective and hazardous industrial wastes). Municipal sewage sludge is discussed by the chapter on sewage.

Domestic waste management policy is laid down in the National Waste Management Plan (NWMP) approved by the Parliament. This plan determines the waste management goals of the National Environmental Program regularly prepared. A short-term projection (through 2008) was prepared on the basis of this plan. The realisation of the goals of the plan is going to have an essential influence on GHG emission. These goals and the awaited trends are as follows.

The total amount of waste should be reduced to the quantity of year 2000 by means of preventive action. To achieve this, the application of low-waste technologies, the production of re-usable and long-life products and a campaign to change the consumption behaviour of the people, shall be supported. This means that the total amount of waste generated in 2008 shall not exceed 68.4 Mt, of which municipal solid waste accounts for 5.2 Mt.

By the end of the period half of the non-biomass waste should not be disposed of at landfills, but is supposed to be recycled or incinerated along with energy utilisation.

Only non-recyclable waste will be allowed to be disposed of. Non-complying landfills should be stopped or reconstructed by 2009. Appropriate technical conditions should be ensured for waste incineration, by the reconstruction or closure of non-complying incinerators. Starting from 2009, waste disposal is supposed to be totally anaerobe along national landfill regulations. The amount of collected and utilised or flared-off methane will increase significantly.

The amount of biodegradable waste disposed of at landfills should be gradually reduced to 50% by 2007 and to 35% by 2014. The waste fractions of municipal waste mostly affected are organic waste from kitchens, gardens and parks and paper. To achieve this target organic waste has to be separately collected and treated, mostly recycled. The amounts predicted for 2007 are 960 thousand tonnes of biomass waste and 470 thousand tonnes of paper and for the year 2014 1340 and 650 thousand tonne of biomass and paper is projected respectively. From GHG emission point of view the most important target is that of recycling of biomass waste, the without measures projection is based on this strategy.

For the 2008-2013 period forecast was extrapolated from the EU trends. Direct material consumption of production units is characterised by the Direct Material Consumption Index (DMCI). This index for Hungary shows that GDP growth has been separated from the growth of primary natural resources consumption. DMCI has shown a slow rise far below GDP growth. As material use is in close connection with waste generation, this trend indicates the reduction of waste generation. The amount of waste produced in the EU is 3.8 t/year/capita. This value in Central- and Eastern Europe is 4.4. This index is composed of an industrial waste amount component, which is higher, and a municipal waste component, which is lower than that of the EU. This clearly indicates that this region has an intensive industrial waste production, but the population generates a lower amount as consumption habits are different from those of the EU population. Supposing that the region follows the EU trend, the quantity of industrial waste is going to decrease, while the amount of municipal waste will grow in the future. As the absolute amount of industrial waste is much higher than the total municipal, the overall value is predicted to decrease. Waste generation changes follow GDP growth with very few exceptions. Only a few European countries have achieved reduction in waste generation alongside GDP growth. OECD projects a 45% increase of waste generation from 1995 through 2020. Some further European countries are predicted to separate their GDP growth from growth of waste, but this cannot be claimed to be a general trend. Solid waste generation in Hungary is predicted to follow GDP growth through 2012 to 2020.

Projection steps:

- Analysis of the GHG emitting processes: waste fractions, treatment step, process of GHG emission.
- CO_2 released from the incineration of carbon containing, non-vegetal waste fraction (e.g. plastics) and the methane released at disposal plants from organic, biodegradable fractions.
- N_2O generated by incineration is negligible, so this model does not calculate with this amount (neglecting can be accepted even if the very high GWP of this gas is considered).
- CO_2 emission of biodegradation (gardening waste,

Baseline projection according to NWMP	2000	2005	2006	2007	2008	2009	2010	2011	2012
Total solid waste	34.5	35.2	35.0	34.8	34.4	34.0	33.7	33.4	33.2
Incinerated sewage sludge and liquid waste	2.7	3.0	3.0	3.1	3.1	3.2	3.2	3.3	3.3
Total incinerated waste	6.2	7.2	7.6	8.0	8.3	8.6	9.0	9.3	9.6
Municipal solid waste	4.6	4.8	5	5.1	5.2	5.3	5.4	5.5	5.6
Organic municipal solid waste disposed of orderly	1.77	1.52	1.46	1.32	1.17	1.17	1.14	1.09	1.01
Organic municipal solid waste disposed of disorderly	0.26	0.24	0.18	0.09	0.00	0.00	0.00	0.00	0.00

Baseline projection according to NWMP	2013	2014	2015	2016	2017	2018	2019	2020
Total solid waste	33.1	32.9	32.9	32.7	32.8	32.9	32.7	32.4
Incinerated sewage sludge and liquid waste	3.3	3.4	3.4	3.4	3.5	3.5	3.5	3.6
Total incinerated waste	9.9	10.2	10.6	11.0	11.3	11.6	12.0	12.3
Municipal solid waste	5.6	5.8	6	6.1	6.2	6.3	6.4	6.5
Organic municipal solid waste disposed of orderly	1.01	.92	.68	.32	.27	.19	.14	.09
Organic municipal solid waste disposed of disorderly	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 6.11 Projected quantities of waste, NWMP scenario, Mt

paper, organic food) does not belong to anthropogenic GHG emissions as this is the re-emission of previously sequestered CO_2.

Determination of waste production trends in the forecast period:

- Changes in the amount of waste.
- Changes of waste composition, based on the National Waste Management Plan.
- Projection of the amount of GHG generating wastes.
- Prediction of the ratio of waste treatment facilities and equipment.

An important element of the prognosis is the forecasting of the changes in the proportion of treatment technologies, as this factor can have a huge influence on GHG emission. For example if plastic waste is disposed of its GHG emission is zero, if incinerated the amount of CO_2 emitted is equal to the carbon content of plastic. If organic waste from gardening is disposed of in a landfill without biogas collection it produces a mixture of CO_2 and CH_4, while if the landfill has a biogas treatment or the waste is composted only CO_2 is released. Differently from previous projections this model calculates the emission from disorderly disposal and considers the amount of industrial waste incinerated, which is much higher than incinerated municipal waste.

GHG emission was calculated as above using the method described by the IPCC Guideline. The weakness of projection is that there is no profound inventory for waste generation and treatment because only few landfills make measurements; the rest is based on estimate.

Two scenarios were developed for the national GHG emission projection. One was based on the strategic goals of the National Waste Management Plan (NWMP) and on the assumption that Hungary successfully integrates into the waste management system required by the EU. The other, worst-case scenario predicts that the targets of the NWMP will not be reached until the deadlines, only with a few years delay, the quantities of waste generation will be slightly higher than planned, the rate of incineration higher, generating more GHG.

Note that this model predicts two times higher amount of methane emissions than the previous national report. This difference is caused by the different methane correction factor applied, which depends on the judgement of the ratio of aerobic-anaerobic processes in landfills. This model supposes a higher ratio for anaerobic processes than that of the previous national GHG inventory report.

Sewage treatment

Forecast was prepared for both industrial and municipal sewage. Municipal sewage was divided into two types: sewage collected in a municipal pipe system and sewage collected in soaking pits. A real problem of municipal sewage disposal is that a considerable ratio of the population is not connected to sewer systems. The proportion of residential places not connected was 10.1% in 2002. The introduction of the soil load fee (charges payable by house owners without connection to the sewer system) has a positive effect on the willingness of population to connect to sewers as it makes it more expensive to collect sewage in soaking pits. By 2015 100% of the collected municipal sewage has to receive biological treatment. Technologies of treatment plants are not predicted to significantly change. New plants are predicted to have a lower anaerobic ratio at the biological treatment phase as a result of better aeration techniques applied. On sensitive places treatment plants are going to be obliged to remove nutrient content. At treatment plants with a capacity higher than 15000 inhabitants equivalent anaerobic sludge conditioning is going to be applied. Spread of anaerobic technique is forecast in general. For this reason the anaerobity index of sludge treatment is expected to grow. Anaerobic treatment of sludge is always accompanied by methane treatment, so emission is not going to rise; it is even expected to decrease.

Industrial waste water generating sectors included in this investigation are: processing of meat-, vegetable and fruit, vegetable and animal oil, fat, milk, starch, distilled spirits, ethyl-alcohol, beer, malt, textile, paper, mineral oil, organic raw material, fertiliser, plastic raw material, nitrogen-compounds, paint and coating, pharmaceutical product, synthetic fibre, rubber products and plastics production. In the case of industrial sewage generation, together with water consumption an overall reduction is expected. Increase can only be caused by new installations. The strict regulation does not make it possible to violate emission limits in a long-term. The moratorium for keeping the emission limits is 2011.

For municipal and industrial sewage 3-3 scenarios were developed respectively, based on three types of release and treatment: a realistic, an optimistic and a pessimistic scenario.

The realistic scenario for municipal sewage counts with a 20% reduction in the size of the population in 50 years time. In 2003 0.5% reduction was registered in stump use. In 5 years from 2004 100% sewer connection has to be realised, which leads to a further 9.6% decrease. It is assumed that 100% of new installations are going to be connected to sewers. According to the national sewer program the inhabitant equivalent of sewer systems is going to increase to 64.1% by the end of 2005, 80.7% by 2010 and 90,7% by 2015. The number of residential places

t CH_4	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Municipal	9 783	9 569	9 341	9 058	8 759	8 634	8 577	8 600	9 870	9 947
Industrial	6 360	6 550	6 749	6 960	7 182	7 416	7 664	7 927	8 207	8 506
Total	16 143	16 118	16 090	16 017	15 941	16 050	16 241	16 527	18 077	18 453

t CH_4	2012	2013	2014	2015	2016	2017	2018	2019	2020
Municipal	10 043	10106	10147	10194	10409	10524	10819	11283	11315
Industrial	8 407	8715	8628	8947	8872	9205	9145	9495	9454
Total	18 451	18821	18775	19141	19281	19729	19964	20778	20769

Table 6.12: Projection of methane emissions from sewage and sludge management, t

supplied with sewer was assumed to reach the capacity ratio planned by the national programme and a linear increase was supposed taking into consideration those, who connect to already existing systems. The ratio of sewage soaking is assumed to decline to 50% by 2015 in a linear trend. Relative municipal Biological Oxygen Demand (BOD) is judged to rise to 55g/person/day by 2006-2015. Relative water consumption is forecast to reduce to a 90l/person/day between 2006-2015. The projected ratio of municipal sewage receiving biological treatment is 66.6% in 2005, 90.6% by 2010, and 100% by 2015. In the meantime a linear increase was supposed. The aerobidity index for sludge treatment is predicted to linearly rise to 0.6 by 2015. Anaerobic sludge treatment is predicted to linearly rise from 82% in 2004 to 90% in 2015. The optimistic scenario predicts a higher welfare, which results in a lower decrease in population growth, a quicker increase of the number of residential places connected to the sewer system, no reduction in water consumption. The pessimistic scenario assumes a lower welfare, leading to higher decrease in population growth, slower growth of connection to sewers, enhanced reduction of water use, a slower realisation of investments.

The overall projection for industrial wastewater predicts a 12% reduction in quantity by 2013. The model assumes that all the actors keep the emission limits by 2011. This can only be achieved if the wastewater released from the industrial activities is subject to biological treatment. For the increase of the application of biological treatment a linear extrapolation was done based on the 2002 fact and the 100% value in 2011. The future anaerobidity index for industrial wastewater is not known, so no tendency was assumed, the 2002 value was used, modified for the optimistic and pessimistic scenario. In case of the meat-, vegetable and food processing industries the index was assumed to equal that of municipal sewage, for the other industries 80% of the municipal index was applied.

The realistic scenario projects that the total methane emission of sewage and sludge management is going to rise by 15% through 2013. The methane emission ratio of municipal sewage decreases from 60% to 55%, while the industrial rises from 40% to 45%. The optimistic scenario predicts a 17% increase of the total methane emission, with 65% municipal and 35% industrial contribution. The pessimistic scenario accounts for 14% overall increase with 55% municipal and 45% industrial emission.

6.3.4 Transport

Most of sector emissions come from road transport. There is a linear correlation between CO_2 emission and the amount of fuel consumed by transport. CH_4 and N_2O also show a linear correlation to fuel consumption, but these emissions are influenced by the composition and technical condition of the vehicle park as well. GHG emission forecast is based on projected fuel consumption by the sector.

The change of the passenger car stock shows a close (99.6%) correlation with GDP growth from 1995 through 2003. Projection was based on this correlation. The stock of gasoline-fuelled buses exponentially declines with a 99.9% correlation with GDP growth between 1995-2003. The newest gasoline-fuelled buses are 3-5 years old. Other fuel types (e.g. gas) represent a very low ratio. Stock changes of trucks also show a decline of gasoline-fuelled vehicles. Unit fuel consumption per kilometre is predicted to decrease as a result of technology improvement.

Rail transport accounted for 2.12% of the total emission of the transport sector in 2002. The emission is the result of operating diesel engines and space heating in stations. GHG emission in this sub-sector is in direct proportion with the fuel consumed. The average passenger km (757.8 km) declined below the EU-15 average in 2001. Based on the communication with the national railway company (MÁV Rt.) present trends are supposed to keep on in the next period. The ratio of electric traction increases, technological level of diesel engines improves, the volume of rail shipping increases, the volume of passenger transport stagnates.

National ship and air transport accounted for 0.13% of the total GHG emission of the sector. The volume of water transport was significantly reduced by the Balkan war, which blocked the Danube, the most important transport

	unit	2004	2005	2006	2007	2008	2009	2010	2011	2012
CO_2	Gg	9 938	10 205	10 451	10 745	11 027	11 303	11 620	11 953	12 282
CH_4		1.45	1.48	1.5	1.53	1.56	1.59	1.63	1.67	1.71
N_2O		1.84	1.89	1.94	2.01	2.06	2.12	2.18	2.24	2.31
CO_2	GWP (Gg)	9 938	10 205	10 451	10 745	11 027	11 303	11 620	11 953	12 282
CH_4		30	31	32	32	33	33	34	35	36
N_2O		571	587	603	622	640	657	676	696	715
TOTAL		10 540	10 823	11 086	11 399	11 699	11 993	12 330	12 684	13 033

	unit	2013	2014	20115	2016	2017	2018	2019	2020
CO_2	Gg	12590	12946	13290	13628	14007	14402	14793	15163
CH_4		1.74	1.78	1.82	1.86	1.91	1.96	2.01	2.05
N_2O		2.38	2.47	2.54	2.62	2.7	2.78	2.87	2.96
CO_2	GWP (Gg)	12590	12946	13290	13628	14007	14402	14793	15163
CH_4		36.54	37.38	38.22	39.06	40.11	41.16	42.21	43.05
N_2O		737.8	765.7	787.4	812.2	837	861.8	889.7	917.6
TOTAL		13364	13749	14116	14479	14884	15305	15725	16124

Table 6.13: Projection for the GHG emission of the transport sector. kt

route for years. National air transport is not considerable and is not expected to grow, 1% increase of fuel consumption is foreseen.

The following steps were taken to develop a complex projection model of fuel consumption:

a. Firstly, national income was estimated by the GDP changes, because national income is considered to be a strong explanatory variable of vehicle stock changes. According to the projection the number of passenger cars per 1000 persons is going to increase from 274 in 2003 to 411 in 2012 (the EU-15 value in 2001 was already 487). Empirical evidence of developed countries show that there is a regressive relationship between the size of the vehicle stock and the national income. The prognosis for truck stock size is 64.7 pieces/1000 persons in 2012. From 2012 a gradual increase is forecasted till 2020, when the expected EU average will be reached.

b. Statistical relationship was analysed between growth of national income and the size of the vehicle stock by vehicle categories (passenger cars, buses, trucks) by use of domestic statistical data.

c. Projection was made of vehicle stocks by results of the statistical observations about stock and income along vehicle categories. Trends experienced in countries with higher GDP and national income were also considered.

d. The relationship between vehicle stocks and fuel consumption was analysed by vehicle categories. Correlation of the two was further explored by introduction of additional explanatory variables: average annual run in vehicle categories (km per year) and the average unit consumption of fuel (litre per km) in each vehicle category. Parameter values were estimated statistically. Observed and estimated domestic fuel consumption volumes show a gap. It is explained by the extensive contraband traffic of fuels from low-taxing countries, e.g. Romania, Slovakia, and the Ukraine. Naturally, no data is available on that part of fuel consumption, so domestic fuel use was forecast by the estimated model.

e. Consumption was projected for three fuel types (motor gasoline, diesel oil and LPG) in each vehicle category by use of the statistically explored parameters of variables that determine the size of vehicle stock.

CO_2, CH_4 and N_2O emissions were calculated from fuel consumption according to the IPCC Guidelines.

6.3.5 Agriculture

Methodology used

The formerly used methodology of the compilation of the inventory of greenhouse gases from agriculture were modified in 2004, and the entire agricultural time series of the period between 1985 and 2003 were re-calculated. The detailed methodology can be found in the National Inventory Report, 2003 (NIR 2003 Hungary). The most important modifications, activity data and emission factors are as follows.

– Livestock population was characterised according to the Revised Guidelines (dairy cows, other cattle, buffalo, sheep, goats, camels, horses, mules and asses, swine and poultry). At the emission calculations the annual average data were used in each category. Annual average data of the period between 1985 and 2003 were made available by HCSO.

– The factors used to the estimation of the average annual N emissions of the single livestock categories were selected using expert consultations (Gundel 2004, Várhegyi 2004), literature data (Walther et al. 1994, IPCC 1996, Várhegyiné et al. 1999, Babinszky et al. 2002) and own preliminary calculations (Borka 2003). The proportion of the nitrogen emitted by the different manure management systems and on the pastures were determined using Ráki (2003), the data of the former years by the HCSO and Mészáros (2000).

– CH_4 emission from rice cultivation were calculated using the official size of cultivated area (HCSO 1985-2003) and the emission factors suggested in the Revised Guidelines.

– Volume of N-agent in synthetic fertilisers used per annum was determined on the basis of the official data provided by the HCSO (HCSO 1985-2003).

– Revised Guidelines Tier 1 method was applied to calculate the used manure-nitrogen.

In calculating the amount of N put into soils together with agricultural residue we practically accounted for all crops cultivated on the plough-land. Calculations were performed by using IPCC Tier 1 default method (IPCC 1996).

In Hungary there has been no legal field burning of agricultural residues since Decree No. 21/1986. (VI. 2.) MT has become effective. According to estimates made by area inspectors of Central (Budapest) Bureau for Soil and Plant Protection, illegal burning of agricultural residues currently is less than 1 % of total sown area (that is, not the entire ploughed area) in the country, therefore we do not account for it. It may be assumed that illegal field burning of agricultural residues was more frequent in the mid 1980s than now. Failing reliable quantitative information, we assumed that field burning of agricultural residues occurred to a decreasing extent in sown areas between 1985 and 1989; practically it was stopped to 1990.

The histosols of Hungary are protected, they are not ploughed so we do not include them into the analysis.

The prediction of the agricultural activity data was mainly performed by using the data provided by the working group of the Agricultural Economics Research Institute (AERI) (Bognár 2005). Agricultural forecasts have been made by the HUSIM (Hungarian Simulation Model) model developed and continuously improved by the Institute since 1998 (Mészáros et al., 1999, 2000a, 2000b; Udovecz, 2000; Mészáros & Spirálszky, 2002). The model in its present form is used to forecast the effects of the acceeding to the EU.

The sources of the input data of the model are the following:

– The forecast of the macroeconomic variants was based on the macroeconomic prognosis till 2008 elaborated by the Ministry of Finance (2004).

– The exchange rate of euro was taken HUF 252 as a constant for 2004, 2005 and 2006

– The development of the production prices between 2004 and 2006 was estimated by using studies of foreign forecasting working groups (OECD, 2004; FAPRI, 2004; EC DG AGRI, 2004) (see Popp et al., 2004). Beyond that, in the case of the relevant products we took into account the actual quotations for different terms of the Budapest Commodity Exchange (2004-2005) as well as the price trends calculated by the Market Information Department of AERI.

