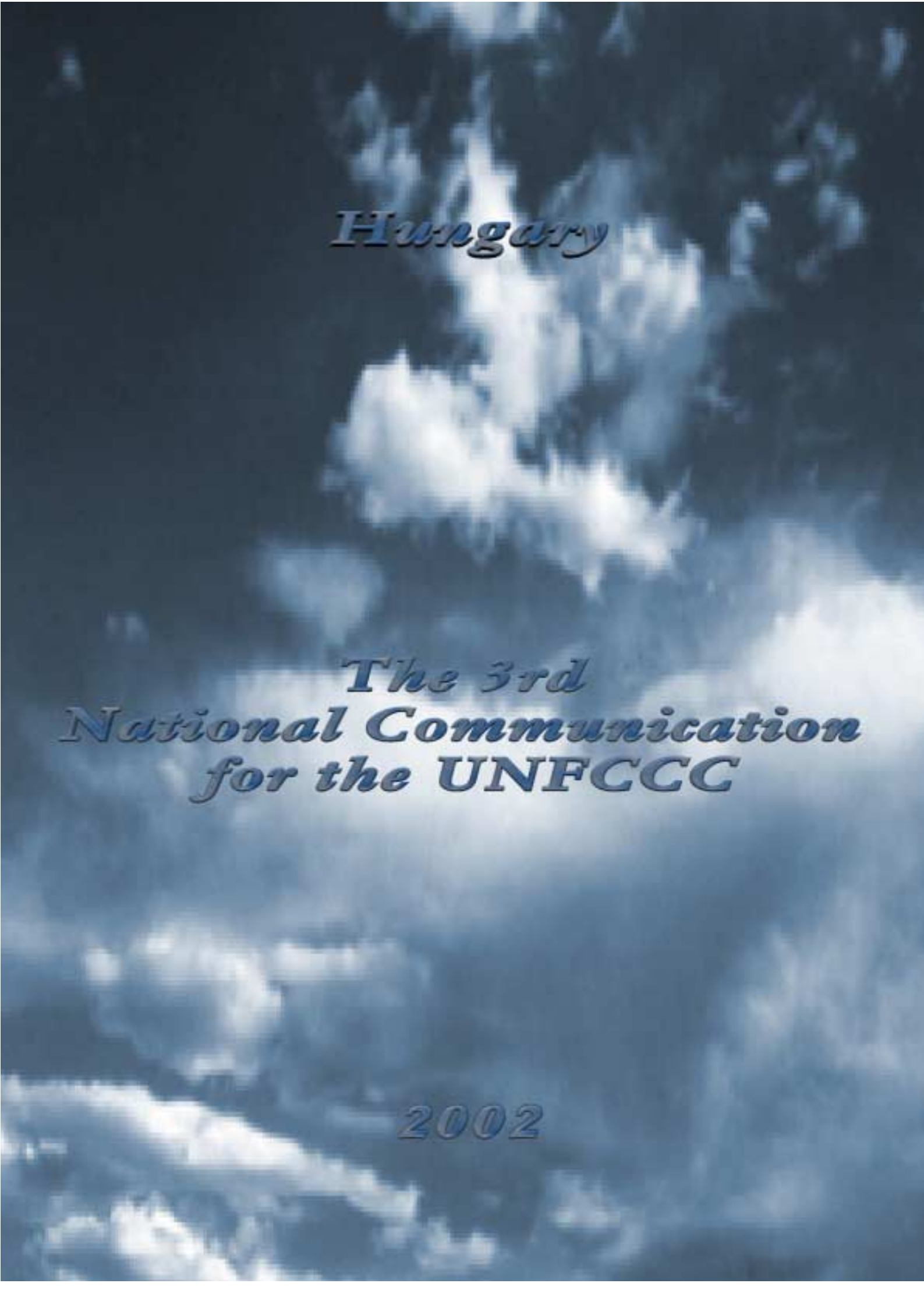
Hungary
The 3rd
National Communication
for the UNFCCC
2002

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2002

I. Executive Summary

National circumstances relevant to GHG emission and removals

Hungary is a landlocked country in Central Europe. The area of the country is 93,033km^2, its population is 10.1 million. The country has an emerging market economy. A deep economic crisis began in the second half of the 80's resulting in the transformation of the whole economic and political system around 1990 when - similarly to other post Soviet countries - the transition process towards market economy began. However, the economic depression lasted till 1993. Since then the economy began to develop and the growth rate of the Hungarian economy exceeded that of the EU at the end of the last century. The main economic indicators are shown in Table I.1. Hungary is one of the candidates of the EU, the accession is supposed to be granted in 2004.

Table I.1. Main economic indicators of Hungary in 1995-2001 (%)

	1995	2000	2001
GDP growth rate	1.5	5.2	3.8
Unemployment rate	10.4	6.4	5.7
Inflation rate	28.2	9.9	9.3
Balance of central government/GDP	-6.0	-2.8	-2.8

Source: Central Statistical Office

One of the important characteristics of the Hungarian energy system is the lack of sufficient, clean and cheap domestic energy resources, therefore the increasing energy demand of the country has to be supplied by increasing the energy import. Nowadays, Hungary's import dependency reaches 70%, and it is expected to be increasing significantly even in the future, because of the exhaustion of the domestic hydrocarbon reserves.

The share of the energy import of the country cannot be modified significantly, but strategic requirements diversified the energy import in the past. If the energy import changes in the future, it will certainly influence the pollutant emissions too, because of the different chemical properties of the imported fossil fuels. The utilization of the low quality domestic energy resources, and therefore the environmental pollution caused by the fuel use in Hungary was relatively high. Regarding the environmental pollution, these features are fundamental and deterministic. We were forced to use the low quality domestic fuels and a huge amount of energy to operate our outdated production system, our aged car fleet, devices and appliances.

Domestic energy production of Hungary (oil, natural gas, brown and hard coal and lignite) can supply roughly the one third of total primary energy used in the country. The rest is covered by imports. The import dependency of the energy supply is 69%. Due to earlier close relations, the major supplier of crude oil and natural gas is Russia but interconnections in the oil and gas pipeline systems were developed towards the West-European energy system. Large quantities of oil can also be imported through the Adria pipeline (connecting Hungary to the Mediterranean Sea) and gas can also be purchased through the Gyor-Baumgarten pipeline which links Hungary to the European gas network.

Now Hungary is an integrated part of the European power system. Our electricity network was connected and works parallel with the UCPTE system, and after a very successful test operation the MVM (Hungarian Power Companies) is now a full member of the UCPTE. Based on the geographical location of Hungary, the future enlargement of the EU would bring the country a key role in the enlarged energy networks (e.g. UCPTE - SÜDEL interconnection) and Hungary has a good transit potential.

The utilisation of nuclear energy in the Hungarian energy system started in 1983. Its share in the primary energy consumption is about 13-15%, but in the domestic electrical energy production its share is much higher, having reached about 40-42%. The utilisation of nuclear energy resulted in more CO_2 equiv. emission savings in the past than that accountable to domestic carbon sinks.

Energy intensity has been gradually decreasing in the last years. In the coming years only 1-2% increase in energy use is expected for a GDP growth of 3-6%, thus energy intensity is likely to fall further. The primary energy use in Hungary in 2000 was 0.7% less than the volume used in 1999. In the same time, GDP increased by 5.2%. This means that energy efficiency improved by cca. 5.5% in 2000.

Regarding the renewable energy sources, Hungary is very rich in subterranean thermal water reserves, which can mainly be gained from sedimentary layers on low temperature (40-95°C). Currently, about 2-3 PJ/a is used for energy purposes from the available stock of 460 x 10^5 PJ. This includes district heating (0.31 PJ/a) and heating of greenhouses. A basic problem of geothermal energy use, that safe and economic way of pumping the water back to the sedimentary layers has not been found yet. Therefore, no significant increase

occurred in the last years and according to expert forecasts, a few PJ/a increase is expected until 2010 only.

About 63% of the territory of Hungary is agricultural area. The Hungarian agriculture provides 4.1% of the GDP. Around 4.8% of the Hungarian active population work in the agriculture sector. Due to the dramatic fallback between 1990 and 1995 the greenhouse gas emission from agriculture has decreased, and stalled between the period of 1995 and 2000. Till the accession of Hungary to the European Union no, or a small growth of livestock is expected, after becoming member of the EU a slight growth is probable.

Hungary used to be a country of dense forest cover, at the time Hungarians occupied the land, with a forest ratio of 40-60% (the figure is subject to debate). In the 17th century, however, the area of forests started to decline parallel to the development of the country and other parts of Europe. Beside the increase of the population and the extension of agriculture, this decrease was mainly caused by the industrialization process of the 19th century. At around the turn of the 19th-20th century, the forest ratio *fell down to 1.1 million hectare*, or 12%.

After World War II, in order to cope with the shortage of wood and to decrease its import, the primary goal of the forestry policy in Hungary became to increase wood supply. Forestry had to focus primarily on the quantity of wood production. Later on, as a result of the large scale national *afforestations*, the forested area of the country increased by *600,000 hectare* and reached 18.4%, or *1.7 million hectare* by 1990.

GHG inventory information

Direct greenhouse gases are CO_2, CH_4, and N_2O, the tropospheric ozone, and recently also fluoride gases (HFCs, PFCs and SF_6) are considered as members of this group. On top of these, the following gases also have an effect on atmospheric warming:

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

Emission inventories focus on "direct" gases, which have the most marked effect on atmospheric warning. In the last few years precursor gases were also included in inventories.

The emission of direct gases is summarized in Table I.2 with data based on yearly emission inventories. The data shows the emission of each greenhouse gas 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 % of the base period.

Table I.2. Total greenhouse gas emissions (Gg CO_2 equivalents)

	CO2 net	CH4	N_2O	F-gases	Total net	% of Base	Total without sinks	% of Base
Base	80 579	13 952	4 005	-	98 536	100	101 633	100
1990	67 206	11 437	3 519	-	82 161	83	86 628	85
1991	64 152	19 197	1 318	-	84 667	86	87 905	86
1992	56 735	16 978	1 543	-	75 255	76	79 078	78
1993	56 129	16 633	1 515	-	74 277	75	78 974	78
1994	54 376	16 300	1 665	-	72 341	73	77 161	76
1995	54 961	16 625	1 533	-	73 119	74	77 916	77
1996	56 545	17 125	1 583	-	75 253	76	79 184	78
1997	54 689	16 600	1 360	-	72 649	74	76 854	76
1998	53 190	14 272	10 863	952	79 277	80	83 687	82
1999	55 616	14 343	11 258	829	82 047	83	86 547	85

Source: IEM Greenhouse Gas Inventory

The GHG emission inventory is calculated on the basis of the IPCC methodology. Hungary has chosen the annual average emission level of the period 1985-87 as a base. The UN FCCC allows for countries with economies in transition to use a base year or base period different from 1990, which is the base year for most Annex I countries. The reason of this choice is that the country went through a deep economic crisis around 1990, which led to a change of the whole economic and political system. Therefore, the base level would have been extremely low, if 1990 had been the base year. The crisis lasted until the middle of the 90's. This is reflected in the GHG inventory data, too. As Table I.2 shows, the overall emission level reached its minimum in 1994.

Policies and measures

In 1999, the elaboration of a New Business Model of the Energy Sector was requested by the government. The energy administration with active participation from the private energy companies has fulfilled this task successfully. While developing the model the motivation was to outline the new medium-term objectives and to prepare a more detailed plan of action for its implementation. Further steps and a detailed timetable of tasks

related to the accession will be finalized according to the date of accession to the European Union.

For this reason the model gives a detailed timetable until 2002, but for the period afterwards it only sets the objectives. By introducing competition ahead of EU accession the construction of domestic capacities on a commercial basis also becomes an important objective. Further steps and the liberalization of export-import rights can be scheduled on the basis of competitive market experiences and the final date of accession.

As a consequence of European integration the security of domestic energy consumption will have to be guaranteed not on the national level but as a part of the internal European energy market. For this reason greater emphasis will be placed on the competitiveness of the Hungarian energy sector on the European level than on the security of energy resources (balance of resources). Responsibility of supply will replace the privilege of supply as a result of competition, but the latter still remains an important task of the government.

Increasing efficiency resulting from the introduction of the competition will decrease prices. One should note however, that irrespective of deregulation, other factors also influence prices, and consequently their impact manifests at the same time. (Changes in fuel prices, increase of environmental protection costs, elimination of state aids to the mining industry, realization of possible power plant construction prescribed by the privatization contracts, lower demand for domestic capacity reserves as a part of the single European internal market.)

The most relevant result of the national climate change strategy is that sectoral programs with major environmental impacts started or starting recently do not ignore the issues of greenhouse-gas emissions any more. A prevalent example climate change awareness in sectoral policymaking is provided by the new Energy Saving and Energy Efficiency Action Programme (1107/1999. (X.8.) Govt. resolution).

This decree resulted in a quantified target obligation on the partially state supported energy saving activities for a CO_2 reduction of 5 Mt/a at the year 2010. From 2000 the realization of the objective is ensured through the Energy Saving Sub-Programme of the Széchenyi Plan

The newest development in energy policy is the parliamentary approval of the new Act on Electricity on the 18th of December 2001. The Act will enter into force on 1st of January 2003 and gives a gradual approach of introducing competition from that date. The first step will be liberalizing 35% of the market. The steps following the opening one will be the government's responsibilities. The market opening would be based on regulated third party access. Until reaching a fully open market there will be two parallel markets: the Public Utility Market and the Competitive Market. The new Act is in full harmony with EU rules and principles. The earlier IEA in-depth-review and the Regulatory Reform peer review recommendations are reflected in the Act. In 2002 the main job of the energy administration will be the preparation of the necessary steps leading to market opening and the workout of the detailed secondary legislation.

Based on the principles of our energy policy and on the updating and using of its main achievements, the document “Basis of Hungarian Energy Policy, Business Model of Energy Management” was made by the order the Government Decision No. 2199/1999(VIII.6.). Priority objectives aimed at improving energy saving and energy efficiency by development of environment-friendly renewable energy use. The Government elaborated the energy saving and energy efficiency development strategy and the Action Program supporting implementation, as described by the Government Decision No. 1107/1999.(X.8.). The energy saving program strives to decrease energy-related load on the environment to the lowest possible level.

According to the most probable scenario an increase in methane emission by 37% till 2012 and by about 40% till 2020 is expected. It is unexpected that a significant reduction of the greenhouse gas emissions from agriculture will occur by technical measures, in the foreseeable future the methane emissions from agriculture will primarily depend on the number of livestock.

Hungary carried out a massive afforestation program in the 20th century. There was no single year without afforestations on thousands of hectares, however, with the collapse of the centrally planned economy, less and less resources were allocated to establish new forests. At the end of the 80’s, a new afforestation program was planned: 150 thousand ha of new forests should have been planted in just ten years. However, due to a shortage of resources, only some two-thirds of the program was realized. Nevertheless the ratio of forested land increased again.

At the turn of the millennium, there are new opportunities to increase forest cover. In this decade, the afforestation of some 170 thousand ha is planned. The resoluteness to carry out this program can be seen from the mere fact that more and more financial resources are allocated to

forestry, and, from 2000 to 2001, the resources set aside for afforestation programs have been tripled. This made it possible to increase the afforestation ratio from around three thousand ha per year in 1994 to 17 thousand ha in the last year.

Projections and the total effects of policies and measures

Two scenarios are considered, namely the base case, and the scenario with measures. We compare the emission level of each scenario to the target level (QELRO). In terms of CO_2 equivalents the overall net GHG emission was 98 536 Gg in the base period (this was the annual average emission in 1985-1987). The target value accepted by Hungary in the Kyoto protocol is 92 624 (i.e. –6%). The protocol is going to be ratified by the Hungarian Parliament in 2002, therefore this commitment is considered as a target. The linear trend from 1994 predicts an annual 100 621 Gg for the period of 2008-2012. This means that the reduction target is 7 997 Gg.

The base case scenario results in a reduction of 4 500 Gg CO_2 emission in the energy sector as described in chapters IV and V. This scenario increases the CO_2 sink by 1 100 Gg. Finally the CH_4 emission is reduced by 56.105 Gg CH4, which is 1 178 Gg in CO_2 equivalent (see chapter V). The scenario with measures results in 6 500 Gg CO_2 emission reduction in the energy sector compared to the base case, and the sink increase is 3 000 Gg. The CH_4 emission reduction is 86.116 Gg, equaling to 1 808 Gg CO_2 equivalent. This means that the base case scenario gives 6 778 Gg reduction, while we can reach 11 308 Gg by the scenario with measures.

Therefore, our results show that the overall emission slightly exceeds the target level in the base case scenario for the period 2008-2012. However, the scenario with measures results in a value, which is far lower than the target level. We do not assume any opportunity to reduce the GHG emissions from the agriculture. The CH_4 emissions from this sector will depend only on the quota for livestock accepted by the EU. This value may vary in a relatively small range, which means that this does not influence the evaluation of the examined scenarios. If the quota for livestock will be low, i.e. being close to the level proposed by the EU, the reduction of CH_4 emission would be maximum of 28.14 Gg, which is only 591 Gg in CO_2 equivalent. This is still less than the difference of the target level and the emission level determined by the base case scenario.

This means that measures are needed in Hungary to keep the limit determined in the Kyoto protocol. Some additional measures will also be needed depending what position the Hungarian agriculture will have after joining the EU. More additional measures will be needed, if EU accepts quota for livestock being close to the present Hungarian proposal.

Vulnerability assessment, climate change impacts and adaptation measures

In Hungary, the vulnerability assessment focuses on research of drought occurrences. As a result of the frequent drought events in the country Hungarian water management specialists, agriculture and ago-meteorology experts are deeply involved in drought investigation. Intensive research work has been extended to the following main topics

- Developing methods for reduction of harmful impacts of drought
- Evaluation of the effects of drought events
- Determination of the reasons and circumstances in which severe drought occurs
- Finding out the effects of drought on plant production and animal husbandry
- Developing methods for reduction of harmful impacts of drought

The strategy of drought mitigation had arisen in agriculture as a complex system of means and measures for the reduction of drought damages in agricultural production. Also the necessity of the establishment of monitoring systems and the use of computerized methods has been emphasized together with well-organized complex research work on different impacts of drought. The Hungarian Academy of Sciences established a special commission for the coordination of research activities in this field.

In spite of the relatively active evaluative and research work conducted for solving drought problems in the country, practical actions and governmental interventions remained in most cases ineffective, unfounded and not quite well consolidated. Most of the measures against drought damages have been improvized, the steps have been mainly follow-up and not preventing ones; and the actions have been mostly stop-gap type actions with partial effects only. Based on these perceptions and joining to relevant international movements in this topic (mentioned above) we came to the conclusion that more complex and preparative type of work is necessary for an effective drought mitigation in Hungary. Methods have been developed both in hydrology and meteorology for the calculation of

drought severity and determination of the processes, which are responsible for the formation of drought in some parts of the country, with the help of which a more proper forecast could have been established and produced.

Financial resources and transfer of technology

Energy

The *Pilot Panel Programme* or Soft Loan System for Panel Reconstruction, established in 1996, makes low-interest funding available for the energy-efficient refurbishment of buildings constructed from prefabricated panels, including insulation and heating system modernization.

The *Hungarian Energy Efficiency Co-finance Programme (HEECP)* was launched in 1997 by the International Finance Corporation (IFC) Environmental Projects Unit with a total of 5.0 million US$ funding from the Global Environmental Facility (GEF). The funds are allocated as follows: 4.25 million US$ as guarantee reserves. US$ 300 000 for technical assistance and US$ 450 000 for program administration and operations over a four-year period. After successful termination of the pilot phase, the guarantee facility has been expanded to 16 million US$.

Under the guarantee program, participating local financing institutions execute so-called Guarantee Facility Agreements with the IFC. HEECP provides partial guarantee support to credits provided by the financial institutions for energy efficiency projects (50% in the pilot phase and 35% under HEECP-2).

Credit guarantees have so far been provided to 15 energy efficiency projects (street lighting and heating systems) with a total investment of approx. 3.7 million US$.

Technical assistance funds are also provided to ESCOs. HEECP also seeks ways to promote expanded energy efficiency markets in Hungary in co-operation with other commercial, governmental and NGO agencies.

The *SCORE Programme* is a mechanism funded by the Dutch Government which makes 165 million HUF available for the development of energy efficiency institutions and networks and demonstration projects. In addition to these funding mechanisms, there have been various EU initiatives, including support under the THERMIE, SAVE and SYNERGY programs.

In parallel to the *National Energy Saving and Energy Efficiency Action Programme*, the UNDP/GEF Public Sector Energy Efficiency Programme aims at helping Hungary to improve energy efficiency in the public sector. The Energy Center is the implementing agency of the project, under the authority of the Ministry of Economic Affairs. The Program also intends to reach out to municipalities and local advice centers and networks. The managing director of the Energy Center is also the director of the program. The budget of the program is approx. 1.5 million US$.

Another GEF program is the *IFC/GEF Efficient Lighting Initiative (ELI)*, which is part of a three-year, US$ 15 million program designed by IFC and funded by GEF to accelerate the penetration of energy efficient lighting technologies into emerging markets in Argentina, the Czech Republic, Hungary, Latvia, Peru, the Philippines and South Africa. ELI has allocated US$ 1.25 million to lower market barriers to efficient lighting in Hungary. The program was initiated in 2000.

Forestry

Financing large forestry programs has always been a considerable burden for the Hungarian national budget. However, it has always been regarded that afforestations are important strategical measure with many mid- and long-term benefits. Therefore, until the end of the 1980-90's, when the country's economy experienced a severe recession, resources were available for the programs. Beginning with the last year, much national resources have been allocated for afforestations again.

Allocating enough resources for the forestry sector will be an economic necessity, too. Tourism is becoming a major economic sector, which requires healthy and peacful landscapes, where tourists can feel themselves close to nature. This especially holds true for regions which may be touristically attractive, have little other choices to the local people to make a living, and where forestation rate is low.

In addition, even more resources are expected to be spent for afforestations when the country becomes a member of the Europen Union, possibly in 2004. There may be three external sources of resources. One is the direct support of the EU. Another may be that European countries with large emissions will engage in Joint Implementation programs: costs are and will remain somewhat lower in Hungary than in many EU-member states, and it is easy to find areas here to afforest. Finally, if Hungary is a member of the EU, investors of other countries, such as the USA, may regard Hungary as

a country where long-term projects, like afforestation, can be conducted at a low risk rate.

Research and systematic observation

In 1995-98, Hungary participated in the U.S. Country Studies Program. The project led by Systemexpert, focused on the development of a comprehensive GHG inventory of the country, on the development of a mitigation strategy and of a climate change action plan for the country.

A group at Veszprém University is engaged in understanding the role of atmospheric aerosols in climate change.

The Hungarian Academy of Sciences (HAS) established a multi-institute research group for exploring the strategic issues related to water management and hydrology at the turn of the millennium in Hungary. Within the framework of this research project, the expected impacts of climate change on hydrology and water management in Hungary have been explored as well.

The Research Institute for Water Management (VITUKI) has been active in research related to the impact of climate change on hydrological resources. One of their projects is aimed at understanding the link between climate change and floods in Hungary.

The Hungarian Meteorological Service (HMS) is working in many areas related to climate change, as described above. Among their projects, activities in drought monitoring are the most significant.

An important activity of the country currently is the participation in the work of the COST E21 Action ("The contribution of forests and forestry in the mitigation of greenhouse gases").

The Hungarian Meteorological Service (HMS, http://www.met.hu/) is the largest meteorological and climatic information provider of the country. The scope of the provided information extends to the past (trends, changes, analyses), to the present (measured and observed meteorological and environmental data), and also to the future (forecasts on meteorological and climatic time-scales).

Besides the HMS, significant scientific and educational activity is expressed in the field of climatic change by the Meteorological Department of the Eötvös Loránd University. Their activities include: statistical down-scaling from circulation patterns; effects of ENSO in the region; surface-atmosphere (SWAT) modeling and others.

Education, training and public awareness

Although the level of environmental awareness of the population is increasing, they do not place a high priority for environmental problems on their agenda.

Hungary has joined the GLOBE (Global Learning and Observations to Benefit the Environment, http://www.globe.gov) network in 1999. The Globe program is an international environmental educational initiative, aimed at increasing the environmental awareness of students in secondary education. The program was launched in 1994 in the USA, and attempts to help the young generations to understand global problems, and facilitates global networking of young people participating in the same program around the planet. In the framework of this program, Hungarian students participate in regular monitoring and measurement activities in their environments in the various fields of science, with the leadership of trained teachers and scientists. The program is supported by the Hungarian government.

The Department of Environmental Sciences and Policy of the Central European University (http://www.personal.ceu.hu/departs/envsci/) is engaged in a graduate level education of the entire climate change problem, encompassing the wide spectrum of issues related to the science, monitoring, impacts, mitigation and policy setting in this complex area. Each year several Masters and PhD theses are conducted in connected fields; especially on subjects related to the regional policy challenges of the climate change problem for countries in transition.

The Budapest University of Technology and Economics is engaged in climate change related education in several disciplines. For instance, the doctoral school of the Civil Engineering Faculty runs a course on the hydrological impacts of climate change. However, much more relevant courses should be offered at this key university, especially at the undergraduate level.

The Szt. István University in Gödöllo is engaged in several educational activities related to climate change. Among others, 5th year students have an opportunity to study the application of mathematical models in climate change mitigation.

Sixteen doctoral dissertations have been defended on the issue of renewable energy have been defended so far and 6-8 university students are preparing their theses on the issue currently, mainly in Sopron, Budapest and Gödöllo. Due to the shortage of leading lecturers in this subject and to the lack of professional conferences, development at other universities can be expected in the long term only.

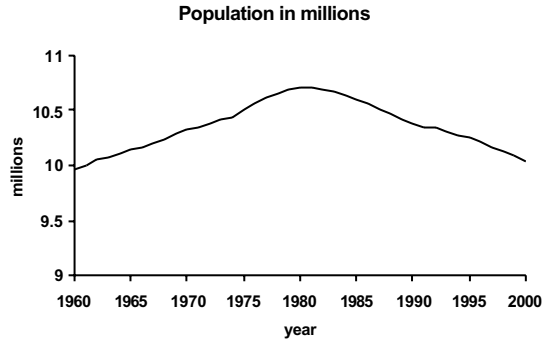
The Physics Department of the Eszterházy Károly College in Eger offers relevant courses and laboratory practices in its subject "Environmental Physics". The course is compulsory for environmental science majors and elective for physics majors.

II. National Circumstances Relevant to GHG Emissions

Hungary is a landlocked country in Central Europe. Hungary is located between 45°48' and 48°35' north and from 16°05' to 22°58' east. Its widest dimension is 528 km in east-west direction and 268 km in north-south direction. 84% of the country area is below 200 m above sea level, 14% is between 200 m and 400 m, 2% above 400 m. The highest point is at 1015 m, the lowest one is at 78 m.

Between 1996 and 2000, the yearly mean temperature varied from 8.2 °C and 12.4 °C, and the yearly amount of precipitation between 203 mm and 1055 mm, the yearly sunshine duration between 1691 h and 2380 h at different places of the country.

Figure II.1: Population between 1960 and 2000



Source: Central Statistical Office

The area of the country is 93,033 km^2, of which 62.9% is agricultural area (48% arable land, 3.2% garden, orchard and vineyard, 11.3% grassland), 18.9% forest, 0.9% reed and fish-pond, 17.2% uncultivated land area. At present in the European Union the proportion of the agricultural land is 40.2%, the average of the candidate countries is 54.2%.

At the beginning of year 2001, the population of the country was 10.2 million, of which 6.6 million people live in towns. The density of population is 109.6 inhabitants/km^2. Between 1970 and 2000 the population decreased by about 125 thousand people. Figure II.1 shows the changes between 1960 and 2000.

The country has now an emerging market economy. A deep economic crisis began in the second half of the 80's. The whole economic and political system was transformed around 1990 similarly to other post Soviet countries, the transition process toward market economy began. However, the economic depression lasted till 1993. Since then the economy began to develop and the growth rate of the Hungarian economy exceeded that of the EU at the end of the last century. The main economic indicators are shown in Table II.1. Hungary is one of the candidates of the EU, the accession is supposed to be realized in 2004.

Table II.1: Main economic indicators of Hungary in 1990-2001 (%)

	1990	1993	1995	2000	2001
GDP growth rate	-3.3	-0.8	1.5	5.2	3.8
Unemployment rate	2.1	12.1	10.4	6.4	5.7
Inflation rate	28.9	22.5	28.2	9.9	9.3
Balance of central government/GDP	0.8	-5.5	-6.0	-2.8	-2.8

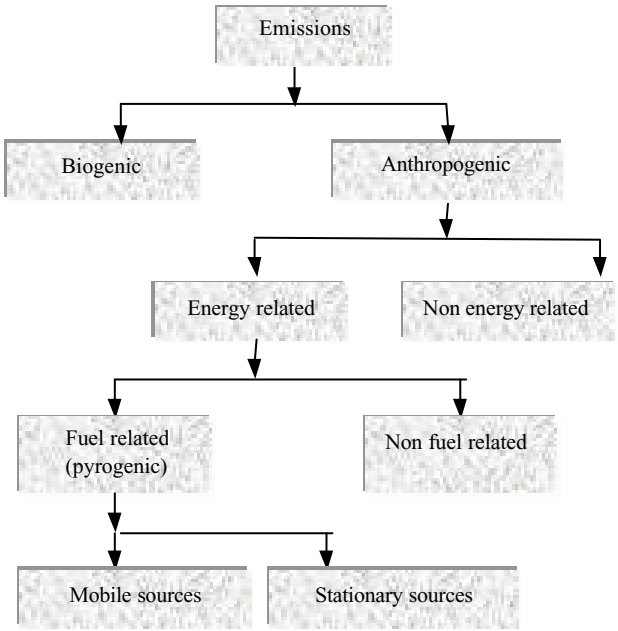
Source: Central Statistical Office

Energy

Long-acting tendencies in the past

Figure II.2. shows the general classification of emissions. In this section we focus on the so-called pyrogenic, fossil fuel related emissions.

Figure II.2: Classification of emissions



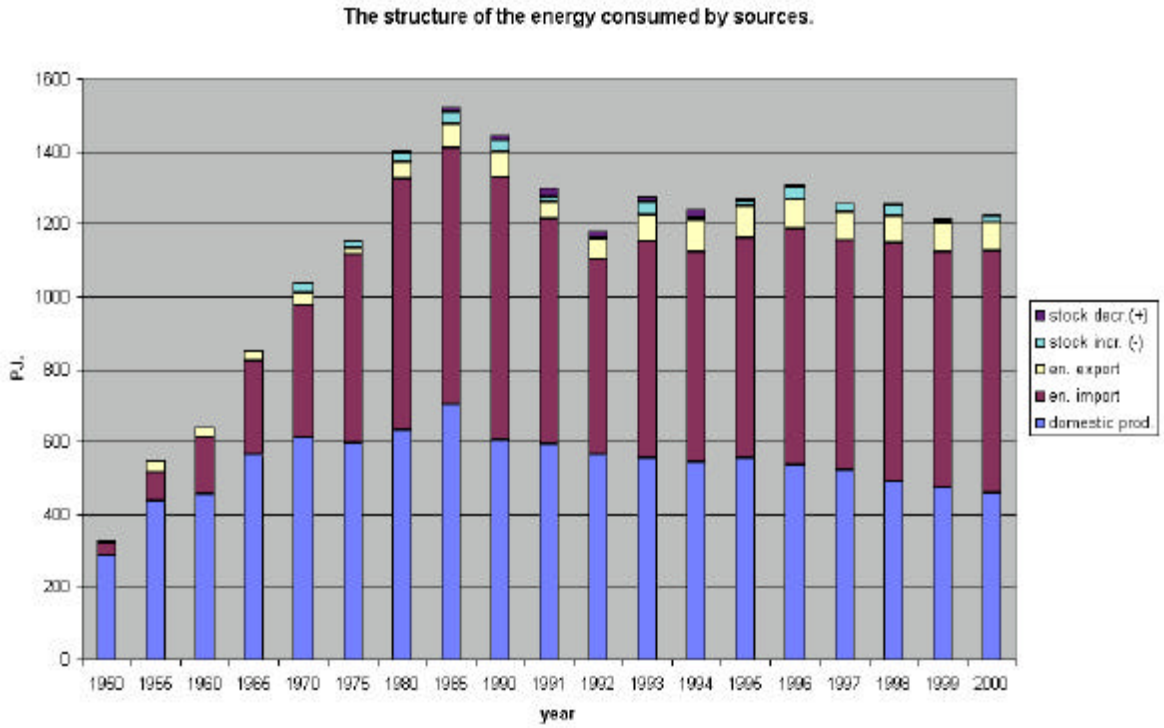
Since the fossil fuel consumption has been selected as the activity level for calculation of the fossil fuel related emissions, it is very important to know the

characteristic features of the Hungarian Energy System (HES), which affected the evaluation of the HES in the past. These features will influence its evaluation in the future too, because their effects are long acting.