– The estimation of fuel and energy prices was based on the mid-term forecast of the Mol Rt. (2004). In the case of the other input items the forecasts of Palócz and Berényi (2004) were used. Land renting was calculated on the basis of simplified payments and of the national top up supports of plough-land crops (the amount was determined at a lower level than 50% of the subventions, regarding the long-term rent contracts reached during the years before the accession). Cost forecasts – except for the costs of milk production, swine and poultry keeping – and direct subventions are the same as the data published by Popp et al. (2004). In the case of the three mentioned animal farming sector those realising the largest losses according to the test data 2002 (2.6% of milk producers, 23.1% of swine keepers and 11.3% of poultry keepers) were not taken into account. Regarding animal farming sectors it is important to stress that investment costs necessary to comply with the hygienic, animal welfare and environmental protection requirements of the Union were not taken into account. So in the case of animal farming branch production costs will growth by 3.8%, while at plant cultivation the growth of production costs will be 7.7% between 2004 and 2006 according to the forecast.

– Beside the direct subsidies, agri-environmental programmes as well as subsidies on less favoured areas were also taken into account in the 16th version of National Rural Development Plan (NRDP).

– Yield estimations were elaborated by the experts of AERI.

– The annual volume of food consumption of 2004 was the same as it was in 2002 according to the forecast of the experts of AERI.

In the course of the final determination of activity data (beside the economic factors that can be forecast) it was also taken into account that agricultural production – on the long run – will harmonise with the ecological endow-

GWP	CO2-equivalent Gg year-1 (100% = Projection Borka, 2005)								
	2004	2005	2006	2007	2008	2009	2010	2011	2012
CH_4-emissions	2028.5	2075.4	2111.9	2151.0	2189.9	2227.2	2265.9	2291.2	2317.1
N_2O-emissions	7752.38	7959.9	8256.6	8713.007	9014.7	9305.4	9597.2	9715.2	9830.1
Total CH_4+N_2O	9781	10035	10369	10864	11205	11533	11863	12006	12147

GWP	CO2-equivalent Gg year-1 (100% = Projection Borka, 2005)							
	2013	2014	2015	2016	2017	2018	2019	2020
CH_4-emissions	2342.2	2367.771	2393.2	2416.4	2439.5	2462.7	2485.9	2509.1
N_2O-emissions	9942.7	10056.3	10169.34	10270.8	10371.8	10472.2	10571.9	10671.1
Total CH_4+N_2O	12285	12424	12563	12687	12811	12935	13058	13180

Table 6.14 Emissions from agriculture

ments of the country and production volume – except for several branches – will be close to the level of the second half of '80s.

The HUSIM model provided the expected activity data for 2010, 2015 and 2020. The data of the interim years were determined by linear interpolation. The activity data forecast by the HUSIM model (80% of the cultivation volume and 90% of animal farming volume) were corrected by using the time series between 1985 and 2003 for the whole product range of the National Inventory Report. It is especially important in the case of the N-fixing crops where the HUSIM took into account only 13% of the whole production.

The expected changes in manure management systems were taken into account. Out of the reduction possibilities the small reduction of N excretion in the field of swine and poultry farming was considered as realistic (see Chapter 4). In the case of swine 10%, of poultry 5% improvements were calculated.

Table 6.14 and Figure 6.6 contain the results of the calculations on greenhouse gas emissions from agriculture of the period between 1985 and 2012. Time series are based on factual data between 1985 and 2003 (partly 2004), and on our own projection between 2005 and 2012.

According to the calculations, the gross greenhouse gas emission of the Hungarian agriculture on the average of the period 2008-2012 will reach 60% of the average of the

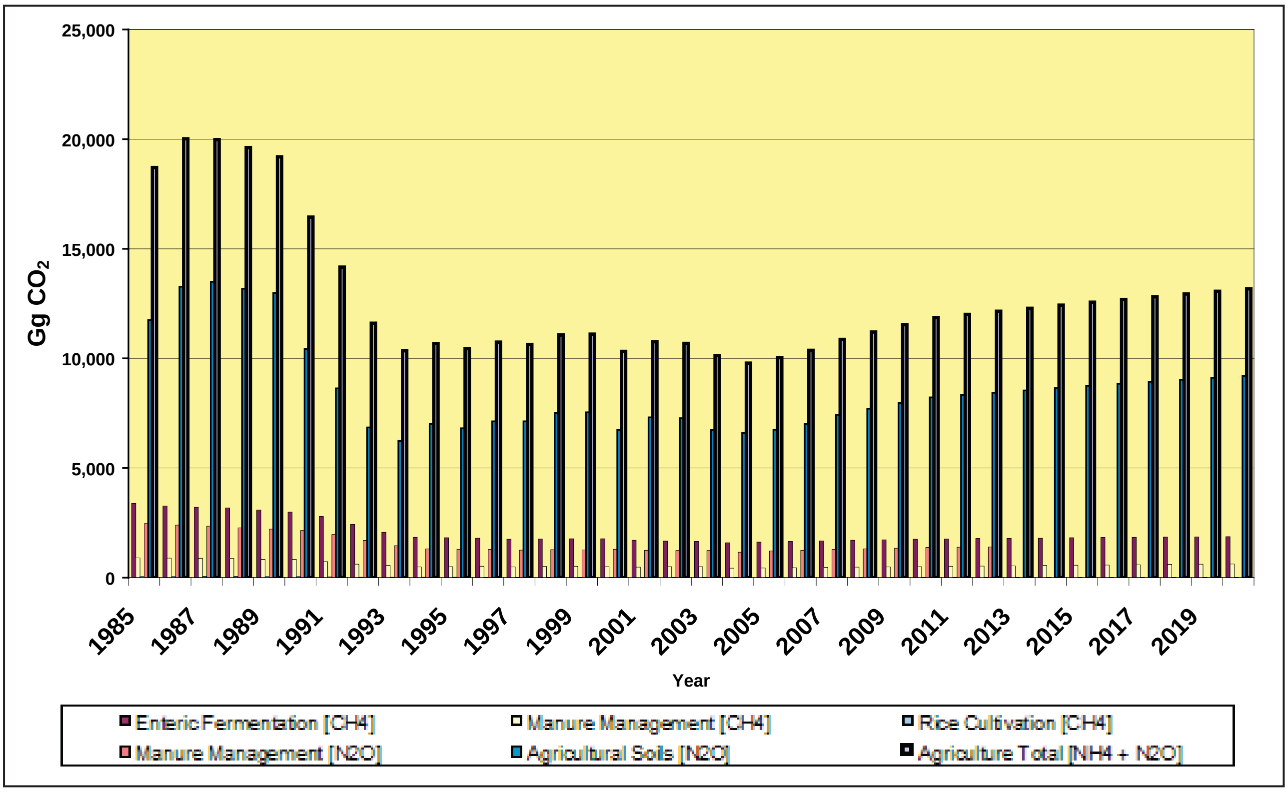

Figure 6.5 Past and projected GHG emissions from agriculture between 1985 and 2012 (in CO_2-equivalent)

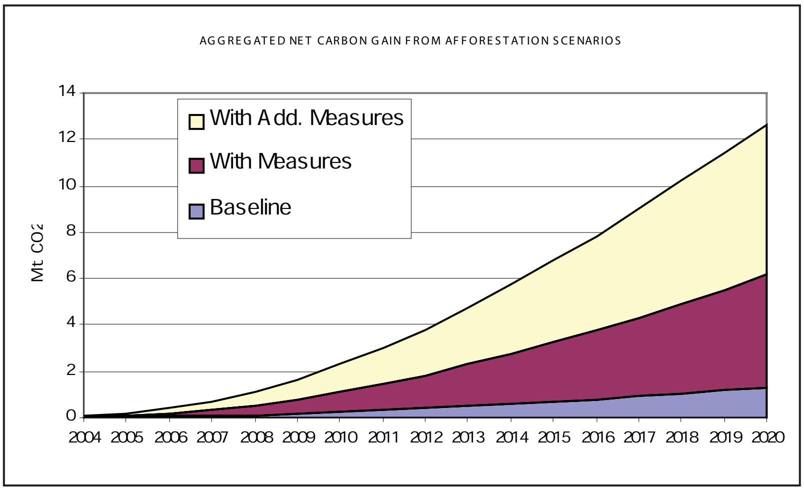

Figure 6.6 The amount of carbon fixed in all of the carbon pools of three afforestation scenarios, I, II and III. Scenario I represents a constant afforestation of 15,500 ha per year, scenario II 8,000 ha per year, and scenario III 4,000 ha per year.

base period (1985-1987). This value is an increase of 11% compared to the average of the last five years (1999-2003) based on whole range factual data.

In the forthcoming period till 2020 a further slight increase is probable up to the level of agricultural production being in harmony with the appropriate ecological potential of the country.

6.3.6 Forestry and land use changes

For the purpose of the National Communication three basic afforestation scenarios of constant afforestation rates were developed. The technical potential scenario (I) involves afforesting 773000 ha of former agricultural land in 50 years (ÁESZ, 1999). In the second scenario (II), it is assumed that average afforestation rates in the past several years (~8000 ha.yr-1) are maintained until 2050. The third scenario assumes that the afforestation rate is equal to the lowest one in the past few decades (~4000 ha.yr-1).

These scenarios are believed to provide a rough estimate of the potential. There are big differences in the scenarios, and thus they well represent a basis for political decisions. The technical potential scenario is expected to represent a high value, since, although a lot of afforestations are supposed to take place in the coming few years, no one can guarantee that a very high rate is sustainable in the long run. On the other hand, the scenario with the lowest afforestation rate is highly unlikely, however, if, for some reason, it will take place, only little carbon will be fixed, and the amount of unfixed carbon can be obtained by comparing this scenario with the technical potential one.

It was also investigated how the choice of baseline scenario affects sequestration estimates. The choices are that the area still to be afforested remains cropland until afforestation, or that it is abandoned at the beginning of the afforestation program, and spontaneous forestation takes place.

Estimates were calculated for the total length of the suggested 50 year afforestation project, as well as for the period 2008–2012 (i.e., the first commitment period of the Kyoto Protocol).

In each scenario, it was assumed that afforestation is done either with predominantly fast growing, short rotation, exotic species such as black locust (*Robinia pseudoacacia*, 50%), poplars (*Populus cultivars*, 35%), and pine (*Pinus sylverstris* and *Pinus nigra*, 15%), or that at least half of it is done with indigenous, slower growing, long rotation species such as Pedunculate oak (*Quercus robur)*. This analysis was important to see how much difference it would make if attention is paid to biodiversity and other forest values, in which case slower growing indigenous species must be preferred.

The results of model runs (Figure 6.6., Table 6.15) show that the technical potential of sequestering carbon in Hungary amounts to some 46 Mt C in 50 years (Somogyi, 2000). Amounts that could be sequestered during the first commitment period (2008–2012) are also substantial. They are amounts are at the order of magnitude of the commitment of Hungary (6%, or 1.63 Mt CO_2-equivalent) in the Kyoto Protocol for this commitment period.

	fast-growing	indigenous
Scenario	species	
I/2050	42.6	32.0
II/2050	22.0	16.5
III/2050	11.0	8.3
I/Kyoto	2.3	1.7
II/Kyoto	1.2	0.9
III/Kyoto	0.6	0.4

Table 6.15 Estimated amounts of carbon fixed in various scenarios and by assuming that either only fast growing species are used, or both indigenous and fast growing exotic ones. "/2050" means that the project lasts from 2001 to 2050, whereas "/Kyoto" denotes carbon sequestration estimates for the same projects in the commitment period 2008–2012.

However, considerable differences exist between various afforestations scenarios, as well as between various assumptions as to the baseline, or species applied. In addition, the cumulative rate of carbon fixation over time is worth attention. Because of the difficulties to quickly afforest large areas (i.e., in only a few years, instead of decades), and because of the characteristic carbon fixation rate of trees over age, a considerable time elapses after the initiation of the afforestation until large amounts

(MtC)									
Mitigation option	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
I	0.02888	0.10339	0.21996	0.37746	0.59048	0.86028	1.18144	1.55353	1.9751
II	0.00578	0.02068	0.04399	0.07549	0.1181	0.17206	0.23628	0.31071	0.39502
III	0.02118	0.07582	0.1613104	0.2768	0.43302	0.63087	0.86639	1.13925	1.4484
Mitigation option	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	
I.	2.44432	2.95685	3.49648	4.0693	4.66367	5.26845	5.87258	6.46674	
II.	0.48886	0.59137	0.69614	0.80822	0.9272	1.05267	1.18424	1.32142	
III.	1.7925	2.16836	2.55252	2.96348	3.39974	3.8598	4.3422	4.8452	

Table 6.16: Aggregated net carbon gain from afforestation scenarios

of carbon are fixed, however intensive the annual afforestation rate is. This may bring about adverse reactions of investors; however, the rate of carbon could be accelerated by proper project preparation.

On the other hand, even if afforestation stops in 2050, the accumulation of carbon continues into the relatively far future (at least 70 years ahead). Although the carbon sequestration does not reach a saturation level until 2100, the increase of the total carbon fixed in the system slows after ca. 2070 and is expected to level off soon after 2100. The levelling off occurs after the end of the afforestation programme, because carbon continues to accumulate in the above and below ground biomass, dead wood and wood products after establishing a forest, and because much carbon is still fixed in dead wood and wood products after the first rotation period.

The precondition for preserving all the estimated amount is, of course, that all newly established stands are protected from land-use change. It is, of course, difficult to predict future land use practices, however, there is a good chance in Hungary for these stands to remain well managed forests in the long term.

It is worth underlining that the uncertainty of the results is modest due to a robust growth model used as one of the main driving forces in the model. By using the assumptions detailed above, the model is though to be underestimate carbon that can be fixed rather than overestimate it. However, considerable uncertainties exist with respect to soil processes, and also whether growth of trees has changed. There are some indications that growth of tree has increased in Hungary by as much as 40 %, which is not reflected in the growth functions that are used in the model. In case of this large increase, considerably more carbon is fixed in afforestation. This requires a thorough

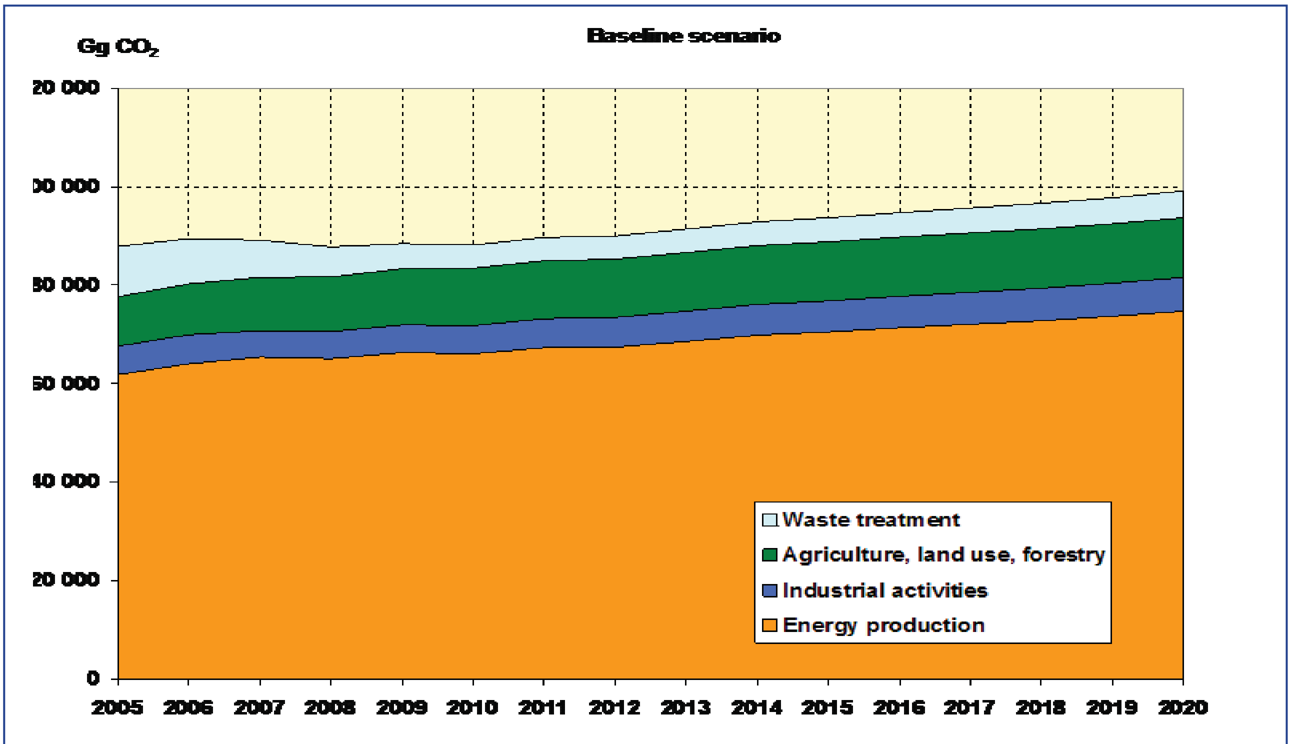

Figure 6.7 Sectoral division of emission trends of the without measures scenario

analysis in the future and an inventory method that more relies on measured values rather than uses growth models.

2005	2006	2007	2008	2009	2010	2011	2012
0.07582	0.16131	0.2768	0.43302	0.63087	0.86639	1.13925	1.4484
2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
1.7925	2.16836	2.55252	2.96348	3.39974	3.8598	4.3422	4.8452

Table 6.17: Net emissions savings from land use change and forestry, with measures scenario (Mt CO_2)

6.4 Aggregated emissions from the without measures scenario

The outline of the aggregate emissions can be seen in Figure 6.7, together with the emissions from the subsectors from 2005 to 2020. The detailed data can be found in Annex 2.

6.5 The total effects of policies and measures – scenario with measures

Forestation, renewables utilisation, measures in agriculture and sustainable transport policy – mitigation options

The “without measures”scenario is treated as the baseline scenario, which is modified with the effects of various policies and measures to arrive at the “with measures” and “with additional measures” scenarios. The emission calculations for the “without measures” scenario already assume that some steps are taken towards energy efficiency, fuel-switch,

gas	2005	2006	2007	2008	2009	2010	2011	2012
CO_2	10205	10294.24	10422.65	10530.79	10624.82	10748.5	10877.23	10992.39
CH_4	31.08	31.0275	31.1661	31.2858	31.3866	31.66275	31.9137	32.13945
Total, incl. N_2O	10822	10918	11058	11172	11274	11405	11541	11665
	2013	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
CO_2	11079.2	11198.29	11296.5	11583.8	11905.95	12241.7	12574.05	12888.55
CH_4	32.1552	32.3337	32.487	33.201	34.0935	34.986	35.8785	36.5925
Total, incl. N_2O	11761	11893	11998	12307	12651	13009	13366	13705

Table 6.18: Expected emissions from road transport, CO_2, with measures scenario

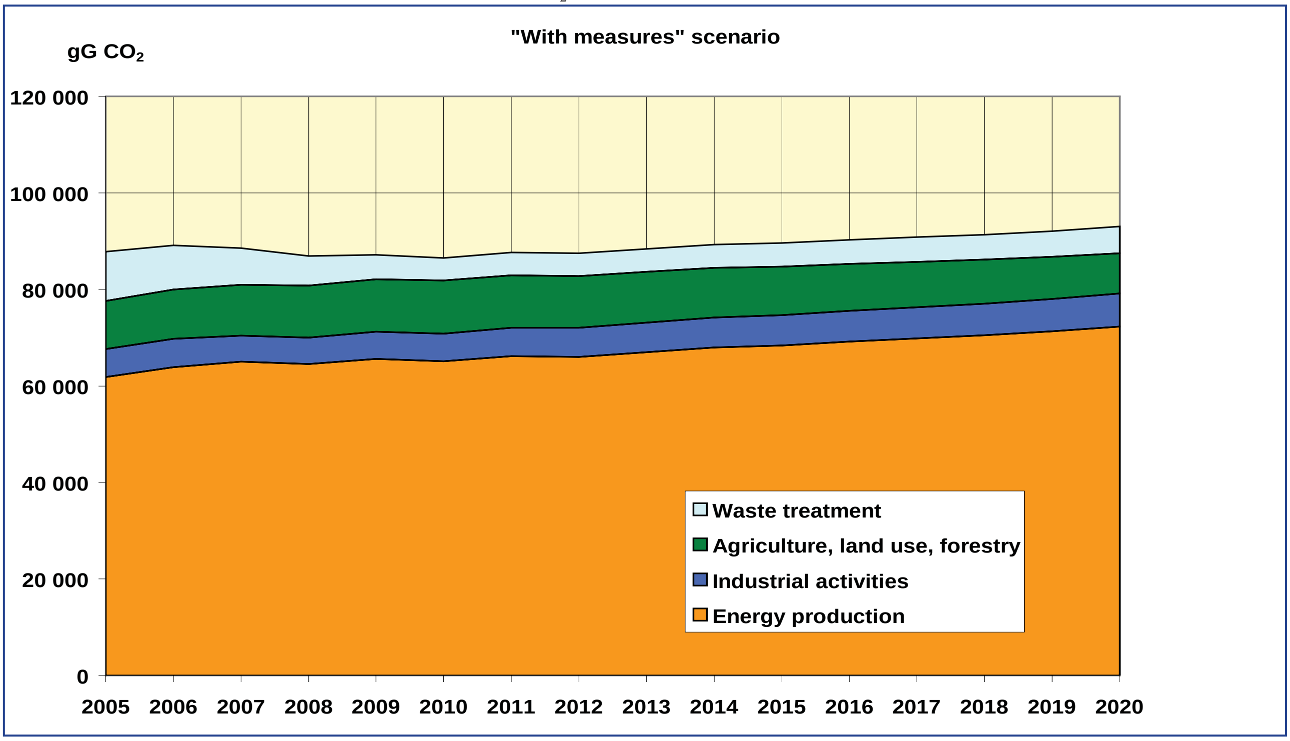

Figure 6.8 Sectoral division of emission trends of the with measures scenario

renewables use, to an extent that this is enforced by existing EU regulation, but no domestic measures have been included.

In the following presentation is given of the effects of policies and measures and additional steps in emission reduction.

According to the targets set in the Hungarian sustainable transport policy, specific CO_2 emissions have to be reduced by 15% and specific CH emissions

by 50% by 2015 compared with 2005. This allows for the following emissions forecast:, assuming a gradual linear reduction for simplicity until 2015 and then maintenance of the reduction compared to the business-as-usual scenario.

The total net emission savings resulting from land use change and afforestation from 2005 are as follows. The second best scenario was assumed, for description see above in the forestry and land use sub-chapter.

The total effects of policies and measures on the forecasted emissions are summarised in Figure 6.8 The detailed data in tabular format in Annex 2.

6.6 Scenario with additional measures

The scenario "with additional measures" assumes a higher rate of governmental interest in increasing energy

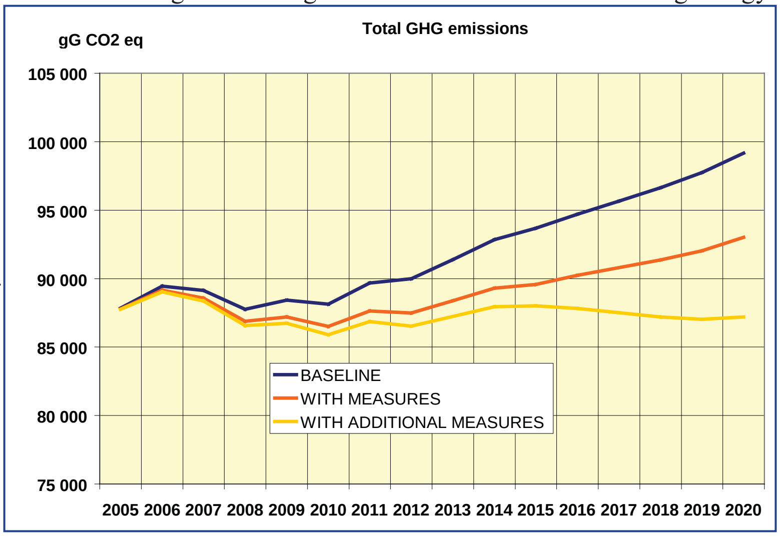

Figure 6.10: Total GHG emissions according to scenarios

efficiency and renewables use, and a higher commitment in transportation and traffic redesign.

The scenario with additional measures is different from the „with measures" scenario in that the government develops and implements from 2015 a radically new traffic and transportation scheme resulting in a decreasing emissions trend from 2015, the strongest afforestation scenario is supported and implemented from 2010, significant measures are taken in the agricultural sector to reduce

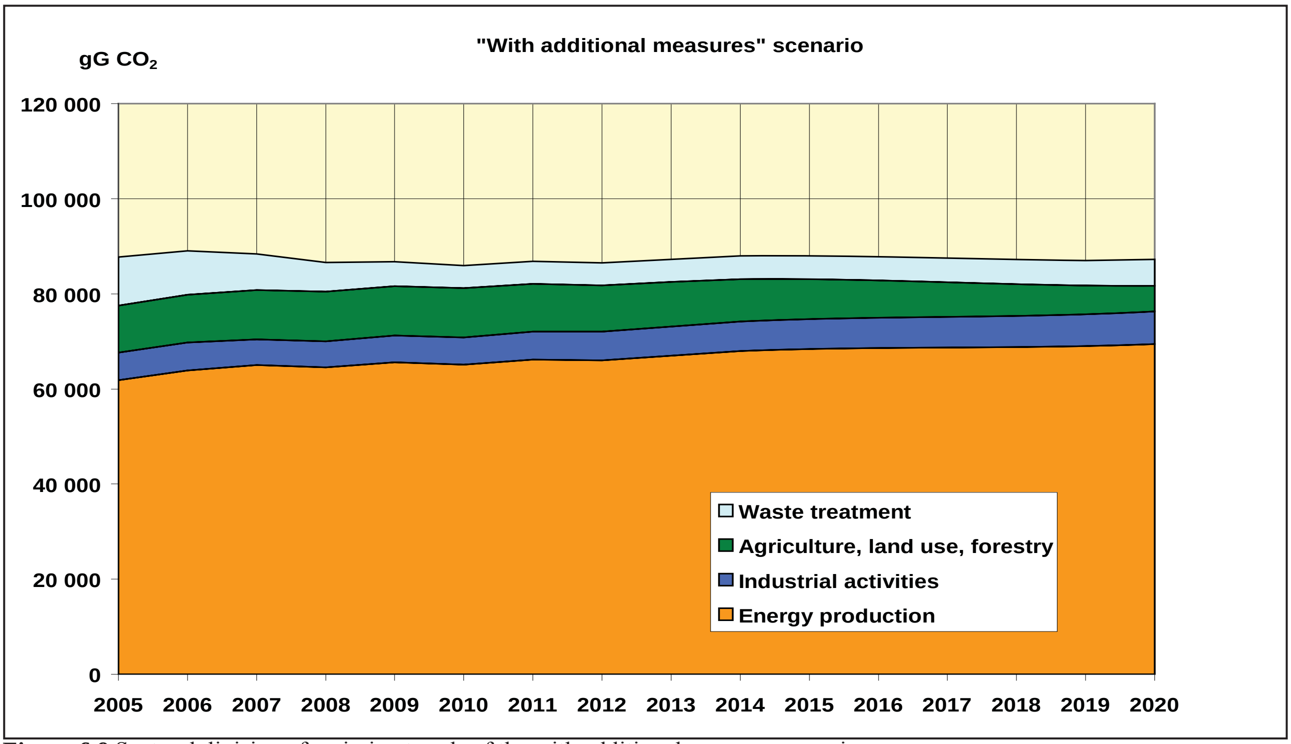

Figure 6.9 Sectoral division of emission trends of the with additional measure scenario

emissions of CH_4 and N_2O, and the support on energy efficiency and renewables in real value grows to 400% of its present value beginning with 2010. The latter is in line with the government's strategy on renewable energy which is currently in the planning stages, and which envisage that by 2013 11,4% of electricity production will be from renewable sources.

As it can be seen in Figure 6.9, even in the case of radical actions taken, significant reduction of the emissions can not be achieved until 2020, only a stabilisation with a slight drop in the emissions seems realistic. The detailed data in tabular format can be found in Annex 2.

Figure 6.10. presents a comprehensive overview of effects of policies and measures and other mitigating options

6.7 Estimation on non-direct greenhouse gas emissions

Forecasted fossil fuel consumption

The forecasted fossil fuel demand, where only volume of the fossil fuels actually fired is taken into consideration.

fuel PJ	2000	2010	2020
Solid	166	140	140
Liquid	81	162	165
Motor fuel	129	156	180
Gaseous	397	470	510
Total	773	928	995

Table 6.19a: Fossil fuel demand

Carbon-monoxide emission

The forecasted carbon-monoxide emissions are shown in Table 6.19b

CO kt.	2000	2010	2020
Solid	25.5	22.0	22.0
Liquid	2.3	4.6	4.7
motor fuel	450.0	244.0	28.0
Gaseous	18.7	22.1	24.0
Total	496.5	592.7	678.7

Table 6.19b: CO emissions in kt

The transportation sector is responsible for about 90% of the carbon-monoxide emissions. It can be reduced by modernization of the passenger car fleet and by a significant reduction of the average age of vehicles.

Solid particulate emission

Particulates kt.	2000	2010	2020
Solid	57.1	48.2	48.2
Liquid	4.0	8.0	8.2
motor fuel	19.9	24.1	27.8
gaseous	0.0	0.0	0.0
total	81.0	80.3	84.2

Table 6.19c: Solid particulate emissions in kt.

The solid particulate emissions may be reduced by modifying the structure of the fossil fuel use. Despite the fact that the greatest part of solid fossil fuels is fired in power plants, where electrofilters are installed, the fuel wood, coke, briquette and coal consumption of other sectors produce significant particulate emissions. Reduction can only be achieved by modifying the fuel use, but it contradicts to the requirements of the EU, according to which the use of renewable energy sources has to be increased in the future.

Non-methane volatile organic compounds emission

The forecasted emissions of the non-methane volatile organic compounds (NMVOC) are shown in Table 5.21d.

NMVOC kt.	2000	2010	2020
Solid	30.3	25.6	25.6
Liquid	0.3	0.7	0.7
motor fuel	63.7	77.0	48.9
Gaseous	1.2	1.4	1.5
Total	95.5	104.7	76.7

Table 6.19d: NMVOC emissions in kt

Motor fuel use (i.e. transportation) causes about two-third of the total NMVOC. The car fleet is aged, thus by increasing the share of new, modern cars the requirements of the Göteborg protocol may be fulfilled. The pressure to decrease the NOx and the CO emission is much higher then to reduce the NMVOC emissions, since in the case of NMVOC emissions there is not too much opportunity for further reduction.

The NMVOC emission from solid fossil fuel use is mainly generated by fuel wood firing in the residential sector. It can be reduced by application of up-to-date firing devices.

Emissions at reduced fuel consumption

Particulates kt.	2000	2010	2020
Solid	57,1	48,2	48,2
Liquid	4,0	7,8	7,8
Motor fuel	19,9	21,6	13,5
Gaseous	0,0	0,0	0,0
Total	81,0	77,6	69,5

Table 6.20a: Emission of particulates, kt

CO kt.	2000	2010	2020
solid	25,5	22,0	22,0
liquid	2,3	4,5	4,5
motor fuel	450,0	198,2	10,3
gaseous	18,7	19,8	20,1
total	496,5	224,5	56,9

Table 6.20b: Emission of CO, kt

NMVOC kt.	2000	2010	2020
solid	30,3	25,6	25,6
liquid	0,3	0,6	0,6
motor fuel	63,7	49,1	15,1
gaseous	1,2	1,3	1,3
total	95,5	76,6	42,6

Table 6.20c: Emission of NMVOC, kt

6.8 Methodology

According to the UNFCCC guidelines on reporting and review (Distr. General FCCC/CP/1999/7) this projection excludes all policies and measures implemented, adopted or planned after the year chosen as the starting point of this projection. The study was prepared in 2004, so first projected year is 2004. However, all regression models of the projections are based on official statistical data going back to at least 1995, but most of the forecast are based on econometric time series models with starting year in 1985.

Projections are provided in an aggregated format for each sector as well as for national total, using global warming potential (GWP) values agreed upon by the Conference of the Parties. (21 for methane; 310 for N_2O)

Inventory data was available from 2001 through 2003. Emission projections for the preceding years were presented relative to these actual inventory data.

Gases projected

Projections are presented on a gas-by-gas basis for the following greenhouse gases (GHGs):

- CO_2
- CH_4
- N_2O

Sectors projected

The baseline projection is presented on the following sectoral breakdown:

Domestic energy production – projections by fossil fuels

Transport

Non-transport, broken down to the following sectors

- Cement Industries
- Coal Mining
- Lime Industries
- Glass Industries
- Pulp and Paper Industries
- Natural Gas Industries
- Power Plants
- Ceramics Industries
- Oil Industries
- Coke-Ferrous metals-Steel Industries
- Other industrial activities

Process emissions from the following industries:

Mineral products

- Process emissions from the Cement Industries
- Process emissions from the Lime Industries
- Process emissions from the Glass Industries
- Process emissions from the Ceramics Industries

Chemical industry

- Process emissions from the chemical industries.

Production of ferrous metals

- Process emissions from the coke industry
- Process emissions from the ferrous metals industries
- Process emissions from the steel industries

Pulp and Paper Industries

- Process emissions from the Pulp and Paper industries.

Agriculture, land use change, forestry (LUC)

Emissions from afforestation, land use change, and agricultural activities

Waste treatment

- Process emissions from waste water management
- Process emissions from solid waste management

The type and characteristics of the model used

Bottom-up sector-wise modelling was used. Models are mostly time series econometric models of sectoral production. All fossil fuel markets were analysed independently from the energy consuming industrial sector models, and the national energy balance was reproduced by forecast fuel breakdown. Emissions from energy users not covered by sectoral models (e.g. households) were estimated on the basis of their projected use of fossil fuels.

The original purpose the model was designed for and the description of its modification for climate change purposes.

All sectoral models were designed and developed for the purpose of the National GHG Emissions Baseline Research Project in the coordination of the Regional Centre for Energy Policy Research (REKK) at the Corvinus University of Budapest, 2004. The only excep-

	2004	2005	2006	2007	2008-2010	2011-2020
GDP	103.9	104.0	104.2	104.3	104.0	104.2
Domestic consumption	104.1	102.2	104.6	105.3	105.5	105.0
Residential consumption	103.1	103.8	103.4	103.5	104.0	104.0
Communal consumption	100.3	99.0	100.6	100.8	104.0	104.0
Investment	109.0	107.3	107.9	107.7	110.0	108.0
Export	114.0	111.0	110.4	109.5	112.0	109.0
Import	112.9	110.7	110.1	109.3	114.0	110.0
Population	99.7	99.6	99.8	99.8	99.8	99.7
Accumulation of fixed assets	97.3	104.8	98.1	100.0	102.2	99.1

Table 6.21: Assumed growth rate of the non-sector specific macro-economic variables

tion is the electricity production capacity model, which was originally developed by the Hungarian Electricity System Operator (MAVIR) and was adapted by the researchers for GHG emissions projection.

Summary of the strengths and weaknesses of the model

Strength of the research was that fossil fuel combustions was projected fuel-wise and sector wise so no systematic omissions are expected.

The baseline projection does not cover PFCs, HFCs and SF_6.

This projection does not contain emissions related to fuel sold to ships and aircraft engaged in international transport. This projection does not cover the emission from the production of non-ferrous metals, the use of halocarbons, SF_6 and NMVOC solvents.

For chemical industry: no data was available for the methane emission from carbon black production.

No data was available for the N_2O emission of catalytic cracking of crude oil.

Besides combustion emission based on the IPCC Method additional process emission was estimated for glass, paper and ceramics industries.

References to more detailed information related to the model

All details of the research, including econometric description of the forecast models were published by the Ministry of Environment and Water in 2004. For details (in Hungarian only) see: http://www.kvvm.hu/szakmai/klima/

Qualitative or where possible quantitative discussion of the sensitivity of the projections to underlying assumptions

Econometric model specifications were computed with numerous explanatory variables sector by sector. Models were refined until best fit was achieved. Overall fit of models was presented by R2 values and Durbin-Watson-statistics. Sensitivity to each independent variable is shown by the estimated parameter values and the t-statistics, all of which are included in the detailed report.

Key underlying assumptions and values of variables

See Table 6.21.

Factors and activities for each sector

See text.

Boundaries of the projection

The projection does not cover PFCs, HFCs and SF_6.This projection does not contain emissions related to fuel sold to ships and aircraft engaged in international transport.

This projection does not cover the emission from the production of non-ferrous metals, the use of halocarbons, SF_6 and NMVOC solvents. For chemical industry: no data was available for the methane emission from carbon black production. No data was available for the N_2O emission of catalytic cracking of crude oil.

Besides combustion emission based on the IPCC Method additional technological emissions were estimated for glass, paper and ceramics industries.

7. Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

The impacts of unfavourable meteorological and environmental events monetised value is significant, with a high inter-annual variance. In Hungary, taking the average of many years of damage and necessary protection, the value is between 600M and 720M euros, around 1% of the GDP. Global climate change seems to change the frequency of certain extreme events, and increase the associated damage costs, besides the not monetisable impacts on human health and nature-environmental values respectively.

This makes the development of a comprehensive climate policy necessary in Hungary. This policy should be characterised by reduction of anthropogenic emissions and adaptation to the harmful effects by proactive and preventive measures. The preparation of a policy systematically addressing vulnerability are in preparation.

7.1 Expected impacts of climate change and vulnerability assessment

The climate of Hungary is defined by the common impact of the continental, oceanic and Mediterranean climate (for details see Chapter 3.). Those together with the topographical characteristics of the Carpathian basin result in a variable climate. Due to the strong fluctuations the statistical trends of climate parameters are not always possible to validate.

The most straightforward changes can be seen in the trends of temperature. The country-wide average follows well the global changes, and indicates a slightly higher than global average warming (0.77 °C). The winters and springs are warming as the average, but the summers are warming to a higher extent (approx. 1°C), while the autumns less (0.4-0.5 °C). In the past 30 years the pace of the warming increased. The average temperature differences of the past two decades in some places in the country are higher even than half degree. The warming is stronger in the eastern and north-western territories. The minima and maxima of the temperature increases similarly the number of days surpassing certain temperature thresholds is increasing, which has significant impact to living beings, including humans.