One of the most characteristic feature of the HES is the lack of sufficient, clean and cheap domestic energy resources, thus the increasing energy demand of the country has to be supplied by increasing the energy import. Nowadays, the import dependency exceeds 50%, and it is expected to be increasing significantly even in the future, because of the exhaustion of the domestic hydrocarbon reserves.

In Figure II.3, the sources of the energy supply of the country are shown, which consist of the domestic production, the energy import and the energy from stock decreasing.

Figure II.3.



Source: Energy Statistical Yearbooks

The share of the energy import of the country cannot be modified significantly, but because of strategic requirements our energy import has been diversified in the near past. If the energy import is modified in the future, it will certainly influence the pollutant emissions too, because of the different chemical properties of the imported fossil fuels. The utilization of the low quality domestic energy resources, and therefore the environmental pollution caused by the fuel use in Hungary was relatively high. Regarding the environmental pollution, these features are fundamental and deterministic. We were forced to use the low quality domestic fuels and a huge amount of energy to operate our outdated production system, our aged car fleet, devices and appliances. The energy sector did its best for the reliable and effective energy supply of the country within its possibilities, for example,

-The structure of the fuel use was changed,
-New technologies and new types of energy have been introduced,
-Destructive technologies in the oil industry has been realized,
-Combined electricity and heat generation has been realized,
-Combined - cycle gas turbine units have been installed,
-Fluidized bed combustion for electrical energy production has been installed,

-Electrostatic precipitators in all coal-fired power plants have been put into operation,
-Desulfurisation of the oil products have been introduced,
-Intensive natural gas program has been realized,
-Nuclear electricity generation was put into operation.
-An adequate tariff system is planned to promote the structural change in the fossil fuel consumption,
-Diversification of the energy import has been developed.

A part of the energy sources is exported, and used for stock increasing. Thus total primary energy requirement (TPER) of the country is equal to the energy sources minus the energy export and minus the energy to stock increasing. When calculating the TPER requirement, the electricity generated by the hydro power plants and the imported electricity are taken into consideration with their fuel equivalent, i.e. with the average heat rate of the domestic power plants in the calendar year. It has also to be emphasized that the nuclear electrical energy production is accounted in the imports, because the fuel rods used by our nuclear power plant were imported in spite of the domestic uranium ore mining. The uranium ore mining in Hungary was stopped because of economic reasons. The uranium concentration of the ore is very low, thus its mining is too costly.

Energy supply

Domestic energy production of Hungary (oil, natural gas, brown and hard coal and lignite) can supply roughly the one third of total primary energy used in the country. The rest is covered by imports. Since domestic production is likely to decrease, the importance of imports is growing.

The import dependency of the energy supply is 69%. Due to the earlier close links, the major supplier of crude oil and natural gas is Russia but the oil, gas pipeline systems have diversified interconnections towards the West-European systems. Some large quantities of oil can also be imported through the Adria pipeline (connecting Hungary to the Mediterranean Sea) and gas can also be purchased through the Gyor-Baumgarten pipeline which links Hungary to the European gas network.

On an annual basis nearly a third the total demand for gas is covered by indigenous production. The remainder is imported mainly from Russia, but since 1996 HAG gas-pipeline (Baumgarten-Gyor) is an existing possibility to import gas from other countries as well. Storage capacity is significant; an essential part of the winter demand is met from indigenous production and storage. Indigenous reserves are large enough to provide cushion gas to manage peaks in demand. Gas supply is thus reasonably secure. However, indigenous production is expected to decline and forecasts call for it to cover little less than a quarter of demand by 2005.

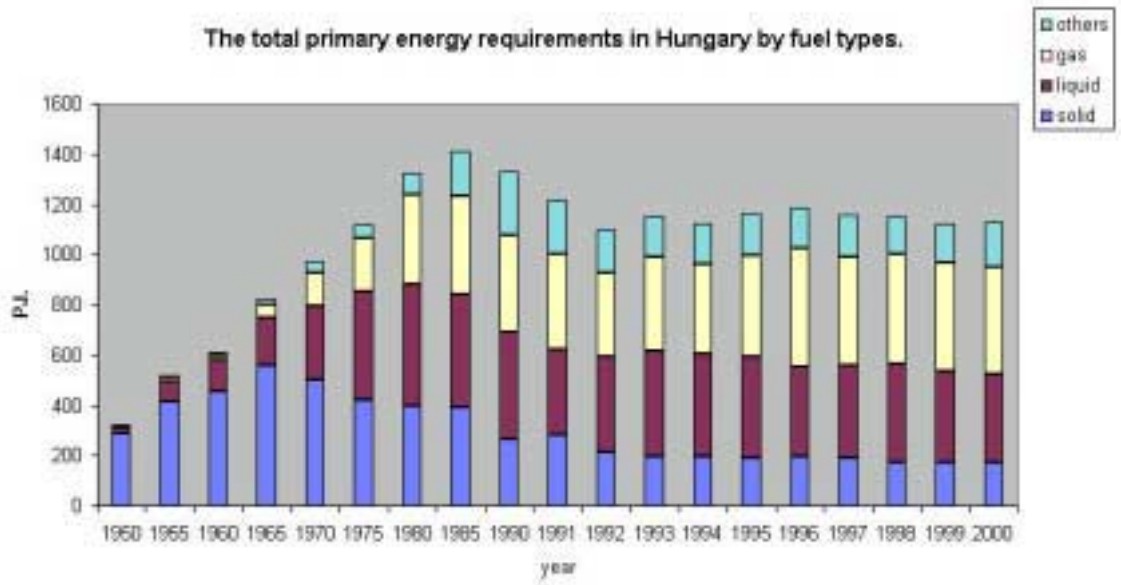
Now Hungary is an integrated part of the European power system. Our electricity network has interconnected and works parallel with the UCPTE system, and after a very successful test operation the MVM (Hungarian Power Companies) is now a full member of the UCPTE. Based on the Hungarian geographical location, in the future enlargement of the EU we shall have a key role also in the enlarged energy networks (e.g. UCPTE - SÜDEL interconnection) and Hungary has a good chance related to transit.

The coal market is also totally liberalized. One part of the coal mining companies has been integrated in the coal-fired power plants, they produce coal mainly for electricity generation. The smaller coal-mining companies are working independent.

TPES (Total Primary Energy Supply) peaked at 31 Mtoe in 1987, when coal and lignite accounted for 27% of supply. In the time period 1987-1992 TPES declined, which was caused mainly the hard time of the economy. After 1992 TPES became stagnant on about 25 Mtoe level, the visible small fluctuation is the effect of the temperature changes. The primary energy use in Hungary in 2000 was 24,7 Mtoe (1036,1PJ), which is 0,7% less than the volume used in 1999. The year 2001 was very cold for this reason in 2001 the TPES was 25.44 Mtoe, which is higher with 2,8% comparing with 2000.

The total primary energy requirement (TPER) of the country by fuel types is shown in Figure II.4.

Figure II.4



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Source: Energy Statistical Yearbooks

Earlier, the consumption of the fossils especially of the coal was dominant. Later on hydrocarbons began to play a more and more important role. The structure of the domestic energy production changed drastically in the past years. The coal production, especially the deep-mining drastically decreased. In the future, the hydrocarbon mining will decrease too, because of the exhaustion of the domestic reserves. Only the production of lignite from the open-pit mining will be maintained, and the role of the renewable energy sources is expected to increase to a certain extent. This means that our energy import should be increased to cover the domestic energy demand and our dependency on energy import will significantly increase in the future.

The penetration of the nuclear electricity into the HES started in 1983. Its share in the primary energy consumption is about 13-15% (see Figure II.4), but in the domestic electrical energy production its share is much higher reaching about 40-42%.

In the last period, the fossil fuel consumption and the electrical energy consumption of the country decreased (Figures II.3 through II.5) because of several factors. These are the overall economic recession, the transition from planned economy to market economy, the restructuring of aged production system in the industry, the decrease of energy intensive uneconomical production, the sharp changes in the structure of the energy consumption, etc.

In the past decade, our electricity import decreased even faster than the domestic electricity consumption, thus the domestic electrical energy production had to be increased to satisfy the electricity demand of the consumers.

Figure II.5.

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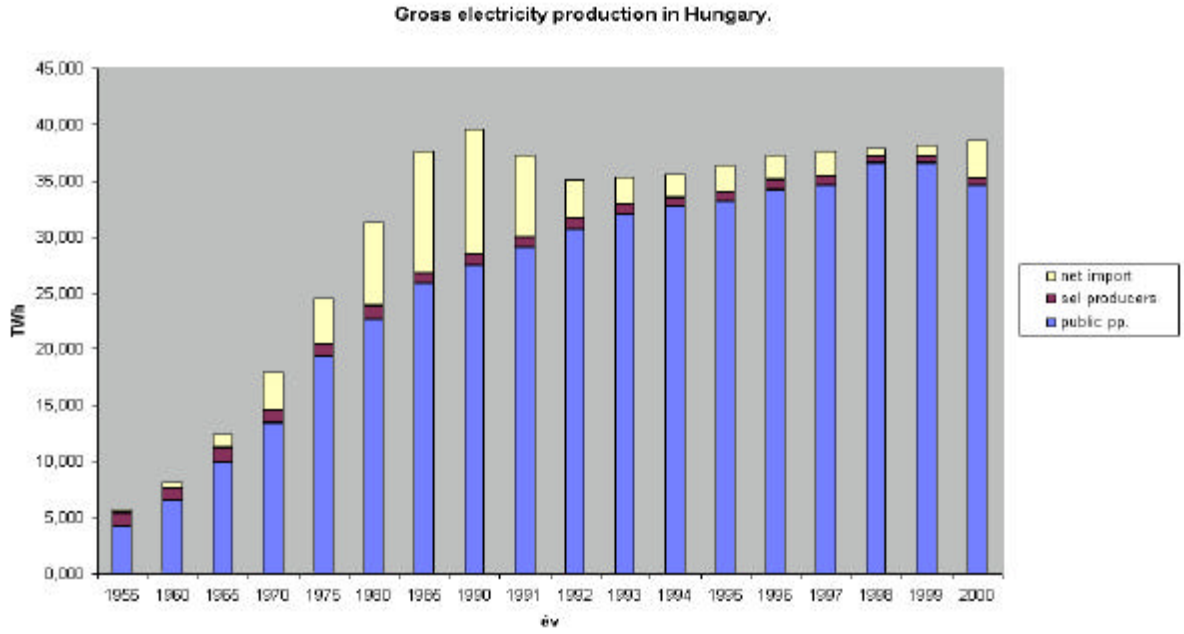
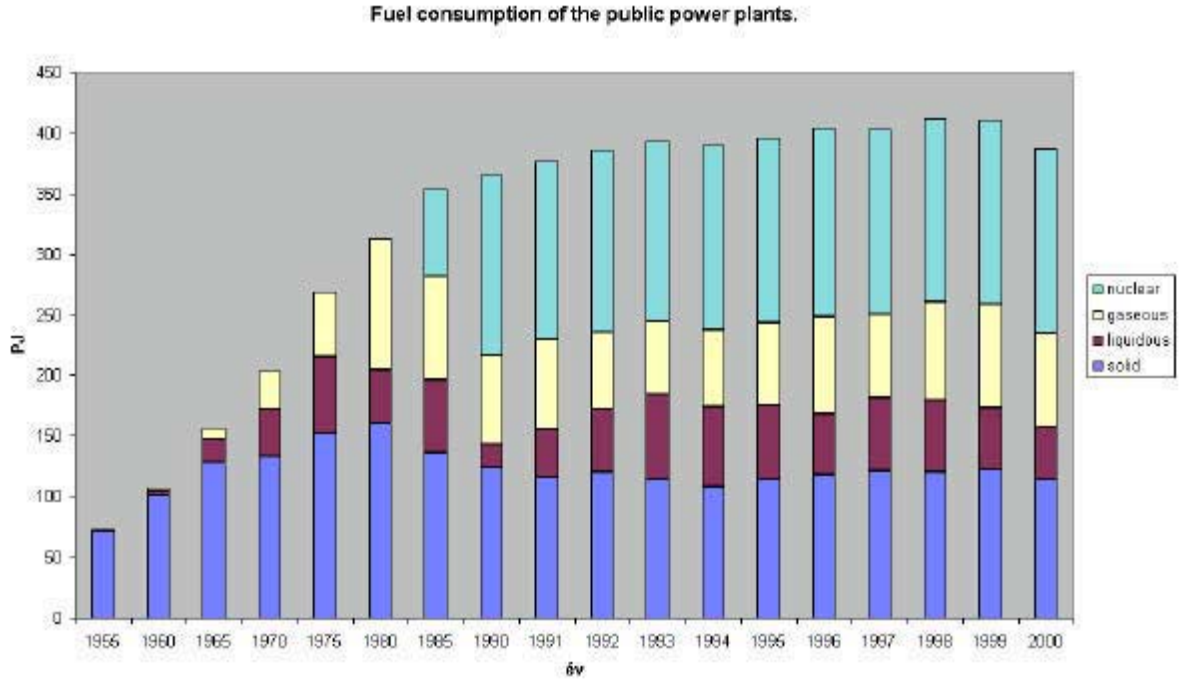


Source Yearbooks of the Hungarian Power Companies

In Figure II.6, the fuel consumption of the public power plants is shown. Nowadays, the fossil fuel consumption of the public power plants is less than it was before the introduction of the nuclear electricity production at a significantly higher production level.

Figure II.6



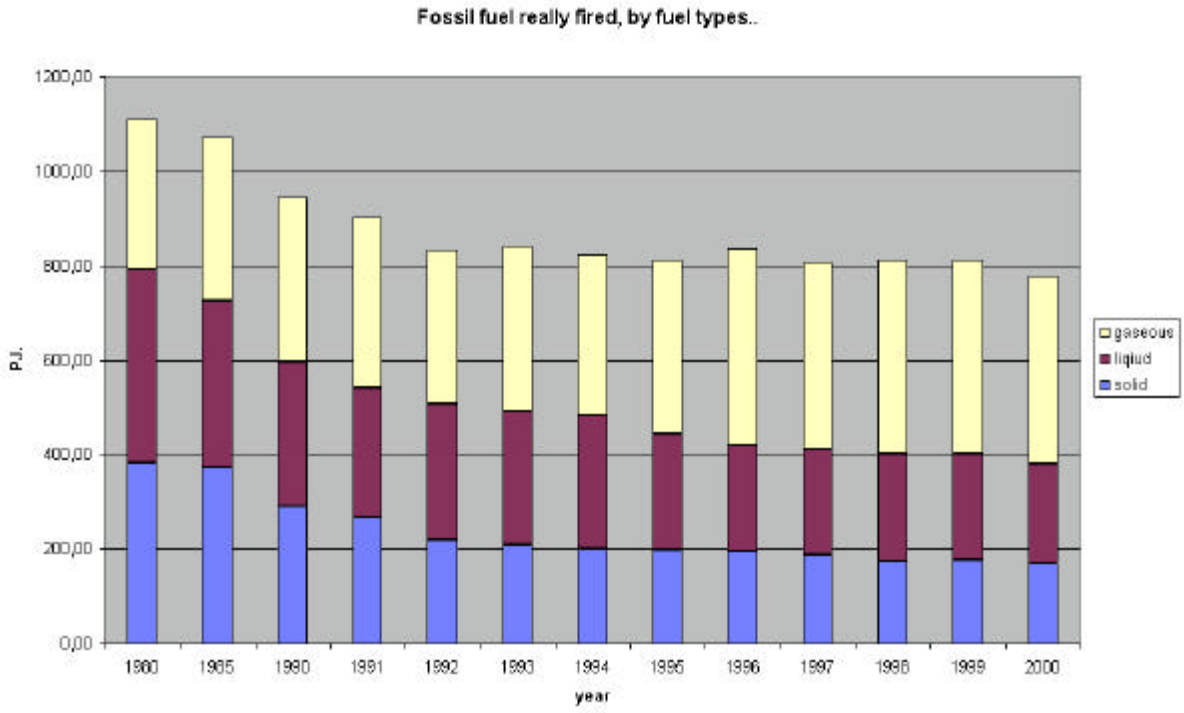
Source: Yearbooks of the Hungarian Power Companies

Due to modification in the structure of fuels fired, and because of other modifications, it was possible to keep the emission limits of the different pollutants regulated by several international agreements.

In 2000, the decrease of the fuel consumption of public power plants was caused be the sharp increase in our net electricity import (see Figure II.5).

In Figure II.7, the volumes of the fossil fuels actually fired in the country are shown by fuel types. Figure II.8 presents the consumption by sectors.

FigureII.7.

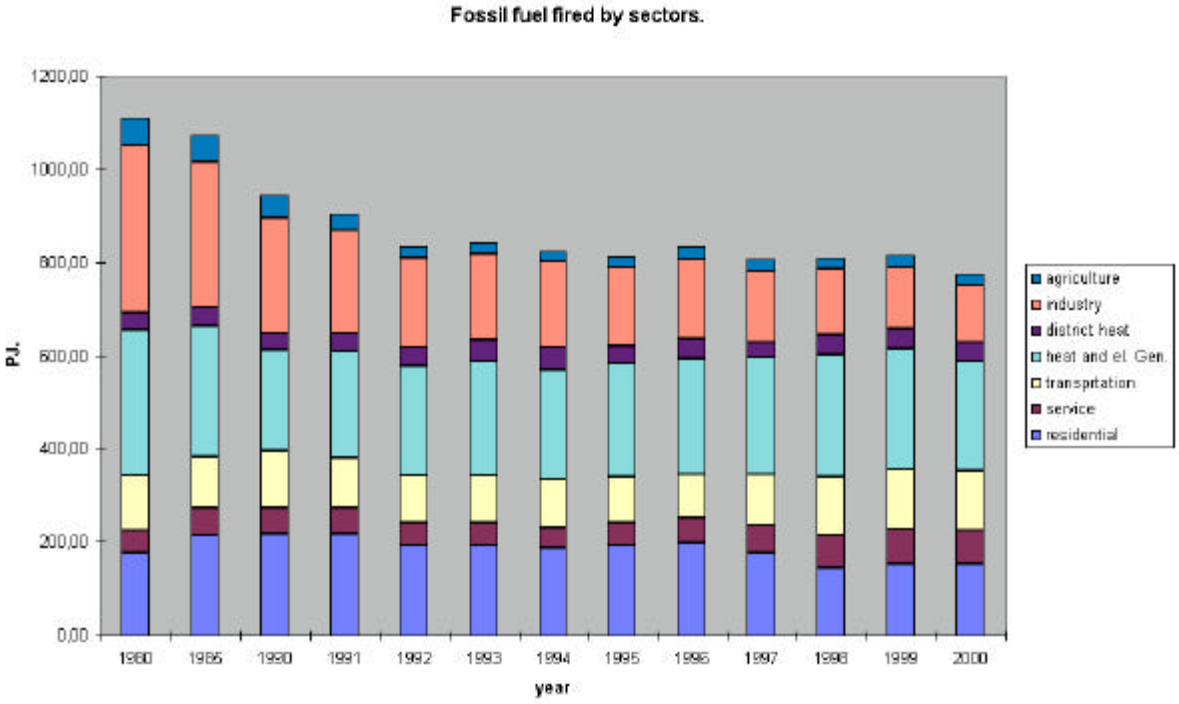


Source: Energy statistical yearbooks

The fossil fuel fired decreased in the last decade. This decrease was mostly due to the high share of the nuclear capacity, the intensive natural gas program, and the modification in the production systems and technologies.

The domestic coal production, especially the deep mining capacity decreased. AT present, more than 90% of the domestically mined coal is consumed by the public power plants.

Figure II.8.



Source: Energy statistical yearbooks

The price of the liquid fuels rapidly increased, and it has already approached the world market price. This led to the decrease of the liquid fuel consumption, especially of motor fuel consumption. One can see the increase of the natural gas consumption, which is very advantageous regarding the environmental pollution connected with the fossil fuel consumption.

Fuel mix

In the energy balance coal, lignite and the other solid fuels now account for 15% of TPES, the share of the oil is about 30%. The consumption of oil and coal has all declined in absolute terms since 1987, and will continue to decline relative to the natural gas. Natural gas consumption is growing in absolute terms as well, reached about 40% in the TPES in 1998. Nuclear power generation has remained constant since 1988 and now accounts for 13% of TPES. Comparing with the EU average fuel mix the most significant differences is the high (nearly double) share of the natural gas. Compared to the average of EU, oil consumption in Hungary is fairly low; this reflects the relatively small part transport plays in energy consumption in Hungary and the relatively restricted use of fuel oil in the residential sector. The structure of end-use energy demand differs significantly between Hungary and EU. Heat, delivered as hot water and process steam to industry and supplied to residential sector consumers via district heating systems, represents about 10% of final consumption in Hungary and less than 2% in EU.

Energy intensity

Energy intensity has been gradually decreasing in the last years. In the coming years only 1-2% increase in energy use is expected for a GDP growth of 3-6%, thus energy intensity is likely to fall further. The primary energy use in Hungary in 2000 was 0.7% less than the volume used in 1999. In the same time the GDP increased by 5.2%. This means that the energy efficiency improved by cca.5.5% in 2000.

Table II.2. Primary and final energy intensities 1991 – 1998

	1991	1992	1993	1994	1995	1996	1997	1998
Primary intensity	0.458	0.428	0.437	0.420	0.423	0.423	0.396	0.379
Final intensity	0.314	0.282	0.287	0.274	0.272	0.277	0.251	0.237
Final intensity at 1991 structure of GDP and with climatic corrections	0.309	0.285	0.278	0.268	0.274	0.271	0.266	0.262

Source: Ministry of Economic Affairs

Energy transformation

The average efficiency of energy transformation was 69.9% in 1998, which is composed of the following key components:

- Oil refining 99.8%
- Thermal public power generation 34.4%
- Nuclear power generation 33.6%
- Combined heat and power production 77.8%
- Public heat production 84.6%

Taking into consideration the different sources of electricity production, the average efficiency of electricity generation is 38.3%.

Energy forecast

According to the latest energy forecast, which was prepared in autumn 2001 as a part of the Hungarian Energy Policy Report to the Parliament in the next ten years, growth of the primary energy supply cca. 1.0% per year growth of the electricity energy supply cca. 1.5% per year was projected (basis of the calculation is about 5% GDP growth).

Coal and coal products demand is forecasted to fall from 157 PJ in 1998 to 135 PJ in 2005. Demand by industry falls strongly, largely because of contraction in the energy intensive industries. Residential demand falls also, due to the substitution of coal with natural gas.

Total demand for natural gas is supposed to increase. Household demand increases is caused by the substitution of coal with natural gas. Gas demand in industry is also projected to grow, depending on the price differentials between gas, heavy fuel oil and coal. Heavy fuel oil may well prove more competitive. Further increases in gas demand could arise for power generation if electricity demand grows more quickly.

Oil consumption is projected to increase slowly, in harmony with the future development of the road transport. Heating oil consumption of the households is expected to decline.

Renewable energy

As greenhouse gas emissions are mainly caused by energy generation and use, appropriate measures should also be taken in this sector to decrease such emissions. To achieve this goal, the following solutions are available in the field of energy management:

a.) Decrease energy use through the application of up-to-date technologies, equipment and construction methods. Summarized, these can be collected under the name of energy saving.

b.) Introduce high efficiency technologies in the energy sector in a wider scope, i.e. increase energy efficiency.

c.) Use renewable, mainly natural energy sources in greater extent, because they do not increase the total carbon volume emitted into the atmosphere, at the same time, the emission of substituted fossil fuels is stopped.

Groups of renewable energy sources available in Hungary in considerable volume, their technical potential and current use are shown by Table II.3:

Table II.3: Renewable energy sources of Hungary

RENEWABLE ENERGY	Technical potential PJ/a	Current use PJ/a
a.) Hydropower[1]	1,2	0,67
b.) Wind[2]	1,3	0,005
c.) Solar energy with active use[3]	3,6	0,061
d.) Geothermal energy (incl. Heat pump)[4]	50,0	3,6
e.) Biomass[5]	165,8	31,5
f.) Communal waste[6]	5,0	0,79
Total:	**225,73**	**36,63**

[1] *Source: Vízenergia Kft. 2001. Annual overview report*
[2] *Source: Ministry of Economics, Department of Energetics*
[3] *Source: Solent Sytem Kft, 2001*
[4] *No electricity is produced at present*
[5] *Source: Co-Energ Kft, 2001, Communal Waste Report*
[6] *Source: Ministry of Economics, Department of Energetics*

General remarks and comments to the above figures:

- Technical potential means the total amount of energy which can be exploited, produced and used by the application of currently available technologies without disturbing the balance of nature, provided that – in case of appropriate market regulation – user's demand can also be ensured.

- Regarding energy statistics in Hungary, renewables are not listed. Therefore, figures on use have been determined on the following basis:
  - In case of items a.), b.) and f.), production data of existing plants;
  - In case of c.), d.) and e.), estimate of experts (number of equipment sold, data of known users, statistics on residents, etc.).

Typical features of renewable energy use are as follows.

Hydropower

Rivers with high fall are not found in Hungary, therefore mainly flat land power stations can be implemented. After the political decision of stopping the implementation of the Danube Hydropower Plant, energy use might be developed by the construction of a few small hydropower stations and by the utilization of the cooling water energy of the basic power plants located along the Danube which would amount to a total additional capacity of about 27 MW.

The total capacity of currently operated hydropower stations is 54.9 MW, production: 186 GWh/a.

Wind

Regarding available measuring data on wind energy potential, it is shown that an annual energy content of 80-180 W/m^2 appears in a segment of the country facing NW-SE direction which would be sufficient for supplying a power plant, however it is much less compared to the usual figures of seaside countries which amount to 660-800 W/m^2/a. On this basis, only two wind turbines of 850 kW capacity have been implemented so far, with an annual output of 1.4 GWh in 2001.

As the development of wind energy use had the greatest increase in the EU, wide-scaled activities have been started in this field in Hungary too. However, low economic return and – sometimes groundless – protest of green organizations represent the main barrier of such developments.

Solar energy

Now we list the applications of active solar energy use.

Solar collectors for heat production

Currently, heat production means nearly DHW supply only. The total built-in collector surface is about 40-44 th.m^2 with a heat output of about 61 TJ/a. Owing partly to currently operating subsidy systems on one hand, while partly to well-proved planning, manufacturing and assembly capacities on the other, this sector of renewable energy use

keeps increasing dynamically. About 2000 m^2 collectors were implemented in 2001 and this figure – despite the low rate of return – continuously increases.

Photovoltaic systems
Photovoltaic systems are used for supply independent from the grid only, with a built-in capacity of 30 kW. Considering the connection to the grid, these systems can hardly be made economic under Hungarian circumstances, therefore the significant increase of their role in energy management is not expected in the near future.

Passive solar energy use
Passive solar energy use is not significant in Hungary, the first buildings of such type are under construction now. These results might reasonably be published by chapters on energy saving.

Geothermal energy
Hungary is very rich in underground hot water stocks, which can mainly be gained from sedimentary layers on low temperature (40-95°C). Currently, about 2-3 PJ/a are used for energy purposes from the available stock of 460 x 10^5 PJ. This includes district heating (0.31 PJ/a) and heating of greenhouses.

A basic problem of geothermal energy use, that safe and economic way of pressing the water back to the sedimentary layers has not been found yet. Therefore, no significant increase in use occurred in the last years and according to expert forecasts, a few PJ/a increase is expected until 2010 only.

Regarding the use of heat pumps, no exact figures are available in Hungary. This method is recommended and can be economic at places, where the ratio of gained heat energy and input electricity is over 3-3.5, e.g. at water over 28-35°C temperature. This method is widely used at swimming pools, thermal baths and food processing plants, where a continuous increase in development is expected.

The produced energy amounts to about 0.6-1 PJ/a. Technical background is fully available, penetration of this system depends mainly on energy prices and subsidies.

Biomass
Currently, this represents the biggest and dominant sector of renewable energy use and – considering available potentials of the country – this will also remain in the future. At the same time, biomass use, effecting most fields of governmental activity, is a complicated, sometimes controversial question. Having a development in this field, the biggest results might be achieved in decreasing the emission of greenhouse gases. Listed in typical groups, current biomass use in Hungary is shown by Table II.4:

Table II.4: Biomass use in Hungary

Biomass groups used for energy generation	
Firewood	22
Wood industrial by-products	4,87
Forest woodchip	0,35
Briquette, pellet	0,18
Wood energy plantations	~ 0
Dendromass total:	*27,4 PJ/a*
Agricultural by-products (straw, corn-cob, sunflower shell, fruit tree prunings, vine-shoots, etc.)	3,94
Grass-like energy plantations	0
Agricultural biomass, total:	*3,94 PJ/a*
Landfill gas	0,04
Sewage gas	0,12
Manure gas	0
Biogas total:	*0,16 PJ/a*
Biodiesel	0
Bio-ethanol	0
Liquid biofuels total:	*0*
Biomass total:	**31,50 PJ/a**

Source: Co-Energy, 2002

Features of bioenergy use are as follows:

- Firewood is used at about 350 thousand households (-equivalent) as main or additional fuel. Regarding heating equipment types, most of them are iron or tile stoves and small boilers made for coal firing respectively. A few hundred up-to-date firing equipments are operated only. About one-third of the total firewood trade does not go through regular trade channels, but directly purchased from or given by the forestry companies or taken out from the forest illegally.
- Plants of the primary woodworking industry mainly solve their energy supply by own woodwaste. This by-product is also supplied to some institutions and district heating systems, but a considerable unused volume is still available.
- Based on users' order, about 30 thousand tons of woodchip is produced from forest and industrial waste annually.
- Bio-briquette is produced at 24 plants now, with an annual volume of 12-14 thousand tons. This amount is partly exported, and partly used by residents. Currently, no pellet is produced.
- Wood energy plantations are in experimental phase only. Industrial-size plantations are being organized at a few places, they have not been put into production now.
- Regarding the by-products of plant cultivation and the connecting processing industry, sunflower shell, corn-cob, hemp sliver and marc are used in industrial size. Straw, fruit tree prunings, vine-shoots and other by-products are used at rural households and – in bigger volume – for greenhouse heating, mainly at low technical level.
- Owing to the latest regulation, landfill gas is produced at more and more landfill sites. Its use is occasional, the gas is mainly used for the heating of plant buildings. CHP unit is operated at one site only.
- Sewage gas production has been implemented at most wastewater plants and is mainly in operation. Currently, six municipal plants have CHP unit with gas engine.
- There is no agricultural biogas production (based on liquid manure or mixed raw material) now. There are two plants built in the 1980s in operation and this system is under implementation at an other animal keeping farm.
- Biodiesel production does not exist at the moment. A biodiesel program is available, within the frame of this, two pilot plants are under implementation with a total capacity of 8000 tons/a.
- Bio-ethanol: Production data are not known, there is no domestic use. A bio-ethanol program is under preparation now.

Communal waste

Currently, energy from communal waste is produced at the Budapest Waste Incinerator only (energy output: 310 TJ/a electricity + 480 TJ/a heat). Regarding selective waste collection/ sorting and implementation of additional incineration capacity, no central program has been elaborated so far. This will expectedly done in the next years.

Situation and circumstances of renewable energy use are similar to those of other countries being in the transitional economy period, however a few national specific features can be identified as follows:

- Supported by strong state subsidy in an earlier 25 year period, practically all Hungarian settlements have been supplied by natural gas. In addition to this, the price of natural gas is even now centrally regulated, and the natural gas is sold to residents and to the communal sector on a beneficial (under market) price. Under these conditions, there is no strong motivation from the market side to convert to renewable energy use.
- Nowadays, the government seems to recognize the necessity of extended use of renewable energy. At the same time, active cooperation has not been established neither in program elaboration, nor in harmonizing subsidy principles and systems among relevant ministries responsible for this issue (Ministry of Economy, Ministry of Environment and Ministry of Agriculture and Regional Development), therefore efforts and funding of governmental organizations which are of no great significance even alone, are dissipated. A program on renewable energy use which would include a reasonably expected development of the groups of renewable energy sources, also determining its financial and economic conditions, has not been made so far, and it is even not under preparation now. The Ministry of Agriculture and Regional Development alone keeps preparing new

program proposals on bioenergy use, however their enforcement failed.
- Renewable energy lobby does not exist in Hungary. Every important field has its scientific or interest-safeguarding association. Among these, the Hungarian Solar Energy Association seems to be the best organized one. Social field and influence of these associations are not dominant. At the same time, a strong gas and oil lobby, furthermore an electric lobby exists which have a counter-interest in developing renewable energy use.