The annual precipitation amount significantly decreased in the 20th century. It is most significant during spring when the sum of precipitation is only 75% of the sum in the beginning of the 20th century. The summer precipitation amount did not change in the past 100 years. The autumn and winter precipitation decrease is 12-14%. The winter precipitation is the lowest in comparison to the other seasons. It is problematic that the decreased amount of precipitations falls in a more intensive pattern which decreases the potential utilization of the water and increases the run-off, which is increasing to the risk of

Hemispheric change	**0.5 °C warming**				**3.0 °C warming**	
Changes in Hungary (°C and mm/period)	17 GCM (1996-2001)	0.5 S	0.5 I		17 GCM (1996-2001)	16 GCM (pre 1996)
Summer temperature	+ 0.8 °C	1.0 °C	1.1 °C		4.6 °C	4.2 °C
Winter temperature	+ 0.6 °C	0.2 °C	0.6 °C		3.8 °C	4.5 °C
Summer precipitation	- 7 mm	- 19 mm	- 17 mm		-29 mm	- 31 mm
Winter precipitation	+ 3 mm	+ 4 mm	+ 4 mm		+ 12 mm	+ 15 mm
Annual precipitation	- 1 mm	- 30 mm	- 26 mm		- 7 mm	+ 29 mm

Table 7.1 Average change according to 17 GCMs in case of 0.5 and 3 °C hemispheric warming. Source: Mika (2005)

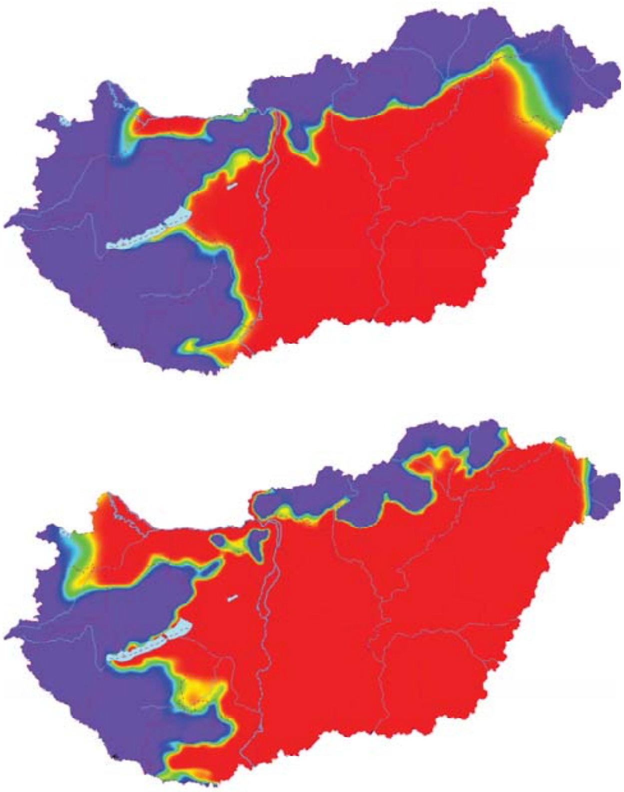

Figure 7.1 Change in ecological zones in response to 1°C summer temperature increase and 40 mm precipitation decrease

floods. On the basis of our current knowledge it can be anticipated that on a long run in Hungary gradual warming of the average temperature will prevail, the amount of yearly precipitation decreases and the frequency and intensity of the extreme weather events increases.

For the scenarios of the future climate change different models gave significantly different scenarios for Hungary. The results of the downscaling with the use of various global circulation models are shown in Table 7.1 for the case of 0.5°C and 3°C warming in the Northern hemisphere.

Vulnerability is a degree to which a system is susceptible to, or unable to cope with, adverse impacts of climate variability and extremes, or of climate change. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. Pragmatically we assume, that vulnerability can measured as the magnitude of change of the output parameter(s) for unit change of the input parameter.

In Hungary the hydrological impacts of the climate change along with increased flood frequency and intensity is that the water stock parameters likely to decrease by the range of few percentage to few tens of percentages (in case of 0.3-0.8 °C average temperature increase). In case of 0.5-4°C average temperature increase will bring up to few ten percentages decrease in the water balance as agro-hydrological impact, but it can also increase the water stress frequency for certain plans species with nearly 100 percent. Increase of temperature will change the boundaries of ecological zones. Figure 7.1 shows the shift of the zone of continuous forest (oak) versus the forested steppe in case of 1°C summer average temperature increase and 40 mm precipitation decrease. According to further estimations 0.7 °C warming of Northern hemisphere leads to decrease of the surface water supply of the catchment of Tisza river by 60%, the subsurface water supply by 80% and the irrigated area by 74% (Simonffy 2000).

With the predicted changes, due to increased evaporation, the surface area of several smaller lakes will significantly decrease, several of the lakes in the Great Hungarian Plain can dry up which will decrease the extent of wetland habitats and the loss of natural values of the country. Along with the decrease of the water circulation their saline content and the risk of eutrophication are increasing. These impacts will have a negative influence on biodiversity and economy.

One of the most climate sensitive region in the Carpathian Basin, besides Lake Balaton (Sió-Balaton catchment's), is the Great Hungarian Plain, especially where small and shallow oxbows are endangered along river Tisza. To estimate how deeply the global warming affects oxbows, located on the floodplain of river Tisza, a method was developed and analyzed for a typical oxbow's expected behaviour for the 21st century (Hunyady 2006).

Based on the results of the analyses the following conclusions can be drawn:

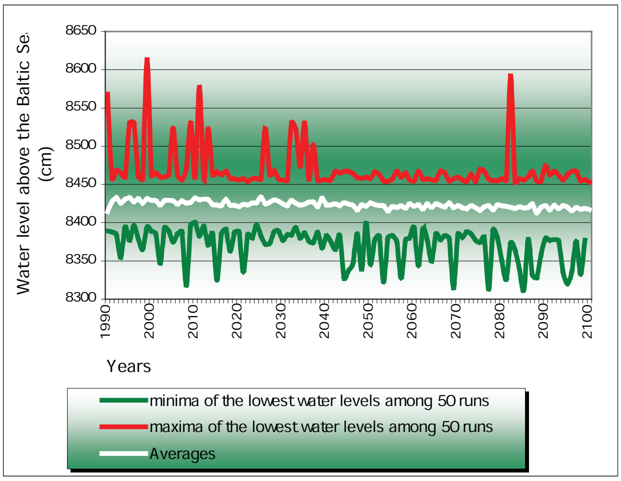

Figure 7.2 Change of the lowest water level simulated for August, using B1 scenario of IPCC, based on 50 model runs, 1990-2100. The modelled oxbow dries up at the water level of 8270 cm above Baltic Sea

- Frequency of extremely low water levels is expected to increase during the 21st century.
- The monthly minimum water levels are expected to decrease, moreover, extreme drought events sometimes result temporary drying-up of the oxbows.

- Duration of periods when the water level remains below a given threshold exhibits significant increase by the last 30 years of the 21st century.
- Decreasing tendencies are expected for the minima, averages and maxima of the monthly minima of the oxbow's water level based on 50 time series of daily water level generated for the oxbow in point. Specifically, this decrease during the 111 years of the simulation in August will be about 29 cm, 11 cm, and 31 cm, respectively (Figure 7.2).

Hungarian agriculture and forestry has suffered from extensive droughts in successive years. This condition has been in the research interest of several scientists, to see whether or not climate change could be an explanation of droughts. It has been found, among other results, that in Hungary an average temperature growth of 1.5% and an average precipitation decrease of 15% would result in a 30% increase of the drought index. Such a change would significantly increase the exposed agricultural areas.

The ecological balance of saline pasturelands is very sensitive to climate change. Also there is a likelihood of significant increase of forest and bush fires even in the case of modest increase of average temperature.

7.2 Adaptation measures

In order to tackle the increasing risk stemming from global climate change, and to support the improvement of the domestic climate policy the Ministry of Environment and the Hungarian Academy of Sciences launched a common research programme titled VAHAVA - "VAltozas-HAtas-VAlaszadas" (change-impact-response), "The domestic effects of global climate change, and the answers to be given to the challenge" in 2003.

Primary aims of the three year project were the preparation to the potential negative and positive effects of climate change, harm reduction, prevention and advancement of restoration and with creation of a large scale synthesis of the various Hungarian climate related research projects. Methodological characteristics of the project was the complex system synthesis, interdisciplinary and multi-sectoral approach, and wide range partnership. The program is not only addressing adaptation, but also energy saving, efficiency, renewables and sustainability. It takes into consideration results from the relevant international research, the National Research Programmes, the National Environmental Programme, the National Environmental-Health Action Programme, and some published results in the domestic literature. The VAHAVA initiative can use its professional and financial background to support running scientific work that is associated with the program.

Within the framework of the program the following activities were realized:

- 20 conferences on specific topics with some 80-100 participants each;
- In the AGRO-21 journal 16 issues were dealing with the issues of the program which meant 162 articles from 275 authors;
- 46 expert studies;
- 5 issues of a specific VAHAVA newsletter;
- a three part documentary film.

The final report from the project will be published in the spring of 2006. It will summarise the unfavourable effects of varying frequency and intensity meteorological events from global climate change; the main elements of the national strategy on adaptation to climate change (preparation, mitigation, harm reduction, restoration) and it will suggest measures for the future to mitigate and adapt to climate change.

The most important recommendation of VAHAVA project is that the Hungarian Parliament should enact a decree on long-term greenhouse gas emission reduction and adaptation in the frame of a National Climate Change Strategy, including the National Drought Strategy. This strategy is to be harmonised with international commitments, integrates into existing development plans and concepts, and forms priorities, defines the role and responsibility of the Government in execution, evaluation and monitoring of progress.

The Hungarian Meteorological Service prepared studies on drought impacts including "climatological water deficit" and makes the metodology and a calculation software available for the public.

8. Research and Systematic Observation

Hungary has become an EU member state since the Third National Communication, and this has had a noticeable influence on climate change related research, environmental and climate change literacy, environmental education and training.

8.1. Research & Development policy

8.1.1 Legal background

Act LIII. of 1995 on the General Rules of Environmental Protection highlights the thematic research and development responsibilities of the Government; most attention should be given to monitoring the state of the environment and to the evaluation of environmental research activities. The Hungarian Government has produced strategies for climate change, which include specifications on R&D issues.

The Government Decision on the Hungarian Climate Protection Strategy in 2000 acknowledges some of the most significant aspects of climate change actions and research. The Decision requirements led the Hungarian Government to produce a Climate Change Action Program within the framework of the second National Environmental Program for 2003-2008 (NEPII).

The 6th Environmental Action Plan of the EC identifies climate change as one of the 4 priority areas for Europe – therefore for Hungary, too – needing urgent action. In line with the objectives of the 6th EAP, the second Action Program of the NEPII is "Climate Change". The Climate Change Action Program considers research as indispensable.

8.1.2 R&D governance structure in Hungary

R&D governance involves three main levels in Hungary: the governmental bodies, the Hungarian Academy of Sciences (HAS), and the research institutes.

On the governmental level until December 2003, the main coordinator and financing responsibilities were assigned to the Science and Technology Policy Secretariat of the Ministry of Education. Due to restructuring and reform of the system in 2004 the coordination functions were taken over by a newly established agency, the National Office of Research and Technology (NORT). Half a year earlier, the Agency for Research Fund Management and Research Exploitation (RFMRE) was also set up for finance distribution tasks. The agency manages and finances R&D and innovation projects through open calls using the resources of the Research and Technology Innovation Fund, the EU Structural Funds and national co-financing. They are also responsible for promoting public-private partnerships, and for advisory services for S&T stakeholders at national and regional level.

The Hungarian Academy of Sciences is an independent public body, with the right and obligation to support scientific research both professionally and financially.

Most of the R&D research groups operate inside a higher education institution, while there is a continuous tendency towards growth in number of privately owned research groups since 1996 (HCSO 2004).

On the stage of international cooperation related to science and technology, a larger panorama has opened for Hungary after the accession to the EU regarding bilateral and multilateral projects. Hungary is part of various European and Euroatlantic research organizations and programs.

Climate change research and systematic observation are associated with all 3 research levels, as well as deeply involved in the private sector and the international arena. Most active groups are found in the HAS, in the Hungarian Meteorological Service (HMS), associated with Universities, or scattered in the private sector.

8.1.3 Funding

The ratio of R&D expenditure to GDP in Hungary is rather low compared to the EU average of 2% (NORT 2004). After a few years of stagnation, spending has started to grow in the last 3-4 years, and in 2002 rose above 1%.

Around half of total R&D expenditure originates from the central budget. Funding of university research groups is largely through normative research support and various governmental funds and programs. Further income is ensured through R&D activities according to contracts from private companies and national and international grants.

Around 40% of the national R&D spending is contributed by the private sector. More and more multinational companies are establishing their own research groups. There has been a doubling of personnel in this area between 1996 and 2001, although the number declined again in 2004 (NORT 2004).

Central funds for climate change research

The most important sources for research activities from central funds are listed in this section. There are some sporadic sources, personal grants, scholarships, the nature of which makes it impossible to collect and detail them here (due to the lack of an already existing listing).

The National Office of Research and Technology (NORT) handles various central funds, among them the Research and Technology Innovation Fund (RTIF). The RTIF is the successor of the Szechenyi Plan (see NC3), and renamed as the “Jedlik Programs” from 2005. Tenders are announced in 5 areas, one of which is “Environmental and material science research”. RTIF calls for applications have been issued twice since the NC3 (in 2002 and 2004). In 2002 there were 3 successful projects related to climate change or air pollution research, with a support of 505 million HUF (2 020 000 €) altogether, and one project in renewable energy research (wind and solar energy), to a value of 120 million HUF (480 000 €). 30% more support, 678.6 million HUF (2 714 400 €), was distributed in 2004 to 4 climate or air pollution research projects, and 450.7 million HUF (1 802 800 €) to 2 renewable projects.

The role of the Hungarian Scientific Research Fund Programmes (HSRFR) is “to provide independent and extensive support to scientific research and to the research infrastructure”, and its invitation for proposals takes place every year. The HSRFRs are different from the NORT grants in that support is distributed to a much larger number of projects (100s vs. 10-20 under the NORT per theme), and the amount of support is smaller (a few 100 000 HUF in HSRFR vs. millions of HUF in NORT).

The VAHAVA project has proven to be an important source of funding and a professional melting pot specifically of Hungarian climate research activities during the last 2 years. The project is a joint initiative by the HAS and the Ministry of Environment and Water, and is responsible for the distribution of 30 million HUF (120 000 €) annually, exclusively for climate change research activities. Details of the project are given in section Chapter 7.

Programs coordinated by the Energy Center are designed for funding applied energy efficiency, energy conservation, renewable energy developments, investments, and occasionally research projects. These sources were earlier held by the Ministry of Economy and Transport. Applicants are local governments, SMEs, institutions, and even individuals. There are programs with non-refundable financing, and 2 for providing loans of low interest rates. Under the National Environmental Program tender, R&D activities of SMEs on energy efficiency are supported among other (non-R&D) types of projects.

International opportunities for funding

The availability of a wide range of EU funds must be emphasized. Hungarian access to EU sources was facilitated before 2004 by pre-accession instruments, but the available funds for environmental protection increased already during the period covered by NC3 (e.g. PHARE, ISPA, SAPARD, LIFE), and since EU accession this has been assisted by further EU resources (e.g. Cohesion and Structural Funds). Intelligent Energy Europe funds (SAVE, ALTENER) have also been available for Hungarians for sustainable energy research.

The main EU funding mechanisms between 2002-2005 for research, technological development and demonstration were the Fifth (1999-2002) and Sixth (2003-2006) R&D Framework Programmes. Both prioritized the support of climate change research. Hungarian researchers have participated extensively, as members of more than 15 projects in the thematic area of “Global change, climate and biological diversity” of the FP5, and in the FP6 “Global change and ecosystems” calls.

Hungarian researchers are aided through the “Sustainable development – global change and ecosystems” Information and Advisory Service of the Eötvös Loránd University. The service organizes information days about EU grants and is available for help in writing proposals or looking for partners, etc.

In 2004, 140 projects with Hungarian participation were running under COST (European Cooperation in the Field of Scientific and Technical Research), out of which 10 were closely related to climate change; many others dealt with climate change to some extent or were conducting other air pollution research.

8.2 Systematic observation

8.2.1 General approach to observation

The Hungarian Meteorological Service (HMS) was extensively introduced in the NC3. Its role and function in climate research is still to serve as the largest meteorological and climatic information provider of the country. The Meteorological Department of the Eötvös Loránd University is also active in climatic, air pollution and meteorological observations. Both of them cooperate with numerous other smaller groups, as well as with each other. The information collected and provided by the two main meteorological organizations covers the past (trends, changes, analyses), the present (measured and observed meteorological and environmental data), and the future (forecasts on meteorological and climatic time-scales).

All the basic atmospheric and routine data-collection and observation information belong to the Department of Atmospheric Observations of the HMS. The department is responsible for operating the synoptic, climatic, precipitation, upper air and radar network, and for carrying out measurements concerning the physics of the atmosphere.

Both the HMS and the Meteorological Department contribute to the education and distribution of knowledge about climate change science, including systematic observation.

Climate data homogeneity

The main tasks of the HMS's climate activities have not changed since NC3, i.e. to secure the long-term preservation, inspection, availability, and analysis of the data that is detected and registered by the surface measurement network throughout the country.

The climate variability and change studies require long homogeneous data series over time. The station locations, the instrumentation and observing standards have changed from time to time and these changes introduce inhomogeneities into the time series. These inhomogenities are filtered out in order to distinguish between natural and artificial change and variability.

Stochastic weather generator

Statistical tools, performing principal deterministic predictability, are referred to as Stochastic Weather Generators (SWG) in the literature. Two types of weather generators are available at the HMS. The first one is LARS, which is able to produce artificial series of temperature (one single value of normal distribution), precipitation and sunshine duration.

As an improvement and radical expansion of the generator, a new 9-variable statistical model has been developed (already referred to in NC3), which improves the initial generator in three respects: i) some generalization of the discrete process of dry/wet duration, ii) substantial extension of the incorporated weather parameters, and iii) parallel simulation of parameters. The initial set of the model parameters is determined by using a 45 year period, considering the statistical correspondence between some conditional statistical parameters of the simulated and observed series.

Regional climate change scenarios

Mesoscale atmospheric modeling has been a key issue in weather prediction for about a decade at the Hungarian Meteorological Service. A large step taken since the NC3 was that in 2004 a new application of these models and the corresponding knowledge basis started, namely a trial to compute local climatic effects of the changes in the atmospheric composition and land use. At present, four models are checked in parallel for their climate reproduction ability. One of them, the REMO, elaborated in the Max Planck Institute of Meteorology in Hamburg, is tested in collaboration by the Institute and Hungarian colleagues.

The Department of Meteorology at the Eötvös Loránd University has been involved in several regional climate projects. The Department operates three national projects under the Research and Technology Innovation Fund and the Hungarian Scientific Research Fund Program. The objective of "The Dynamical Meteorological Study and Prediction of the Regional Climate over Hungary Based on Numerical Weather Prediction Models" is the dynamic modeling of regional climate. The "Climate Change Scenario for the Carpathian Basin Using Regional Model Outputs" project was started in 2005 to fulfill a synoptic-climatological analysis, a regional tendency analysis of climate time series observed during the 20th century at Hungarian meteorological stations, and to carry out dynamic and stochastic downscaling of the outputs of global climate models for the Carpathian Basin. Simulations with the recent set of 17 coupled ocean-atmosphere general circulation models at the Hungarian Meteorological Service, together with the above mentioned Carpathian Basin research, support the statistical relationships between local climate changes in the Carpathian Basin and parallel changes on a hemispherical scale.

The University of Western Hungary has been participating in a forest monitoring network, which could be the starting point for a more developed regional observation system for ecosystems. The project is detailed in section II/D.2.b.

8.2.2 Meteorological and atmospheric observation

Only 2 years after the establishment of the first regionally representative, long-term tall tower CO_2 concentration and flux measurements in 1992 in the USA, Hungary inaugurated a similar station at Hegyhátsál which is still functioning and participating in international networks.

WMO made it obligatory to continuously follow CO_2 concentrations at the stations belonging to the Network of GAW (Global Atmosphere Watch). In Hungary Hegyhátsál station was assigned responsibility for vertical measurements of CO_2 concentration and other important parameters (wind, temperature, humidity).

At Hegyhátsál station, member of the NOAA network, besides regular CO_2 measurements, also determine the CO, CH_4, N_2O, SF_6 and the CO_2 stable isotope concentration of the air. The station started to provide long-term data on CO_2 exchange between the surface and the atmosphere in 1997, and vegetation CO_2 flux measurements were also started in 1999, in a collaborative project between the HMS and the Eötvös Loránd University, Department of Meteorology. With the help of EU financial support, monitoring was extended to the investigation of GHG distribution in the lower troposphere. Hegyhátsál will be one of the three main sites of GHG measurements in Europe.

Emission observation methodology has been addressed by a number of international projects with Hungarian cooperation under the EU FP and COST Actions.

The Framework Programme project, "Continuous High-Precision Tall Tower Observations of Greenhouse Gases" (CHIOTTO) with the Department of Meteorology at the Eötvös Loránd University aims to build an improved infrastructure for the continuous monitoring of the concentrations of greenhouse gases on the European continent above the surface layer using tall towers. The project is based on and extends existing research projects (AEROCARB, T-COS and TACOS).

8.2.3 Terrestrial observations

There are various groups working on observing terrestrial changes and following climate impacts on terrestrial ecosystems, most of which are associated with various Universities (Szent István University, Gödöllő, Eötvös Loránd University, Budapest, University of Western Hungary, Sopron). Hungarian research groups have been participating in large numbers of national and international projects investigating the change of vegetation due to climatic variations, as well as the ability of ecosystems to adapt.

Carbon cycle research

As part of the EU FP5, two projects ran with the participation of the Global Climate Change and Vegetation observation site of the Plant Ecology Research Group of HAS, Gödöllő, during 2002-2004. The "Greengrass, Sources and Sinks of Greenhouse Gases from Managed European Grasslands and Mitigation Scenarios" project investigated and contrasted the balance of CO_2, N_2O, and CH_4 exchanges between grasslands and the atmosphere at 9 European sites, in order to decrease the large uncertainties related to the fluxes of the most important GHG gases. The Hungarian team examined the carbon and nitrogen balance of differently managed (fertilized, irrigated, grazed) loess and sand grassland, which are widely distributed and representative of the grassland ecosystems and some typical land use changes in the Carpathian Basin. A similar project with a focus on mountains was the "Carbomont: Investigation of the Effects of Change in Land Use Strategies on Ecosystem's C-balance in Mountainous Ecosystems".

In parallel, the Department of Meteorology at the Eötvös Loránd University participated in the AEROCARB project (FP5, from 2000 to 2003) which was also part of the CarboEurope cluster. The objective was to demonstrate the feasibility of an integrated approach to estimate and monitor the net European carbon balance as a means to corroborate EU-wide controls of CO_2 emissions. All experimental results are to be included in a mesoscale inverse modelling system and an optimized spatially and temporally resolved surface carbon balance of Europe will be delivered.

Closely connected to these efforts is a COST project (Action 627: Carbon storage in European Grasslands) running between 2000-2005 to study the management and manageability of stocks and flows of carbon in the soil, plant and atmosphere system of grasslands at ecosystem, regional and continental scales.

Under the EU 6 R&D Framework Program, "CarboEurope IP: Assessment of the European Terrestrial Carbon

Balance" has been started for the period of 2004-2008. A new network has been built that focuses on the role of different and characteristic European ecosystems including forests, grasslands, croplands, and wetlands in the global C-cycle. The network integrates former carbon related EU projects (e.g. Greengrass, Carbomont, Carboinvest) with a contribution from 101 European institutes.

Vegetation observations

Hungary is participating in an international action group aiming at establishing a phenological monitoring network for climatological applications under COST Action 725 during 2004-2009, chaired by Austrian experts. The project is a result of the realization of the importance of the fact that plant development phases reflect – among other things – the environmental characteristics of the climate in the region where they occur. A long series of phenological observations could be used for the detection of climate variability or climate change. By establishing a European reference data set of phenological observations, a special climate monitoring and detection system will be available.

Hungarian researchers at the University of Western Hungary have been participating in a Europe-wide forest monitoring network since 1987, which could be the starting point for a more developed regional observation system. The network is responsible for continuously following the state of health of the forests on gridpoints of a grid of 4x4 km across Europe. A crucial observation has been the identification of "new-type forest damages" due to climatic extremes during the last decades.

8.3 Research activities related to climate change

This chapter reviews briefly the key climate research projects. Since there is a high level of interconnectedness between research and educational initiatives, there are various research and educational activities which are not project based, but can rather be attributed to an institute. Therefore an annex is added to review the key institutions contributing to the research and public education concerning climate change in Hungary.

The description of the VAHAVA project, a major multi-year research of adaptation related research can be found in Chapter 6.

Paleoclimate studies

Isotope techniques are applied for paleoclimate research in the Laboratory of Environmental Studies of ATOMKI in co-operation with researchers of the University of Szeged and the Hungarian Natural History Museum. The oxygen isotopic ratio is used as a tracer for studying: (1) past climate and the hydrological cycle, (2) carbonate precipitation and dissolution and (3) photosynthesis and related processes in the past.

8.3.1 Impact of climate change

Impacts on ecosystems

There are two sites belonging to the EU Long-term Experimental Ecological Station Network in Hungary which have been in operation since 1994.

The Department of Botany and Plant Physiology of Szent István University hosts the "Global Climate Change and Vegetation" site (GCCP) in Gödöllő. The GCCP investigates the effects of increasing CO_2 concentrations and temperature on herbaceous plants and vegetation. It consists of chambers to grow plants at present and elevated CO_2 concentrations. Under the framework of the "Agroecology" program of the RTIF (2002-2005) the diversity, botanical and coenological composition, physiognomical structure, function and production of grassland vegetation, the ecophysiology and production of crops, weeds and trees under present-day (350 ppm) and elevated (700 ppm) CO_2 concentrations are investigated. The station is a member of the Global Change and Terrestrial Ecosystems (GCTE) Core 1 Network of the International Geosphere and Biosphere Program (IGBP). GCCP participates in COST Action 627, "Carbon Storage in European Grasslands" and Action 619, "Effect of Atmospheric CO_2 Increase on Carbon Fluxes in Grassland-Ecosystems".

Impacts on agriculture and forestry

Regarding impacts on forestry, the University of Western Hungary has taken a leading role. The research group has been investigating the tolerance curves of different species of trees and other plants, to assess the expected impact on and adaptation abilities of various forests. This work is supplemented by insect diversity studies in various forest observation spots. The University has also been coordinating the so called "Forest-and-Climate" cooperation between Hungarian climatologists, foresters, and ecologists since 1994.

Impacts on water and soil

The Department of Physical Geography of the Geographical Research Institute of the Hungarian Academy of Sciences has shown a trend towards aridification in Hungary. A 2 year research project that started in 2003, entitled "Physico-geographical Impacts of Global Climate Change. Monitoring of Aridification on the Danube-Tisza Interfluve", is supported by the Hungarian Ministry for Environment and Water.

The impacts of climate change in the Tisza area was also studied by modeling the water level of oxbow-lakes under the auspices of the Water Resources Research Institute, the HMS, and the Department of Meteorology at the Eötvös Loránd University. Results suggest that the monthly minimum water levels are expected to decrease, moreover extreme drought events sometimes result in temporary drying-up of the oxbow.

International cooperation on soil is taking place under COST Action 623, "Soil Erosion and Global Change". The main objectives of the Action are to make realistic predictions of the impacts of changes in land-use and climate on soil erosion across a range of temporal and spatial scales; to identify critical thresholds in the landscape and soil profile which lead to irreversible changes in the rate and style of soil erosion, and also to develop indicators that forecast irreversible change; and to identify, assemble and take available datasets pertaining to historic and current erosion.

Impacts on human life

The National Institute of Environmental Health of 'Fodor József' National Centre for Public Health participates in various projects that touch on many sides of health impacts of climate change. A multilateral cooperation, the "Prevention of Acute Health Effects of Weather Conditions in Europe (PHEWE) 2003-2005". The aim of the project is to search for and analyze the relationship between meteorological and health data of the participant countries. Project members have introduced a pilot extreme heat early warning system in 5 cities to predict high temperature periods with potential health hazards. The Institute has been investigating the direct and indirect health impacts of climate change (with the professional support of the WHO/ECEH, Rome) since 2000.

Human health impacts are also assessed in cooperation with other European partners under European cooperation by the COST Action 726, "Long Term Changes and Climatology of UV Radiation". The Polish lead project has set as an objective the advancement of the understanding of UV radiation distribution under various meteorological conditions in Europe in order to determine UV radiation climatology and to assess UV changes over Europe, and to be able to predict UV-related health effects.

Studies are carried out by the National Institute of Environmental Health and the Budapest Institute of the National Public Health and Medical Officers' Service under the Hungarian National Environmental Health Action Programme. The study has analyzed the relationship between atmospheric conditions, temperature fluctuation, and overall daily mortality as well as mortality from cardiovascular and respiratory diseases, and has looked into the manifestation of biological air pollutants (pollen and spores), over geographic areas and along timelines, comparing that with fluctuations in the seasonality of aeroallergens and meteorological factors, using 10-year-set of data.

Socio-economic studies

Many organizations have been involved with the analysis of policy-making, economics and social aspects of climate change. The projects cover a wide range of themes from capacity assessment to the flexibility mechanisms, and the following list can do no more than provide an overview of research in this area.

"The Impact of Structural Changes in the Energy Sector of Central and Eastern European Countries on the Creation of a Sustainable Energy Path" project was commissioned by the European Parliament, and executed by a consortium of 10 experts from 6 countries, which was led by the Central European University's Department of Environmental Sciences and Policy.

The Regional Energy Policy Research Centre (REKK) at the Corvinus University coordinated the "National GHG Projection" project in 2004 to forecast the national total GHG emissions, as well as emissions related to sectors and sub-sectors from 2004 through 2012. The results help the Ministry of Environment and Water in setting proper sectoral emission caps under the EU ETS Scheme. Furthermore, two strategic studies were conducted at the Corvinus University for the Ministry of Finance on the national implementation of the EU ETS Scheme, one about the theoretical foundations and EU regulation of carbon-dioxide emission trading, while another analyzed the expected impact of CO_2 trading on the domestic power market.

8.3.2 Mitigation

Access to further European research funds have provided an important impetus towards policy research in the fields of energy efficiency, renewable energy and other related subjects. Here we highlight a selection.

Beyond the implementation of the EU ETS, efforts have started to form the post-Kyoto climate change strategy and policy of Hungary. The Central European University has been contracted by the Ministry of Environment and Water to prepare a background study to help the dialogue on the medium- and long-term climate change strategies of Hungary.

The University of Western Hungary has been coordinating the so called "Forest-and-Climate" cooperation between Hungarian climatologists, foresters, and ecologists. In the framework of a conference held every 3rd year, these experts discuss the latest observations, results, and their research related to the adaptation to and impact of climate change on forests. As an advance in this cooperation, an

RTIF project was launched in 2003 in order to synthesize various research areas of climate change impact on ecosystems.

8.3.3. Adaptation

The DG Sanco EC project entitled "Improving Public Health Responses To Heat-Waves" has been created, among other aims, to lay the basis for a future European law on human health adaptation and response abilities. The National Environmental Health Institute is operating a pilot early warning system in Budapest to predict high temperature periods with potential health hazards. The project works in the scope of a multilateral cooperation entitled the "Prevention of acute health effects of weather conditions in Europe (PHEWE) 2003-2005".

A project called "Improving Public Health Responses To Heat-Waves (EURO HEAT)" has been launched in 2005 to improve the response ability of the European region to extreme weather events and extreme temperatures with support from the European Union DG Sanco. This project addresses the implementation of the recommendations developed for the Fourth Ministerial Conference on Environment and Health, Budapest, 2004. In particular it considers how to take action to reduce disease burden; to coordinate and collaborate among public health authorities, meteorological services and agencies (national and international), emergency response agencies and civil societies in developing local, regional, national and European interventions; to facilitate the sharing of information, data and lessons learned; and to elaborate tools for early warning systems as well as address rapid information exchange.

Within the framework of the VAHAVA, the Agricultural Research Institute of the Hungarian Academy of Sciences investigated the effects of and adaptation potential to heat stress, one of the possible consequences of climate change, during the ripening of winter wheat varieties, and the extent to which the damage caused by high temperature was modified by the doubling of the atmospheric CO_2 concentration.

9. Education, training and Public Awareness

9.1 Environmental awareness and climate change literacy

9.1.1 Concern for the environment and climate change

During the last decade, the Hungarian population was repeatedly reported to have a very low level of interest in environmental problems in a number of national and international studies, also in NC3. The "Health of the Planet" survey in 1992 assessed environmental attitudes in 22 countries, and Hungarians were found to have attached the lowest importance to environmental problems among all the nations surveyed (Dunlap *et al.* 1992, Dunlap 1994).

There have not been several studies on the awareness and understanding of climate change issues among the Hungarian population during the last 10 years, and the ones that exist often offer contradicting evidence about the level of public awareness on climate change. In contrast to the above mentioned Gallup survey, a Eurobarometer survey in 2002 (Hungarian Gallup Organization 2003) concluded that environmental developments were the top interest issues (61%) in Hungary, even above medicine, genetics or astronomy. Research carried out by Hungarian social scientists compared attitudes to various global problems (Székely 2002) showed an increased worry by Hungarian citizens about poverty and environmental pollution both on a global and national level.

An ALTENER project in 2002, the 4CE (Consumer Choice and Carbon Consciousness for Electricity) survey found that concern about impacts of electricity generation is rather high in Hungary (around an average of 7-8 points on a scale of 10), above the European average (Palmer 2003, Kiss 2005). In 2004, in the context of a special Eurobarometer survey respondents in the Old Member States (EU15) and the New Member States (NMS) were questioned in order to shed light on some of the differences between the EU15 and the enlarged Europe nations (EC 2005). 32% of Hungarians chose climate change as one of 5 most important environmental problems that they were worried about from a list of 15 items. The ratio fits well into the NMS average, however staying way below the EU15 average (47%). At the same time, the largest concern by Hungarians was given to air pollution in general (59%), which refers to the fact that local problems still worry citizens more than global ones. Highlighting the importance of awareness raising and lack of information, it was in particular climate change where the Hungarian respondents (33%) missed proper information much above the EU averages (24-26%) (EC 2005).

The 4CE project, mentioned above, had the chance to also measure how well Europeans, and among them Hungarians know what climate change is (Palmer 2003, Kiss 2005). 88% of Hungarians (similarly to the average Europeans, 82%) were able to associate fossil fuel burning to climatic impacts. It is disappointing though that the majority (80%) agree or strongly agree that "climate change is caused by a hole in the Earth's atmosphere", and only 14% were against this statement. There seems to be confusion about the exact concept of climate change, but when faced with specific questions, 60% were able to agree that climate change is likely to cause sea level rise.

9.1.2 Perception of citizen responsibility and involvement

In 2004, a special Eurobarometer study (EC 2005) found that 42% of Hungarian respondents thought that raising general awareness would be one of the best moves to combat environmental problems effectively. This means support by almost as many as those for better enforcement of laws (57%) or stricter legislation (51%), and reflects a strong sense of citizen responsibility.

Unfortunately, survey questions concerning personal involvement in environmental protection differ significantly from study to study, making valid conclusions extremely difficult. In the beginning of the 1990s, 6% of the population was active in an environmental group compared to the average (10%) of other countries (Dunlap et al. 1992). Such an involvement projected a strong potential environmental movement which was on the rise at that time in the world.

Personal efforts to protect the environment were reported to have been made by 74% of the population in the 2005 Eurobarometer study, which indicates a significant increase, and is almost the NMS average (75%) (EC 2005). The primary reason for non-action in Hungary is that “it does not have much of an impact as long as other citizens do not do the same”, cited by about half of the respondents (48%).

9.1.3 Activities and measures towards raising public awareness about climate change

Governmental strategy

The Climate Change Action Program under the second program of the National Environmental Program was elaborated as a result of the Government Decision on the Hungarian Climate Protection Strategy in 2000. The Government Decision acknowledged some of the most significant aspects of climate change actions, and among them also highlighted soft measures (information facilitation and dissemination, raising awareness, and education) as means to combat climate problems.

In 2004 the Ministry of Informatics and Communication and the Ministry of Environment and Water launched a nationwide initiative, the eEnvironment (eKörnyezet) Program. This is one of the 19 ePrograms, and aims at a large scale dissemination of specific environmental values. 44 million HUF (176 000 €) have been allocated to the Ministry of Environment and Water for the implementation of the four subprograms, air pollution, meteorology, nature protection, and water. The governmental informational responsibility is laid down in the Hungarian Information Society Strategy, under whose aegis the following environmental developments are expected: increased public access to environmental information, improved access to the air quality measuring network, improvements of the nature protection informational system, and most important for the present interest the development of the Regional Climate Change database for the Carpathian Basin.

Campaigning and energy advisory activities

There is a definite trend towards decentralization of NGO activities related to raising general environmental and climate awareness, which increases their ability to act at a local level, reacting to local peculiarities.

Energy advisory centers are operating in more than 10 NGOs, and also in central organizations. The most well known centers are run by the Ecoservice Foundation, the Clean Air Action Group, the National Society of Conservationists and the Energy Club (where the advisory group is called the Budapest Energy Efficiency Advice Centre) in Budapest. They all have specific climate change sections, too. On the local level, some NGOs belong to the Green Energy Network. Advisory activities usually include, inter alia, a call center, where citizens or even companies are advised on energy and resource saving methods, library and internet facilities, website, on-site inspection and projections and calculations on impacts of improving energy efficiency, energy saving investments. Services are offered for free.

Energy advisory activities are also carried out in the Energy Center and the Hungarian Energy Office. The former operates a website and a body called the Energy Efficiency Information Center.

The Energy Center used to operate a civil grant for supporting energy saving investments by house owners. The ratio of support was 30%, and most applicants intended to upgrade their heating system or renovate windows and doors, or increase the insulation ability of the dwelling.

Brochures and informational leaflets are also common forms of campaigning among all organizations. Some important outputs involve the energy series by the Green Bridge, “Hot Air” by the National Society of Conservationists, “Energy Taxes in the EU and Hungary” by the CAAG, and the “Energy cure” leaflet by the Energy Center that provides practical advice on household energy conservation.

Green Days are organized in every locality. The best known is “Earth Day”, where the climate change issue appears repeatedly. Other days include the “Global Day of Environmental Protection”, and “Car free day”. Such events are always of value and an opportunity for spreading messages.

At the “Students’ Island” event every August (with more than 300 000 visitors/week) the Energy Club and other green NGOs organize Green Events. In 2002 the Club organized a climate change event with lectures on the causes of and solutions to climate change. In 2003, the Energy Club, the Young Greens and the Green Point Foundation took responsibility for organizing the Island Festival’s Green Court. Info stalls were established with exhibitions and photo displays, including information on climate change. An open discussion was organized about the causes and effects of climate change and other relevant issues. The specialty of the 2004 Festival was a climate quiz.

“Public University”

Adult education and awareness raising is associated mostly with the Hungarian version of the French initiative of “l’Université de tous les savoirs” (Public University), which was launched in 2002, under the professional supervision of the HAS. The Public University has grown to be a weekly lecture series, given by renowned professors of the Hungarian scientific community. Presentations are broadcast on public TV and radio stations. During the 2.5 years of its operation there have been several lectures dealing with climate change, which have probably had a significant impact on public literacy in the subject.

Hungarian media

The Hungarian adult population receives most of its new information from the media, especially the television. Today’s adult population were not educated about climate change in their school years, however they are open to the topic, in particular in the light of recent catastrophes (repeated extraordinary flood events and extremely long and hot summers in Europe and Hungary) that were directly related to changing climate by the media.

Climate change appears in the general daily newspapers, too, in a similar way – in the form of attractive topics. However, all newspapers have a regular environmental (often named “green”) section performing a more scientific approach.

There is a large number of specific Environmental Magazines both for adults and for children (examples: National Geographic, Science and Technology, Nature Observer, Environmental protection, Our Environment, The World of Nature). In 2004, with the contribution of leading scientists in climate change, a special edition of “The World of Nature” magazine devoted to climate change (see next section) was published. An indication of the trends in coverage of climate change in scientific publications is that the number of articles on climate change in the “World of Nature” magazine, (not counting the special edition) has increased by 50% between 2001-2002 and 2003-2004 (from 9-10 per year to 15 in 2004).