In addition to these, general symptoms being typical of CEE countries can also be observed in Hungary. These are summarized below:

- Due to the low income level of a significant part of the population, most people can not afford any conversion to or excess costs on green energy. On the same basis, it is not possible to impose tax on fossil fuel consumption at present.
- Hungary has a considerable amount of excess electricity production capacity, and this is even more increased by the CHP plants implemented in the last years. In this situation, more expensive green energy is not needed by the market.
- Compared to the tasks to be solved, financial situation of the country can make only relatively small funds for renewable energy development possible. These funds can mainly be obtained for smaller projects (this is the cause why solar collectors can develop faster than any other renewable projects), since they are insufficient for bigger and costly investments. International funds can be obtained through long and difficult tendering processes, therefore they are not very attractive.
- In many cases (reasonably grounded or groundless) aversion and uncertainty might occur against new projects. To implement the first convincing project is sometimes difficult.

On the basis of above description, the situation of renewable energy use can be judged as Hungary are considerably behind compared with both the EU and the country's own interests and possibilities. This backwardness might be decreased by a significant governmental action, which can put the market in motion.

Agriculture

Currently, the Hungarian agriculture sector provides 4.1% of the GDP (1.8 billion euro). In the European Union only Greece has higher proportion (6.7%). But the total value in euro of the Hungarian agriculture sector is less than half of the Portuguese, Danish, or Swedish agricultural production. 4.8% of the Hungarian employees, 220 thousand people work in the agriculture sector. This proportion is 14.3% on the average in the candidate countries and 4.3% in the current European Union. 47.1% of the Hungarian agricultural export goes to the European Union while 51.8% of the agricultural import comes from there. In 2000 and 2001 Hungary exported more agricultural products to the European Union by 618 and 518 million euros, respectively than imported from there.

Forestry

Forests and forestry in Hungary, as in many other countries, play an integral role in the life of people. Managing forests requires a substantial body of information on forest resources, their natural environment, as well as the economic and social system in which the forests are managed. This chapter summarizes the latest information available on these issues. The information is based on sources from relevant ministries and the National Forest Service.

Forest resources, forest area

Hungary used to be a country of dense forest cover, at the time Hungarians occupied the land, with a forest ratio of 40-60% (the figure is debated, see Németh, 1998 and Bartha-Oroszi, 1996). In the 17th century, however, the *forested area* started to decline parallel to the development in the country and other parts of Europe. Beside the increase of the population and the extension of agriculture, this decrease was mainly caused by the industrialization process of the 19th century. At around the turn of the 19-20th century, the forest ratio *fell down to 1.1 million hectare*, or, 12%.

After World War II, in order to cope with the shortage of wood and to decrease its import, the primary goal of the forestry policy in Hungary became to increase wood supply. Forestry had to focus first of all on the quantity of wood production. Later on, as a result of the large scale

national *afforestations*, the forested area of the country increased by *600,000 hectare* and reached 18.4%, or *1.7 million hectare* by 1990 (see Table II.5). With this rate of forest cover, Hungary still belongs to the relatively little forested countries.

Table II.5: Expansion of the area under forest management

Time (year)		1930	1950	1960	1970	1980	1990	1993	1998	2000
Forest area	1000 ha	1091	1167	1306	1471	1587	1708	1674	1905	1773
	Ratio (%)	11.8	12.5	14.0	15.8	17.1	18.4	18.0	20.3	20.4

Source: *Ministry of Agriculture, (FM, FVM), 1995-2001.; Halász, 1994*

By 2000, the total forested area in Hungary increased to *1.773 million hectares*. This area includes the stocked forests and the temporarily unstocked areas, but it excludes the roads, alleys, rides, clearings, fields, water surfaces and buildings, which are all integrated parts of forest holdings. The total area of the *stocked area* amounts to *1.658 million hectares*. The distribution of this area by primary management objectives is shown in Table II.6.

Table II.6: Distribution of forest areas by primary management objectives

Time (year)	1980	1985	1993	2000
Primary objective:	1000 ha			
Productive forest	1287.3	1306.5	1348.4	1220.4
Seed crop stands	2.8	3.1	5.6	3.5
Game Management	1.9	34.1	25.0	56.7
Protection forest	174.3	183.8	186.1	151.1
Nature conserv.	24.0	40.5	59.0	231.1
Recreation	54.9	56.5	45.6	34.1
Other forest	33.6	40.6	39.0	76.3
Total	1618.8	1665.1	1708.7	1773.3

Source: *FM, 1996.; FVM, 1995-2001.*

Site conditions

Hungary is situated in the Carpathian basin. It is dominated by lowlands (67%) and hilly regions of 200-400 meter high (29%). The "mountainous" area (above 400 m) is only 4%. The highest peak of the country is 1015 m above sea-level in the Mátra Mountains. The dominant climate is continental, but the Sub-Atlantic and Sub-Mediterranean influence also brings about rapid changes and considerable differences in the various parts of the country. About 25% of Hungarian forests are situated at the border 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. Some additional characteristic climatic figures are shown in Table II.7.

Table II.7: Main characteristics of the climate of Hungary

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

Source: National Meteorological Service

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 Duna 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.

Tree species composition, origin and age structure

In Hungary, unlike in most countries in Europe, an overwhelming majority of the forests is covered by *broad-leaved species* (see Table II.8). 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.

Almost all forests in Hungary are considered as *even-aged and established artificially*. Some experts distinguish plantations and natural types of forests. The existence of virgin forests in the country is questionable.

Table II.8: Forest area by species (as of 1 Jan 2000)

Tree-species	Area	
	ha	%
Oak	352149	21,2
Turkey oak	189454	11,4
Beech	103054	6,2
Hornbeam	97467	5,9
Black locust	352159	21,2
Other hardwood	73255	4,4
Poplars	157818	9,5
Other softwood	93139	5,6
Scots pine	142261	8,6
Black pine	68151	4,1
Other pine	28919	1,7
Total	1657826	100

Source: National Forestry Database. National Forest Service (ÁESZ.)

As for origin, *stands of coppice origin 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) amounts to about 50%. As a result of the regulative measures to achieve sustained yield, the age structure of the forests has been improving. The distribution of the forest area by age classes is shown in Table II.9.

Table II.9: Area of age classes in percent of the total forested area

Age class (year)	% of area in year		
	1972	1990	2000
1 - 10	22.5	13.9	10.9
11 - 20	20.5	18.2	18.3
21 - 30	16.5	15.3	15.8
31 - 40	11.3	13.8	12.7
41 - 60	16.3	16.6	17.4
61 - 80	8.9	12.6	13.3
81 – 100	2.8	7.2	8.2
- 100	1.1	2.4	3.4

Source: National Forestry Database. National Forest Service (ÁESZ.)

Wood production capacity

The total growing stock of the productive forests amounts to 325.1 million m^3, and the majority of the current annual increment, 11.7 million m^3, is also being produced in these forests (see Table II.10).

The mean net specific current annual increment, 8.5m^3/ha, is quite high compared to the European average. This 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.

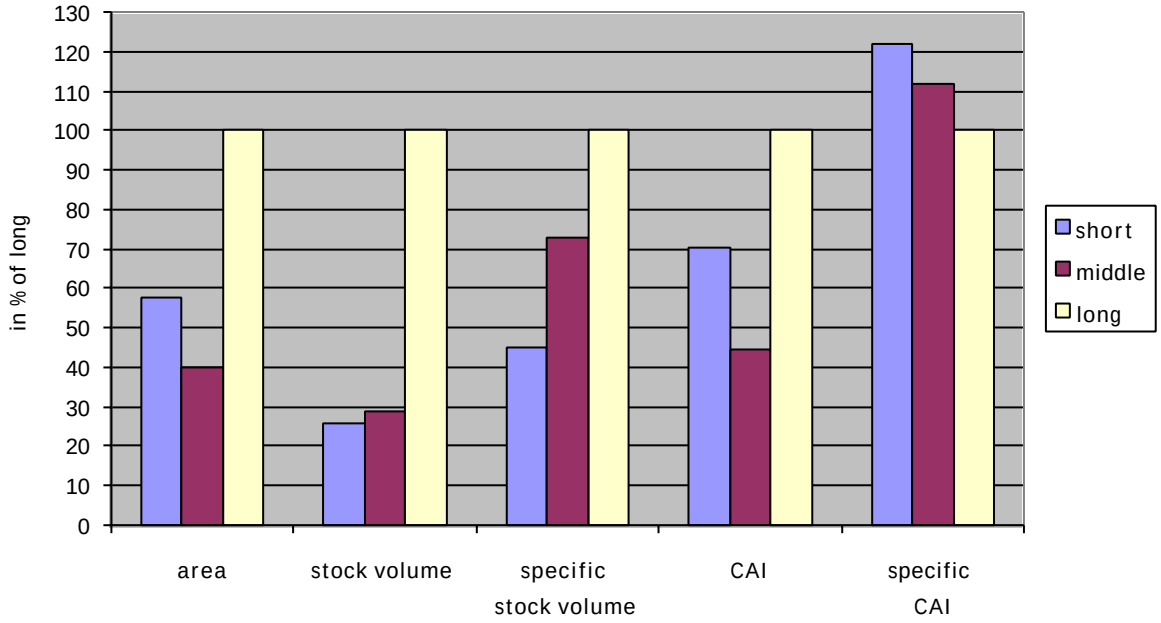
Table II.10: Growing stock and Current Annual Increment (CAI) of the main tree species (in 2000).

Tree-species	Growing stock		CAI	
	million m^3	%	1000 m^3	%
Oak	82,8	25,5	2455,0	21,0
Turkey oak	42,5	13,1	946,2	8,1
Beech	39,1	12,0	878,1	7,5
Hornbeam	17,9	5,5	356,3	3,0
Black locust	39,2	12,0	2471,6	21,1
Other hardwood	14,3	4,4	595,8	5,1
Hybrid poplar	13,0	4,0	842,6	7,2
Indigenous poplar	8,0	2,5	439,7	3,8
Willow	4,3	1,3	224,8	1,9
Alder	8,3	2,6	320,2	2,7
Other softwood	6,2	1,9	225,3	1,9
Scots pine	32,6	10,0	1218,7	10,4
Black pine	10,8	3,3	412,9	3,5
Other pine	6,2	1,9	323,6	2,8
Total	325,2	100,0	11710,6	100,0

Source: National Forestry Database. National Forest Service (ÁESZ.)

The data available on the short, medium or long rotation systems makes it possible to compare them with respect to their carbon content. Figure II.9 shows the various characteristic data of the three systems relative to those of the long rotation system. Especially the specific values show that, although the specific increment of the short rotation system, characterized by fast growing species, is by some 22% larger than that of the long rotation system, the stock volume, and consequently the carbon content, of the short rotation system is less than half of that of the long rotation system. This underlines the importance of establishing forests with long-living species whose rotation period is long. Moreover, these forests, mostly consisting of indigenous species, are on the long run more stabile than short rotation systems, at least in Hungary.

Figure II.9: Various carbon content related characteristics of the Hungarian forests. The data of the short, medium long and long rotation systems are expressed in relation to those of the long rotation system.

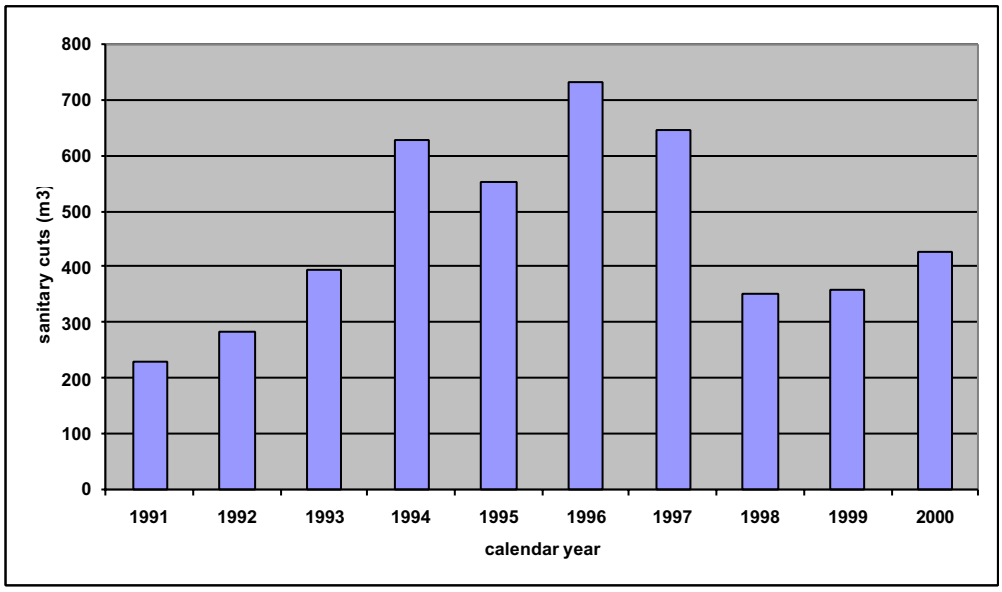


Source:National Forestry Database. National Forest Service (ÁESZ.)

Health condition of trees

Health of the Hungarian forests seems to have stabilized in the last few years. Before that, the symptoms of „forest decline" could be observed in many parts of the country, the oak decline causing the most serious problems. The amount of sanitary cuttings, which can be regarded as one indicator of the health status of the trees, was about 426 thousand m^3 in 2000, which is about 6% of the annual harvest, Figure II.10. This is still more than a few years ago, or in the previous decade, but is much less than at the middle of the 1990's.

Figure II.10: The amount of sanitary cuts in the last decade.



Source: Hungarian Annales of Statistics, 1990-2000. Budapest.; National Forestry Database. National Forest Service (ÁESZ.)

Forest ownership structure

Since 1938, there have been considerable changes in the various ownership categories (Table II.11).

There is clear evidence in the data that the collectivization of the communistic era dramatically changed ownership structure. However, the ownership structure of forests in Hungary became a very critical issue at the beginning of the 1990's and was again under dramatic changes. Along the general privatization process in the country, forests were also under the gavel. About 40% of the forests have been privatized (although, from a legal point of view, the process has not been finished yet). Mostly forests of short rotation and those on poor and medium site were bought by private owners. Forests under nature protection were not to be privatized. As for the agricultural lands, they have also been privatized, but to a much larger extent than forested areas.

Table II.11. Forest area (in % of total) by ownership categories.

Ownership	Calendar year						
	1938	1950	1960	1980	1990	1993	2000
Public	23,7	91,6	89,1	71,5	68,7	67,5	60,0
- State forest enterprises	4,3	89,1	72,8	65,3	62,3	61,4	59,0
- State farms	1,8	0,5	2,1	4,4	4,7	4,8	-
- Other state	-	-	0,7	-	-	-	-
- Communities	17,5	2,0	13,5	-	-	-	-
- Other public	17,5	-	14,2	1,8	1,7	1,3	1,0
Cooperatives	-	0,2	7,7	27,9	30,7	31,3	-
Private	76,3	8,2	3,4	0,7	0,5	0,6	40,0
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Source: Halász, 1994.; National Forestry Database. National Forest Service (AESZ.)

Currently, the majority of the forest area, some 1 million ha, is managed by 19 state forest companies, now under the control of the State Assets Handling Joint-Stock Company. About 80,000 ha of forests belong to other Ministries, such as the Ministry of Environment and Regional Policy, Ministry of Defense, and Ministry of Transport, Telecommunication and Construction. The legal status of some forests, mostly privately owned ones, is yet to be clarified.

Forest industry

Hungary's present domestic use of wood products is greater than her forests' wood production capacity. Therefore, Hungary is reduced to importing (see Table II.12).

Table II.12: Foreign trade, domestic production and domestic use in 1000 m3 of roundwood equivalent for 1975-1990; for year 2000, value of trade of all wood and wood products, in USD

Trade/production	in year				
	1975	1980	1985	1990	2000
Import	5645	4726	4610	3274	149
Export	1451	1369	2048	2374	148
Domestic roundwood production	5384	6161	6262	5973	N/A
Balance (domestic use)	9578	9518	8824	6873	N/A

Source: Halász, 1994.; Hungarian Statistical Yearbooks, 1990-2000. Budapest.

Foreign trade in the forestry sector is characterized by the data in Table II.13. As it can be seen from the table, the balance of foreign trade was improving during this period mainly due to the development in the field of wood processing and to a sharp decline in domestic consumption.

Table II.13: Foreign trade of wood and wood products in 1000 m^3 of raw material equivalent (Import/Export), as well as domestic roundwood production.

Products	in year					
		1975	1980	1985	1990	2000
Primary wood products	*Import*	1796	1478	1329	620	N/A
	Export	846	767	1303	1341	N/A
Sawn wood products	*Import*	1833	1214	1254	1038	N/A
	Export	331	221	302	586	N/A
Panels and veneer sheets	*Import*	245	188	225	121	N/A
	Export	47	50	90	120	N/A
Pulp and paper products	*Import*	1771	1845	1803	1495	N/A
	Export	227	331	353	327	N/A
Total	*Import*	5645	4726	4610	3274	N/A
	Export	1451	1369	2048	2374	N/A
Domestic roundwood production		***5384***	***6161***	***6262***	***5973***	***5902***

Source: Halász, 1994.; Hungarian Statistical Yearbooks, 1990-2000. Budapest.

Forest management

Due to the considerable political, economic, and legal changes, and changes in the ownership system both in the whole country and in the forestry sector, and as well as due to the new Laws on Forests and Forestry, Nature Conservation, and Hunting and Game Management that were passed in 1996, the behaviour of managers of forests has changed. Unauthorized wood harvest occurs regularly at some places, especially in the poor parts of the country. Planned wood harvests are more dependent on the wood market, which shows considerable fluctuations. The 19 state-owned forestry companies that manage some 60% of the nation's forests are run on a profit-oriented basis with a close scrutiny on how they observe forest law and other regulations. To inspect the activity of the private forest owners, whose number totals some 250 thousand, is much more difficult. The National Forest Service is doing a great effort to identify problematic areas, and inflicts high fines to limit unauthorized forestry operations and thieving of wood from the forests. As it was mentioned before, the rate of afforestations has increased recently. Propagation materials are produced at about the same quantities in nurseries of both the state-owned forestry companies, as well as thousands of private producers. Since even more afforestations are expected in the coming decades, adapting production capacities to demands is a strategic issue. However, this adoption will only take 1-2 years for Black Locust and 3-4 years for Poplars, which belong to the mostly used tree species in afforestations on private land.

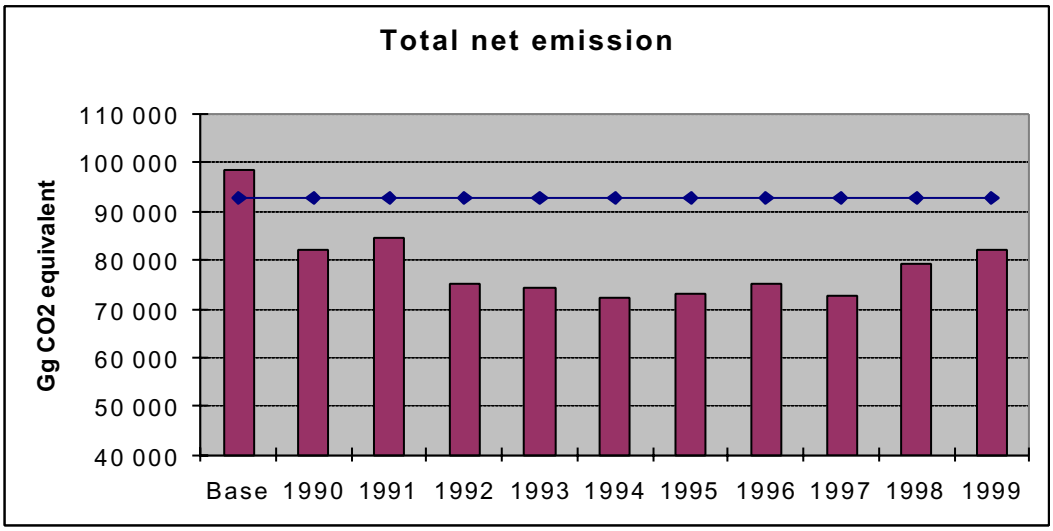
III. GHG Inventory Information

A. Summary Tables

Among the signatories of the Framework Convention on Climate Change, several of the developed countries listed in Annex I have committed under the Kyoto Protocol to the reduction of greenhouse gases for the period 2008-2012 compared to the base year (or to the base period). The commitment was stated in terms of "CO_2 equivalent" values, which includes the total amount of greenhouse gases. The Global Warning Potential (GWP) of each greenhouse gas shows the relative contribution of that gas to global warming over a period of 100 years as compared to the contribution of carbon dioxide, which thus has a GWP value of 1. The GWP value for methane is 21, while for SF_6 it is 23,900. The values accepted by COP 5 are listed in Appendix 1.

Figure III.1 shows the 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.

Figure III.1. Total net emissions

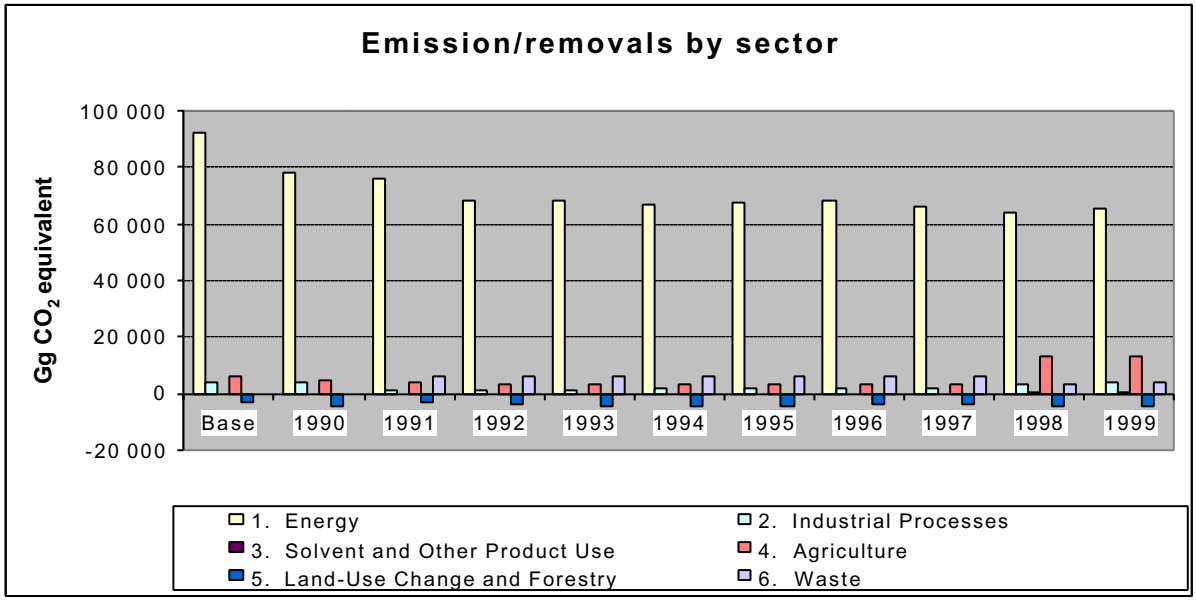


Source: IEM: Greenhouse Gas Inventory, 1999

Hungary has committed to the reduction of greenhouse gas emission by 6% compared to the average level of the base period (1985-87). The straight line on Figure III.1 shows the limit. 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. By the end of the decade there was a slow increase in emissions. However, even though by 1999 GDP reached pre-1990 levels, emission values remained significantly below the base value. Based on this observation, *Hungary is expected to be able to honor the commitment it made under the Kyoto Protocol*.

Figure III.2 shows the change in the emission of various sources as well as removals, by sectors of the economy. Emissions by the Energy and Agriculture sectors have the most significant effect on total emission.

Figure III.2.



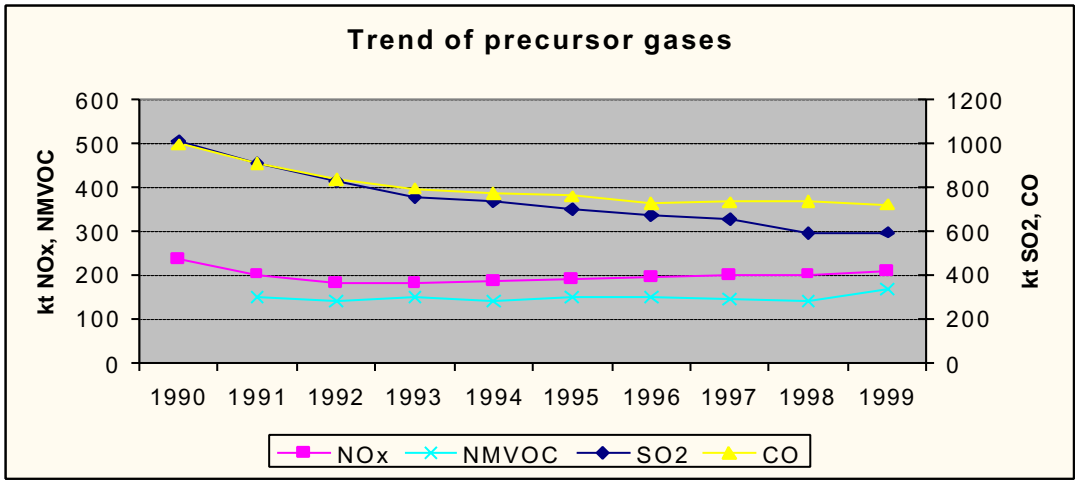
Source: IEM: Greenhouse Gas Inventory, 1999

The emissions from energy sector have fallen every year, and it is the agricultural sector that is responsible for the increase in emissions shown for the last two years on Figure III.2.

When analyzing these figures, the earlier remarks on data *inconsistency also need to be taken* into consideration.

Figure III.3 shows the changes of *precursor gas emissions* over time.

Figure III.3.



Source: IEM: Greenhouse Gas Inventory, 1999

B. Descriptive Summary

Introduction and methodology

As previously mentioned, Hungary produced its first National Communication in 1994, after joining the UN Framework Convention on Climate Change (UNFCCC). As a consequence, the greenhouse gas emissions were prepared for the base period and the inventory is updated year by year. 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 prepared the inventory. From 1998 onwards, the Ministry for Environment commissioned the Institute for Environmental Management Directoriate for Environmental Protection (IEM) to prepare the inventories. The 1998 and 1999 inventories (published in 2000 and

2001 respectively) were prepared by IEM based on the modified version of the "Draft Guidelines…" published by IPCC as the "Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories" (further referred to as "Revised 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 was used for the preparation of the last two inventories. 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"), the elements of which were also used for the preparation of the 1999 inventory. The EIT countries were allowed a two-year extension to conform to the prescriptions of the handbook, because of their lack of resources.

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 technologies, or means to obtain these values. It has included also the "newer" greenhouse gases (i.e. partially fluorized hydrocarbons /HFCs/, fully fluorized hydrocarbons /PFCs/ and sulfur hexafluoride /SF_6/). Furthermore, the preparation of the inventory also included the precursor gases: nitrogen oxides (NOx), carbon monoxide (CO), non-methane volatile organic hydrocarbons (NMVOC), and sulfur dioxide (SO_2).

The CRF software was based on the Revised Guidelines methodology, partially using the IPCC tables, expanding them with properties to favor

- Easier comparisons,
- Better supervision and,
- The assessment of trend data.

From 2000 onwards, the inventory must be submitted in this format, complemented by the assessment provided in the National Inventory Report (NIR).

The Good Practice Guidance, as mentioned in its title, prescribes methodologies ensuring the preparation of inventories at *appropriate quality*. It lists the main requirements for the inventory as follows and the methodologies to obtain them:

- Transparency,
- Consistency,
- Comparability,
- Completeness,
- Accuracy.

The Good Practice Guidance introduces the concept of *key source category*, which comprises of 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.

The base period for Hungary was defined in the first report. The choice of 1990 as the base year for comparison in the Framework Convention did not seem appropriate, given that Hungary's economic performance showed a strong decline (in the transition towards market economy). It would have been disadvantageous for Hungary to select a year of such deep economic decline as the base year. For this reason the average of the years 1985-1987, a period of stable economic performance, was suggested as the base period for Hungary. *The COP accepted this period as the base period.*

When new greenhouse gases were defined it became necessary to determine the base year for 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 on the energy balance collected by the Energy Center Non-profit Co. and the yearbooks of the Hungarian Central Statistics Office. We have also used specific data in relation with agriculture, forestry and various industrial sectors. To determine the emission of fluoride gases, import data provided by the Hungarian Customs and Finance Guard was used (since these gases are not produced domestically), complemented by data from the cooling industry associations.

Problems

The resources required to produce the emission inventories are not available primarily due to a lack of funding. Since the Kyoto Protocol has not been ratified, the Government has not made this area a priority. At the government's IEM a staff of three in full and part time is responsible for the inventories. As a result we have not had the chance to recalculation the inventories for 1985 through 1997 in line with the Revised Guidelines. Thus the time lines for the gases are not consistent – and there are major different the data between 1997 and 1998 are due mostly to the change in methodology.

The statistical system in the nineties was different from the one required by the Revised Guidelines. Therefore, in many cases 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 by the end of the last decade was in line with international standards, but a few years will be necessary for the changes to trickle down through the entire economy.

The lack of factor values adapted to Hungary's idiosyncrasies in most sectors is another source of problems. In the majority of calculations we used the default values recommended by the Revised Guidelines for Eastern European technologies. However, in sectors where Western 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 of the Revised Guidelines.

Also, as the experience of the professionals preparing the inventories over the years has improved in collecting and using the data, the level of completeness and thus the quality of the inventories have also improved.

Solutions

Improvement in capacity building would solve the problems mentioned above. It is planned to recalculate inventories of earlier years in line with the Revised Guidelines. It would be preferrable to determine the factor values for technologies unique to Hungary. All of these goals require extra funding, which should have to be ensured before the end of the year from UNITAR's (United Nations Institute for Training and Research) Capacity Building program as well as Government sources.

Emissions by sectors

The most important data for Hungary's 1999 emission inventory are summarized in Table III.1 below. SO_2 and precursor gas emissions are also included.

Table III.1: Emissions by sectors in Hungary, in 1999 (Gg)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	NO_x	CO	NMVOC	SO_2
	Emissions/removals									
	(Gg)	(Gg)	(Gg)	CO_2 equivalent (Gg)		(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Total National Net Emissions	55 616	682.99	36.32	154.27	573.71	0.00	210.45	622.79	170.37	594.66
1. Energy	56 490	410.91	0.48				207.66	582.38	100.66	586.30
2. Industrial Processes	2 709	0.66	1.10	154.27	573.71	0.004	1.99	16.36	29.71	8.35
3. Solvent and Other Product Use	32		0.00						40.00	
4. Agriculture	0	115.81	34.74				0.74	21.75	0.00	0.00
5. Land-Use Change and Forestry	-4500	0.26	0.00				0.07	2.29	0.00	0.00
6. Waste	885	0.00	155.35				0.00	0.00	0.00	0.00
International Bunkers	596	0.00	0.00				0.00	0.11	0.00	0.00
Biomass	1 476									

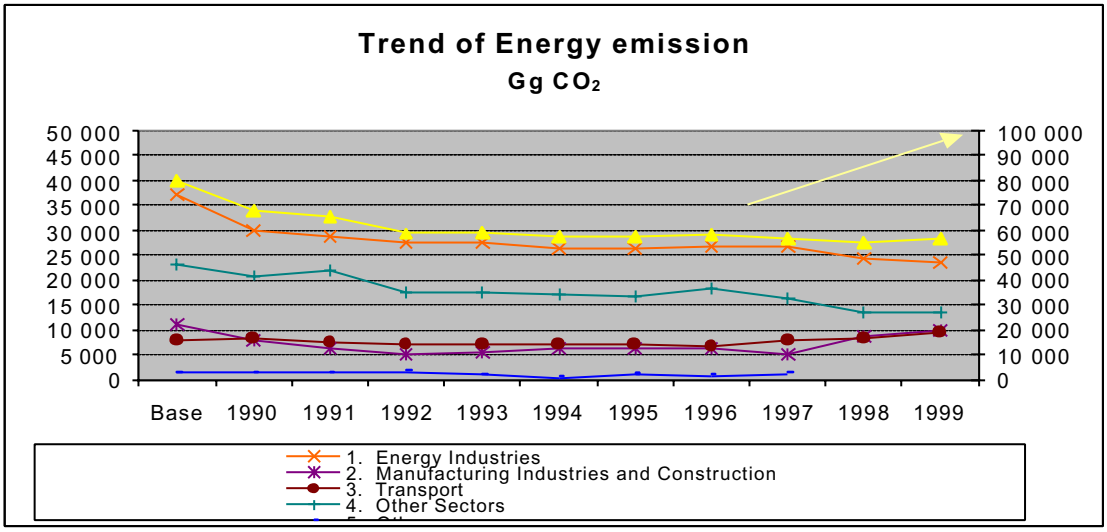
Source: IEM: Greenhouse Gas Inventory, 1999

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

Energy sector

The *carbon dioxide* emission of the energy sector is the largest item in the inventory. The amount of emission, however, has fallen each year since the base year both in total and in subcategories, with the exception of the Manufacturing and Transport subcategory, which has shown a slight increase in the past three years (see Figure III.4).