Publications

In 2004, the World of Nature magazine released a special edition on climate change: “Climate change – Hungarian impacts”. The volume contained 22 papers written in popular language with a wide set of illustrations. The topics were climate science, impact and adaptation and also mitigation in relation to other problems of environmental protection. To date 2300 copies have been sold (3000 copies were printed), which is a record of the last 3 years.

A book reflecting the extensive cooperation between professionals in leading Hungarian institutions (both central and civil sector) was released in June 2005. The book “Climate Change in the World and in Hungary” is with contributions from many of the most prominent climate experts, but written in popular language.

Agro-21 journal is a scientific forum distributed to governmental bodies, to educational institutions, and to libraries. The issues are published by the HAS and since 2004 the Agro-21 series has purely dealt with climate change, and the journal has become the official publication site for VAHAVA (see section II/D). In 2005, the Hungarian Science journal dedicated its July issue to the results and findings of the VAHAVA program, publishing 10 articles.

Besides media, the adult population collects information from the Internet. In 2002 16% of the population used the internet regularly, 5% of the households had internet. Internet connection of households is constantly and sharply increasing (HCSO 2002), for instance the number of households connected to the web grew to 14% by 2004 (HCSO 2005). Below is a short summary of a few key Internet sites which are available for the public in Hungarian on the topic, with special attention to changes since the last Communication. Similarly to other trends, the internet based informational base is increasing rapidly.

9.2 Education and training

9.2.1 Legislation and policy background

The rules and responsibilities for public education were founded in 1993 by the Act LXXIX on Public Education. The Act has been amended on various occasions, introducing new concepts and new focus. It is emphasized in the subject specific guidelines of the Framework Curriculum – the latest governmental instruction for environmental education – that “today’s children will not be expected to remember and to cite large amounts of pure data […], but rather they have to be educated to find their way through the information load, and data flow”. As a consequence, environmental education was one of the innovative topics that found its way into the formal system.

The National Environmental Programs (NEP) are drawn up every 6th year and form the basis for environmental planning in Hungary. In line with the objectives of the 6th EAP of the EU, the first two Action Programs of the NEPII for 2003-2008, are "Raising Environmental Awareness" and "Climate Change". The Hungarian Government realizes the "main obstacles preventing the spread of environmentally-aware behavior are [*inter alia*] lack of knowledge [*and*] lack of positive examples". As an important means to combat climate change (following the ideas of the EAP), the Climate Change Action Programme considers both research and education as indispensable.

The definition and execution of a teaching program in a particular school is based on multilevel guidelines, consisting of:

- The National Base Curriculum
- The Framework Curriculum
- Pedagogical Program
- Local Curriculum

The first two are annexes to the 1995 and 2002 Amendments of the Public Education Act respectively, and provide a frame and direction for the second two. The National Base Curriculum and the Framework Curriculum are two alternative guidelines that schools may choose to build their Pedagogical Program on. As ordered by the 2003 Amendment of the public Education Act, the Pedagogical Programs must incorporate, *inter alia*, the concept of environmental education. An essential part of the Pedagogical Program is the Local Curriculum, which is the actual detailed implementation plan.

The same trend can be noticed in higher education. The NEPII also has provisions for "imparting knowledge on environmental protection, nature conservation and sustainability, development of environmentally-aware abilities in higher education." The Ministry of Education has commissioned the Program Office for Environmental Education and Communication (EECPO, see later) to develop and implement a program that is designed for the integration of environmental education. The initiative has developed into the Higher Education for Sustainable Development Programme and is now separate from the office whose main task remains public education support.

9.2.2 Institutional capacity for environmental education

Teachers and schools are assisted in their environmental efforts by several national organizations.

The Ministry of Education and the Ministry of Environment and Water are jointly responsible for overall supervision of the overall environmental education. Unfortunately, the level of cooperation between them exists only at a few contact points.

The Program Office for Environmental Education and Communication (EECPO) was shortly introduced already in the NC3, and more details can be found in Annex II. The EECPO was created to carry out cross-cutting governmental duties of environmental education in Hungary, with a mission "to educate people to develop knowledge, awareness and responsibility for their environment with a view of promoting proactive professional interest in environmental sustainability". The Office engaged in the preparation of guidebooks aiding schools to integrate the above detailed policy instruments into their local programs, and to fulfill their related tasks. The Office was split recently in accordance with tasks. Primary and secondary education is still assigned to EECPO, but the organization itself has been incorporated into SuliNova Kht., while higher education remained at the level of a program, named the Higher Education for the Sustainable Development Program. Finally in March 2005, the program itself ended, with a a chance of revival at Eötvös Loránd University in the near future. More information can be found at www.konkomp.hu and www.sulinova.hu.

The Hungarian Ecoschool Network is the Hungarian part of the ecoschool program of the ENSI (Environmental and School Initiatives, www.ensi.org) project, under the auspices of the OECD-Centre for Educational Research & Innovation. The Hungarian Network is coordinated by the National Institute for Public Education, Centre for Curriculum and Program Development with the professional and financial support of the Ministry of Education and the Ministry for Environment and Water. The specialty of an ecoschool is that the principles of sustainability are integrated into all fields of school life, e.g. from the basic operation of the school to the catering and buffet of the children. The Hungarian Ecoschool Network organizes teacher trainings and programs, prepares publications, guidelines, and represents the members at the international level. More information can be found at www.okoiskola.hu.

9.2.3 Primary and secondary education

According to NEPII, "efficient environmental education is considered a major long-term prevention tool". Pupils and students spend a large portion of their time in school till at least the age of 16, therefore the impacts cannot be overestimated.

Already briefly introduced above, the National Base Curriculum (NBC) was announced by the then Minister of Education as a philosophical step and not a central reform. The NBC broke with the traditional pedagogical instruction in that it did not talk about separate subjects, but rather about 10 integrated topics, and emphasized the incorporation of "new" cross-cutting issues, such as health development, environmental awareness, and European knowledge.

In 2002, after restructuringthe curriculum, the Framework Curriculum was launched. This Curriculum stands between the NBC and the local program of individual schools, and returns to the traditional, subject-based system, while keeping the value-laden teaching aims from the NBC.

The latest large step towards an environmental orientation by all schools was the 2003 amendment of the 1993 Public Education Act, which obliged every school to incorporate (if not already included), environmental values and environmental education into the pedagogical program by April 2004, and to update by every April thereafter.

Climate change related issues are marginally covered by either the Base or the Framework Curriculum, however climate change related knowledge can form components of a wide spectrum of subjects such as physics, chemistry, biology, geography, history and technology.

9.2.4 Higher education

The number of students in higher education is growing rapidly due to the government-level strategic changes which aim at moving the average education of the population from the secondary level to a higher one.

In the Universities and colleges there are no programs directly related to climate change. However, as reported in the NC3 already, there are numerous educational programs around the country that cover at least some aspects of climate change. The number of streams that at least touch on climate change as a global problem has increased, as well as the number of theses in the field. This is due mostly to the rising interest from graduate students. As far as doctoral programs are concerned, the size of environmental programs has enlarged, and new ones have sprung up.

The Ministry of Education considered the integration of environmental studies into the higher education system to be as important as its integration into the public education, as outlined in the various Curricula. The aim of environmental education at the higher level is that nobody should graduate without at least a basic level of environmental literacy. The tasks were assigned to the "Higher Education for the Sustainable Development Program". These included the organization of conferences and trainings, publishing of guidelines and books, holding the Environmental Education Library Network and Thesaurus, however as mentioned above, the program ended in March 2005.

Ecological research aspects of climate change (and global changes in general) are taught at 6 universities at Master's level; the main departments are introduced below. Leading climatological and meteorological educators are employed in Budapest at the Department of Meteorology, however some climatology is also taught in smaller departments, too, e.g. at the József Attila University in Szeged. Research institutes and the Hungarian Meteorological Service have various responsibilities in education, supervising practical education activities, guiding thesis projects, and giving lectures.

Students at the Department of Meteorology at the Eötvös Loránd University receive a high level education on the basics and details of climate, global changes and the processes behind the climate change concept. The staff of the department participate in teaching students from other departments, such as geography, geophysics, geography education, environmental science education. Streams include "Introduction to Meteorology", "Environmental Climatology", "Climatology", "Environmental Protection", "Global and Regional Climate Change". During the PhD studies of meteorology, more in depth knowledge may be acquired through further streams of Climatology.

The Department of Climatology and Landscape Ecology at József Attila University also plays an important role in teaching climatological and environmental subjects. Related courses are: "Climatology of Hungary and the Earth", "Environmental Protection of Atmosphere", "Local and Microclimates", "Long-range Weather Forecast", and "Paleoclimatology". Details of their work can be found at http://www.sci.u-szeged.hu/eghajlattan/english.html.

The Department of Applied Geography, an external department of Eötvös Loránd University operating in the Geographical Research Institute, provides a course entitled: "Global change" for undergraduate students of geography in the 10th semester. This course deals mainly with global climate change and its environmental consequences.

Debrecen University (formerly Kossuth University) introduced the following innovative courses more than 10 years ago for all natural science students: "Sustainable Development", "About a New World Picture" and "History of Nature", in all of which global problems (climate change, too) are discussed to a certain extent. It is estimated that more than half of the students of the Debrecen University receive some knowledge about the concepts of climate change at the end of their studies. More specialized information is mediated to both undergraduate and PhD students in the context of the course "Environmental Physics" which includes a section on "Global Climatic Effects: The Greenhouse Effect".

The Department of Applied Informatics at the Szent István University offers a course for environmental engineering and applied informatics in the global emission modeling of anthropogenic activities. The course aims at presenting the up-to-date methodology in computerised modeling of energy related emissions and systems planning.

Doctoral students at the Technical University of Budapest may choose to enroll to the “Climate change and water management” seminar. The classes discuss methodology for the prediction of change in hydrological features of ground level and underground waters as a result of climatic variance.

The Department of Environmental Economy at the Szent István University is involved in Master’s level education. Relevant courses are “Environmental Policy”, where students learn about policy instruments dealing with GHG gases, “Economics of Renewable Resources”, where participants are introduced to the effects caused by climate change on renewable resources (esp. forests, fisheries), “Global problems of sustainability”, which discusses the corporate world and its impacts on the global environment, and the “Economics of sustainable agriculture”, which touches on the external impacts of agriculture and the way to mitigate climate change. During the last few years two related MSc theses have been produced dealing with biogas production in Hungary.

Education and research work on the relationships between forestry and climate change issues are improving, but not yet satisfactory. However, it is promising that climate change related forestry issues have become hot topics of the higher education at the Faculty of Forestry of the Western Hungarian University which is the only major university level education centre of forestry issues in Hungary. Climate change was also included in the general agenda, and discussed in various special events, of and the Forestry Commission of the Hungarian Academy of Sciences and the Hungarian Forestry Association.

In the NC3 it was reported that the Ministry of Education had declared that the subject of “Environmental education” would become compulsory in teacher training colleges. No such move has been realized since then.

9.2.5 Training

There are a large number of national and international conferences and expert workshops, a list of which is impossible to produce. Some important events have been referred to during the relevant research sections above. Organizers include the HAS, Universities, HMS, the Energy Center, IEF, REC, some NGOs, professional associations, and climate research project coordinators. The trend already reported in NC3 has continued, and there have been an increasing number of events related to the flexibility mechanisms, distribution of CO_2 emission certificates, the development of national policies for emissions trading and joint implementation, and development, innovation, potentials and implementation of renewable energy sources in the country.

Detailed scientific information is disseminated through a number of periodicals. The number that deal with the climate change issue specifically has not grown since NC3, but still the number of scientific papers and forums to meet has grown significantly because the AGRO-21 journal has been launched, and the VAHAVA program hosts numerous meetings and platforms to discuss scientific results.

Annex 1: Summary of Policies and Measures

Energy

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas thousand tons CO2 eq.		
						2005	2010	2015
Limitation of SO_2 emissions from power plants	Fuel switch in power plants	CO_2	Regulatory	implemented	Regional Environmental Inspectorates	980	980	980
Support of cogeneration	Increase the share of combined heat and power generation	CO_2	Regulatory Economic	implemented	Hungarian Energy Office	634	719	805
Support of renewable-based power generation	Promote renewables in order to meet EU targets	CO_2	Regulatory Economic	implemented	Hungarian Energy Office	80	1033	1201
Land-based support for energy crops and forests	Assist growing plant for energy use	CO_2	Economic	implemented	Ministry of Agriculture and Rural Development and Office for Agriculture and Rural Development	included in the forecasts for related measures		
Life extension of the Paks nuclear plant	extend nuclear-based power generation for at least 20 years	CO_2	Other: technical	adopted	The Paks Nuclear Plant	0	0	1477
Energy tax and environmental levy	incentives for energy saving, funding for nature conservation	CO_2, CH_4	Regulatory Fiscal	implemented	Hungarian Customs and Finance Guard (VPOP) State Tax Authority (APEH)	not directly quantifiable, but included in the overall emission forecasts		
Energy audits in industry and the communal sector	identify energy saving opportunities increase energy awareness	CO_2	Economic	implemented / suspended	Energy Efficiency, Environment and Energy Information Agency (Energy Centre)	not directly quantifiable, but included in the overall emission forecasts		
New legislation for the energy efficiency of buildings	reduced energy consumption for space heating	CO_2	Regulatory	adopted	Authorities for construction licences (municipalities) National Office for Housing and Construction (OLÉH)	0	97	108

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas thousand tons CO2 eq.		
						2005	2010	2015
Improving energy awareness	increased energy awareness of the public leading to concrete savings	CO_2	Information, education	implemented	Energy Centre, through an application system	not directly quantifiable, but included in the overall emission forecasts		
R&D for energy efficiency and renewables	improved R&D with emphasis on energy efficiency and renewable energy	CO_2, CH_4	Research	implemented	Ministry of Education (earlier) National Office for Research and Technology (from 2004) Energy Centre	included in the forecasts for related measures		
Support for the improvement of industrial energy efficiency	Reduced energy consumption in industry	CO_2	Economic	implemented	Energy Centre, through an application system	53	63	73
Support for the improvement of residential/communal energy efficiency	Reduced energy consumption in the residential and communal sector	CO_2	Economic	implemented / suspended	Energy Centre, through an application system	81	97	112
Support for end-user renewable energy	larger share of renewables	CO_2	Economic	implemented / suspended	Energy Centre, through an application system	29	38	46
Modernising district heating systems	improved efficiency in district heating	CO_2	Economic	implemented	Energy Centre, through an application system	94	114	129
Energy efficiency support schemes	improved efficiency, larger utilisation of renewables	CO_2	Economic	implemented	Energy Centre, Ministries, National Office for Housing and Construction (OLÉH)	included in the forecasts for related measures		

Transport

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas thousand tons CO2 eq.		
						2005	2010	2015
National targets and support for renewable automotive fuels	Increased share of automotive bio-fuels	CO_2	Fiscal	Implemented	Ministry of Economic Affairs and Transport, Ministry of Environment and Water Management, Ministry of Agriculture and Rural Development, Ministry of Finance	not directly quantifiable, but included in the overall emission forecasts		
General transport related policies and measures	Reduced urban environmental problems due to traffic	CO_2	Mainly economic	Adopted	Various	0	925	2118

Industry

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas thousand tons CO2 eq.
Various	Reduced GHG emissions and waste production		Regulatory, economic, fiscal	Various	Various	included in the forecasts for related measures

Agriculture

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas thousand tons CO2 eq.		
Various	Modernisation of animal husbandry and promotion of natural farming methods	CO_2	Various	Continuous	Ministry of Agriculture and Rural Development	0	353	751

Land use change and forestry

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas thousand tons CO2 eq.		
Afforestation	Increasing the area of forests	CO_2	Economic	Implemented	Ministry of Agriculture and Rural Development	82	945	2800

Waste management

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entity or entities	Estimate of mitigation impact, by gas thousand tons CO2 eq.		
						2005	2010	2015
National Waste Management Plan	Creation of a framework for waste management		Regulatory, economic	Implemented	Ministry Environment and Water Management, Regional Environmental Inspectorates, Municipalities	No direct impact		

Annex 2: Summary Tables of Emission Projections

Baseline projection for total GHG emission, Gg CO2 eq

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	20115	2016	2017	2018	2019	2020
Energy production																	
Transport	10 539	10 822	11 084	11 400	11 698	11 994	12 330	12 682	13 034	13364	13749	14116	14479	14884	15305	15725	16124
Non-transport	49 516	50 988	52 928	53 965	53 350	54 306	53 708	54 619	54 339	55202	56067	56362	56859	57162	57465	57949	58586
Industrial activities																	
Mineral products	2 387	2 493	2 607	2 710	2 800	2 903	3 022	3 172	3 338	3414	3500	3574	3635	3710	3800	3921	4058
Chemical industry	1 066	1 099	1 089	465	494	504	498	505	506	535	545	540	547	587	590	592	601
Production of ferrous metals	2 203	2 203	2 204	2 204	2 204	2 204	2 204	2 204	2 204	2204	2204	2204	2204	2204	2204	2204	2204
Agriculture. land use. forestry																	
Agriculture	9781	10035	10376	10886	11236	11573	11920	12073	12225	12378	12532	12685	12826	12966	13107	13248	13389
Forestry. and land use change (net)	-6	-21	-44	-75	-118	-172	-236	-311	-395	-489	-591	-696	808.22	-927.2	1052	1184	1321
Waste treatment																	
Waste water	338	336	335	337	341	347	380	388	387	395	394	402	405	414	419	436	436
Solid waste	10 500	9 884	8 863	7 239	5 760	4 762	4 304	4 340	4 343	4383	4438	4483	4563	4662.	4801	4847	5079
TOTAL	86.324	87.840	89.442	89.131	87.765	88.421	88.128	89.673	89.982	91.388	92.838	93.671	94.710	95.663	96.638	97.738	99.156

Projection for total GHG emission in the “with measures” scenario, Gg CO_2 eq

	2005	2006	2007	2008	2009	2010	2011	2012
Energy production								
Transport	10822	10918	11058	11172	11274	11405	11541	11665
Non-transport	50988.15	52928.1	53965.46	53349.92	54306.32	53708.21	54618.77	54339.11
Industrial activities								
Mineral products	2 493	2 607	2 710	2 800	2 903	3 022	3 172	3 338
Chemical industry	1 099	1 089	465	494	504	498	505	506
Production of ferrous metals	2 203	2 204	2 204	2 204	2 204	2 204	2 204	2 204
Agriculture, land use, forestry								
Agriculture	10035.34	10368.61	10864.05	11204.62	11532.72	11863.24	12006.46	12147.23
Forestry, and land use change (net)	-75.82	-161.31	-276.8	-433.02	-630.87	-866.393	-1139.25	-1448.4
Waste treatment								
Waste water	336	335	337	341	347	380	388	387
Solid waste	9 884	8 863	7 239	5 760	4 762	4 304	4 340	4 343
TOTAL	87415	88781	88196	86522	86832	86146	87266	87111

	2013	2014	20115	2016	2017	2018	2019	2020
Energy production								
Transport	11761	11893	11998	12307	12651	13009	13366	13705
Non-transport	55201.84	56066.6	56361.92	56858.72	57161.63	57464.67	57948.51	58585.93
Industrial activities								
Mineral products	3414.207	3499.989	3573.847	3635.188	3709.691	3799.425	3921.179	4057.958
Chemical industry	535	545	540	547	587	590	592	601
Production of ferrous metals	2204	2204	2204	2204	2204	2204	2204	2204
Agriculture, land use, forestry								
Agriculture	12285	12424.07	12562.59	12687.28	12811.4	12934.95	13057.91	13180.3
Forestry, land use change	-1792.5	-2168.36	-2552.52	-2963.48	-3399.74	-3859.8	-4342.2	-4845.2
Waste treatment								
Waste water	395	394	402	405	414	419	436	436
Solid waste	4383.604	4438.18	4483.749	4563.47	4662.948	4801.142	4847.33	5079.498
TOTAL	88017	88926	89204	89874	90432	90992	91661	92634

Projection for total GHG emission in the “with additional measures” scenario, Gg CO2 eq

	2005	2006	2007	2008	2009	2010	2011	2012
Energy production								
Transport	10822	10918	11058	11172	11274	11405	11541	11665
Non-transport	50988.15	52928.1	53965.46	53349.92	54306.32	53708.21	54618.77	54339.11
Industrial activities								
Mineral products	2 493	2 607	2 710	2 800	2 903	3 022	3 172	3 338
Chemical industry	1 099	1 089	465	494	504	498	505	506
Production of ferrous metals	2 203	2 204	2 204	2 204	2 204	2 204	2 204	2 204
Agriculture, land use, forestry								
Agriculture	-103.39	-219.969	-377.46	-590.48	-860.28	-1181.45	-1553.53	-1975.1
Forestry, and land use change (net)	10035.34	10316.77	10755.41	11036.55	11302.07	11566.65	11646.27	11722.08
Waste treatment								
Waste water	336	335	337	341	347	380	388	387
Solid waste	9 884	8 863	7 239	5 760	4 762	4 304	4 340	4 343
TOTAL	87387	88671	87987	86197	86372	84425	85381	85049

	2013	2014	20115	2016	2017	2018	2019	2020
Energy production								
Transport	11761	11893	11998	11758.04	11522.88	11292.42	11066.57	10845.24
Non-transport	55201.84	56066.6	56361.92	56858.72	57161.63	57464.67	57948.51	58585.93
Industrial activities								
Mineral products	3414	3500	3574	3635	3710	3800	3921	4058
Chemical industry	535	545	540	547	587	590	592	601
Production of ferrous metals	2204	2204	2204	2204	2204	2204	2204	2204
Agriculture, land use, forestry								
Agriculture	11793.6	11864.99	11934.46	11926.05	11914.6	11900.15	11882.7	11862.27
Forestry, land use change	-2444.32	-2956.85	-3496.48	-4069.3	-4663.67	-5268.45	-5872.58	-6466.74
Waste treatment								
Waste water	395	394	402	405	414	419	436	436
Solid waste	4383.604	4438.18	4483.749	4563.47	4662.948	4801.142	4847.33	5079.498
TOTAL	85764	86469	86521	86348	86033	85722	85546	85725

Annex 3: Summary Tables of National Inventory Report

This annex contains the emission trend tables as these were submitted by Hungary as part of the submission of CRF and NIR 2005.

Greenhouse gas	Chemical formula	CO_2 equivalent
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous oxide	N_2O	310
Hydrofluorocarbons (HFCs)		
HFC-23	CHF_3	11 700
HFC-32	CH_2F_2	650
HFC-41	CH_3F	150
HFC-43-10mee	$C_5H_2F_{10}$	1 300
HFC-125	C_2HF_5	2 800
HFC-134	$C_2H_2F_4$ (CHF_2CHF_2)	1 000
HFC-134a	$C_2H_2F_4$ (CH_2FCF_3)	1 300
HFC-152a	C_2H_4F2 (CH_3CHF_2)	140
HFC-143	$C_2H_3F_3$ (CHF_2CH_2F)	300
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	3 800
HFC-227ea	C_3HF_7	2 900
HFC-236fa	$C_3H_2F_6$	6 300
HFC-245ca	$C_3H_3F_5$	560
Perfluorocarbons (PFCs)		
Perfluoromethane	CF_4	6 500
Perfluoroethane	C_2F_6	9 200
Perfluoropropane	C_3F_8	7 000
Perfluorobutane	C_4F_{10}	7 000
Perfluorocyclobutane	$c\text{-}C_4F_8$	8 700
Perfluoropentane	C_5F_{12}	7 500
Perfluorohexane	C_6F_{14}	7 400
Sulphur hexafluoride	SF_6	23 900

1995 IPCC global warming potential (GWP) values as provided by the IPCC in its Second Assessment Report based on the effects of greenhouse gases over a 100-year time horizon.

TRENDS (CO_2) HUNGARY

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1985-87)	1985	1986	1987	1988	1989	1990	1991	1992	1993
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**79 296.87**	**80 079.05**	**78 837.31**	**78 974.25**	**75 008.68**	**72 863.95**	**67 577.87**	**65 463.85**	**59 577.75**	**60 042.54**
A. Fuel Combustion (Sectoral Approach)	79 296.87	80 079.05	78 837.31	78 974.25	75 008.68	72 863.95	67 577.87	65 463.85	59 577.75	60 042.54
1. Energy Industries	24 807.37	24 777.19	25 157.93	24 486.99	21 633.30	20 820.24	20 116.29	20 777.18	21 664.76	22 567.36
2. Manufacturing Industries and Construction	22 588.00	23 107.92	22 659.86	21 996.22	21 850.15	20 779.61	17 293.05	14 838.91	14 154.83	13 572.53
3. Transport	7 568.83	7 274.75	7 551.92	7 879.81	7 907.29	8 233.19	7 984.04	6 989.86	6 781.82	6 771.27
4. Other Sectors	24 332.68	24 919.20	23 467.60	24 611.24	23 617.95	23 030.92	22 184.49	22 857.90	16 976.34	17 131.37
5. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO
1. Solid Fuels	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
2. Oil and Natural Gas	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO	IE.NA. NE.NO
2. Industrial Processes	**5 250.66**	**5 253.31**	**5 172.82**	**5 325.84**	**5 115.39**	**5 099.60**	**4 541.17**	**2 810.67**	**2 186.69**	**2 503.29**
A. Mineral Products	2 613.13	2 561.12	2 558.62	2 719.64	2 686.80	2 683.51	2 576.10	1 611.75	1 378.38	1 540.90
B. Chemical Industry	1 995.97	2 050.02	1 964.94	1 972.93	1 795.15	1 812.73	1 415.53	838.06	562.28	687.24
C. Metal Production	641.57	642.17	649.27	633.27	633.45	603.35	549.54	360.86	246.03	275.15
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**130.69**	**132.85**	**127.73**	**131.47**	**120.74**	**108.60**	**95.77**	**60.20**	**68.07**	**56.61**
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils (2)										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use. Land-Use Change and Forestry	**-1 348.27**	**-1 462.80**	**-1 136.61**	**-1 445.39**	**-392.63**	**-251.68**	**-2 370.50**	**-1 536.67**	**-2 289.68**	**-3 320.11**
6. Waste	**97.62**	**101.09**	**90.76**	**101.01**	**81.59**	**29.55**	**62.87**	**105.04**	**141.06**	**131.06**
A. Solid Waste Disposal on Land	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO

B. Waste-water Handling										
C. Waste Incineration	97.62	101.09	90.76	101.01	81.59	29.55	62.87	105.04	141.06	131.06
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (as specified in Summary 1.A)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LUCF (4)	**83 427.57**	**84 103.52**	**83 092.01**	**83 087.18**	**79 933.77**	**77 850.02**	**69 907.18**	**66 903.09**	**59 683.88**	**59 413.38**
Total CO_2 emissions excluding net CO_2 from LUCF (4)	**84 775.84**	**85 566.31**	**84 228.63**	**84 532.58**	**80 326.40**	**78 101.70**	**72 277.68**	**68 439.76**	**61 973.56**	**62 733.49**
Memo Items:										
International Bunkers	**431.39**	**430.73**	**436.60**	**426.83**	**432.07**	**448.14**	**475.04**	**375.87**	**385.85**	**361.15**
Aviation	431.39	430.73	436.60	426.83	432.07	448.14	475.04	375.87	385.85	361.15
Marine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Multilateral Operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass	**1 421.26**	**1 556.21**	**1 342.71**	**1 364.85**	**1 288.88**	**1 374.41**	**1 020.36**	**1 456.76**	**1 444.28**	**1 504.63**

TABLE 10 EMISSIONS TRENDS (CO_2)

(Sheet 1 of 5)

(Part 2 of 3)

HUNGARY
2003
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
1. Energy	**58 553.41**	**57 807.38**	**59 135.76**	**57 398.64**	**57 083.33**	**56 989.01**	**54 535.21**	**56 110.54**	**54 805.83**	**57 592.31**
A. Fuel Combustion (Sectoral Approach)	58 553.41	57 807.38	59 135.76	57 398.64	57 083.33	56 989.01	54 535.21	56 110.54	54 805.83	57 592.31
1. Energy Industries	21 909.44	21 708.26	22 411.35	22 278.83	23 453.07	23 269.76	21 231.14	21 247.00	19 679.64	20 501.45
2. Manufacturing Industries and Construction	13 067.76	13 207.27	13 303.19	11 942.42	11 640.48	10 581.17	10 565.08	10 640.23	10 127.53	10 564.17
3. Transport	6 670.24	6 796.49	6 795.82	7 208.86	8 193.50	8 555.04	8 516.82	8 844.79	9 269.69	9 588.80
4. Other Sectors	16 905.97	16 095.36	16 625.40	15 968.53	13 796.28	14 583.03	14 222.17	15 378.53	15 728.97	16 937.88
5. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO
1. Solid Fuels	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA	NO	NO	NO
2. Oil and Natural Gas	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	NO	NO	NO	NO
2. Industrial Processes	**2 843.25**	**2 874.63**	**2 860.77**	**2 846.45**	**2 812.90**	**2 786.38**	**3 025.85**	**3 005.78**	**2 702.09**	**2 687.88**
A. Mineral Products	1 724.10	1 770.05	1 658.13	1 702.36	1 751.39	1 808.53	1 876.69	1 894.21	1 804.35	1 801.90
B. Chemical Industry	817.08	808.32	902.16	864.98	766.27	683.55	846.33	797.32	568.87	565.87
C. Metal Production	302.07	296.27	300.48	279.10	295.24	294.31	302.83	314.25	328.87	320.12
D. Other Production	NO	NO	NO	NO	NO	NO	IE	NO	NO	NO
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**58.23**	**50.74**	**85.97**	**91.76**	**94.58**	**93.82**	**97.72**	**97.01**	**88.41**	**81.46**
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils (2)										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										

5. Land Use. Land-Use Change and Forestry	**-5 417.43**	**-5 321.44**	**-4 735.36**	**-4 970.83**	**-4 989.62**	**-4 775.81**	**-4 376.56**	**-4 541.71**	**-2 365.85**	**-3 964.57**
6. Waste	**140.15**	**136.91**	**137.12**	**140.85**	**147.86**	**146.16**	**144.46**	**146.45**	**106.90**	**99.42**
A. Solid Waste Disposal on Land	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NO	NO
B. Waste-water Handling										
C. Waste Incineration	140.15	136.91	137.12	140.85	147.86	146.16	144.46	146.45	106.90	99.42
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (as specified in Summary 1.A)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
Total CO_2 emissions including net CO_2 from LUCF (4)	**56 177.61**	**55 548.21**	**57 484.26**	**55 506.87**	**55 149.06**	**55 239.56**	**53 426.67**	**54 818.08**	**55 337.38**	**56 496.49**
Total CO_2 emissions excluding net CO_2 from LUCF (4)	**61 595.04**	**60 869.65**	**62 219.62**	**60 477.70**	**60 138.68**	**60 015.37**	**57 803.24**	**59 359.79**	**57 703.23**	**60 461.06**
Memo Items:										
International Bunkers	**532.23**	**523.88**	**559.56**	**531.24**	**555.59**	**596.29**	**634.02**	**538.11**	**576.90**	**591.62**
Aviation	532.23	523.88	559.56	531.24	555.59	596.29	634.02	538.11	576.90	591.62
Marine	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
Multilateral Operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass	**1 519.50**	**1 723.01**	**1 571.06**	**1 594.18**	**1 471.98**	**1 476.97**	**1 619.91**	**1 469.48**	**1 583.77**	**2 120.16**

TABLE 10 EMISSIONS TRENDS (CH_4) HUNGARY
(Sheet 2 of 5) 2003
(Part 1 of 3) 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1985-87)	1985	1986	1987	1988	1989	1990	1991	1992	1993
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Total CH_4 emissions	**632.88**	**624.13**	**630.40**	**644.09**	**652.71**	**646.26**	**565.24**	**543.97**	**513.33**	**478.89**
1. Energy	177.71	180.56	176.42	176.15	169.07	164.24	147.65	146.96	132.15	135.57
A. Fuel Combustion (Sectoral Approach)	48.62	50.36	48.10	47.39	44.35	42.76	40.31	39.05	34.76	34.95
1. Energy Industries	0.68	0.73	0.69	0.63	0.60	0.58	0.58	0.59	0.63	0.64
2. Manufacturing Industries and Construction	8.03	8.54	8.15	7.41	7.09	6.30	4.71	4.01	3.36	3.28
3. Transport	1.27	1.22	1.27	1.33	1.38	1.52	1.53	1.39	1.29	1.31
4. Other Sectors	18.63	19.88	17.99	18.02	15.28	14.36	13.50	13.07	9.48	9.72
5. Other	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
B. Fugitive Emissions from Fuels	129.09	130.20	128.32	128.77	124.73	121.47	107.35	107.91	97.39	100.62
1. Solid Fuels	72.76	74.81	71.99	71.47	67.76	64.20	53.54	51.52	39.12	34.64
2. Oil and Natural Gas	56.34	55.38	56.33	57.29	56.96	57.27	53.81	56.38	58.26	65.98
2. Industrial Processes	**0.37**	**0.37**	**0.37**	**0.37**	**0.37**	**0.36**	**0.34**	**0.35**	**0.37**	**0.37**
A. Mineral Products	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA
B. Chemical Industry	0.37	0.37	0.37	0.37	0.37	0.36	0.34	0.35	0.37	0.37
C. Metal Production	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use										
4. Agriculture	**203.54**	**208.97**	**202.65**	**199.00**	**197.69**	**190.07**	**184.44**	**169.53**	**145.59**	**125.92**
A. Enteric Fermentation	156.60	161.19	155.79	152.82	151.38	146.87	142.15	132.87	115.39	98.59
B. Manure Management	42.36	42.74	42.45	41.89	41.61	39.72	39.89	34.87	29.20	26.33
C. Rice Cultivation	2.41	2.27	2.33	2.64	2.62	2.40	2.40	1.80	1.00	1.00
D. Agricultural Soils	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	2.17	2.77	2.08	1.65	2.09	1.09	NA.NO	NA.NO	NA.NO	NA.NO

G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use. Land-Use Change and Forestry	**0.36**	**0.36**	**0.36**	**0.36**	**1.36**	**1.36**	**0.31**	**1.22**	**1.12**	**0.98**
6. Waste	**250.89**	**233.87**	**250.60**	**268.20**	**284.22**	**290.22**	**232.50**	**225.91**	**234.11**	**216.04**
A. Solid Waste Disposal on Land	187.66	170.37	187.40	205.20	223.90	231.10	173.00	169.70	178.80	161.60
B. Waste-water Handling	63.23	63.50	63.20	63.00	60.32	59.12	59.50	56.21	55.31	54.44
C. Waste Incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (as specified in Summary 1.A)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items:										
International Bunkers	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Aviation	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Marine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Multilateral Operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass										

TABLE 10 EMISSIONS TRENDS (CH_4)

(Sheet 2 of 5)

(Part 2 of 3)

HUNGARY

2003

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Total CH_4 emissions	**471.57**	**478.64**	**484.17**	**479.71**	**494.66**	**477.34**	**481.05**	**493.14**	**465.01**	**453.46**
1. Energy	137.79	142.41	144.76	144.37	142.07	141.14	135.32	136.84	133.79	129.29
A. Fuel Combustion (Sectoral Approach)	35.32	34.61	33.97	33.00	31.85	32.73	32.58	31.99	32.70	34.46
1. Energy Industries	0.57	0.35	0.44	0.39	0.45	0.45	0.40	0.40	0.33	0.39
2. Manufacturing Industries and Construction	3.74	3.32	3.39	2.66	3.00	3.68	3.26	2.80	2.75	2.60
3. Transport	1.29	1.27	1.19	1.24	1.39	1.34	1.35	1.32	1.56	1.64
4. Other Sectors	9.72	9.67	8.96	8.71	7.01	7.26	7.58	7.48	8.06	9.83
5. Other	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00
B. Fugitive Emissions from Fuels	102.47	107.80	110.79	111.37	110.22	108.41	102.74	104.84	101.09	94.82
1. Solid Fuels	33.14	33.48	34.49	33.98	31.87	30.07	26.96	28.83	24.42	21.74
2. Oil and Natural Gas	69.33	74.31	76.30	77.39	78.35	78.34	75.78	76.02	76.66	73.08
2. Industrial Processes	**0.38**	**0.37**	**0.38**	**0.41**	**0.44**	**0.42**	**0.50**	**0.50**	**0.48**	**0.48**
A. Mineral Products	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	NO	NO	NO	NO
B. Chemical Industry	0.38	0.37	0.38	0.41	0.44	0.42	0.50	0.50	0.48	0.48
C. Metal Production	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE.NA.NO	IE	NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use										
4. Agriculture	**111.88**	**111.20**	**111.24**	**107.18**	**108.95**	**109.53**	**108.89**	**104.64**	**103.56**	**102.53**
A. Enteric Fermentation	87.44	86.60	85.98	83.46	84.10	84.42	84.41	81.13	79.45	78.39
B. Manure Management	23.45	23.80	24.63	23.28	24.39	24.65	23.84	23.04	23.64	23.62
C. Rice Cultivation	1.00	0.80	0.62	0.44	0.46	0.45	0.64	0.47	0.47	0.51
D. Agricultural Soils	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NE	NA.NE	NA	NA
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO

G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NO	NO
5. Land Use. Land-Use Change and Forestry	**1.00**	**1.05**	**1.14**	**1.16**	**1.13**	**1.19**	**1.27**	**1.22**	**1.22**	**1.22**
6. Waste	**220.51**	**223.61**	**226.65**	**226.58**	**242.07**	**225.07**	**235.06**	**249.96**	**225.96**	**219.94**
A. Solid Waste Disposal on Land	166.90	168.80	170.70	172.60	186.10	173.20	182.11	198.99	175.50	177.02
B. Waste-water Handling	53.61	54.81	55.95	53.98	55.97	51.87	52.95	50.96	50.46	42.93
C. Waste Incineration	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (as specified in Summary 1.A)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items:										
International Bunkers	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Aviation	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Marine	NA	NA	NA	NA	NA	NA	NA.NO	NA.NO	NA	NO
Multilateral Operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass										

TABLE 10 EMISSIONS TRENDS (N_2O)
(Sheet 3 of 5)
(Part 1 of 3)

HUNGARY
2003
2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1985-87)	1985	1986	1987	1988	1989	1990	1991	1992	1993
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Total N_2O emissions	**76.83**	**77.16**	**76.28**	**77.04**	**74.60**	**72.19**	**60.95**	**49.17**	**39.66**	**38.71**
1. Energy	**10.60**	**10.55**	**10.44**	**10.80**	**10.08**	**9.75**	**9.32**	**9.18**	**8.62**	**8.88**
A. Fuel Combustion (Sectoral Approach)	10.60	10.55	10.44	10.80	10.08	9.75	9.32	9.18	8.62	8.88
1. Energy Industries	3.15	3.17	3.14	3.14	2.63	2.49	2.37	2.55	2.76	2.96
2. Manufacturing Industries and Construction	1.28	1.27	1.30	1.27	1.28	1.13	1.06	0.87	0.86	0.84
3. Transport	1.24	1.20	1.23	1.27	1.23	1.22	1.22	1.02	0.97	0.97
4. Other Sectors	4.93	4.91	4.78	5.12	4.93	4.91	4.67	4.74	4.02	4.11
5. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO
1. Solid Fuels	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
2. Oil and Natural Gas	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO
2. Industrial Processes	**14.65**	**15.26**	**14.41**	**14.28**	**13.74**	**12.57**	**10.37**	**5.24**	**2.87**	**4.34**
A. Mineral Products	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA
B. Chemical Industry	14.65	15.26	14.41	14.28	13.74	12.57	10.37	5.24	2.87	4.34
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**0.82**	**0.78**	**0.83**	**0.84**	**0.89**	**0.82**	**0.70**	**0.54**	**0.59**	**0.64**
4. Agriculture	**50.76**	**50.57**	**50.58**	**51.11**	**49.88**	**49.05**	**40.56**	**34.20**	**27.57**	**24.84**
A. Enteric Fermentation										
B. Manure Management	7.74	7.94	7.72	7.57	7.34	7.15	6.93	6.35	5.48	4.70
C. Rice Cultivation										
D. Agricultural Soils	42.97	42.58	42.82	43.51	42.49	41.87	33.63	27.85	22.09	20.14
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