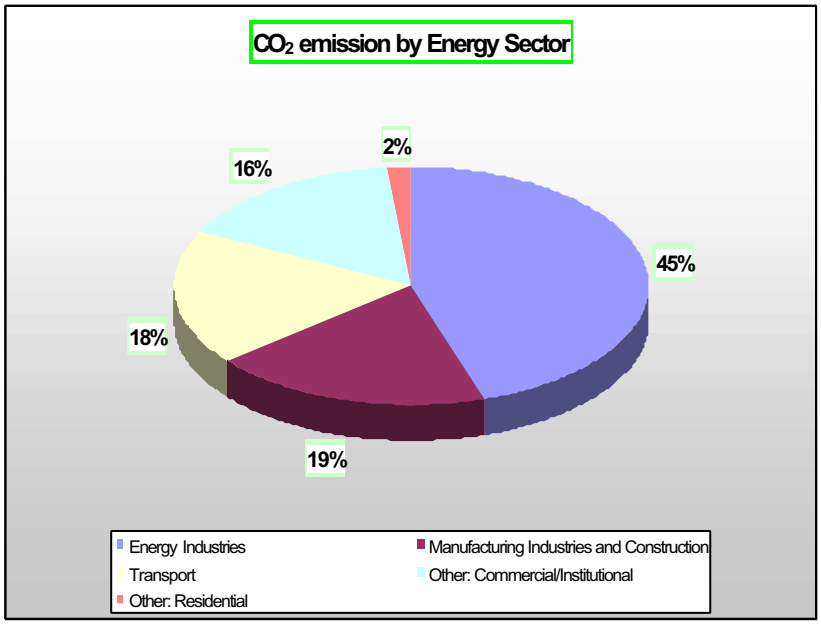
Figure III.4.



Source: IEM: Greenhouse Gas Inventory, 1999

Figure III.5 shows the breakdown of the various subcategories within the Energy sector.

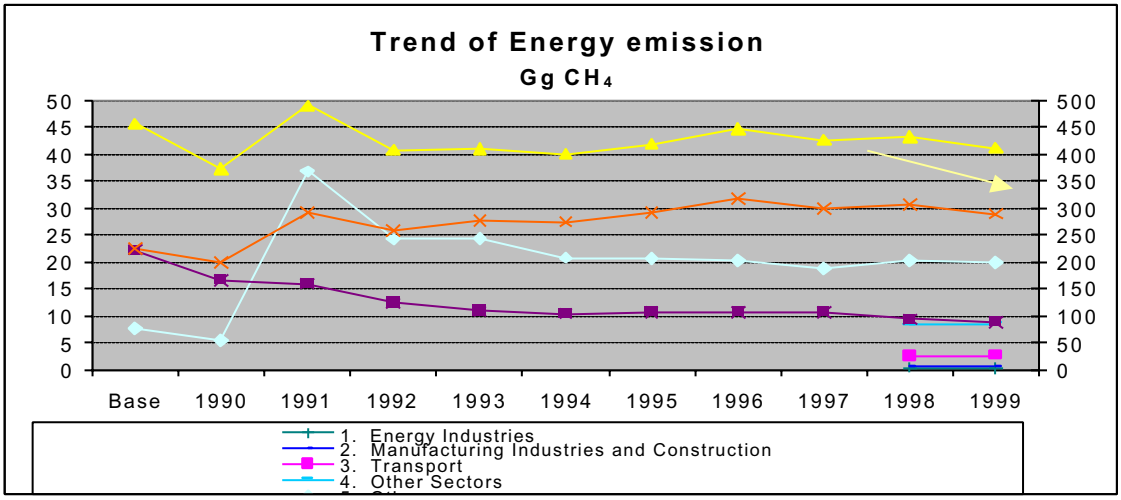
Figure III.5



Source: IEM: Greenhouse Gas Inventory, 1999

Regarding the *methane* output of the energy sector, a slight downward trend with some fluctuation becomes apparent, see Figure III.6. The effects of shrinking coal mining activities and an increase in oil and natural gas consumption are also visible in the trends of this figure. Values of the "Other" sector for earlier years need to be revised. In several subcategories no estimates are available for before 1998.

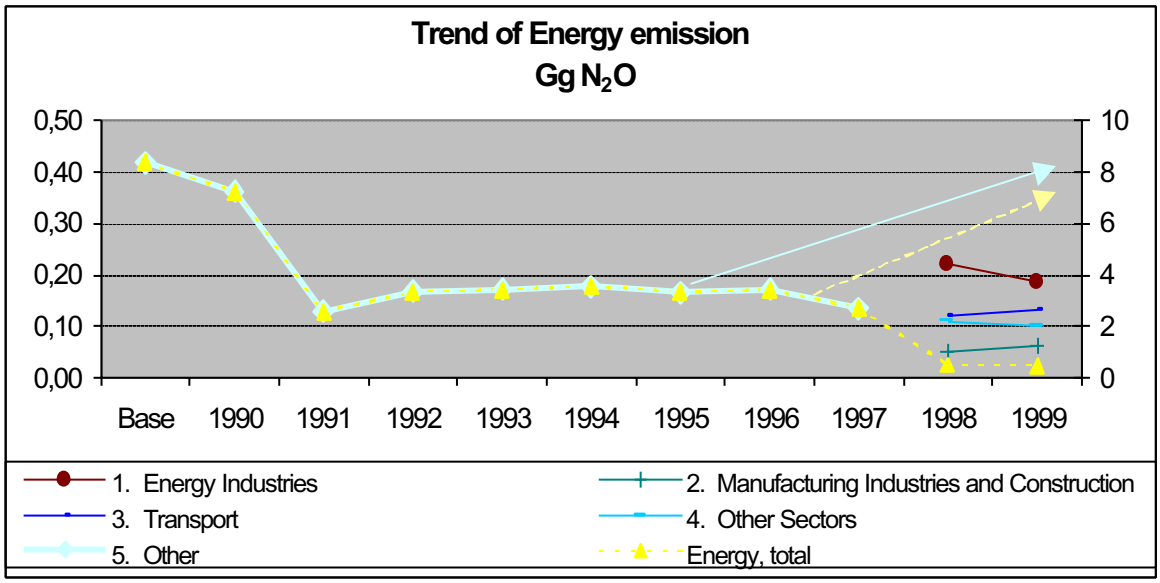
Figure III.6.



Source: IEM: Greenhouse Gas Inventory, 1999

The emission values for *nitrous oxide* show a continuous decline presented by Figure III.7, which – besides the decline in combustion – is likely caused by a change in methodology used for the estimation of emissions. This is especially true for the values of the last two years. Before 1998, the emission values were determined by using the bottom-up method, in line with the Draft Guidelines. In the past two years, emission values were calculated with the top-down method, using the factor value in the Revised Guidelines. In our opinion, these latter ones are the least reliable values of the emission data, due mostly to the factor values. (The Good Practice Guidance estimates the uncertainty of the factor values to be around 50%-100%). On the other hand in 1998-1999 newer technologies were also included in the calculation at a greater detail.

Figure III. 7.



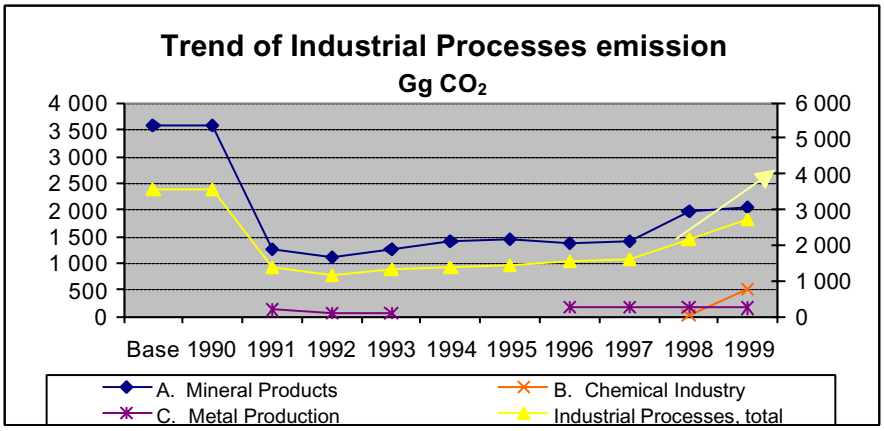
Source: IEM: Greenhouse Gas Inventory, 1999

Industrial processes

Carbon dioxide emission reflects the economic trends of the last decade very well. The early nineties saw a sharp fall compared to the base years, but as the industrial production slowly picked up, so did carbon dioxide emission, see Figure III.8. Most of the industrial output is due to the Mineral

Products subcategory, especially to cement manufacturing. A further increase in total emissions in 1998-1999 was due to the inclusion of several new technologies.

Figure III.8.



Source: IEM: Greenhouse Gas Inventory, 1999

In the case of Metal Production emission, estimates are missing for several years due to a lack of source data. The major increase in the Chemical Industry subcategory is due to underreporting of ammonia production data for 1998. This will be corrected going forward.

In this sector *methane* emission was only included within the "Other Chemicals" activity, resulting in only 1.4 Gg in 1998 and 0.66 in 1999. This value was not estimated in the preceding years.

Nitrous oxide emissions were previously not considered in the Industry subcategory. In 1999 a value of 1.1 Gg was included in the "Other" category. Those emissions of technologies were included under this heading which - due to aggregation of statistical data - could not be named individually.

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 tried to determine the potential and actual emission values based on import data. In the case of PFCs the amount produced during aluminum manufacturing was calculated according to the Revised Guidelines. The resulting data for the three groups (HFCs, PFCs, SF_6) came to 0.2 Gg, the GWP value of which is approximately 820 Gg CO_2 equivalent.

Solvent and other product use

This sector was not filled up before. The Revised Guidelines offer only a little help for the specific values. We mainly filled in paint application data. 100 % of the solvents used for dilution and the solvent content of the paints used in Hungary were calculated as NMVOC emission. From this, knowing the approximate chemical composition, the carbon content and the corresponding CO_2 amount were calculated. Additionally, an estimated 10 % of the chlorinated hydrocarbons used for degreasing and dry-cleaning was considered as emission. The values can be found in Table III.2.

Table III.2: Emission from Solvent use (Gg)

Source	CO_2		NMVOC	
	1998	1999	1998	1999
Paint Application	27.84	31.96	34.91	39.92
Degreasing and Dry Cleaning	0.05	0.05	0.08	0.08
Total	**27.89**	**32.01**	**34.99**	**40.0**

Source: IEM: Greenhouse Gas Inventory, 1999

In 1999 paint use and the resulting emission has risen slightly.

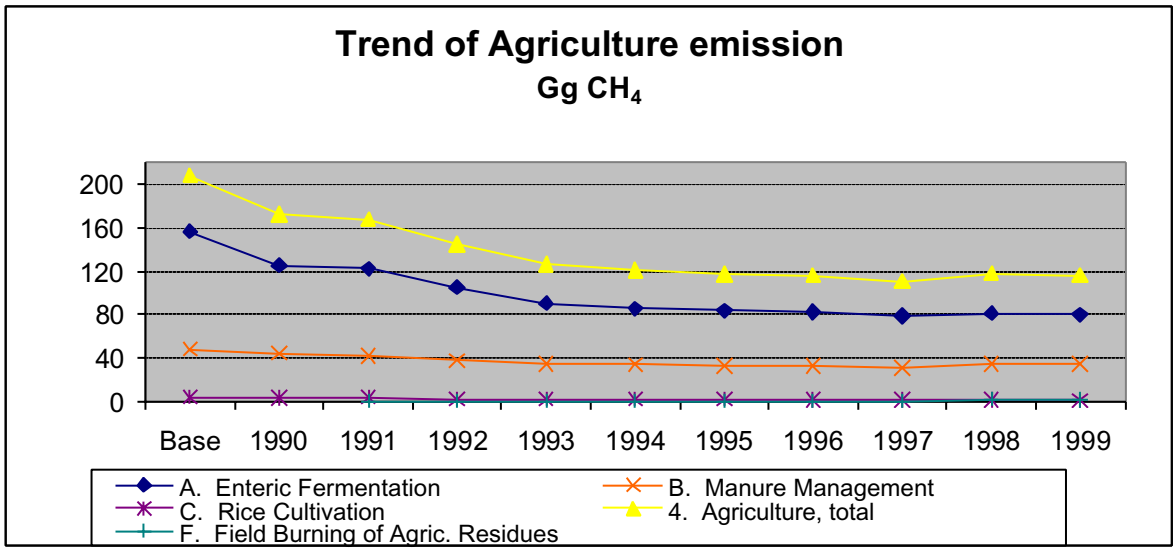
We did not calculate with other emissions in this sector.

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 III.9**.** The decline through 1998 is apparent, with a minimal increase for 1999. 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 before, was reduced significantly already by the base year. The small production that was left before 1990 has been further declining. Values for Field Burning were also calculated, but these values are so small (0.1-1 Gg) that they do not show up on the Figure.

Figure III. 9.



Source: IEM: Greenhouse Gas Inventory, 1999

Data for nitrous oxide emission are summarized in Table III.3. The emission is due mostly to the usage of manure as fertilizer. The sharp decline in 1991 is probably due to the decline in animal husbandry and thus manure production. For the rest of the period the value fluctuates, not following the continuing decline in of the sector apparent in the methane emission figures. A major jump in the values occurs in 1998-1999, when the methodology of the Revised Guidelines was used. This is due to a change in the methodology of data evaluation as well as the different default factor value used by IEM. This was coupled with the less than clear instructions of the Guidelines. The problem will be addressed in the work dealing with the consistency of timeline data discussed before. (Also, as discussed before, of all the factor values, it is the values for N_2O that show the highest uncertainty.)

Table III.3: Emissions of agriculture

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)										
4. Agriculture	**4.56**	**4.10**	**1.68**	**1.63**	**1.46**	**1.80**	**1.61**	**1.68**	**1.67**	**34.54**	**34.74**
A. Enteric Fermentation											
B. Manure Management										1.60	1.56
C. Rice Cultivation											
D. Agricultural Soils	4.56	4.10	1.68	1.63	1.46	1.80	1.61	1.68	1.67	32.91	33.16
E. Prescribed Burning of Savannas											
F. Field Burning of Agricultural Residues										0.03	0.02

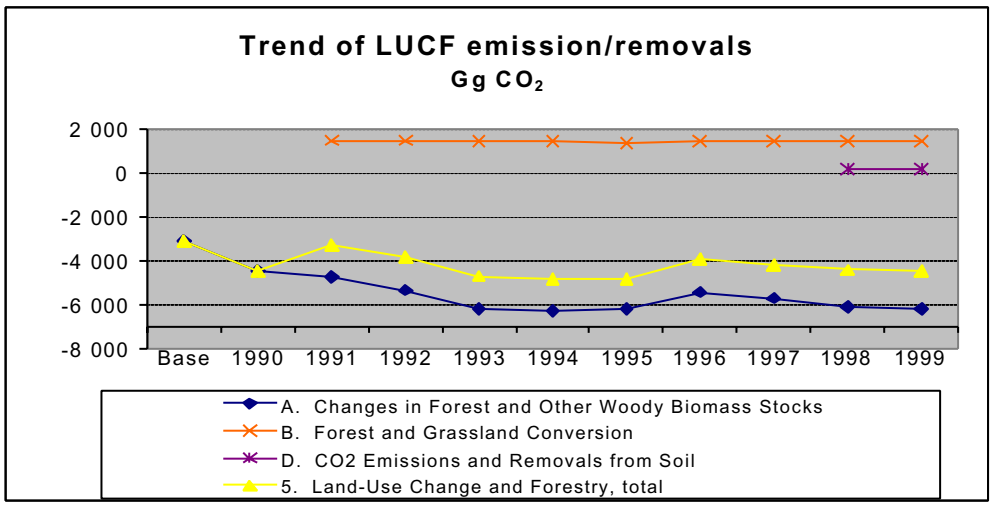
Source: IEM: Greenhouse Gas Inventory, 1999

Land use change and forestry

For carbon dioxide the sector is showing negative emissions – or removal. As Figure III.10 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 3 % to 7 % of the *total* CO_2 emission, with a slight increase over the years due to the gradual increase in the overall forest size.

In the early nineties, around the 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.

Figure III.10



Source: IEM: Greenhouse Gas Inventory, 1999

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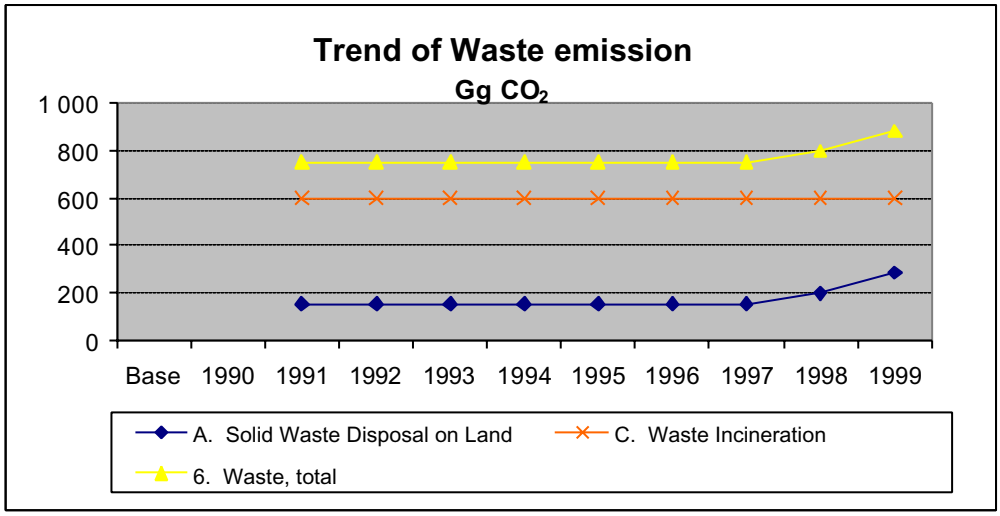
Waste

Figure III.11 shows the change in carbon dioxide emission from waste. Both incineration and landfill emissions are included for solid waste. Unfortunately, only estimates are available for the amount of household and communal waste produced. In these estimated values there has been no major change over the last ten years, so the emission curve is flat.

Figure III. 11.



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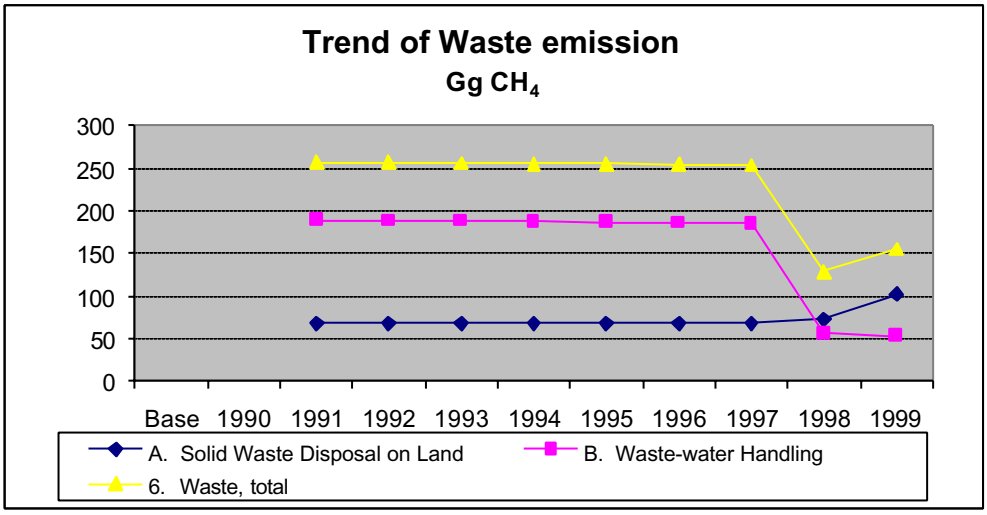
Source: IEM: Greenhouse Gas Inventory, 1999

The increase for the last two years is due to a difference in the methodology applied to estimate the amount of waste. Hungary's definition of non-industrial solid waste makes it difficult for us to apply the Revised Guidelines. Non-industrial waste consists of household waste, which includes decomposing material as well as communal waste, which includes construction waste. Factor values, on the other hand, are available for the waste as a single and uniform category.

We have estimated the actual emission of the Budapest incineration plant, which has operated on 100 % capacity over the last few years. Data for prior years is not available, and has to be filled in during the recalculation phase.

The same problems with lack of landfill data arises in the case of *methane* emissions, see Figure III.12. The emission of waste water and sludge has declined due to a change in calculation methodology. However, no data collection exists for these values, so we had to resort to various estimates in this area.

Figure III.12



Source: IEM: Greenhouse Gas Inventory, 1999

There has been no calculation made for *nitrous oxide* emission in this sector.

Key source categories

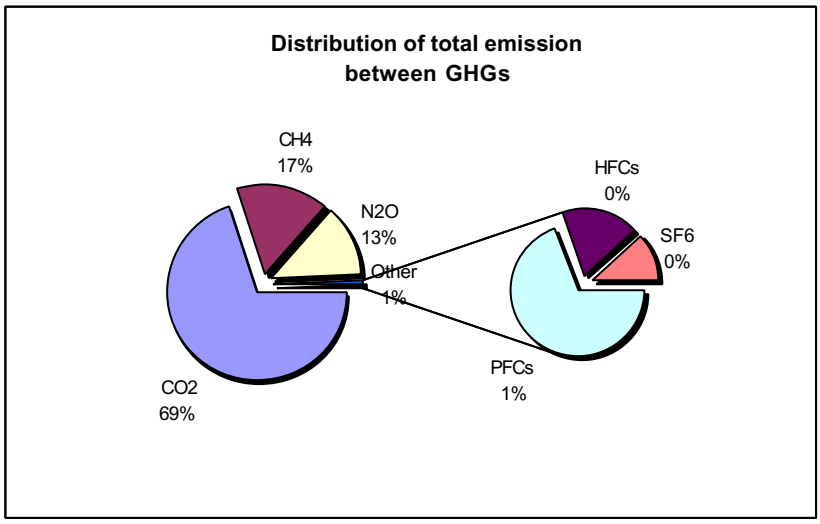
To improve the quality of the prepared inventories, the Good Practice Guidance introduces the notion of "key source categories" – referring to sources that have a major impact on the total emissions. By paying special attention to the data of these categories, the quality and reliability of the inventories increases substantially. Following the Good Practice Guidance we determined these categories based on the 1999 inventory. Because sufficient estimates for uncertainty values are not available, we have used TIER 1 methodology to determine the categories. We used the Summary 2 table of the Common Reporting Format as our starting point, modifying the data in line with the requirements of the applied methodology. The results are presented in Appendix 2.

Due to the different nature of the gases, the comparisons were based on GWP. The value of total emissions (not taking into consideration any removal) is 86,547 Gg of CO_2 equivalent. Calculations show that 12 source categories are responsible for 95 % of the total emission value – when using this method. Energy Industry combustion technologies are responsible for the largest single share of 27 %. The second most important source is the Other subcategory of the Energy sector, which includes Commercial/Institutional and Residential heating. In the case of sources other than those of CO_2 agricultural land is the largest emitter for N_2O (12 %), while oil and natural gas production is the largest emitter for methane (7 %). None of the fluoride sources was large enough to be included among the key sources. The largest fluoride source is PFC related to aluminum production, but its share is only 0.65 %.

Similar model calculations have been performed for greenhouse gases and sectors. The results of these calculations are summarized in Appendix 2 and on Figures III.13 and III.14. Examining the gases the share of the "older" gases was 99%, and among them, as expected, carbon dioxide has the highest

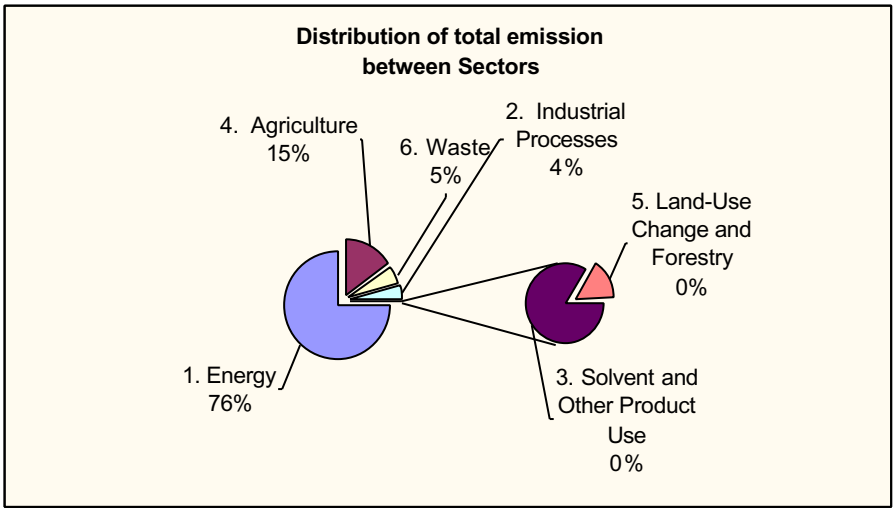
share at 69%. Looking at total emissions by sector, Energy, Agriculture and Waste are responsible for 96% of total emissions, with Energy alone providing 76%.

Figure III.13.



Source: IEM: Greenhouse Gas Inventory, 1999

Figure III. 14.



Source: IEM: Greenhouse Gas Inventory, 1999

Uncertainties

As mentioned above, EIT countries have received a two-year extension for the implementation of reliability measures described in the Good Practice Guidelines. Hungary does indeed need this grace period, because the resources available for the preparation of the inventory are very limited. Despite this problem, several aspects of the Guidelines were implemented as early as in the 1999 inventory. For example, a data sheet was prepared for each technology, on which we have listed the source for each data and factor value, when necessary along with the calculation method applied, and we have evaluated the reliability level of the emission data used for each technology on a four-point scale. Based on this evaluation, the data for combustion emissions was found the most reliable, while estimates for nitrous oxide and HFCs emission were the least reliable.

IV. Policies and Measures

A Policy making process

Cross sectoral (horizontal) climate change policy

For Hungary, the accession to the European Union in means of environmental and economic competitiveness while maintaining a sustainable pathway is of strategical importance.

The environmental policy (National Environmental Programme) in force directs the country towards a common, differentiated and proportional participation in the international cooperation for mitigating climate change as it also befits the environmental priorities of Hungary. The concept of sustainability as a leading guideline in forming development strategies took over from the fall of the 90's in the governmental decision-making process, together with the notion that these strategies should also encompass global environmental considerations.

In the following section we summarize the political, legal, institutional consequences of this coherent and horizontal multisectoral strategical approach.

General overview of the main policy trends

The first important step in the climate change related policy making during the present reporting period was the formulation of the official Hungarian position on the accession to the Kyoto Protocol in 1997. Based on the recommendation of the Hungarian Commission on Sustainable Development and empowered by the governmental resolution 2378/1997 (XI.26.) Hungary took a commitment of reducing emissions by 6%. (As the Protocol provided flexibility for countries with economies in transition in selecting base level for the emission reduction commitment, Hungary selected the average level of the period of 1985-87.) The Ministry of Environment prepared the proposal for signing the Protocol, which was accepted in the government resolution of 2264/1998 (XI.30). (Due to administrative faults the document of signing was not submitted to the Depository at due time and this mistake was discovered only after the final deadline of the signature period.)

The reporting period brought along two major milestones in climate-related policy making, namely the preparation of the National Climate Change Strategy, and the formulation and governmental approval of the climate-related focus points of the National Research & Development Plan, as detailed in 4.2.1 and 4.2.2. Though scheduled after the reporting period, we shortly summarize the most important points of the Climate Change Action Program as prepared in the framework of the National Environmental Program.

The most relevant result of the national climate change strategy is that sectoral programs with major environmental impacts started or starting recently do not ignore the issues of greenhouse-gas emissions any more. A prevalent example climate change awareness in sectoral policymaking is provided by the new Energy Saving and Energy Efficiency Action Programme (1107/1999. (X.8.) Govt. resolution).

This decree resulted in a quantified target obligation on the partially state supported energy saving activities for a CO_2 reduction of 5 Mt/a at the year 2010. From 2000 the realization of the objective is ensured through the Energy Saving Sub-Programme of the Széchenyi Plan.

A notice has to be made that the government founded the Energy Saving Interministerial Committee, which among its field of responsibilities has propositional authority on climate related project implementation.

Another example of sectoral integration of climate change objectives is the National Program on Adoption of the EU's Acquis Communataire (ANP). Point 6.1.12 of the governmental decree on ANP focuses on climate change as follows. In the implementation of the EU's decree 93/389/EGK on the monitoring system and measurement of CO_2 greenhouse gases in the community, the measures to be taken are in the field of (technological, equipmental, personal) further development of the institutional background. For the costs of the measures until the accession to the EU, the ANP allocates 276 mHUF (~1.1 mEuro).

Description of the relevant policy and measures

National climate change strategy

a.) Definition and targets

The domestic climate change strategy as outlined in the 2206/2000 (IX.13.) government decision follows dual objectives: on one hand it defines the governmental and non-governmental tasks in the light of preparation for accession, on the other hand it gives a general planning and conceptual framework till 2012. The national climate change strategy gives a general condition for the domestic mitigation measures objective. That is, the net Hungarian global warming potential has to be at least 6% lower than in the selected base period of

1985-87. The basic principles of the climate change strategy are as follows:

- The potential harmful impacts of climate change would eventually also affect the Central-European region, therefore pose a potential threat on economic development and social welfare. The principle of shared responsibility and the principle of precaution both justify a proportional participation in combating this global problem.
- The Kyoto commitments of Hungary should be fulfilled by domestic policies and measures. The Hungarian participation in the Kyoto Protocol's flexible mechanisms should result in an overall reduction of GHG emissions.
- The reduction surplus attained is a national „treasure" and should be considered "public property". Through its management (emissions trading) it should be used to promote the principles of sustainable development and to provide a value management of the savings.

b.) Implementation issues
For the period until 2010, the national climate change strategy identifies the following main areas of activities for the respective sectors:

Energy: From the aspect of climate change mitigation, energy is a sector of high priority: two-thirds of our domestic greenhouse gas emission comes from burning fossil fuels. On the basis of the respective Government Resolution, a consistent implementation of the Energy Saving and Energy Efficiency Action Programme until 2010 must be secured, with special attention to the implementation of the quantified targets contained therein and the provision of the necessary central government budget sources. A reconstruction of the distance-heating sector gives an especially favorable cost/benefit ratio in terms of emission reduction, therefore, environment protection sources should also be used for financing these investments. Special attention should be paid to the gradual opening of the electricity and gas market, and, in the course of energy price and tariff policy, to the moderation of the competitive disadvantage of renewable fuels, and the combined heat and electricity production. Efforts should be made to work out the framework of conditions for voluntary agreements between the energy producer/ supplier side, and the authorities in the energy sector and environmental protection..

Transport: Considering the tendencies of the developed countries and the expected increase of domestic transport demand, greenhouse gas emissions from transport may just as well double in the next decades. The requirements stemming from sustainable development can only be implemented in the transport sector if the government elaborates its long-term strategy on environmentally sound development of transport and the related action programme.

Industry: The dissemination of corporate environmental strategies, programs and management systems must be encouraged through voluntary agreements to be created between the authority and the user of the environment. These activities comply with the implementation requirements of Hungary's accession to the EU, further to improving the company's competitiveness through economical "plant operation", and improving the company's market position in the long term by the environmentally sound corporate attitude.

Agriculture: Among greenhouse gases of agricultural origin, methane emission from animal husbandry and nitrous-oxide from artificial fertilizer application should be mentioned. The dissemination of sustainable agricultural and animal husbandry methods should be encouraged together with the utilization of resulting methane as biogas. For the short run an information program for farmers on "good agricultural practice" should be launched in connection with the Agro-Environmental Programme.

Forestry: The reinforcement and implementation of the afforestation programme ending in 2010 is justified from the aspect of climate protection. In addition, approximately 700 thousand hectares currently under agricultural cultivation will have to be taken out of cultivation subsequent to the accession to the EU. On these lands (fully or partially) plantations will have to be promoted. Environmentally sound and efficient utilization of the biomass from plantations and forests for energy production purpose should be promoted by creating small community CHP plants and/or heating plants.

The preparation of the climate change strategy involving several ministries and authorities indirectly provided a good addition to the formulation of the institutional background of climate change. From 1999 the tasks of the greenhouse gas emission inventories was relocated to the Institute for Environmental Management. The institute is the field institutional contact, the expertise of the personnel responsible ensures the required niveau of inventory formulation. Nonetheless, the present human and financial

resources do not enable the expansion of the activities (calculation of emission baselines) and development (formulation of local emission factors).

Beginning with 2000 the Energy Center – National Energy Efficiency Agency – under the supervision of the Ministry of Economics, Ministry of Environment and the Hungarian Energy Office as respective owners, is the designated central agency for JI project management. The reorganization of the agency in 1999 also stemmed from finding a satisfactory solution for the management of this task. The institute has skill and expertise for most of the projects qualifying for JI, and has experience in project management. The institute has governmental approval for the qualification of energy saving projects, therefore has a project pool of JI. (The national JI strategy being outlined assigns further tasks to this entity.)

c.) Evaluation of the effects of the measures

The horizontal climate change policy, created and affirmed in the end of 90's brought by the first results in Hungary: the recently experienced economic growth was not accompanied by the growth of greenhouse gas emissions (decoupling). With further reinforcement of this policy Hungary could significantly overcomply with its Kyoto commitments.

With the climate change strategy, the Government accepted that the reduction of greenhouse gases – through indirect effects – has a beneficial impact on almost all levels of the economy and the society. The more efficient and rational material and resource management – one of the main priorities of climate change mitigation – improves profitability on the supply side, while imposing cost reduction on the consumer side. Therefore climate change mitigation can be regarded as a measure of economic development contributing to the improvement of competitiveness of the economy while also having benefits in social welfare. Climate change mitigation provides a new pathway of innovation and technological development on the global level, improving employment and promotion of enterprises. The formulation of the information society (remote work, online shopping, online education) also aids energy efficiency, therefore complying with climate change mitigation requirements. The beneficial effect of afforestation and biomass utilization as climate change mitigation measures on employment and welfare of people in rural areas also has to be mentioned here.

Climate-related focus area in the National Research & Development Programme

a.) Definition and targets

The National Research and Development Plan was accepted by the Government in 2000. The document identifies the environment-oriented innovation as an important supplemental measure to the implementation of the environmental policy of the country. It is therefore of priority to develop knowledge-base, to enhance domestic scientific and technological experience, to spread up-to-date technologies, to increase field research, to strengthen innovative and technological relations. The Global Change Sub-Programme of the National Research And Development Plan aims at realizing the following objectives.

From the aspect of advancing scientific research it is important that the climate change processes require installation of integrated monitoring-evaluating systems, complex research programs, and coordinated international measures. As a conclusion the installation of new monitoring sytems, the refinement and extension of measuring methodologies, the development of measuring equipment aimed at detecting changes in environment and forecasting eventual disasters is a must.

The interdisciplinary basic research on climate change and impact assessment should be intensified and strengthened.

In the field of technological development and innovation the realization of the climate change strategy has to be ensured with special regards to renewable energy sources, up-to-date fuel saving means of transportation, and energy intensive technologies.

b.) Implementation issues

The execution of the National Research & Development Plan is ensured by the Széchenyi Plan's Research and Development Sub-programme. Major Research & Development priorities are as follows:

- Basic research in climate change: The promotion of research aimed at better understanding of causes and implications of climate change and at discovering options for adaptation.
- Energy saving and greenhouse gas emission minimizing technology development:
  - New technology development on methane, N_2O and other

greenhouse-gas emission reduction purposes

- Research & Development subsidies aimed at new energy efficient technology development, market development and demonstration programs
- Research and development on technology aimed at reducing greenhouse gas from fossil fuel use, and on marketing of non-fossil energy sources

- Strengthening of carbon sinks: Support of research, development and innovation activities necessary for advancement of sustainable forestry and land use.
- Promotion of climate change demonstration programs: Education, raising of public awareness, formulation of public relation and information services on consumer behaviour relevant to sustainable development, adaptation and prevention strategies.

c.) Evaluation of the effects of the measures

In 2001 and 2002 in the framework of the Széchenyi Plan's Research and Development Sub-programme approximately 700 mHUF (cca. 2.8 mEuro) was distributed among projects aimed at climate change research and climate change mitigation. Implementation of these projects has begun, but no information on their direct or indirect benefits on climate change or socio-economic welfare is available yet.

Development of the Climate Change Action Program in the framework of the second National Environmental Program (preliminary information)

In 2002 the first planning period of the National Environmental Program finished. The concept of the second National Environmental Program is defined in a Governmental Decision, 1117/2001 (X.13.). This document prescribes that a Climate Change Action Program has to be elaborated in the framework of the National Environmental Program. This Action Program will also serve as the national program for the Kyoto Protocol. In the frame of the action program the following has to be accomplished:

- Periodical observations have to be done on the efficiency of the separate sectoral measures, serving as a basis for modification and intervention
- In order to strengthen public participation – in concordance with the framework of the action program on raising environmental awareness – a campaign on raising climate awareness has to be initiated
- In cooperation with the corporate sector an innovation program on climate change mitigation has to be started, enabling state-of-the-art, environment-friendly technologies (mainly in energy use) to gain position in domestic use
- The monitoring and accounting system of greenhouse gases has to be elaborated following EU and OECD guidelines and directives. The annual greenhouse gas inventories have to be published in addition to their communication in international data exchange and reporting obligations

Since main emission sources of greenhouse gases are in the industry and household sector, therefore new type of cooperative partnerships harmonizing with sectoral programs have to be formulated in the framework of the Climate Change Action Programme. The Action Program incorporates the acidification and atmospheric ozone protection measures. In defining the measures and steps to be taken, priority has to be placed on modification of existing programs in order to conform with climate change mitigation, and on market mechanisms of climate change.

Energy

Hungarian Energy Policy from 1993

The first energy policy after the fundamental political changes in 1990 (from communist regime with centrally planned economy to a democratic system with market oriented economy) was adopted by the Parliament in April 1993. On the basis of a policy document, the Hungarian Energy Policy was prepared by the former Ministry of Industry and Trade and finalized in July 1992 with the following strategic objectives:

- diversification of energy supplies and elimination of import dependence on the former Soviet Union;
- improved protection of the environment and minimization of pollution;
- increased energy efficiency through the modernization of supply structures and better management of electricity consumption;
- improved public acceptance of new energy facilities through provision of better information to the general public;
- attraction of foreign capital for investment in capital-intensive energy projects with low rates of return.

In accepting the policy document the Parliament made four additional provisions in its resolution (No.21/1993):

- The Government should give particular attention to ensuring secure, economic and environmentally acceptable supplies of energy to meet demand from the residential sector and industry. To this end efforts should be directed at diversifying sources of imported energy.
- The Government should develop a national energy conservation and efficiency programme and assure its implementation. The expected impact of the programme should be fully reflected in energy forecasting and in power generation expansion plans.
- As no decision could yet be taken on construction of a new baseload power station, the Government should continue preparatory studies, including environmental assessments, to establish the need for such a plant with a view to submitting a proposal to the Parliament on the type and location of a new station.
- The Government should assure the necessary gradual contraction of coal mining, taking into account social welfare considerations, by merging coal mines supplying power stations with the power companies under the control of MVM (Hungarian Power Companies) or by promoting long term co-operation between the mines and MVM. (The Government chose the former course.)

The Hungarian Energy Policy, fit closely with IEA (International Energy Agency) member countries' objective to create conditions in which the energy sector can make the fullest possible contribution to sustainable economic development and the well-being of the people and environment. In this organization Hungary is a full member from 1997.

Market conform legislation 1994-1996

Between 1994 and 1996, three major pieces of legislation were adopted, which created the necessary conditions for privatization: (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.

In 1996, the European Commission assessed the implementation and achievements of Hungary's energy policy in the aspect of the country's application for EU accession. The results of this assessment were published in a Country Opinion, which states that the objectives of Hungarian energy policy are in conformity with the principal EU requirements.

Electricity produced from renewables

Notice should also be made of the Ministerial Decree 55/1996 on the Establishment of the Purchase Price of Electricity by Public Power Stations. According to this decree (and as stipulated in the Electricity Law) the purchase of electricity generated from renewable sources is compulsory, once the capacity is at least 0.1 MW. The Government plans to introduce a system of tradable green certificates, as soon as the market of renewable electricity has reached a critical mass for competition of 300-350 MW. In the transition period, there will be a fixed premium system for small-scale power plants based on cogeneration or renewables.

According to new Government regulation, electricity supply companies are obliged to purchase electricity produced from renewable sources and from small scale CHP (up to 20 MW) at guaranteed prices, between 12-13 HUF/kWh and 20 HUF/kWh (approx. EUR 0.045 – 0.075). The surplus costs of this purchase are incorporated in the consumer price.

Energy pricing

Since the economic transformation in 1990, energy prices have been gradually adjusted to actual cost levels. While prices for oil products, coal and LPG were already liberalized in 1991 and 1992, natural gas, electricity and heat prices remained regulated, providing a sufficient transitory period to raise them to economic levels and to eliminate cross-subsidies, in particular from the industrial sector to households.

Prices were raised, moderately at first and rapidly after 1994, but the unexpectedly high inflation rate in the mid-1990s eroded much of the increase in real energy prices that had been achieved by that time. In 1995, it was estimated that average end-user prices for natural gas were still only half the level needed to cover costs, and that electricity prices had to increase very substantially in real terms. Subsequently, prices were raised drastically. Cross-subsidies began to be dismantled, with industrial energy prices rising less than residential prices.

Since 1997, prices for electricity and natural gas are calculated according to pricing principles and price formulas defined by the Hungarian Energy Office. The key element of pricing is cost-based

prices +8% investment-related profit. Since July 1, 1999, a new tariff system has come into force (Decrees 9/1999 and 10/1999), which aims at complying with the EU's requirements regarding the termination of cross financing between consumer groups.

According to the new Energy Policy Principles (the "Business Model"), price controls for power transmission and distribution and for captive consumers will remain in force, at least for the time being.

Similar to electricity, in the case of natural gas cost-based tariffs were introduced by July 1, 1999 (Decree 11/1999), eliminating cross financing between consumer groups. It appears that there are still some cross-subsidies between products within MOL, natural gas being subsidized by the price of petroleum products.

The Business Model calls for the development of a new system of price regulation, taking into consideration import prices and a system of setting transmission tariffs in the competitive market. Regulated third party access is the Government's preferred options in view of Hungary's integration in the European Internal Gas Market.

Energy taxation

Value-added tax on natural gas and electricity is only 12%, compared to the regular rate of 25%, which applies for example for vehicle fuels. According to the Ministry of Finance, there are no immediate plans to adjust the VAT-rate of natural gas and electricity to the regular rate (such an adjustment would have to be part of a comprehensive revision of the taxation system, not expected before 2003).

In some contrast to the preferential VAT-rate for gas and electricity, energy saving equipment and energy efficiency services (e.g., ESCO-services) appear to be subject to the regular VAT-rate. Reduced VAT for solar energy appliances has been abolished.

Currently there is also a so-called product charge of <5% which is levied on gasoline. This product charge is one of the largest sources for the Environmental Fund managed by the Ministry of Environment. Another source of income of the Fund is environmental penalties.

The Ministry of Environment intends to introduce an Environmental Emission Fee on three environmental media: air, water and soil. The Environmental Emission Fee will be a classical Pigouvian tax levied on the amount of polluting emission, with the aim of internalizing external costs. The proposal is still being debated. The energy sector would be the first sector concerned with the air emission fee on SO_2, NO_x, CO, particles and other toxic emissions.

New Business Model of the Energy Sector 1999

In 1999, the elaboration of a New Business Model of the Energy Sector was requested by the government. The energy administration with active participation from the private energy companies fulfilled this job. Developing the model the motivation was to outline the new medium-term objectives and to prepare a more detailed plan of action for its implementation. Further steps and a detailed timetable of tasks related to the accession will be finalized according to the date of accession to the European Union.

For this reason the model gives a detailed timetable until 2002, but for the period afterwards it only sets the objectives. By introducing competition ahead of EU accession the construction of domestic capacities on a commercial basis also becomes an important objective. Further steps and the liberalization of export-import rights can be scheduled on the basis of competitive market experiences and the final date of accession.

As a consequence of European integration the security of domestic energy consumption will have to be guaranteed not on the national level but as a part of the internal European energy market. For this reason greater emphasis will be placed on the competitiveness of the Hungarian energy sector on the European level than on the security of energy resources (balance of resources). Responsibility of supply will replace the privilege of supply as a result of competition.

Increasing efficiency resulting from the introduction of the competition will decrease prices. One should note however, that irrespective of deregulation, other factors also influence prices, and consequently their impact manifests at the same time. (Changes in fuel prices, increase of environmental protection costs, elimination of state aids to the mining industry, realization of possible power plant construction prescribed by the privatization contracts, lower demand for domestic capacity reserves as a part of the single European internal market.)

The energy management should be made more efficient in order to improve the competitiveness of the economy. Energy industry is one of the major sources of environmental pollution.

According to international obligations those emissions have to be reduced drastically. Foreign experiences show that it is difficult to find commercially reversionary solutions and external involvement is indispensable. The population and the corporate decision-makers can do the most for energy efficiency and protection of the environment. The state has only indirect means, like influencing consciousness, the transfer of up-to-date knowledge and the financial support of investments. A complex program will be elaborated, which integrates the affected institutions and gives emphasized support to the above mentioned issues. The state assists investments promoting energy conservation by granting non-refundable and/or interest free credits to the population and preferential rate credits to the industry.

Exploiting benefits of sound energy management in environmental protection, national economy, and in providing competitive services in the district-heating sector is a very important objective.

Concerning energy conservation and efficiency, the Government mainly relies on "the coordinated application of domestic and foreign funds available for that specific purpose and other funds earmarked for various purposes." Like in other fields of energy policy, complying with EU requirements appears to be the principal driving force. Increasing the country's renewable energy use from presently 3.5% to 6-7% is another aim of the policy.

The Business Model announces the establishment of a "national programme to spread awareness of energy conservation and renewable energy sources, conveying their advantages and the means of implementing them", to provide investments for increasing energy efficiency, to apply tariffs based on actual costs and to extend the Energy Saving Credit Programme.

The Business Model states as a central aspect of energy policy "the internalization of environmentally-related costs", in a way that they "must not exceed what the public can bear and must not threaten the international competitiveness of the economy". Environmental costs will be mainly determined by the requirements of new EU-harmonized legislation.

The model outlined is still short of responding to a number of issues in respect of political decisions which should be made and/or the answers can be brought by the completion of the tasks set hereby.

New Act on Electricity

The newest energy policy development is the Parliamentary approval of the new Act on Electricity on 18th of December 2001. The Act will enter into force on 1st of January 2003 and gives a gradual introduction of introducing competition from that date. The first step will be liberalizing 35% of the market. The steps following the opening one will be the Government's responsibilities. The market opening would be based on regulated third party access. Until reaching a fully open market there will be two parallel markets: the Public Utility Market and the Competitive Market. The new Act is in full harmony with EU rules and principles. The earlier IEA in-depth-review and the Regulatory Reform peer review recommendations are reflected in the Act. In 2002 the main job of the energy administration will be the preparation of the necessary steps before market opening and the workout of the secondary detailed legislation.

The third conference of the member states of the Climate Change Framework held in Kyoto in 3-10 December 1997, set the aim to stabilize greenhouse gas concentration in the atmosphere. This decision may serve the benefit of all mankind in long term. Participating countries committed themselves to decrease the emission in different extent compared to the basic year or basic period.

Hungary has committed a decrease of 6% carbon dioxide equivalent for the period 2008-2012 related to the emission value in 1985-87.

Antecedents

At the end of the 1980s a recession broke in the Hungarian economy. Due to this decline, energy use decreased and a structural and productivity change started in the industry. Regarding the energy sector, Hungary had a very great dependency from the Soviet Union in 1990. Capacity of the economy touched the bottom in 1993 when energy consumption amounted to only 78% of the figures of 1987.

Political, economic and social changes following the collapse of the communist regime required the reconsideration of energy policy, to bring it in harmony with the requirements of a market economy. The draft of the Hungarian energy policy was made subject to a wide-range professional, social and political debate. Following this, the report on energy policy was accepted by the Government in 1992, then by the Parliament in March 1993 and basic principle and main strategy guidelines of the energy policy were confirmed by the Decision of the Parliament No.

21/1993.(IV.9.). Protection of the environment, energy saving and increase of the share of renewable energy sources were already part of the basic principles.

In 1993, when the Hungarian energy policy was accepted, elaboration of an energy saving program improving domestic energy efficiency and international competitiveness was ordered by the Decision No. 21/1993. (IV.9.) of the Parliament. The Concept of the Energy Saving Program was prepared at that time, followed by the Action Program ensuring its operation. Decision No. 2399/1995(XII.12.) of the Government gave green light to the Action Program, however the required budget funding was not granted for the efficient function of this program. Financial experts' opinion was that a considerable increase of energy prices is sufficient to motivate energy saving, consequently no investment subsidies are necessary to promote it.

Later, establishment of the Energy Saving Credit Program was ordered by the Government Decisions No. 1113/1996. (XI.29.) and 1128/1997 (XII.18.). In addition, a few actions for energy saving have also been started, which were supported by the Central Environmental Fund. Within these tendering subsidy systems, among energy saving tenders showing similar outputs, those had priority, which could save energy through renewable energy use. This actions supported by small funds had little success.

Based on the principle of accepted energy policy and updating and using its main achievements, the document "Basis of Hungarian Energy Policy, Business Model of Energy Management" was made by the order the Government Decision No. 2199/1999(VIII.6.). Priority objectives aimed at improving energy saving and energy efficiency by development of environment-friendly renewable energy use. The Government elaborated the energy saving and energy efficiency development strategy and the Action Program supporting implementation, as described by the Government Decision No. 1107/1999. (X.8.). The energy saving program strives to decrease energy-related load on the environment to the lowest possible level.

Within the 15 task groups of the Action Program, special attention is paid to the sub-program of renewable energy use, however other items are also connected to this subject, e.g. energy management of local municipalities, increased use of alternative firing systems, reconstruction of district heating systems, competitiveness of district heat supply, etc.

The Government set the following aim:

- The Program should promote the direction of development in Hungary, which would realize 5% GDP increase at max. 1.5% annual increase in energy demand.
- Through energy saving actions partly subsidized by the state, 75 PJ/a (1.8 million tons oil equivalent) energy should be saved, or converted by renewable energy carriers until 2010. Owing to these savings, sulfur dioxide emission should decrease by 50,000 tons/a, while carbon dioxide emission by 5 million tons/a.
- In order to save traditional energy sources and to mitigate harmful impacts on the environment, share of renewable energy use should increase from the present value of 28 PJ/a to 50 PJ/a in 2010.

As non-refundable grant, 100 million HUF was given from the available budget to finance projects on renewable energy use through submitted tenders.

With the introduction of the Széchenyi Plan in 2001, different subsidy and tendering systems of the Ministry of Economic Affairs gained a uniform appearance. Energy saving tenders are also included in this plan. Regarding tenders of the Széchenyi Plan, non-recurrent grants substitute different subsidy methods given earlier. The budget of energy saving fund increased to 2 billion HUF in 2001, compared to the 900 million HUF in the previous year. A separated amount of 3 billion HUF was available for supporting the energy saving reconstruction of residential buildings built by industrial technology.

Within the frame of the Energy Saving Program of the Széchenyi Plan, amount of funds available for tenders developing renewable energy sources and increasing renewable energy use, were raised from 100 million HUF to 350 million and keeping the 30% share determined in the previous year as upper limit of support, the maximal amount of grant was lifted from 200,000 HUF/flat to 250,000 HUF/flat for individuals, while these amounts changed from 2 million HUF to 35 million at municipalities and companies. Aims of support have not changed in 2002, however conditions have improved.

The subsidy system was supplemented by the Order of the Ministry of Economy No. 46/2000 (XII.21.) which considerably increased the upper limit of purchase price of electricity produced by renewable energy, waste and small capacity cogeneration. The Order No. 36/2001 (XII.22.) on electricity purchase ensures a further price increase in 2002. In addition to regulated purchase price, the law also guarantees electricity take-over.

The law on electricity production, transport and supply (Law No. CX. of 2001) orders that over 100 kW capacity, purchase of electricity produced from renewable energy sources (geothermal energy, hydropower, solar energy, wind, biomass, biogas) should not be rejected by the electricity deliverer (in case of power plants connecting to the main grid) or the regional electricity supplier (in case of power plants connecting to the distribution grid). In case of cogeneration, purchase of electricity is compulsory, if the electric capacity of the power plant (unit) is under 20 MW.

Results achieved through tenders are promising. About 120 tender applications on renewable energy use were submitted in 2000, adding a total amount of about 0.6 PJ/a to energy saving. In 2001, within the frame of the Energy Saving Program of the Széchenyi Plan, 239 tender applications were submitted, representing a twofold increase in saving, compared to the previous year.

Despite results achieved, it is unfortunately seen that the share of renewable energy use has increased in small extent only and it did not reach the required ratio. Actually, it is not the Kyoto Protocol, which would force the development of renewable energy use, but it is a requirement of the Hungarian energy policy and the accession to the EU.

The use of renewable energy will expectedly reach the value of 37 PJ in 2001, which – depending on the conditions of subsidies – may reach 79 PJ in 2010. In order to realize the planned increase of renewable energy use, a program determining guidelines to 2010 should be started, which also needs considerable funding.
To be able to fulfil expectations on the development of renewable energy, much more funds for subsidy should be separated from the national budget. One possible way of subsidy is investment support, another is price support. Proper ratio of these two should be found. The renewable energy program being under preparation, would include actions promoting the development of renewable energy use and therefore to be subsidized. According to targets set by the Government, use of renewable energy sources might be doubled through these actions until 2010.

Agriculture

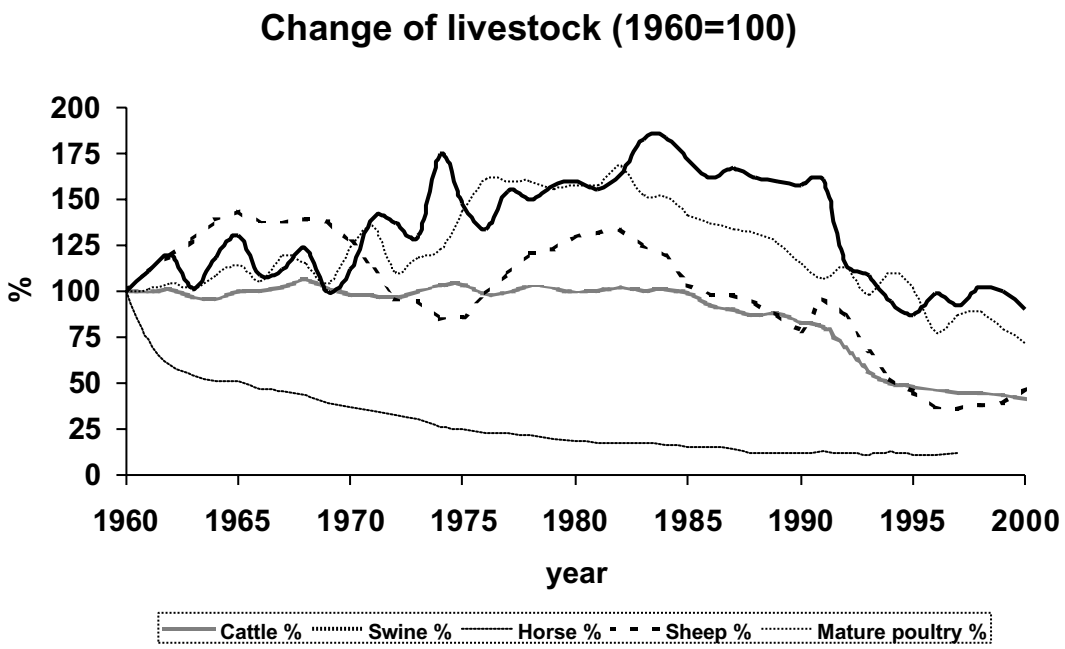
The Hungarian agricultural production has practically developed in accordance with the country's ecological and economic capabilities till 1990, several branches have reached world standard. After the change of regime in 1990, however, a dramatic fallback occurred. Between 1990 and 2000 the number of agricultural production units decreased by more than 30%, the employees in agriculture by more than 50% and the volume index of gross production of agricultural products by more than 30%. Figure IV.1 shows the decrease in livestock. Simultaneously, the production efficiency of several branches has decreased.

Production per hectare of agricultural land has decreased both in plant production and animal breeding. Due to the dramatic fallback suffered between 1990 and 1995 that primarily touched animal breeding the greenhouse gas emission of agriculture has decreased (Figure IV.2).

Hungary will prospectively join the European Union in 2004. The European Commission started the discussion the chapters of accession negotiations pertaining to the community supports at the end of January 2002 between the 15 Member States and the 10 candidates for the accession in 2004. According to the current state of the negotiations in 2004 the agricultural enterprises of the candidate countries would receive 25% of the Union's direct supports. This proportion would be increased by 5% annually till 2007 then by 10% annually till 2013 when it would reach its full amount. The production quotas proposed by the European Commission were based on the production between 1995 and 1999, and they are greatly under the candidates' demands. In the course of the negotiations formally starting in June 2002 between the Hungarian Government and the EU, the Hungarian experts – on the basis of the future production growth opportunities – try to improve the proposal that is offered to the Member States by the European Commission pertaining to the integration conditions of the Hungarian agriculture. There is a chance to have favourable changes for the Hungarian agriculture since the treaty of the European integration binds the Union agriculture policy to guarantee an adequate income to every farmer and it will be valid for the farmers of the joining Eastern countries, too. Nevertheless, it is expected that the Hungarian agriculture sector – by complying with the Union tendencies – will lay emphasis on the consolidation of land property, on quality - but not quantity - food production and on intensively increasing the proportion of processed agricultural products.

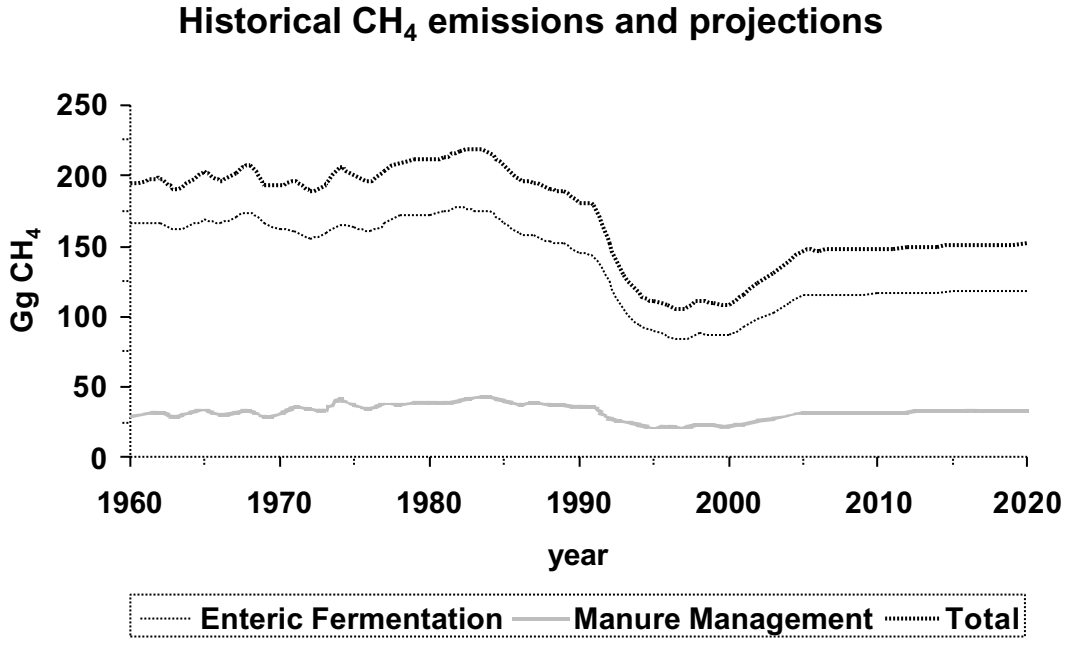
Within reasonable time Hungary will be the member of the European Union so it will belong to the European internal market. The compliance, however, with the restructuring of the agriculture, environmental and rural policies of the European Union will only be possible if the promotion of the agri-environmental production will be a priority in the agricultural supports.

Figure IV.1: Change of livestock between 1960 and 2000



Source: Hungarian Statistical Office

Figure IV.2: Historical emissions and projections for CH_4 emissions from livestock production 1960 to 2020



Source: Hungarian Statistical Office, National Communications of Hungary

Forestry

As outlined previously, Hungary carried out a massive afforestation program in the 20th century. There was no single year without afforestations on thousands of hectares, however, with the collapse of the centrally planned economy, less and less resources could be allocated to establish new forests. At the end of the 80's, a new afforestation program had been drafted: 150 thousand ha of new

forests should have been established in just ten years. However, due to a shortage of resources, only around two-thirds of the program was realized. Yet, the forested ratio increased again.

At the turn of the millennia, new opportunities are expected for increasing forest cover. In this decade, the afforestation of some 170 thousand ha is planned. The resoluteness to carry out this program can be seen from the mere fact that more and more financial resources are allocated to forestry, and from 2000 to 2001 the resources separated for afforestation programs were tripled. This made it possible to increase the afforestation ratio from around three thousand ha per year in 1994 to 17 thousand ha in the last year.

Even more opportunities can be exploited in the next three decades. Because of the economic development, more intense international dependence, and the possible accession of the country to the EU, large areas of agricultural fields will be available for other use, e.g., afforestaion. The utilization of these areas is still debated, but detailed estimations exist on the distribution and size of the land that can be set aside for afforestation.

B. Policies and measures and their effects

Institutional background of energy efficiency

The Ministry of Economic Affairs is responsible for the design and formulation of the overall energy policy, including energy efficiency. Responsibility within the Ministry is with the Energy Department.

Regulation of the energy sector has been delegated to the Hungarian Energy Office by Law. The Hungarian Energy Office regulates the electricity and natural gas sectors through licensing procedures (for the construction, starting-up and operation of new and existing projects), through the approval of purchase agreements and through the setting of prices and tariffs. The Hungarian Energy Office is also responsible for consumer protection and promoting energy efficiency.

Other Ministries involved in energy efficiency issues are the Ministry of the Environment, the Ministry of Agriculture and Rural Development, the Ministry of Transport, Telecommunication and Water Management and – as far as district heating is concerned – the Ministry of the Interior.

While the Ministry of the Environment has played a role in shaping energy efficiency and policy, its main concern is environmental regulation in the energy sector (emissions from energy conversion).

The Ministry of Agriculture and Rural Development deals with biomass and biofuels, while the Ministry of Transport, Telecommunication and Water Management deals with energy efficiency aspects within the Framework Policy of Transport .

In 1992, the Hungarian Government and the European Union established the “Hungarian-EU Energy Center”, which has been one of the first cooperation schemes between the EU and Central Europe in this field. Since 1997, when the financing contract period with the EU ended, the Center has been a so-called public interest company.