F. Field Burning of Agricultural Residues	0.04	0.06	0.04	0.03	0.05	0.03	NA.NO	NA.NO	NA.NO	NA.NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use. Land-Use Change and Forestry	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.01**	**0.00**	**0.01**	**0.01**	**0.01**
6. Waste	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE
C. Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (as specified in Summary 1.A)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items:										
International Bunkers	**0.06**	**0.06**	**0.06**	**0.06**	**0.06**	**0.06**	**0.07**	**0.05**	**0.05**	**0.05**
Aviation	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.05	0.05	0.05
Marine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Multilateral Operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass										

TABLE 10 EMISSIONS TRENDS (N_2O) HUNGARY

(Sheet 3 of 5) 2003

(Part 2 of 3) 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Total N_2O emissions	**42.63**	**39.99**	**43.00**	**42.60**	**42.59**	**42.15**	**40.59**	**43.55**	**40.71**	**40.11**
1. Energy	**8.68**	**8.83**	**9.05**	**8.99**	**8.67**	**8.87**	**8.44**	**9.09**	**8.82**	**9.47**
A. Fuel Combustion (Sectoral Approach)	8.68	8.83	9.05	8.99	8.67	8.87	8.44	9.09	8.82	9.47
1. Energy Industries	2.83	2.80	2.76	2.87	2.93	2.80	2.52	2.57	2.20	2.30
2. Manufacturing Industries and Construction	0.83	0.73	0.73	0.65	0.54	0.51	0.49	0.55	0.49	0.53
3. Transport	0.98	0.99	0.89	1.14	1.40	1.54	1.45	1.63	1.75	1.77
4. Other Sectors	4.04	4.31	4.66	4.34	3.80	4.03	3.98	4.33	4.39	4.88
5. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
B. Fugitive Emissions from Fuels	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO
1. Solid Fuels	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA	NO	NO	NO
2. Oil and Natural Gas	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	IE.NA.NE.NO	NO	NO	NO	NO
2. Industrial Processes	**6.56**	**4.35**	**6.21**	**5.98**	**5.02**	**4.40**	**5.79**	**6.29**	**4.04**	**4.27**
A. Mineral Products	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	IE.NA	NO	NO	NO	NO
B. Chemical Industry	6.56	4.35	6.21	5.98	5.02	4.40	5.79	6.29	4.04	4.27
C. Metal Production	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**0.53**	**0.64**	**0.61**	**0.56**	**0.55**	**0.47**	**0.45**	**0.54**	**0.39**	**0.62**
4. Agriculture	**26.85**	**26.16**	**27.12**	**27.05**	**28.33**	**28.39**	**25.90**	**27.62**	**27.45**	**25.73**
A. Enteric Fermentation										
B. Manure Management	4.23	4.18	4.13	4.05	4.11	4.07	4.16	4.02	3.98	4.00
C. Rice Cultivation										
D. Agricultural Soils	22.62	21.98	22.99	23.00	24.23	24.32	21.74	23.60	23.48	21.73
E. Prescribed Burning of Savannas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F. Field Burning of Agricultural Residues	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO

G. Other	NA	NA	NA	NA	NA	NA	NO	NO	NO	NO
5. Land Use. Land-Use Change and Forestry	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.02**	**0.01**	**0.01**	**0.01**	**0.01**
6. Waste	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE	NA.NE
C. Waste Incineration	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (as specified in Summary 1.A)	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**
	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Memo Items:										
International Bunkers	**0.06**	**0.07**	**0.08**	**0.08**	**0.08**	**0.08**	**0.09**	**0.08**	**0.08**	**0.08**
Aviation	0.06	0.07	0.08	0.08	0.08	0.08	0.09	0.08	0.08	0.08
Marine	NA	NA	NA	NA	NA	NA	NA.NO	NA.NO	NA	NO
Multilateral Operations	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass										

TABLE 10 EMISSION TRENDS (HFCs. PFCs and SF_6)

(Sheet 4 of 5)

(Part 1 of 3)

HUNGARY

2003

2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1985-87)	1985	1986	1987	1988	1989	1990	1991	1992	1993
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs(5) - (Gg CO_2 equivalent)	**NA.NO**	**NA.NO**	**NA.NO**	**NA.NO**	**NA.NO**	**NA.NO**	**NA.NO**	**NA.NO**	**0.07**	**0.07**
HFC-23	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-32	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-41	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-43-10mee	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-125	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-134	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-134a	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	0.00	0.00
HFC-152a	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-143	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-143a	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-227ea	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-236fa	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-245ca	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
Unspecified mix of listed HFCs (6) - (Gg CO_2 equivalent)	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
Emissions of PFCs(5) - (Gg CO_2 equivalent)	**268.49**	**266.16**	**269.27**	**270.03**	**263.52**	**285.10**	**270.83**	**233.72**	**134.82**	**145.73**
CF_4	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.02	0.02

C_2F_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_3F_8	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
C_4F_{10}	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
c-C_4F_8	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
C_5F_{12}	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
C_6F_{14}	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
Unspecified mix of listed PFCs [(6)] - (Gg CO_2 equivalent)	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
Emissions of SF_6 [(5)] - (Gg CO_2 equivalent)	**81.02**	**100.45**	**77.33**	**65.26**	**83.65**	**24.57**	**39.87**	**52.72**	**48.97**	**51.79**
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 10 EMISSION TRENDS (HFCs. PFCs and SF_6) HUNGARY

(Sheet 4 of 5) 2003

(Part 2 of 3) 2005

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[(5)] - ($Gg\ CO_2$ equivalent)	**1.12**	**1.74**	**1.57**	**45.20**	**125.07**	**347.27**	**205.73**	**280.73**	**392.59**	**478.26**
HFC-23	NA.NO	NA.NO	NA.NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-32	NA.NO	NA.NO	NA.NO	0.00	0.00	0.00	0.00	0.00	0.00	0.01
HFC-41	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-43-10mee	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-125	NA.NO	NA.NO	NA.NO	0.00	0.01	0.02	0.02	0.02	0.04	0.05
HFC-134	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NE.NO
HFC-134a	0.00	0.00	0.00	0.03	0.06	0.13	0.06	0.09	0.10	0.14
HFC-152a	NA.NO	NA.NO	NA.NO	0.00	0.00	0.00	0.00	0.00	0.00	NA.NO
HFC-143	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-143a	NA.NO	NA.NO	NA.NO	0.00	0.01	0.02	0.02	0.03	0.04	0.04
HFC-227ea	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-236fa	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
HFC-245ca	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
Unspecified mix of listed HFCs [(6)] - ($Gg\ CO_2$ equivalent)	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
Emissions of PFCs[(5)] - ($Gg\ CO_2$ equivalent)	**158.93**	**166.82**	**159.40**	**161.44**	**171.66**	**189.16**	**211.26**	**199.10**	**203.26**	**189.60**
CF_4	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03

C_2F_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_3F_8	NA.NO	NA.NO	NA.NO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C_4F_{10}	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
c-C_4F_8	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
C_5F_{12}	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
C_6F_{14}	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	0.00	NA.NO	NA.NO	NA.NO	NA.NO
Unspecified mix of listed PFCs (6) - (Gg CO_2 equivalent)	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO
Emissions of SF_6 (5) - (Gg CO_2 equivalent)	**67.95**	**70.15**	**69.00**	**68.02**	**68.47**	**126.82**	**140.11**	**107.43**	**119.55**	**161.92**
SF_6	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.01

TABLE 10 EMISSION TRENDS (SUMMARY) HUNGARY

(Sheet 5 of 5) 2003

(Part 1 of 3) 2005

GREENHOUSE GAS EMISSIONS	Base year (1985-87)	1985	1986	1987	1988	1989	1990	1991	1992	1993
	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF(4)	83 427.57	84 103.52	83 092.01	83 087.18	79 933.77	77 850.02	69 907.18	66 903.09	59 683.88	59 413.38
CO_2 emissions excluding net CO_2 from LULUCF (4)	84 775.84	85 566.31	84 228.63	84 532.58	80 326.40	78 101.70	72 277.68	68 439.76	61 973.56	62 733.49
CH_4	13 290.38	13 106.83	13 238.36	13 525.95	13 706.99	13 571.36	11 870.10	11 423.27	10 780.02	10 056.72
N_2O	23 816.22	23 920.55	23 645.49	23 882.62	23 127.19	22 379.99	18 894.60	15 242.82	12 293.66	12 001.25
HFCs	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	NA.NO	0.07	0.07
PFCs	268.49	266.16	269.27	270.03	263.52	285.10	270.83	233.72	134.82	145.73
SF_6	81.02	100.45	77.33	65.26	83.65	24.57	39.87	52.72	48.97	51.79
Total (including net CO_2 from LULUCF)(4)	**120 883.67**	**121 497.50**	**120 322.47**	**120 831.05**	**117 115.12**	**114 111.04**	**100 982.57**	**93 855.62**	**82 941.42**	**81 668.93**
Total (excluding net CO_2 from LULUCF)(4), (7)	**122 223.58**	**122 951.97**	**121 450.65**	**122 268.11**	**117 476.27**	**114 331.35**	**103 345.85**	**95 364.11**	**85 205.26**	**84 966.27**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1985-87)	1985	1986	1987	1988	1989	1990	1991	1992	1993
	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)
1. Energy	86 314.04	87 140.09	85 779.32	86 022.70	81 683.28	79 336.58	73 568.11	71 396.28	65 024.50	65 643.25

2. Industrial Processes	10 149.51	10 357.14	9 995.88	10 095.50	9 731.13	9 313.07	8 073.01	4 728.78	3 267.24	4 052.97
3. Solvent and Other Product Use	384.46	375.28	385.97	392.12	397.14	361.62	311.73	227.52	251.16	255.99
4. Agriculture	20 008.57	20 066.19	19 935.56	20 023.95	19 613.97	19 195.62	16 447.25	14 161.76	11 604.04	10 345.41
5. Land Use. Land-Use Change and Forestry [8]	-1 339.91	-1 454.47	-1 128.18	-1 437.07	-361.15	-220.31	-2 363.28	-1 508.49	-2 263.84	-3 297.34
6. Waste	5 367.00	5 013.26	5 353.92	5 733.83	6 050.76	6 124.45	4 945.74	4 849.76	5 058.32	4 668.65
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF) [8]	**120 883.67**	**121 497.50**	**120 322.47**	**120 831.05**	**117 115.12**	**114 111.04**	**100 982.57**	**93 855.62**	**82 941.42**	**81 668.93**

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(Part 2 of 3)

2003
2005

GREENHOUSE GAS EMISSIONS	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)
CO_2 emissions including net CO_2 from LULUCF(4)	56 177.61	55 548.21	57 484.26	55 506.87	55 149.06	55 239.56	53 426.67	54 818.08	55 337.38	56 496.49
CO_2 emissions excluding net CO_2 from LULUCF (4)	61 595.04	60 869.65	62 219.62	60 477.70	60 138.68	60 015.37	57 803.24	59 359.79	57 703.23	60 461.06
CH_4	9 902.94	10 051.42	10 167.58	10 073.89	10 387.77	10 024.18	10 102.00	10 356.00	9 765.29	9 522.65
N_2O	13 213.85	12 396.81	13 330.28	13 204.83	13 203.06	13 065.59	12 583.47	13 499.67	12 621.48	12 434.04
HFCs	1.12	1.74	1.57	45.20	125.07	347.27	205.73	280.73	392.59	478.26
PFCs	158.93	166.82	159.40	161.44	171.66	189.16	211.26	199.10	203.26	189.60
SF_6	67.95	70.15	69.00	68.02	68.47	126.82	140.11	107.43	119.55	161.92
Total (including net CO_2 from LULUCF)(4)	**79 522.40**	**78 235.16**	**81 212.07**	**79 060.25**	**79 105.09**	**78 992.58**	**76 669.23**	**79 261.01**	**78 439.55**	**79 282.97**
Total (excluding net CO_2 from LULUCF)(4), (7)	**84 916.59**	**83 532.33**	**85 921.06**	**84 004.17**	**84 067.87**	**83 738.36**	**81 016.41**	**83 774.61**	**80 777.08**	**83 219.21**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)
1. Energy	64 138.44	63 534.59	64 981.41	63 218.04	62 754.28	62 702.66	59 993.27	61 800.92	60 349.46	63 243.62

2. Industrial Processes	5 112.24	4 468.85	5 024.16	4 984.17	4 744.22	4 822.01	5 389.88	5 554.36	4 681.35	4 852.02
3. Solvent and Other Product Use	221.29	250.38	274.13	265.68	266.27	238.57	235.84	263.38	208.31	274.58
4. Agriculture	10 672.86	10 444.98	10 743.71	10 636.34	11 070.87	11 101.85	10 315.76	10 759.52	10 685.15	10 130.25
5. Land Use. Land-Use Change and Forestry (8)	-5 394.19	-5 297.18	-4 708.98	-4 943.92	-4 962.79	-4 745.78	-4 347.18	-4 513.60	-2 337.52	-3 936.24
6. Waste	4 771.76	4 833.53	4 897.65	4 899.93	5 232.23	4 873.26	5 081.66	5 396.43	4 852.81	4 718.74
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF) (8)	**79 522.40**	**78 235.16**	**81 212.07**	**79 060.25**	**79 105.09**	**78 992.58**	**76 669.23**	**79 261.01**	**78 439.55**	**79 282.97**

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Annex 5: Glossary

Abbreviation	Meaning
4CE	Consumer Choice and Carbon Consciousness for Electricity
AEEF	State Energy and Energy Safety Authority
AERI	Agricultural Economics Research Institute
APEH	State Tax Authority
ATOMKI	Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen
AVOP	Agriculture and Rural Development Operative Programme
BOD	Biological Oxygen Demand
CCGT	Combined Cycle Gas Turbine
CDM	Clean Development Mechanism
CEE	Central Eastern Europe
CEU	Central European University
CHP	Combined heat and power
COP	Conference of the Parties
COST	European Cooperation in the Field of Scientific and Technical Research
CPI	Consumer Price Index
CRF	Common Reporting Format
DG	Directorate General (of the European Commission)
DH	District heating
DMCI	Direct Material Consumption Index
DSM	Demand side management
EAP	Environmental Action Program
EC DG AGRI	European Council Directorate General for Agriculture
EHA	Energy Saving Loan Fund
EHP	Energy Saving Loan Programme
EIT	Economies In Transition
ELS	Entry Level Scheme
Energy Centre	Energy Efficiency, Environment and Energy Information Agency
ERU	Emission Reduction Units
ESAP	Energy Saving Action Plan
ESEEAP	Energy Saving and Energy Efficiency Action Programme
ETS	Greenhouse gas Emission Trading System of the European Union
EU	European Union

Abbreviation	Meaning
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
FAPRI	Food and Agricultural Policy Research Institute
FGD	Flue Gas Desulphurisation
FP5	EU Fifth Research and Development Framework Programme (1999-2002)
FP6	EU Sixth Research and Development Framework Programme (2003-2006)
FVM	Ministry of Agriculture and Rural Development
GCCP	Global Climate Change and Vegetation
GCTE	Global Change and Terrestrial Ecosystems
GDP	Gross Domestic Product
GEF	Global Environmental Fund
GHG	Greenhouse gas
GWP	Global Warming Potential
HAS	Hungarian Academy of Sciences (MTA, Magyar Tudományos Akadémia)
HCSO	Hungarian Central Statistical Office
HEECP	Hungarian Energy Efficiency Co-Financing Programme
HEO	Hungarian Energy Office (Energia Hivatal)
HIR	Information System on Wastes
HMS	Hungarian Meteorological Service (Országos Meteorológiai Szolgálat)
HSRFR	Hungarian Scientific Research Fund Programmes (OTKA, Országos Tudományos Kutatási Alapprogramok)
HUSIM	Hungarian Simulation Model
HVAC	Heating, ventilation and air-conditioning
ICMS	Integrated Crop Management System
IEM	Institute for Environmental Directorate
IGBP	International Geosphere and Biosphere Program
IOBC	International Organisation for Biological Control
IPCC	International Panel on Climate Change
IPM	Integrated Pest Management
JI	Joint Implementation
KAC	Hungarian Environmental Fund
KIOP	Environment and Infrastructure Operative Programme

Abbreviation	Meaning
KMÜFA	The Central Technical Development Base Program
KvVM	Ministry of Environment and Water
LCP	Least Cost Planning
LPG	Liquid Petroleum Gas
LRTAP	Long-range Transboundary Air Pollution
LTER	Long Term Ecological Research (Hosszú távú ökológiai vizsgálatok)
LUCF	Land Use Change and Forestry
MÁV Rt	Hungarian Railways Ltd.
MAVIR	Hungarian Power System Operator Company
MOL Rt	Hungarian Oil and Gas Company
MVH	Office for Agriculture and Rural Development
MVM Rt	Hungarian Electricity Company
NAEP	National Agri-environment Programme
NC3	Third National Communication to the UNFCCC
NC4	Fourth National Communication to the UNFCCC
NDP	National Development Plan
NEC	National Emission Ceilings
NEP	National Energy Efficiency Programme
NEPI	First National Environmental Program (NKP I., Első Nemzeti Környezetvédelmi Program)
NEPII	Second National Environmental Program (2003-2008) (NKP II., Második Nemzeti Környezetvédelmi Program)
NGO	Non-governmental Organisation
NIR	National Inventory Report
NKFP	National Research and Development Programmes
NMS	New EU Member States (Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)
NOAA	National Oceanic and Atmospheric Administration
NORT	National Office of Research and Technology (NKTH, Nemzeti Kutatási és Technológiai Hivatal)
NRDP	National Rural Development Plan
NWMP	National Waste Management Plan
OECD	Organisation for Economic Co-Operation and Development
OFS	Organic Farming Scheme
OGY	Hungarian Parliament
OKTVF	National Directorate for Environment, Nature and Water
OLÉH	National Office for Housing and Construction
ORC	Organic Rankine Cycle
PAM	Policies and Measures
PaMs	Programs and Measures
R&D	Research and Development
R&D	Research and development
REC	Regional Environmental Center
REEEP	Renewable Energy and Energy Efficiency Partnership
REKK	Regional Centre for Energy Policy Research

Abbreviation	Meaning
RFMRE	Research Fund Management and Research Exploitation (KPI, Kutatás-fejlesztési, Pályázati és Kutatáshasznosítási Iroda)
RFOP	Regional Development Operative Programme
RTIF	Research and Technology Innovation Fund (NKFP, Nemzeti Kutatási és Fejlesztési Pályázatok)
S&T	Science and Technology
SAPARD	Special Accession Programme for Agriculture and Rural Development
SMEs	Small and Medium size Enterprises
SWG	Stochastic Weather Generators
SZT-EN	The energy efficiency chapter of the Széchenyi Plan
TAP	Thematic action programme
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Program
UNFCCC	UN Framework Convention on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change
VAHAVA	VÁltozás-HAtás-VÁlaszadás (Change-impact-response)
VAT	Value Added Tax
VPOP	Hungarian Customs and Finance Guard
WHO/ECEH	World Health Organization - European Centre for Environment and Health
WRI	World Resources Institute

Annex 6: Acknowledgements

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