Building on the experience of the Hungarian-EU Energy Center, which has functioned as an institutional background for EU-Hungarian co-operation projects, the “old” Energy Center continued to operate as a focal point for integrating and adapting experiences from several EU countries in the Hungarian context, focusing mainly on the development of strategies, preparation of decision making, project implementation, awareness raising and coalition building.

At present, the Energy Center is owned by the Ministry of Economic Affairs (60%), the Ministry of Environment (25%) and the Hungarian Energy Office (15%). In 2000, the Energy Center was strengthened and merged with the former Energy Information Agency (EIA). It was appointed as the national energy efficiency agency mainly responsible for the implementation of the National Energy Saving and Energy Efficiency Action Programme. Main tasks of the “new” Energy Center are managing national, bilateral and EU funded energy efficiency programs and projects, including the Energy Saving Programme in the Széchenyi Plan.

The Energy Center in his present form has been established by Government Resolution 1031/2000 under the official name: “Energy Center” Energy Efficiency, Environmental Protection and Energy Information Agency. The same Government Resolution also creates a budget title for the Center and stipulates the use of 100 million HUF out of the 1 billion HUF budget of the National Energy Saving and Energy Efficiency Action Programme for “project and institutional development and for managing of projects of the Action Programme by the Energy Center”. The staff of the Energy Center has increased from eight to more than fifty.

Resolution 1031/2000 also orders the establishment of the Energy Saving Inter-Ministerial Committee whose task is to "award supports related to energy saving programmes". The Committee is in charge of approving applications for funding under the Energy Saving Action Programme. Taking into consideration the increasing number of applications, this task of the Committee might turn out to be very demanding and might need the development of specific procedures.

Positive effects of the EE programs on GHG emissions
Emission forecast for the energy sector

The 1999's Energy Efficiency Programme gives a well-defined task on the energy saving, on renewable energy sources and on GHG emission reduction. All of the additional other programs were calculated and their impacts were integrated in this Government's Decree. In Chapter VII, the measured results of the EE programs are listed. These results up to 2010 (mid-year of the Kyoto commitment) are reflected in the Decree as follows:

- Reduction of energy intensity with 3.5%/year, assuming an annual growth of GDP of 5%/year and a growth rate of energy consumption of 1.5%/year.
- Saving of 75 PJ/year (1.8 Mtoe/year) of primary energy sources.
- Reduction of 50 kt/year of SO_2 and 5 Mt/year of CO_2 emissions.
- Increase of renewable energy production of 50 PJ/year (1.2 Mtoe/year)

In December 2001 the Hungarian Government and Parliament accepted an energy policy report with a forecast for the future. In accordance with this document the total energy supply will increase in the next ten years 1,0% / year and the electricity supply with 1,5% (as medium, the range 1-2%). The basis of this analysis is a sustainable 5% increase in GDP.

In Chapter V, two scenarios for the energy-related emissions are given depending on the amount (hence the structure) of fuel used. If we take into account the opportunity of increasing the use of renewable energy sources, we get the scenario with measures for the energy sector. The CO_2 emissions of this scenario is projected as follows::

	1997	*1998*	*2005*	*2010*
Supply (Mtoe)	25,44	25,26	28,6	30,0
Em. ($MtCO_2$)	59,0	58,0	57,8	60,8

Renewable energy

As it has been mentioned already, there is an existing strategy in Hungary on the increased use of renewable energy until 2010, however an implementation program has not been prepared so far. Therefore, the following should be considered when determining scenarios for the future:

- The programs will speed up later, i.e. strategic aims – with some delay, though – will be fulfilled, comprehensive and detailed programs will be elaborated and a financing system will also be established.
- After the accession to the EU, Hungary will take over EU guidelines and can obtain certain grants required for compliance, which would be added to existing domestic grants.

Considering these, summarized figures of the two scenarios are presented below, which may serve as a basis for the calculation of reachable decrease of greenhouse gas emissions. These figures are included in Table IV.1.

Table IV.1: Scenarios on the use of renewable energy sources until 2012

Renewable energy source	Base case			Scenario with measures		
	Electricity GWh/a	Heat PJ/a	Total PJ/a	Electricity GWh/a	Heat PJ/a	Total PJ / a
Hydropower	333	-	1,2	333	-	1,2
Wind	120	-	0,43	165	-	0,6
Solar energy	1	1,8	1,81	1,5	2,9	3,0
Geothermal Energy	-	5,1	5,1	480	13,7	15,0
Biomass	780	63,06	65,86	1500	70,2	75,6
Communal and other waste	273	3,9	4,9	280	4,0	5,0
Total:	1507	73,6	79	2759,5	89,9	100

Source: Co-Energy, 2002

The above data was elaborated in cooperation with the experts of the Ministry of Economic Affairs.

Remarks and additions to the table

Hydropower: Existing technical potential will be exploited, further increase is not possible.

Wind: Better exploitation of this energy source mainly depends on the increase of subsidies, however most probably due to the protest of green (nature preservation) organizations, a lot of sites will be rejected for further implementation. Data in the table include the installation of 100 and 150 wind turbines respectively.

Solar energy: This will mainly mean utilization of solar thermal energy in the future, too. The given data include the installation of 1.7 and 3.0 million m^2 collectors respectively, provided that integration of solar energy into the heating system could be made economical.

Geothermal energy: Considerable development is expected only when a suitable technology of pumping back the water to the sedimentary layers is found. Should this problem be solved, the use of geothermal energy – with appropriate grants - might develop enormously.

Biomass: Given figures also include the development of energy plant growing, which is considered for 50 th.ha increase in "normal" scenario, and 100 th.ha in "developed" one. According to present assumptions, it does not make any difference if the energy plants would be used for the production of liquid biofuels or solid fuels.

Communal waste: In order to be able to realize the figures planned, complex measuring packages would be necessary, as follows:

- Selective waste collection, separate manipulation of organic and combustible parts
- Implementation of waste incinerator plants at settlements with population over 100 thousand souls

Effect of measures on greenhouse gas emissions

A forecast on greenhouse gas, namely carbon dioxide and methane emission reduction obtainable through the development of the use of renewable energy sources is summarized by the Tables IV.2 and IV.3 respectively.

Table IV.2: Carbon dioxide emission reduction obtainable through renewable energy use in 2012 (1000 tons/a) (compared to the situation of the year 2001)

Renewable energy source	Base case			Scenario with measures		
	Electricity GWh/a	Heat PJ/a	Total PJ/a	Electricity GWh/a	Heat PJ/a	Total PJ/a
Hydropower	160	-	160	160	-	160
Wind	128,6	-	128,6	179,8	-	179,8
Solar energy	1,1	183,8	184,9	1,6	296	297,6
Geothermal energy	-	78	78	523,2	502	1025,2
Biomass	836	1643	2479	1620	2015	3635
MSW	248	170,5	290,6	255	174,7	298,4
Total:	1373,7	2075,3	3321,1	2739,6	2856,7	5596,3

Source: Co-Energy, 2002

Table IV.3: Methane emission reduction obtainable through renewable energy use in 2012 (tons/a) (compared to the situation of the year 2001)

Reduction is achieved by:	Base case	Scenario with measures
Reduction of coal use for electricity production	4544	9071
Reduction of hydrocarbon use for electricity production	5662	11312
Reduction of hydrocarbon use for heat production	34353	49239
Incineration of communal waste (MSW)	13653	13986
Use of landfill gas/ biogas	9245	13860
Total:	67457	97468

Source: Co-Energy, 2002

Some explanation relating to the figures of these tables is given below.

- Power plant capacity can be substituted by electricity production from renewable energy sources. These power plants, fuelled 50% by coal and 50% by hydrocarbons have an average efficiency of 0.32. Substitution of power plant capacity based on advanced CHP technology has not been considered.
- In order to make the emission figures suitable for evaluation, the basis of calculation at electricity production is the electricity generated, while at heat production it is based on the input fuel heat.
- Concerning biomass, CO_2 emission is considered zero, even if this situation is likely only after a few years (e.g. wood).
- The amount of CO_2 emitted by the incineration of non-biological materials from the combustible part of communal waste, has been deducted from total savings.
- Solar heat production substitutes electricity and natural gas in 50-50 %.
- Relating to heat production, substitution of natural gas has been considered at all cases. Substitution of existing oil firing and development of biofuels may cause a higher reduction in CO_2 emission, therefore these values seem to be safely reached.

- Relating to biogas, mainly the use of gas produced by the existing landfill sites has been considered.

Agriculture

National Agri-Environmental Programme (NAEP)

The Hungarian Parliament decided on the establishment and the implementation of the National Agri-Environmental Programme (NAEP). The NAEP, in accordance with the European Union Council Regulation No. 2078/92 "on the support of agricultural production methods that are environmentally friendly and aim at the preservation of rural areas", tries to encourage different environmentally friendly production methods and production serving the protection of environment and nature.

In the NAEP the environmental tasks pertaining to the agriculture sector were defined. The declared principles are sustainability and quality. One of the decisive factors of sustainable agricultural development is to provide the long-term protection of natural resources. It may also increase the competitiveness of the Hungarian agriculture. The state of environment of the Hungarian agriculture gives a better picture in certain areas than in the developed European countries. In Hungary the load of agricultural origin played significantly less role in the deterioration of soil quality, in the contamination of surface and subsurface waters, in the decrease of biodiversity than in the countries having developed industry and industrialized agriculture. Looking at the development of the Hungarian agriculture the NAEP considers as comparative advantage and market factor that environmentally friendly processes should be applied and the more and more stringent international requirements of agri-environmental protection should be proceeded in the entire agriculture sector.

The original target of NAEP is to establish such an agricultural practice that is based on the sustainable use of natural resources (soil, surface and subsurface waters, genetic resources, forest and landscape), on the conservation of natural values, biodiversity, on the protection of the values of landscape and on the production of healthy products. Though in the intensively used areas the primary target is still the economical production, the NAEP stresses that even in these areas resource-saving, professional and controlled production technologies should be applied. The NAEP aims to establish a multi-functional model. The major features of the model are the following:

- Establishment of an agriculture competitive on the world market without excessive supports
- Comprehensive application of environmentally friendly production methods
- Keeping multi-coloured production systems, forms, conservation of production traditions, protection of rural environment and landscape
- Establishment of a simpler, plainer agriculture policy that drives the use of resources in a way that the whole society will benefit from it, not only the farmers

In the framework of the NAEP the establishment of the following action programs and its integration into the agricultural support system are planned.

A) National (horizontal) programs
1. Agri-Environmental production program
2. Integrated production program
3. Ecological production program
4. Grassland management program
5. Wetland management program

B) Regional (zonal) programs
1. Nature conservation programs
2. Soil protection programs
3. Water protection programs

C) Training, advisory and demonstration programs

The planned agri-environmental measures cover soil protection, nature conservation, protection of surface and subsurface waters, landscape protection and air quality protection. Though according to the authors of the NAEP the air pollution caused by agriculture can be considered as marginal but the incidental air pollution caused by the emissions from livestock, liquid manure application and certain plant protection procedures require measures, especially the reduction of greenhouse gas emissions demand attention. Nevertheless the NAEP does not mention concrete measures on this.

The stage established in 1999 of the NAEP covers the period between 1st January 2000 and 31st December 2006. Simultaneously with the NAEP a Monitoring Programme following the environmental-economic-social impacts will also be implemented, according to the plans. By utilizing the results of it an interim evaluation in 2003, then a final program evaluation in 2006 will take place. On the basis of the evaluation, if necessary, the NAEP will be modified for the second period between 2007 and 2013.

Measures to reducing methane emission from agriculture – In theory it is possible to reduce methane emissions by measures in the area of livestock feeding, increasing production level,

manure management as well as the number of livestock.

From the aspect of livestock feeding the methane losses emerging in the course of enteric fermentation are economic losses, too. Researches aiming at minimizing the methane production of ruminants have been in progress all over the world for decades. In the case of cattle the - compared to the results so far not too serious - reduction can be achieved by increasing the cereals and fat feeding. The percentage of grains is quite high in rations at present, so it can not be increased further. The same can be said about fat supplementation. The social acceptance of other possible measures (defaunation, use of antibiotics, hormones or biotechnology) are questionable. The increase of the livestock yield reduces the specific (calculated to unity product, e.g. to kg milk) methane emissions, but it has influence on the absolute emissions only in connection with the number of livestock.

In theory in the area of manure management methane emission can be reduced through many measures. Due to the lack of necessary practical knowledge the opportunities cannot be entirely exploited. Further practice-oriented research is necessary to elaborate specific recommendations pertaining to low-emission management of farm manure. The efficiency of covering the manure storage ought to be examined, too. The change from liquid to solid manure can reduce methane emission. In Hungary, however, currently the percentage of solid manure systems are already much higher than in Western Europe so further significant increase is improbable. There is conflict of interests between period and type of storage and in handling manure. The air and water protection interests are partly out of accord with the interests of the reduction of methane emission (emissions of ammonia, long storage period, surface drain-off). And last but not least, many issues pertaining to the costs should be cleared.

It is assumed that livestock and especially the number of dairy cattle will be reduced due to the development in breeding (increasing production level) and the ecological requirements toward agriculture. This statement, however, in the case of Hungary would only be true after Hungary would reach again the number of livestock in accordance with the ecological and economic possibilities of the country (2015-2020). The further reduction of livestock – despite the expectable quick improvement of production level – is unlikely after the shock of 1990-1995, rather, there would be some increase.

Summarizing the above-mentioned details it can be ascertained that at the moment there are no simple and efficient methods to reduce or prevent methane emissions of agriculture origin that could be applied in Hungary. In the foreseeable future the methane emissions of Hungarian agriculture will primarily depend on the number of livestock.

Fundamentally the same conclusion can be drawn in relation to the N_2O emission of agriculture. After the accession to the European Union –or till getting back to the former production level – quantitative and qualitative development is also expected in plant production, therefore the use of manure and N-fertilizers will grow instead of reduction in the short run.

C. Policies and measures no longer in place

Energy conservation measures 1985-1993

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

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 ÁEEF. At present, factories consuming 5,000GJ or more annually are designated as such.

System of energy managers

Factories consuming 10,000GJ or more annually were obliged to post energy managers.

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.

Energy diagnosis of factories

The State Energy and Energy Safety Authority (ÁEEF) conducted an energy conservation diagnosis of about 400 enterprises in five years.

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.

Promoting and informing activities for energy conservation in the industrial sector

The former Ministry of Industry and Trade, jointly with ÁEEF, held an energy conservation seminar every year for energy specialists in large enterprises as well as in small and medium enterprises.

Furthermore, the former Ministry of Industry and Trade held a meeting 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.

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

The specific energy conservation measures were 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

Energy Efficiency Policy and Programme 1993-1999

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

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

The relevant Parliamentary Resolution also underlined the importance of energy efficiency as follows.

The Government should develop a national energy conservation and efficiency programme and assure its implementation. The expected impact of the program had to be fully reflected in energy forecasting and in power generation expansion plans.

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: (i) least-cost planning and demand side management, as defined in the Electricity and Gas Laws, (ii) cost-based energy pricing in order to motivate energy saving, (iii) development of a new energy statistics and information system, (iv) introduction of individual metering and regulation in new apartment blocks with district heating supply, (v) implementation of minimum standards for the insulation of new buildings, (vi) energy efficiency labeling of household appliances, (vii) awareness raising and education on energy saving, (viii) improving energy efficiency in municipalities – via the Energy Saving Credit Programme (see below), (ix) training for energy professionals, (x) increasing the use of renewable energy and (xi) prioritizing 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.

Energy Efficiency Programme 1999

With Government resolution 1107/1999, a new Energy Saving and Energy Efficiency Action Programme was adopted in September 1999. The new program defines the following targets by 2010:

- Reduction of energy intensity with 3.5%/year, assuming an annual growth of GDP of 5%/year and a growth rate of energy consumption of 1.5%/year
- Saving of 75 PJ/year (1.8 Mtoe/year) of primary energy sources
- Reduction of 50 kt/year of SO_2 and 5 Mt/year of CO_2 emissions
- Increase of renewable energy production of 50 PJ/year (1.2 Mtoe/year)

Initial funding of the Action Programme will be from the Economic Development Fund of the Ministry of Economic Affairs. While the initial budget allocation was HUF 1 billion/year for the period 2000–2001, the budget for 2001 has been increased to HUF 2 billion, supplemented by additional funding of 3 billion HUF from the Housing Programme of the Széchenyi Plan, earmarked for funding of energy efficiency measures in the housing sector. The Housing Programme is managed by the Building Department of the Ministry of Economic Affairs.

The main highlights of the various actions are as follows.

1. Revealing the possibilities of support from the European Union

The possibilities of making use of EU grants before and after accession should be revealed, in order to complement funding from national sources.

2. Energy saving attitude, ongoing education

This action aims at raising awareness, providing information and education via the educational system and the organization 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 the use of energy efficiency labels.

3. R&D relating to energy saving and expanding renewable energy sources

This action aims at encouraging the participation of Hungarian scientists in foreign research, as well as the incorporation of energy saving and environmentally friendly technologies in the Hungarian R&D, including demonstration projects.

4. To perform regular audits revealing energy loss in production

The Programme will provide grants for energy audits at companies with energy costs of HUF 50 million per year of higher and support the implementation of energy saving measures identified.

5. To improve the energy management of local governments

Following the experiences of the Energy Saving Credit Programme, grants will be provided for the local governments to elaborate local energy saving concepts, energy plans and perform energy audits.

6. Planning for least cost application of programmes influencing consumer demand

In accordance with new and expected energy sector legislation, a methodology will be developed to induce energy suppliers to reduce energy demand, taking into consideration compensation for costs arising for energy suppliers from their involvement in these measures.

7. Energy saving organization of transport and transportation

Incentives will be provided for organizational measures that will moderate the increase of road transportation and shift it to railway, waterways and combined way, as well as to moderate the use of passenger cars and switch traffic to public transport.

8. To moderate the use of industrial energy

Grants will be provided for: (i) energy-technological modernization of industrial production, (ii) improving heat insulation, (iii) improving the efficiency of energy consuming equipment and (iv) improving the efficiency of energy producing equipment.

9. Modernization of transport

This action is aimed at reconstruction of energy saving and environmentally sound transport alternatives (railway, waterway) and public transport, as well as upgrading and/or replacing existing vehicles.

10. Energy-technological modernization of agricultural production

Grants will be provided to modernize technologies leading to energy saving.

11. Support for population and public energy saving

Grants will be provided for investments aimed at the improvement of heat insulation of buildings (facades, roofs, cellars, doors and windows) and the modernization of the internal heat supply in buildings with district heating (regulation and measurement).

12. To increase the application of alternative heating systems

This action is aimed at moderating the consumption of gas and increasing the use of biomass and dual-fired (solid fuel and gas) heat generation at household, municipal and public consumers.

13. Modernization of energy consumption used for public lighting for local governments

This action is aimed at moderating the costs of public lighting by substitution of lamps and other technical measures.

14. Expanding the consumption of renewable energy sources

Elaboration of a program to increase the use of renewable energy sources, identify foreign funds and grants accessible for that purpose and to provide financial support to projects.

14a. Expanding the use of biomass, geothermal energy, organic waste

This specific activity is aimed at capacity building for electricity generation from the mentioned renewable sources.

14b. Program for 20 000 roofs with solar cells, 2010

This program intends to provide 20-30% of the investment necessary for institutional and residential buildings to install solar thermal and photovoltaic installations.

15. Renewal of district heating systems, making district heat supply competitive

Drafting a proposal for a modernization program for district heating systems and providing support to (i) increasing combined heat and power generation (CHP), (ii) reconstruction and implementation of heat measurement at the supply-side and (iii) introduction of regulation and cost allocation at the consumer side.

V. Projections and the Total Effects of Policies and Measures

A. Projections – diagrams

Energy

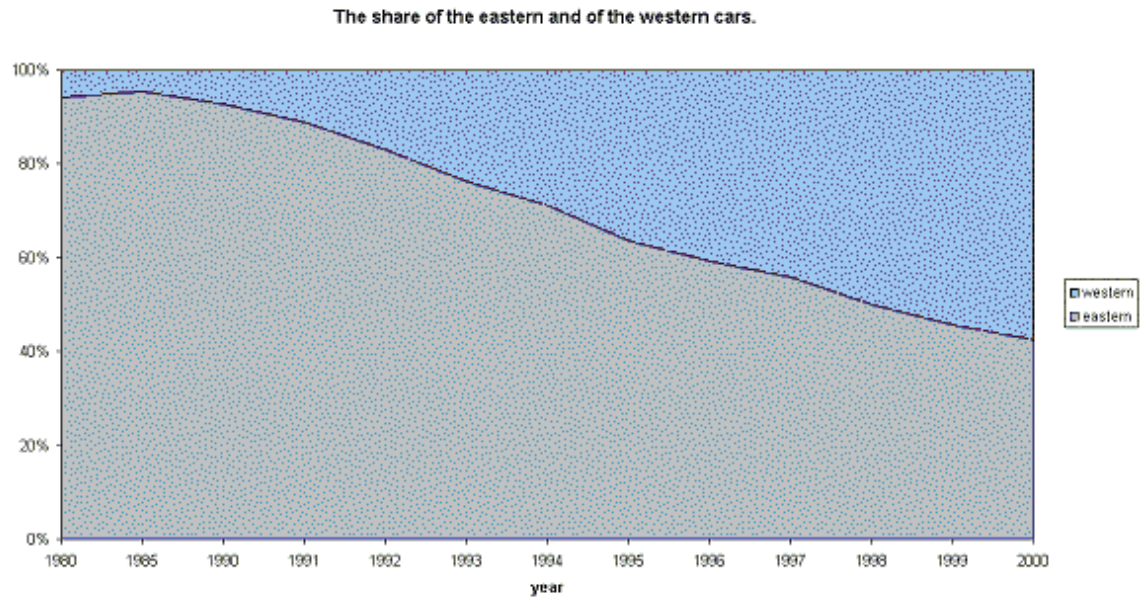
When forecasting the energy demand of the households attention was paid to the fact that according to the Hungarian Central Statistical Office the population is expected to decrease for a long period, thus increase of flats and houses built may be less than expected earlier. However, the aged flats will be reconstructed or replaced by new family houses. The area of the new flats and the number of rooms will increase, thus the heated space volume will be higher. The increase in energy demand for communal heating will be caused by the higher heated volume, not by the increase of the number of flats. However, a part of this increase will be compensated by better thermal insulation of new buildings and by their more adequate orientation, therefore only a slight increase in the energy consumption is expected. Practically, the increase in the energy consumption of the residential sector is determined by the new electrical devices and appliances. In the new flats and houses, modern devices of low consumption are expected to be used. The old appliances are normally changed only, when they brake down, and outdated appliances are often bought because of their lower prices. The penetration of modern energy saving devices will increase only in the second part of the investigated time horizon.

The increase of the share of district heating is not expected, because no high elevation building estates are expected to be built, and district heat supply of single family houses is not economical either on present or on future price level.

When forecasting the energy demand of the service sector, it was assumed to be similar to the residential sector. The operational area of the service sector will increase either with reconstruction and/or with new buildings. The new buildings will be built with better thermal insulation, thus only a slight increase is expected in the energy consumption. New devices and appliances of low thermal loss will be installed. The role of the communal sector will increase in the future, and modern, low energy consuming appliances will be used, thus the modernization of this sector will be realized within a shorter time period.

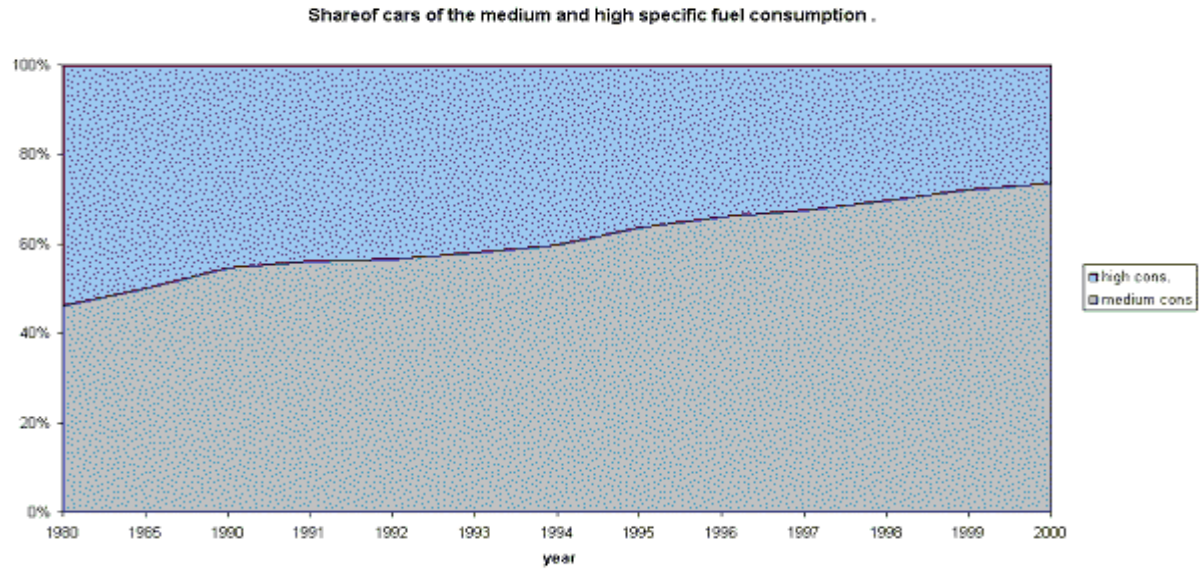
It is worth mentioning that the motor fuel demand of the residential and service sectors is taken into consideration separately within the so-called transportation sector, because there is a strong cross-dependence between the private and the mass transportation. When forecasting the motor fuel demand and the respective emissions, we have to take into consideration the characteristics of the car fleet. Figure V.1 shows the modification of the car fleet with time. While at the beginning of the transition to the market economy about 10% of our cars originated from Western countries, this share nowadays is a little bit higher than 50%. The specific fuel consumption of the Western cars is less than the consumption of the Eastern ones, produced in former Soviet block countries. Figure V.2 presents fuel economy. Nowadays, about 60% of the car fleet consists of cars of lower specific fuel consumption. At present, about 60% of the NO_x emissions and about 80% of the CO emissions originate from motor fuel usage.

Figure V.1



Source: Central Statistical Office

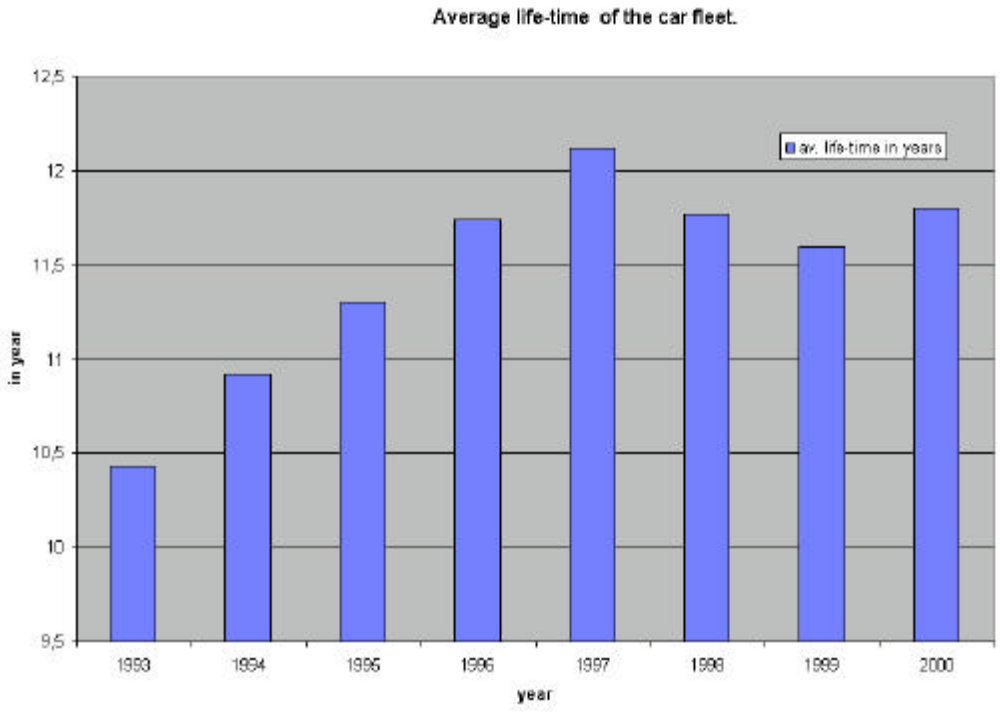
Figure V.2.



Source: Central Statistical Office

In Figure V.3, the average life-time of the car fleet is presented. It shows that the Hungarian car fleet is an aged one. Especially in the last years, the purchase of new cars could not compensate the aging of old cars. A great share of new cars is bought second-hand, thus the emissions related with motor fuel consumption has not decreased characteristically. The emission factors of aged cars are significantly higher than that of new cars and according to several publications the emission factors of aged cars increase exponentially with time.

Figure V.3.



Source: Central Statistical Office

The energy demand of the industrial sectors was forecasted in connection with the assessment of the GDP. We took into consideration that the aged production systems, devices, etc. cannot be replaced immediately, thus at the first period of the time horizon, the elasticity is supposed to be higher than later on. Similarly, the restructuring of the economy needs longer time horizon than was expected earlier.

It is assumed that the new fossil fuel-fired power plants will be designed with supercritical parameters in the future, i.e. their efficiency will go up to 40%, compared to the present average level of 30-33%. The domestic electric energy production will be based on fossil fired power plants in the future in accordance with the international practice at present. In the short run, the aged coal fired power plants of low efficiency will be retired, and new power plants of lower heat rate will be put into operation. Also combined cycle gas-turbines (of 140-150 MW, some of them already in operation), and coal (lignite)-fired new power plants or units will be installed.

Another pathway is to increase the installed nuclear capacity, a new block and retrofitting of the old ones may be realized within the time horizon of this forecasting.

The electricity market in Hungary will be liberalized within the projection period. When determining its effects on energy consumption, international practice was followed, as we do not have any domestic experience.

New energy sources, the use of renewable and non-carbon based energy, and/or a relevant modification in the final energy consumption of the residential and communal sectors are needed to fulfil the requirements of the Kyoto protocol. The way the penetration of the clean fuels and control technologies should be promoted and realized at the final consumers has to be investigated in the future.

When forecasting emissions, different evolution in technologies, devices and appliances have been taken into consideration.

When calculating the mitigation in the direct and indirect emissions, it was assumed that the main chemical- physical characteristics of the fossil fuels consumed are the same as in the baseline scenario.

In Hungary, significant post-combustion control technologies are introduced to control the particulate emissions in public power plants, e.g. mechanical filters (cyclones, multicyclones) and electrofilters (electrostatic precipitators, ESP). In every coal-fired power plants of large capacity there are ESP-s installed, and in a hydrocarbon (HC) fired power plant a single ESP unit is installed to a 215 MW block.

In the Mátra lignite-fired power plant a flue-gas desulfurisation unit was installed in 2000 for the 200 MW blocks, and the emission of the 100 MW blocks is planned to be controlled too. The installation resulted in about 100 kt SO_2 emission decrease for the public power plants. If the brown-coal fired Oroszlány Power Plant would be retrofitted, a flue-gas desulfurization plant will be installed to fulfil the new environmental requirements.

Within the post-combustion technologies, the three-way catalytic converters, selective catalytic reduction have to be mentioned too, especially in the transportation sector, e.g. for controlling the emissions of gasoline engine cars.

Forecasted fossil fuel consumption

Table V.1 and in Figure V.4 present the forecasted fossil fuel demand, where only volume of the fossil fuels actually fired is considered.

Table. V.1

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

Source: Energy Statistical Yearbooks, Central Statistical Office

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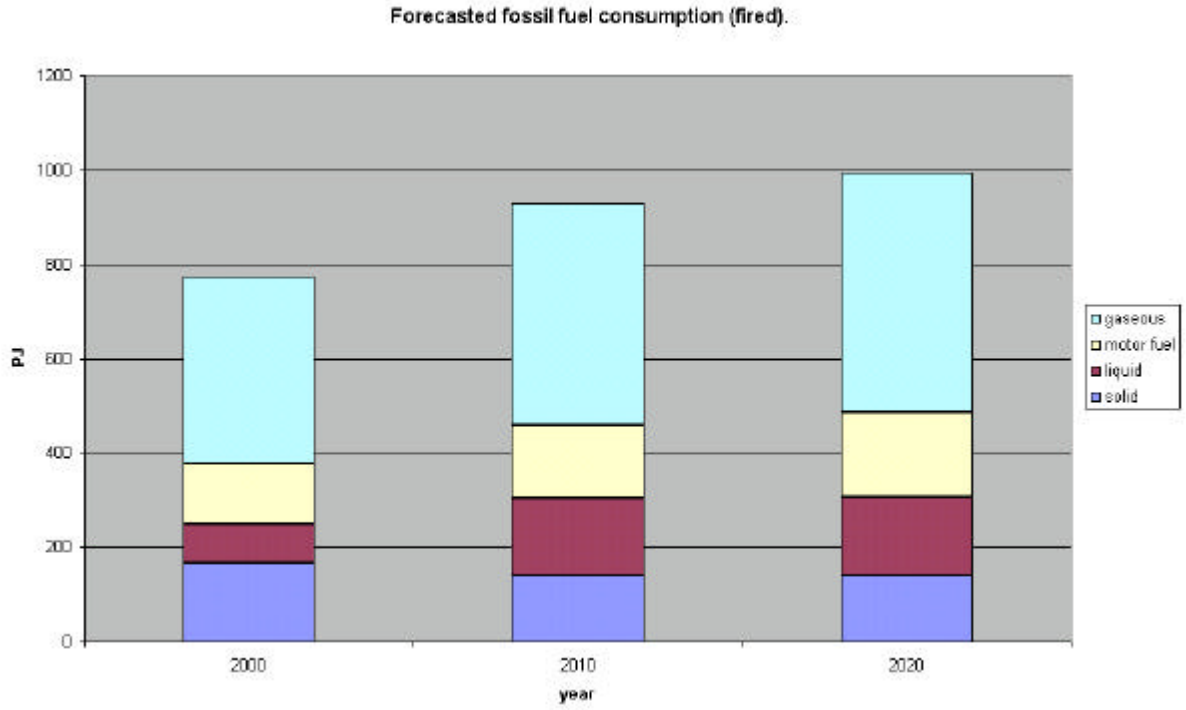
Figure V.4.



Source: Energy Statistical Yearbooks, Central Statistical Office

According to expectations, the solid fuel consumption will decrease, while the hydrocarbon consumption will increase. This means that our import dependency will also increase.

When making the energy forecasting, the above mentioned characteristics were considered, that is the forced and promoted energy saving and energy conservation, the utilization of low energy consumption devices and technologies, the increasing import of electricity, new gas-turbine units for electricity generation, the acceleration of the decrease of the car fleet lifetime, the utilization of domestic coal products for electricity and heat generation only. About 10-15 TWh increase in the electricity consumption is expected in the forecasted period.

In the second period of the investigated time horizon, a new base nuclear power plant for electricity generation may be installed, if the present public opinion will change. In this case, the fossil fuel consumption would be modified according to the capacity of the new nuclear units installed.

Forecasted emissions – baseline scenario

When forecasting the fossil fuel consumption related emissions, the new legal environmental

requirements have to be taken into account, too. The old uneconomical coal-fired power plants will be either retired or retrofitted. This latter means the application of post combustion control technologies.

Comprehensive baseline in the power sector of Hungary

In the following section we present a scenario aimed at defining a Hungarian greenhouse-gas emission baseline in the electric energy sector, taking into consideration capacity development and extension plans of the Hungarian Power Companies (MVM). The estimation of the future emissions were based on these, using the modules BALANCE and IMPACTS of the ENPEP program package, for the study period of 2001-2012, 2012-2020. MVM's extension plan was used as an optimal program for the runs of IMPACTS to aggregated and specific emission results.
We assumed that the capacities replacing old ones or being installed as new ones always use the most up-to-date technologies available.

Two demand growth scenarios were examined, a relatively smaller (growth rate of peak load 0,9% per annum, gorwth rate of demand 1%) and a relatively larger (growth rate of peak load: 0,9% until 2005, after it 1,8%, growth rate of demand 1% until 2005, after it 2%) growth rate in the time period examined. Demand base used in 2000: peak load 5750MW, annual demand: 38,5 TWh. Three different import scenarios were outlined , a smaller, a higher, and a minimal rate of import.
The possible alternatives of the nuclear power plant of Paks were also examined in different scenarios: the prolongation of the NPP's operation, the fuel switch to gas/oil power plant, and a fuel switch to coal power plant.

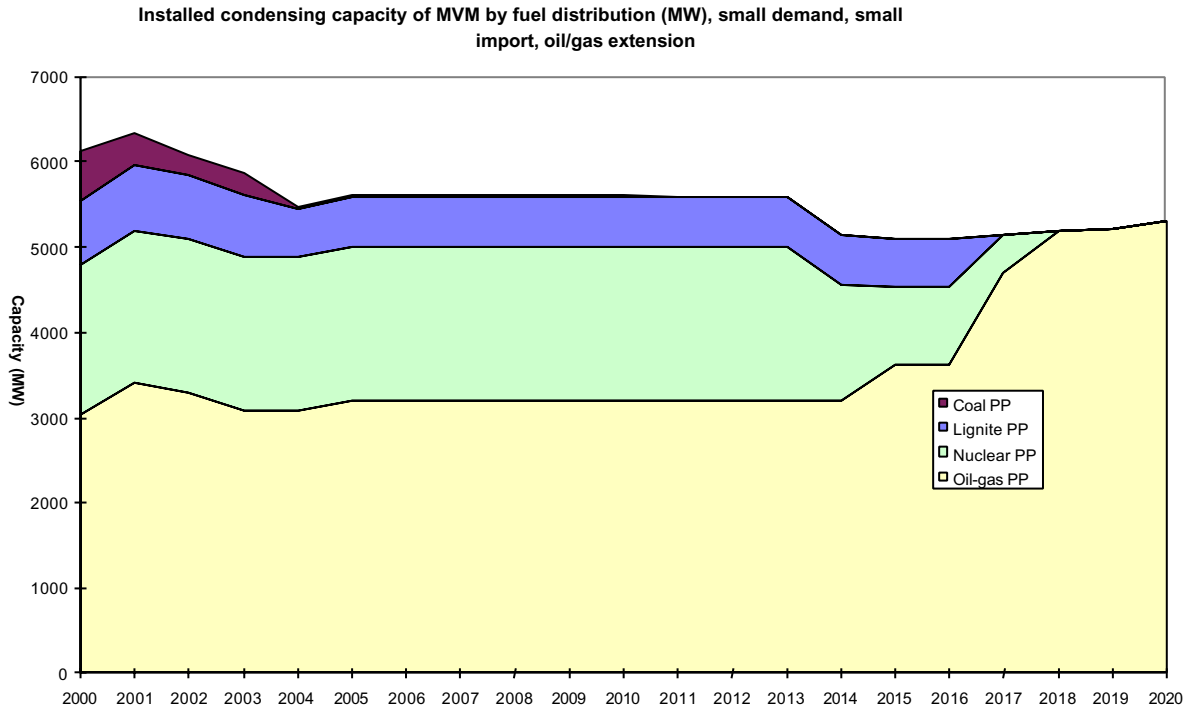
The network used for the model consisted of the following parts:

- Primary energy extraction, import and primary energy transformation
- Electricity and district heat generation
- Energy transportation and distribution
- End use technologies

Since the results are based on the long-term strategy of MVM together with the main expected evolution of the main macroeconomic indicators, it can be considered as an addition to the future decision making in Hungary's power sector.

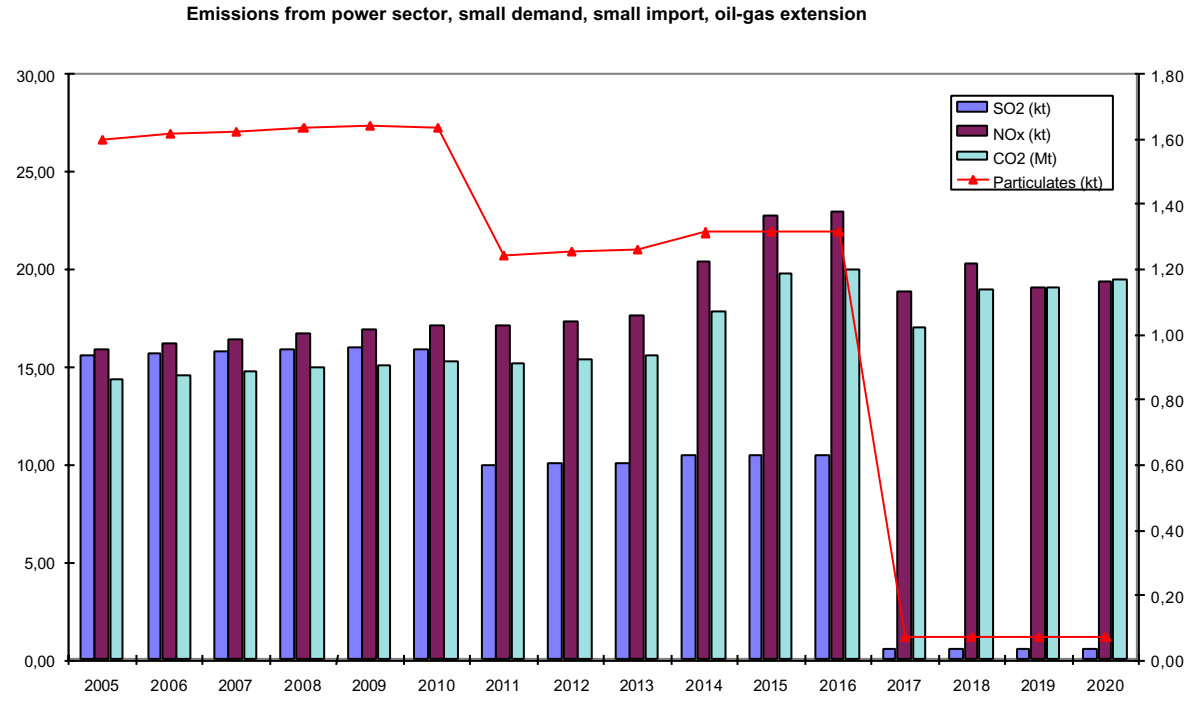
Considering the Hungarian climate change policy and the Energy Saving Action Programme, the most likely scenario involved a small growth in demand and import, and a gas and oil capacity enlargement. However the latter had differentiation effect only after 2012. Two charts are presented here which outline the forecasted composition of the installed capacity of the Hungarian power sector and GHG emissions in the mentioned scenario.

Figure V.5.



Source: Systemexpert, 2000

Figure V.6.



Source: Systemexpert, 2000

Sulfur-dioxide emissions

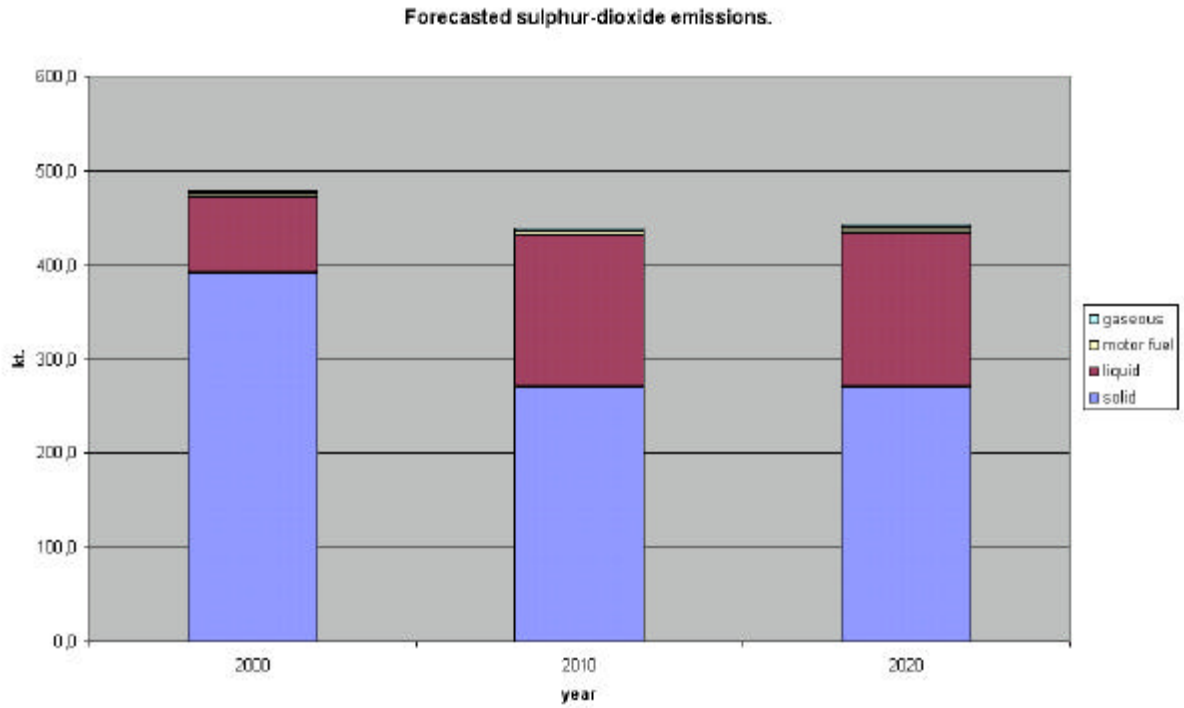
The forecasted sulfur-dioxide emissions are presented in Table V.2 and in Figure V.7, where only the flue-gas desulfurisation unit installed in the Mátra power plant was taken into consideration. If the Oroszlány brown coal-fired power plant is privatized in the near future and its life-time is prolonged, a flue-gas desulfurisation plant will also be installed there, and about 80kt. SO_2 reduction per year would be achieved.

The sulfur content of the Diesel-oil will be reduced below 0,1%. Similarly, the sulfur content of the imported coal must be less than 1%.

Table V.2: SO_2 emissions in kt.

	2000	2010	2020
Solid	392,0	270,0	270,0
Liquid	80,5	161,0	164,0
Motor fuel	3,0	4,0	4,5
Gaseous	3,1	3,8	4,3
Total	478,6	438,8	442,8

Figure V.7.



Source: IEA Review, 2000

As it can be seen in Figure V.7, the greatest part of the sulfur-dioxide emission is related with coal consumption. If the flue-gas desulfurisation plant were installed in the Oroszlány power plant, the emission would fall by about 80 kt per year. A significant emission increase is expected related with liquid fuel consumption. As we mentioned, the sulfur content of the Diesel oil will be reduced below 0.1%. This will not result in a significant decrease, because the sulfur content of the Diesel oil supplied to city buses is already in this range. Further reduction may be achieved by reducing the sulfur-content of the different heating oils.

The requirements of the Göteborg protocol can be met without any problem.

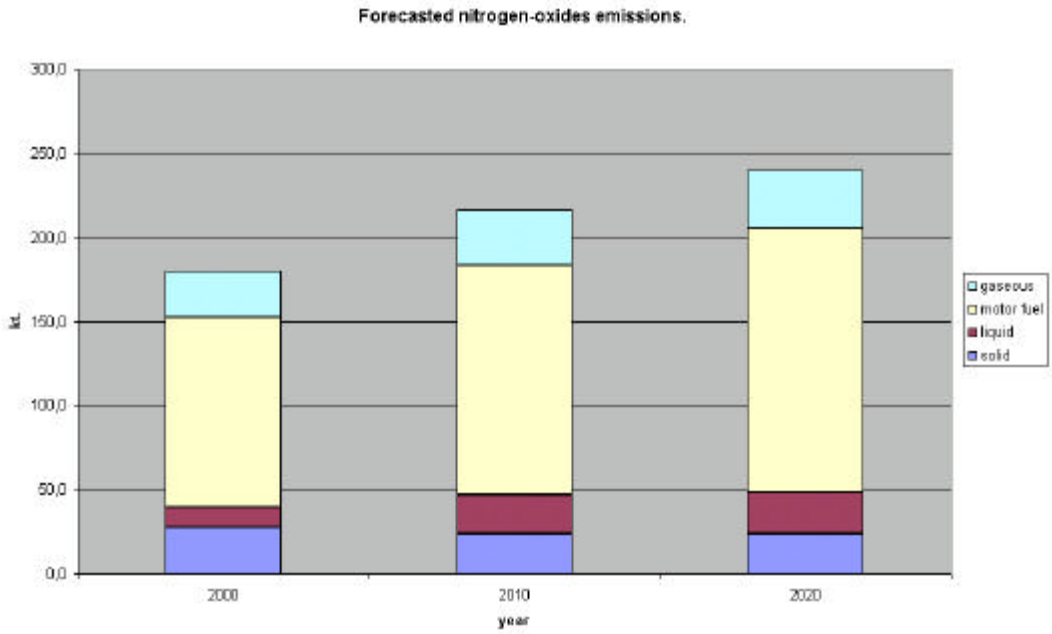
Nitrogen-oxides emission

Table V.3 and Figure V.8 show the forecasted NOx emissions.

Table V.3: NO_x emissions in kt

NOx kt.	2000	2010	2020
Solid	28,0	24,0	24,0
Liquid	11,7	23,0	24,0
Motor fuel	112,5	136,0	157,0
Gaseous	27,5	33,0	35,0
Total	179,7	216,0	240,0

Figure V.8.



Source: IEA Review, 2000

About 60% of the NO_x emissions comes from motor fuel usage, originating in the transportation sector. Significant improvement may be achieved by intensive programs aimed at reducing the age of the passenger car fleet. This improvement is really needed to fulfil the Göteborg protocol (which says that the NO_x emission may not exceed 98kt. in 2010).

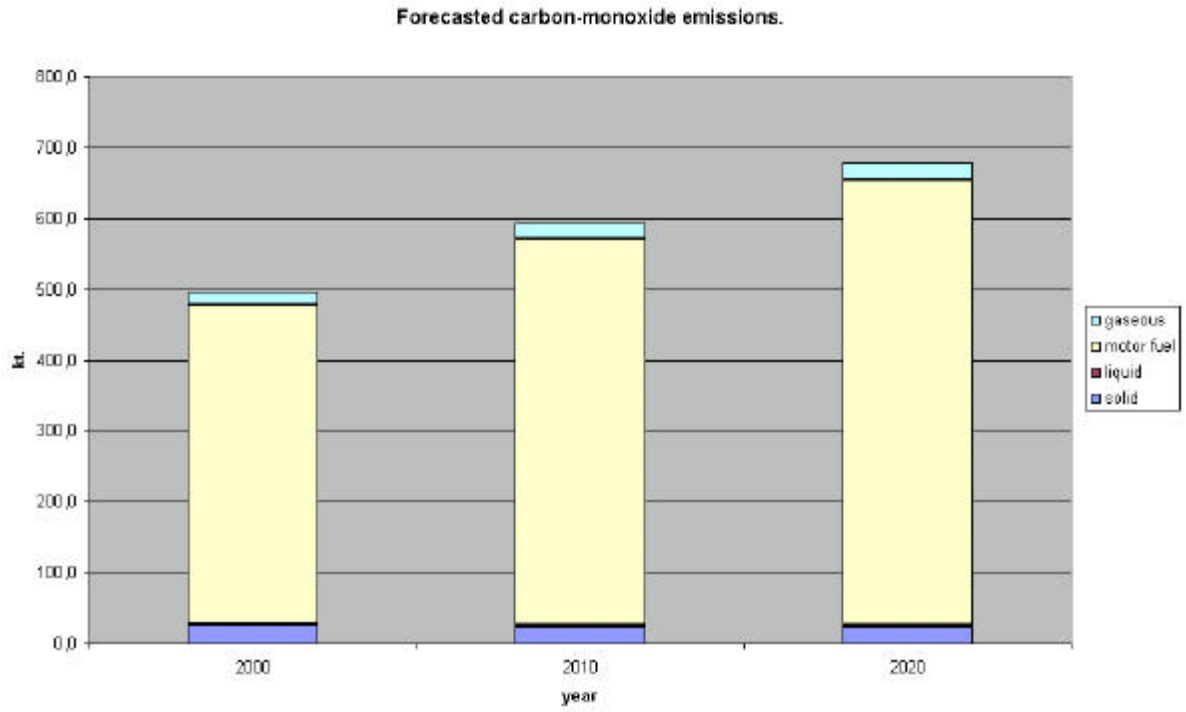
Carbon-monoxide emission

The forecasted carbon-monoxide emissions are shown in Table V.4 and Figure V.9.

Table V.4: CO emissions in kt

CO kt.	2000	2010	2020
Solid	25,5	22	22
Liquid	2,3	4,6	4,7
Motor fuel	450	544	628
Gaseous	18,7	22,1	24
Total	496,5	592,7	678,7

Figure V.9.



Source: IEA Review, 2000

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 lifetime.

Solid particulate emission

Table V.5 and Figure V.10 present the solid particulate emissions.

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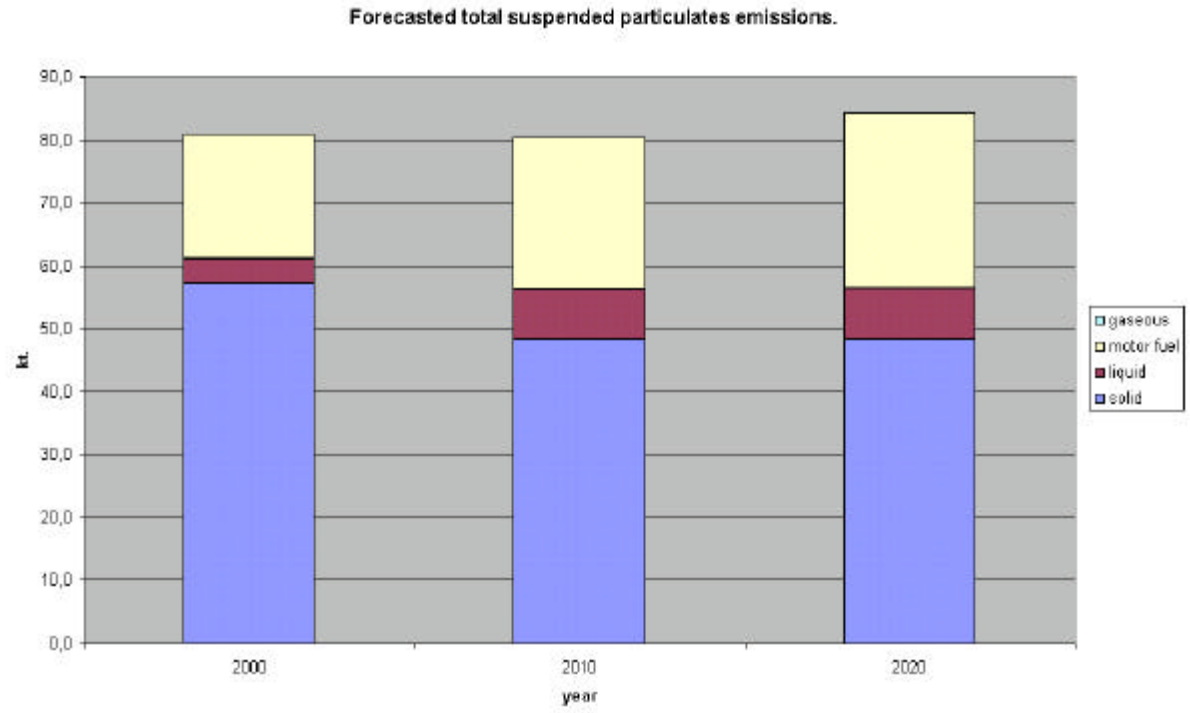
Table V.5: Particulate emissions in kt

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

FigureV.10



Source: IEA Review, 2000

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 V.6 and in Figure V.11.

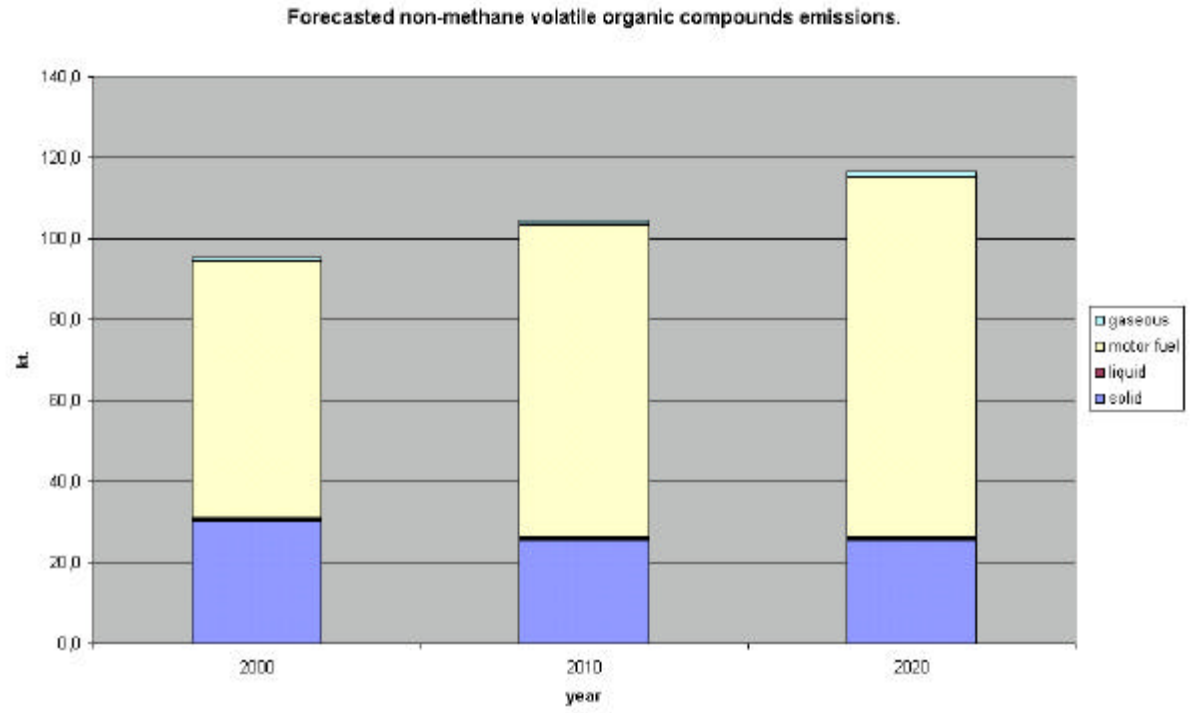
Table V.6: NMVOC emissions in kt

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	88,9
Gaseous	1,2	1,4	1,5
Total	95,5	104,7	116,7

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 NO_x 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.

Figure V.11.



Source: IEA Review, 2000

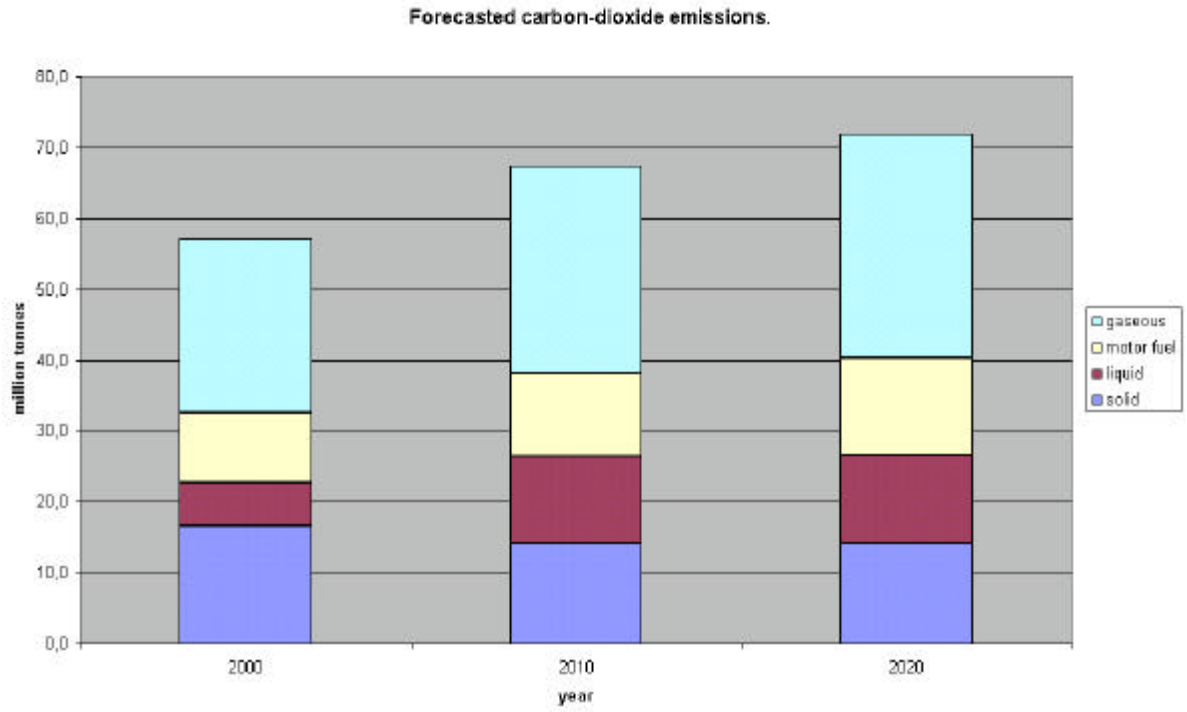
The carbon-dioxide emission

The forecasted carbon-dioxide emissions are shown in Table V.7 and in Figure V.12.

Table V.7: CO2 emissions in Mt

CO2 Mt.	2000	2010	2020
Solid	16,6	14	14
Liquid	6,156	12,312	12,54
Motor fuel	9,804	11,856	13,68
Gaseous	24,614	29,14	31,62
Total	57,174	67,308	71,84

Figure V.12.



Source: IEA Review, 2000

The mitigation of carbon-dioxide emissions may be realized by introducing non-carbon based fuels. This means either the increase of nuclear capacities and/or the more extensive use of renewable energy sources. The renewable energy sources are not competitive with the traditional energy sources at the present price level except for the biomass.

Forecasted emissions – scenarios with measures and with additional measures

We calculated the emissions assuming the reduced fossil fuel consumption (see Table V.8). Tables 9 through 14 present the emission values.

Table V.8: Reduced fossil fuel consumption

Fuel PJ	2000	2010	2020
Solid	166,0	140,0	140,0
Liquid	81,0	158,2	157,4
Motor fuel	129,0	140,0	152,0
Gaseous	397,0	420,8	426,6
Total	773,0	859,0	876,0

Tables 9-14: Emissions at reduced fuel consumption

SO_2 kt.	2000	2010	2020
Solid	392,0	270,0	270,0
Liquid	80,5	157,2	156,4
Motor fuel	3,0	3,6	3,8
Gaseous	3,1	3,4	3,6
Total	478,6	434,2	433,8

NO_x kt.	2000	2010	2020
Solid	28,0	24,0	24,0
Liquid	11,7	22,5	22,9
Motor fuel	112,5	122,1	132,6
Gaseous	27,5	29,5	29,3
Total	179,7	198,1	208,7

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	23,5
Gaseous	0,0	0,0	0,0
Total	81,0	77,6	79,5

CO kt.	2000	2010	2020
Solid	25,5	22,0	22,0
Liquid	2,3	4,5	4,5
Motor fuel	450,0	488,2	530,3
Gaseous	18,7	19,8	20,1
Total	496,5	534,5	576,9

NMVOC kt.	2000	2010	2020
Solid	30,3	25,6	25,6
Liquid	0,3	0,6	0,6
Motor fuel	63,7	69,1	75,1
Gaseous	1,2	1,3	1,3
Total	95,5	96,6	102,6

CO_2 Mt.	2000	2010	2020
Solid	16,6	14,0	14,0
Liquid	6,2	12,0	12,0
Motor fuel	9,8	10,6	11,6
Gaseous	24,6	26,1	26,4
Total	57,2	62,8	64,0

As a scenario with measures we took into consideration the increased share of natural gas, the increase of renewables, and the maintenance of the share of nuclear energy in the power generation. The CO_2 emissions can be further reduced in this case as presented in section IV.B.

Agriculture

In Hungary the majority of the greenhouse gas emissions of agricultural origin comes from animal production. The proportion of other methane emission sources (field burning of agricultural residues, rice cultivation) is negligible; they do not affect significantly the trend.

Methodological background – The IPCC-1 method (default emission factors) was used to calculate methane emission pertaining to the period 1960-2020. The average factors given to the larger geographic units, however only partly correspond to the production conditions of the Hungarian agriculture so this methodology was modified. In the course of the modification the emission factors of the enteric fermentation of dairy cattle were adjusted to the actual values as well as the forecast milk production (kg milk/cow/year) with the help of the regression equation based on the IPCC basic data (Table V.15). The calculated regression equation is valid between 2550 l/cow/year and 6700 l/cow/year. Since milk production in Hungary is expected to reach 6700 l/cow/year till about 2004 therefore from that time it is necessary to extrapolate. The emission factors for Eastern Europe were used for manure management in the case of dairy cattle and other cattle, in the case of swine the Western European ones were used. Table V.16 shows the emission factors used in the calculations.

End-of-year number of livestock was used as input data of agricultural production so the mid-year fluctuations were ignored. The official data of the Central Statistical Office for the period of 1960-2000 were used. The numbers of livestock of the period of 2001-2020 were forecast on the basis of consultation with the experts of the Ministry of Agriculture and Rural Development and on the information available on the position of the European Union accession negotiations. The result of the negotiations will significantly affect the evolution of the cattle and sheep stocks; in the case of the remaining animal species the trend would be determined by the ecological possibilities and the economic conditions. After the fallback of '90s small growth or stagnation is expected in the numbers of livestock till the accession to the European Union, followed probably by a slight growth onwards.

The cattle and sheep stocks were forecast on the basis of the following three scenarios:

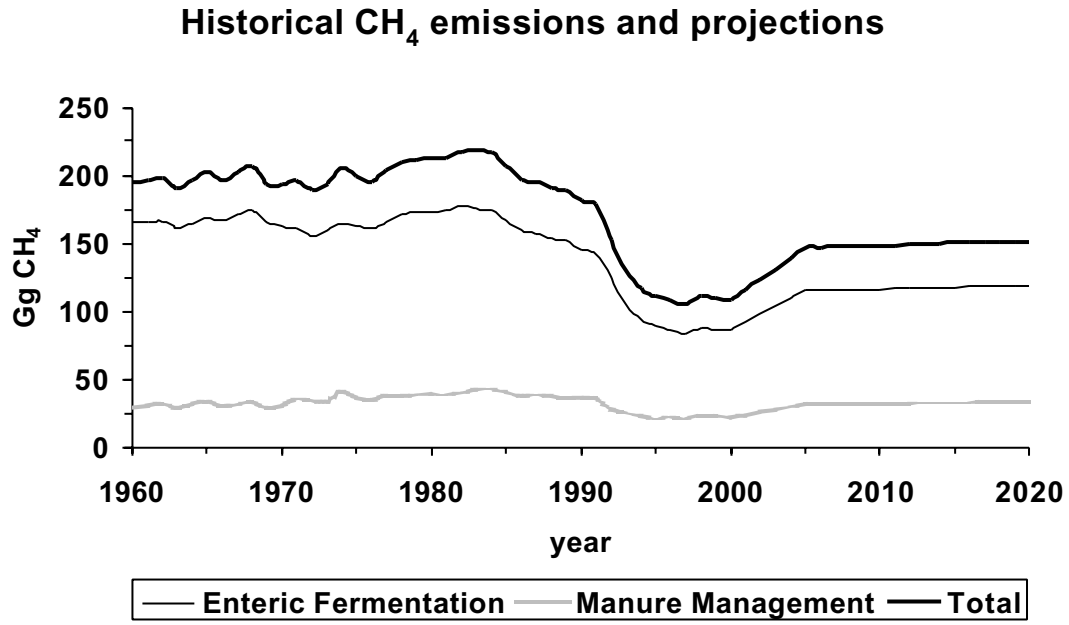
Scenario "A": in the course of the accession negotiations Hungary and the European Union will agree on the production quotas close to the Hungarian claim.
Scenario "B": in the course of the accession negotiations Hungary and the European Union will agree on the production quotas close to the 2002 proposal of the European Commission.
Scenario "C": in the course of the accession negotiations Hungary and the European Union will agree to the production quotas in about half-way between the Hungarian claim and the 2002 proposal of the European Commission.

In the case of the other animal categories the following were assumed. The current goat stock will probably stay stable. At the moment the Hungarian buffalo stock consists of a few hundred animals. The intensification of the demand toward tourism and special products may increase the number of livestock to a little extent, one or two thousand ones at largest. The reduction of the number of working horses as well as the increase of the number of sport and hobby horses will probably result in a slight increase of the total number of horses. The ass and mule stocks are very small and expectedly will remain the same. In the European Union there are no production limits pertaining to swine and poultry. According to the plans the swine stock will reach 5 million till 2002 and 7.5 million till 2004, then will not change significantly. The growing demand toward poultry is a world tendency so an annual 3% growth (basis=2000) is expected. Table V.17 (period between 2000 and 2020) and 4 (period between 2008 and 2012) show the forecast of the evolution of livestock according to the three scenarios.

Methane emissions between 1960 and 2020 – Figure V.13 and V.14 show the methane emission of the Hungarian agriculture between the period of 1960-2020 (emission between 2000 and 2020 according to Scenario "C"). The results of the calculations were summarized according to Scenario "A", "B" and "C" in Table V.19 (period between 2000 and 2020) and Table V.20 (period between 2008 and 2012).

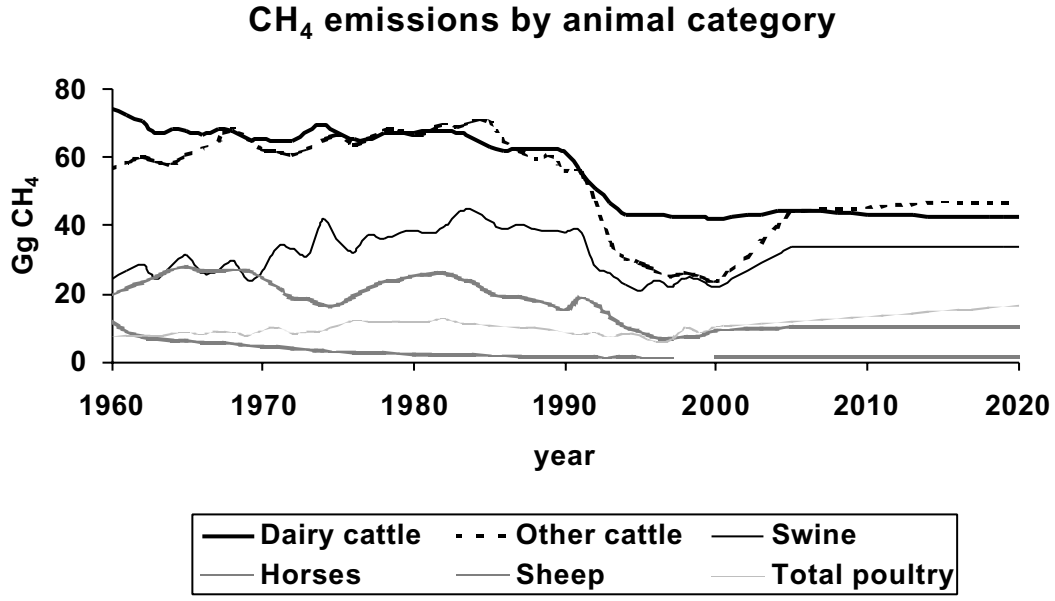
In the case of the occurrence of Scenario "A" the methane emission of the agriculture may grow by 50% to 2012 (basis=2000). In the case of Scenario "B" a smaller increase, about 25% is expected. On the basis of the most likely version, Scenario "C" an increase in methane emission by 37% till 2012 and by about 40% till 2020 is expected.

Figure V.13: Historical emissions and projections for CH_4 emissions from livestock production 1960 to 2020



Source: Central Statistical Office

Figure V.14: Historical emissions and projections for CH_4 emissions from livestock production 1960 to 2020 by animal category



Source: Central Statistical Office

Table V.15: Emission factors for enteric fermentation

Category	Emission Factor for Enteric Fermentation kg CH_4 $head^{-1}$ a^{-1}	Comments
Dairy cattle	79.6 - 126.3 (1960-2020)	Calculated *)
Other cattle	48.0	IPCC-factor for Western-Europe
Buffalo	55.0	IPCC-factor for Developed Countries
Sheep	8.0	IPCC-factor for Developed Countries
Goats	5.0	IPCC-factor for Developed Countries
Horses	18.0	IPCC-factor for Developed Countries
Asses and Mules	10.0	IPCC-factor for Developed Countries
Swine	1.5	IPCC-factor for Developed Countries
Poultry	0.2	Assumed

**) Basis: IPCC-data, default emission factors from enteric fermentation and average annual milk production per cow for North-America, Western Europe and Eastern Europe;*
Equation: $y = 0.0088x + 60.319$, $R^2 = 0.9823$;
y = Emission Factor from Enteric Fermentation in kg $head^{-1}$ a^{-1},
x = Average annual milk production per cow in l cow_{-1} a^{-1}

Table V.16: Emission factors for manure management

Category	Emission Factor for Manure Management kg CH_4 $head^{-1}$ a^{-1}	Comments
Dairy cattle	6.0	IPCC-factor for Eastern-Europe
Other cattle	4.0	IPCC-factor for Eastern-Europe
Buffalo	3.0	IPCC-factor for Eastern-Europe
Sheep	0.2	IPCC-factor for Developed Countries
Goats	0.1	IPCC-factor for Developed Countries
Horses	1.4	IPCC-factor for Developed Countries
Asses and Mules	0.8	IPCC-factor for Developed Countries
Swine	3.0	IPCC-factor for Western-Europe
Poultry	0.078	IPCC-factor for Developed Countries

Table V.17: Livestock input data (1000 heads) 2000-2020

Parameter		**2000**	**2005**	**2010**	**2015**	**2020**
Dairy Cattle	Scenario A	355.0	360.0	388.9	378.4	373.3
	Scenario B	355.0	294.1	277.8	270.3	266.7
	Scenario C	355.0	352.9	333.3	324.3	320.0
Other Cattle	Scenario A	450.0	864.5	976.4	1003.9	994.3
	Scenario B	450.0	739.3	765.3	798.5	791.7
	Scenario C	450.0	851.1	870.8	901.2	893.0
Buffalo		0.3	0.4	0.6	0.8	1.0
Sheep	Scenario A	1129.0	1500.0	1500.0	1500.0	1500.0
	Scenario B	1129.0	1000.0	1000.0	1000.0	1000.0
	Scenario C	1129.0	1250.0	1250.0	1250.0	1250.
Goats		100.0	100.0	100.0	100.0	100.0
Horses		75.0	76.0	77.0	78.0	79.0
Asses & Mules		4.0	4.0	4.0	4.0	4.0
Swine		4834.0	7500.0	7500.0	7500.0	7500.0
Poultry		37016.0	42568.4	48120.8	53673.2	59225.6

Table V.18: Livestock input data (1000 heads) 2008-2012

		2008	2009	2010	2011	2012
Dairy Cattle	Scenario A	377.3	383.1	388.9	386.7	384.6
	Scenario B	284.3	281.0	277.8	276.2	274.7
	Scenario C	341.2	337.3	333.3	331.5	329.7
Other Cattle	Scenario A	931.6	954.0	976.4	981.8	987.3
	Scenario B	754.9	760.1	765.3	771.9	778.5
	Scenario C	862.9	866.9	870.8	876.8	882.9
Buffalo		0.5	0.6	0.6	0.6	0.7
Sheep	Scenario A	1500.0	1500.0	1500.0	1500.0	1500.0
	Scenario B	1000.0	1000.0	1000.0	1000.0	1000.0
	Scenario C	1250.0	1250.0	1250.0	1250.0	1250.0
Goats		100.0	100.0	100.0	100.0	100.0
Horses		76.6	76.8	77.0	77.2	77.4
Asses & Mules		4.0	4.0	4.0	4.0	4.0
Swine		7500.0	7500.0	7500.0	7500.0	7500.0
Poultry		45899.8	47010.3	48120.8	49231.3	50341.8

Table V.19: Past and projected annual methane emissions from agriculture (Gg CH_4) 2000-2020

		2000	2005	2010	2015	2020
Enteric fermentation	Scenario A	86.9	118.4	129.8	131.6	132.0
	Scenario B	86.9	100.5	101.9	104.2	104.8
	Scenario C	86.9	115.0	115.9	117.9	118.4
Manure management	Scenario A	21.7	31.8	32.9	33.4	33.7
	Scenario B	21.7	30.9	31.3	31.8	32.2
	Scenario C	21.7	31.7	32.1	32.6	33.0
Total	Scenario A	108.6	150.3	162.7	165.0	165.7
	Scenario B	108.6	131.4	133.2	136.0	137.0
	Scenario C	108.6	146.7	148.0	150.5	151.4

Table V.20: Projected annual methane emissions from agriculture (Gg CH_4) 2008-2012

		2008	**2009**	**2010**	**2011**	**2012**
Enteric fermentation	Scenario A	125.2	127.5	129.8	130.2	130.5
	Scenario B	101.4	101.7	101.9	102.4	102.8
	Scenario C	115.5	115.7	115.9	116.3	116.7
Manure management	Scenario A	32.5	32.7	32.9	33.0	33.1
	Scenario B	31.1	31.2	31.3	31.4	31.5
	Scenario C	31.9	32.0	32.1	32.2	32.3
Total	Scenario A	157.7	160.2	162.7	163.2	163.6
	Scenario B	**132.5**	**132.9**	**133.2**	**133.8**	**134.3**
	Scenario C	**147.5**	**147.7**	**148.0**	**148.5**	**149.0**

Forestry

The CASMOR (see point C) model assumes that normal, professional forest management is carried out on the reforested land using three tree species groups. These groups represent all the tree species (the number of which is around ten) that could be planted to comply with site, economic and social conditions in the country. A relatively slow-growing broadlived species group is characterized by „Black Locust", a relatively fast-growing broadlived species group is characterized by „Poplar", and the evergreens are modeled by „Conifers".

Figure V.15. Carbon pools, streams and other interrelationships in the CASMOR model.

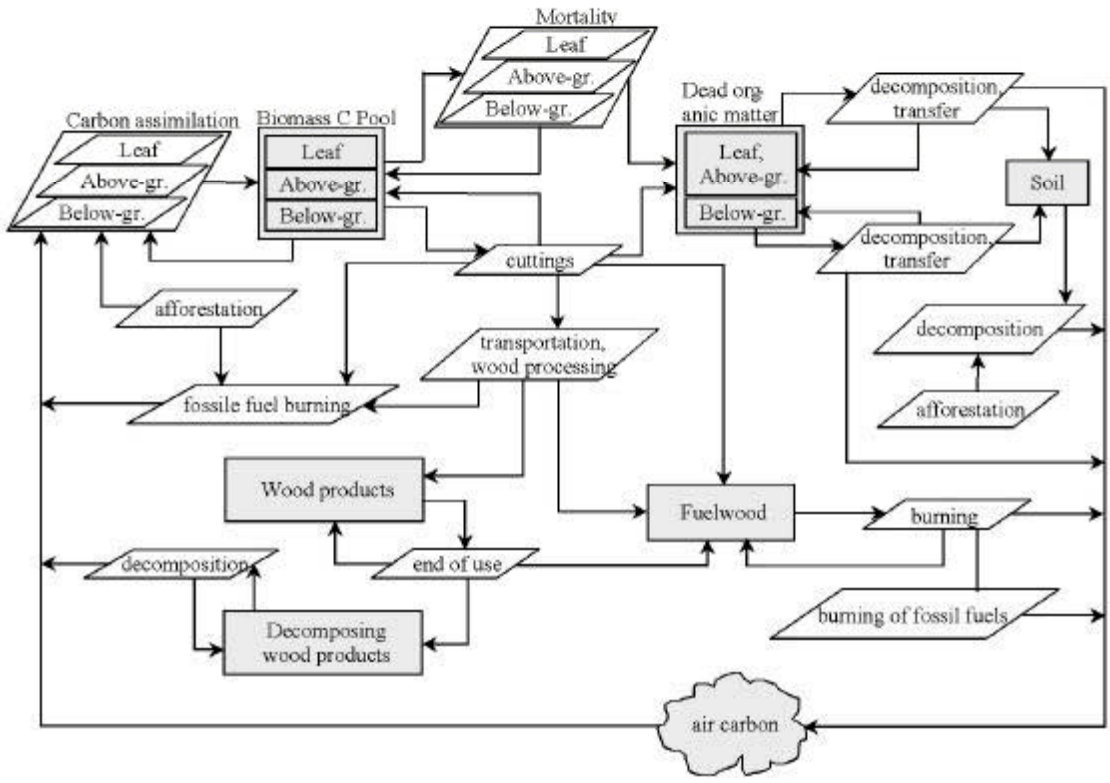


Figure V.15 shows the processes modeled, the carbon pools and their main interrelationships. They are not described here, because they are used in the same or very similar way as in COMAP, and because they are generally well known and applied. Only some specific considerations are noted here with regard to the main processes, functions, interrelationships and the assumptions that are applied in the design or in the running of the model. These considerations are rather technical, however, they are necessary for the assessment of the applicability of the results, which is important before taking decisions on large-scale programs. In addition, many model characteristics also reflect the characteristics of the Hungarian forests, as well as forest management.

The above mentioned considerations are the following ones.

Forest cover is increased by afforestations.

Land to be afforested is supposed to be abandoned and available for afforestation already at the beginning of the project.

• Land afforestation happens at a constant rate over time. (In reality, it will greatly depend on the production capacity of the economy, and the amount of foreign capital that will be invested to contribute to the reduction of the amount of carbon in the air.)

• Clearcut of mature plantations occurs at the rotation age of the respective species, or species groups, after the last vegetation period.

• Regeneration of clearcut areas occurs in the year of clearcut, i.e., before the beginning of the next vegetation season.

• Total forestation in a year is the sum of afforestation and regeneration in that year.

• Forest cover is the accumulated sum of forestations up to the given year.

Carbon assimilation by plants is the only process that increases sequestered carbon pools and reduces atmospheric carbon.

• The assimilation rate, i.e., the growth rate is age-dependent for all species.

• The assimilation rate used is site-independent, and is taken from yield tables for medium quality sites. In reality, afforestations will take place on poorer and better sites, too, but their exact distribution can only be modeled after a comprehensive site assessment, but even then the expected site distribution may also be different from the actual one, so no exact prediction is possible.

Afforestation must be started on the best sites available, which would considerably improve the benefits of the project. However, the above assumption was used to take into account that land available for afforestation is not very good for agriculture, and consequently will not be the best for forest management, either.

Carbon pools in Baseline Scenario also grow in time, but slowly.

• After abandonment of the fields, aboveground vegetation goes through a succession, in which pioneer trees slowly occupy the land. These trees and the associated vegetation also contain carbon.
• The root mass in the soil, i.e., belowground biomass, is supposed to grow at a constant proportion of the aboveground biomass growth, and root mass is supposed to be a constant proportion of aboveground biomass (i.e., their interrelationships do not change over time).
• The amount of soil carbon (dead organic matter) under the established forest is supposed to remain constant over time (in reality, it increases with increasing vegetation biomass).
• The amount of soil carbon in the country varies greatly. Without extensive measurements, there is no evidence what the average might be. The minimum carbon density of soils to be afforested in the country was measured to be 62 tC/ha. In the model, an average soil carbon density of 100 tC/ha was used, because (1) it is the change of this pool, and not its actual size, what matters, and (2) any large number like this mirrors the fact that the carbon pool of the aboveground biomass is far smaller than belowground ones are.
• The whole area of wasteland is supposed to be evenly stocked by the vegetation.

Carbon pools in Mitigation Scenarios in CASMOR are modeled in a more detailed way than in COMAP.

• The carbon pools of the afforested land are transferred from the Baseline Scenario System to the Mitigation Scenario System.
• The original vegetation of the afforested area is cleared at reforestation and is transferred to the decomposing dead organic material pool.
• Since the carbon content of the areas to be afforested is significant, the carbon loss due to reforestation is also accounted for. After ploughing, which is a rather frequent technological element of reforestation in Hungary, a certain percent of soil carbon is assumed to be oxidized and lost.
• The afforested area is evenly stocked.
• The area is afforested using three tree species (or, species groups). The allocation of a species is supposed to be adjusted to site, but the species' ratio by area is constant in time.
• The aboveground vegetation biomass increases through afforestation and growth, and decreases through natural mortality, thinnings and clearcuts.
• Volume increment is supposed to be unaffected by thinnings.
• Aboveground biomass with and without leaves, as well as their increment are supposed to be a constant proportion of aboveground tree volume.
• Belowground biomass (i.e., roots) and its increment is a constant proportion of aboveground tree biomass.
• Leaves and a (constant) ratio of aboveground wood biomass becomes dead by the end of the year because of pests and abiotic damages. Self-thinning is supposed not to play any role because of supposedly correct forest management.
• The leaves of conifers are supposed to live for several years.
• Dead leaves and aboveground wood biomass will decompose during the next period of years (the period being of constant length).
• A certain amount of dead organic matter will not decompose - or, at least, not entirely - and increases soil carbon density. This increase is a function of the rate of dead organic matter production, and, ultimately, a function of carbon assimilation by plants.
• The managing of the plantations includes two or three thinnings depending on the species and reflecting the currently common practice.
• Thinnings and final cuttings take place at the end of the year, after the cessation of the vegetation period.
• At thinnings and final cuttings, no leaves are on the trees for broadleaves, the green leaves of conifers are cut, too.
• At thinnings and final cuttings, roots immediately become dead.
• Natural mortality ensues due to both biotic and abiotic damaging agents in a constant proportion to annual increment.
• Decomposition takes place at a constant rate, but that of dead wood is faster than that of roots.
• Firewood is burnt in the first year after production.
• All wood products are supposed to be marketable either in the country or abroad.
• For the age of wood products, an average value is used. After the end of the use of the products, they are either burnt or they decompose. Pools associated with these processes are of little importance and are modeled for good measure only.

Carbon released in forestry operations may be small compared to the carbon fixed, yet, here it is accounted for to get a complete picture of the carbon cycle.

• Liquid fuel consumption in afforestations is somewhat lower for Black Locust than for other

species, because Black Locust may be regenerated from root suckers.
• Liquid fuel consumption varies with the type of thinning and final cutting.
• Transportation and primary processing of wood (e.g., debarking) releases carbon at a constant proportion of the amount of wood products.

Some important characteristics and figures used in the model are summarized in Table V.21. Finally, it must be noted that, as it is clear from above, many processes and interrelationships are taken as linear in the model. This is, however, not the case in reality, where nonlinear processes rule and linear ones are the exceptions. Nevertheless, it is assumed here that this approach still enables one to rightly assess the importance and magnitude of processes so that one can make a sound professional and political decision.

Table V.21. Some characteristics of the model by main species

Characteristics	Black Locust	Poplar	Conifers
Ratio by area (%)	50	35	15
Rotation age (year)	35	20	45
Dry specific weight (t/m^3)	0.740000	0.370000	0.499313
Aboveground biomass (excluding leaves) over stemwood volume ratio	0.724	0.373	0.410
Leaf biomass over aboveground biomass (excluding leaves) ratio	0.0384	0.0384	0.0384
Ratio of wood that dies naturally over wood produced	0.05	0.05	0.05
Age of first thinning (year)	6	5	10
Age of second thinning (year)	14	9	20
Age of third thinning (year)	24	0	32
Thinning intensity (volume of thinnings per total net yield)	0.4	0.4	0.4
Wood cut at final cutting (m^3/ha)	253.185	240.380	362.777
Percent of unused (dead) wood in clearcuts (%)	20	20	20
Number of years required for the aboveground dead organic material to decompose (year)	10	8	10
Number of years required for the belowground dead organic material to decompose (year)	25	10	30
Average age of wood products (year)	35	25	30
Mean liquid fuel consumption in afforestations (l/ha)	200	250	250
Mean liquid fuel consumption in clearcuts per unit wood exploited (l/m3)	4.0	3.5	4.0

Source: Somogyi, 2000

Scenarios

To run the model, three basic afforestation scenarios of constant afforestation rates were developed. The technical potential scenario (I) involves afforesting 773,000 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 (~8,000 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 (~4,000 ha.yr-1). In this sense, the third scenario is the base case. The second scenario is considered as a scenario with measures, while the third one is the scenario with additional measures.

These scenarios are believed to provide a rough estimate of the potential. There are big differences between 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, it can not be guaranteed that a very high rate would be sustainable on the long run. On the other hand, the scenario with the lowest afforestation rate is highly unlikely, however, if, for some reason, it would 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).

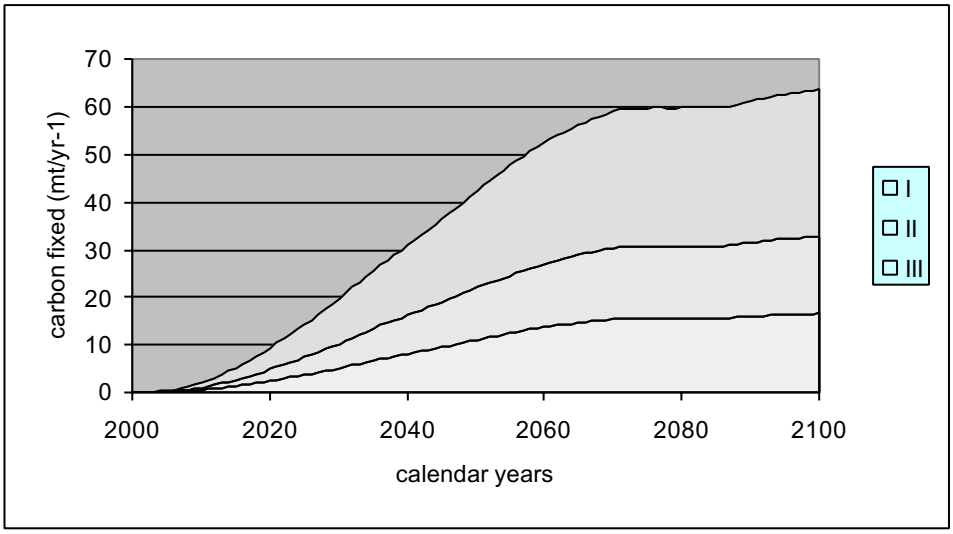
In each scenario, it was assumed that afforestation is done either with predominantly fast growing, short rotation, exotic species such as black locust

(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.

Results

The results of model runs (Figure V.16, Table V.22) show that the technical potential of sequestering carbon in Hungary amounts to some 46 Mt C in 50 years (Somogyi, 2000). This compares well to the estimates of another studies, Somogyi (1997), Szendrodi et al. (1999a,b). This amount is about the same as the total emissions of the country for all sectors in three years. Amounts that could be sequestered during the first commitment period (2008–2012) are also substantial. They are amounts at the order of magnitude of the commitment of Hungary (6%, or 1.63 Mt CO_2-equivalent) in the Kyoto Protocol for the commitment period.

Figure V.16: 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.



Source: Somogyi, 2000

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 (Figure V.16) is worth paying attention. Because of the difficulties to quickly afforest large areas (i.e., in only a few years, instead of decades), and because of the variation of carbon fixation rate of trees over age, a considerable time elapses after the initiation of the afforestation until large amounts 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, Figure V.16 also shows that, even if afforestation stops in 2050, the accumulation of carbon continues in 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 cca. 2070 and is expected to level off soon after 2100. The leveling off occurs after the end of the afforestation program, 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.

Table V.22 estimates amounts of carbon fixed (Mt) in various scenarios 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 annually in the commitment period 2008–2012.

Table V.22. Estimated amounts of carbon fixed in various scenarios

	Species	
Scenario	**Fast-growing**	**Indigenous**
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

Source: Somogyi, 2000.

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 used as one of the main driving forces in the model. By using the assumptions detailed above, the model is more likely to 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 the afforestations. This requires a thorough analysis in the future and an inventory method that relies more heavily on measured values rather than on growth model.

B. Assessment of aggregate effects of policies and measures

In this section, we give the projections of the overall anthropogenic GHG emissions of Hungary till 2012. We express the overall emission here by CO_2 equivalents. Two scenarios are considered namely the base case and the scenario with ongoing/planned measures as defined in Sections IV.B. We compare the emission level of each scenario to the target level (see Chapter III). We remind that the considered scenarios have been defined as follows:

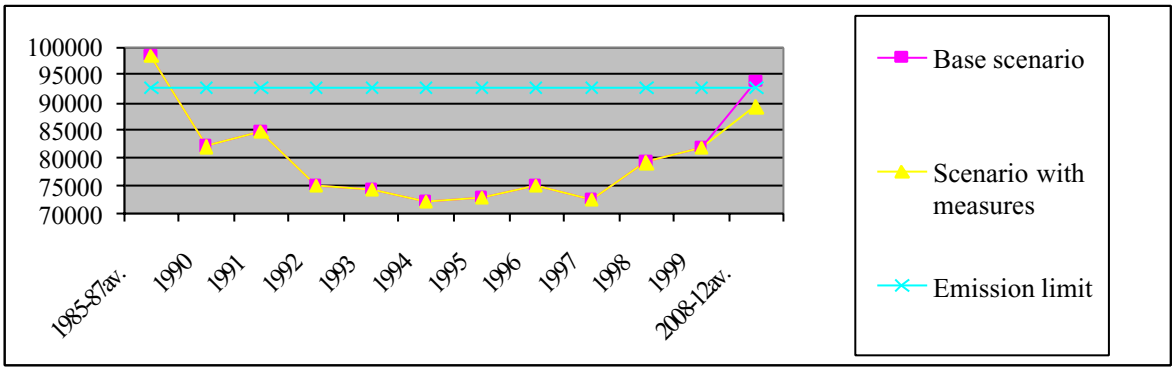
- CO_2 from the energy sector: (1) base case, reduced fuel use and change of fuel structure, (2) reduced fuel use, change of fuel structure and increased share of renewables
- CH_4 from energy and waste management: (1) base case, increased share of renewables and improvement of waste management, (2) further increase of renewables and further improvement of waste management

In terms of CO_2 equivalents the overall net GHG emission was 98 536 Gg in the base period (this was the annual average emission in 1985-1987). The target value (QELRO) accepted by Hungary in the Kyoto protocol is 92 624 (i.e. –6%). Since the Kyoto Protocol is going to be ratified by the Hungarian Parliament in 2002, this limit is considered as a target. The linear trend from 1994 predicts an annual 100 621 Gg for the period of 2008-2012. This means that the reduction target is 7997 Gg.

The base scenario results in a reduction of 4500 Gg CO_2 emission in the energy sector as described in Chapter IV and above in Section A. This scenario increases the CO_2 sink by 1100 Gg. Finally the CH_4 emission is reduced by 56.105 Gg CH4, which is 1178 Gg in CO_2 equivalent (see Chapter IV). The scenario with measures results in 6500 Gg CO_2 emission reduction in the energy sector compared to the base case, and the sink increase is 3000 Gg. The CH_4 emission reduction is 86.116 Gg, equaling to 1808 Gg CO_2 equivalent. This means that the base scenario gives 6778 Gg reduction, while we can reach 11 308 Gg by the scenario with measures.

Therefore, our results show that the overall emission exceeds the target level in the base case scenario for the period 2008-2012. However, the scenario with measure results in a value, which is far lower than the target level. We remind that we do not suppose any opportunity to reduce the GHG emissions from the agriculture. The CH_4 emissions from this sector will depend only on the quota for livestock accepted by the EU. This value may vary in a relatively small range, which means that this does not influence the evaluation of the examined scenarios. If the quota for livestock will be low, i.e. being close to the level proposed by the EU, the reduction of CH_4 emission would be at maximum 28.14 Gg, which is only 591 Gg in CO_2 equivalent. This is still less than the difference of the target level and the emission level determined by the base scenario. Figure V.17 summarizes the results.

Figure V.15: Emissions (Gg) in CO_2 equivalents corresponding to the two scenarios and the emission limit determined by the Kyoto protocol.



Source: IEM Greenhouse Gas Inventory, 1999, Trend calculations

It can be seen on Figure V. 17 that the emission level in 2000 does not reach that of the base period. This means that the original commitment according to the UNFCCC is fulfilled. However measures are needed in Hungary to keep the limit defined in the Kyoto protocol. Some additional measures will also be needed depending what position the Hungarian agriculture will have after joining the EU. More additional measures will be needed, if EU accepts quota for livestock being close to the present Hungarian proposal

C. Methodology

We supposed that the baseline emission follows a linear trend. We have emission data from 1985, but 1994 was chosen as the initial year for this calculation. This year was the turning point of the anthropogenic GHG emissions, which began to grow after in connection with the economic recovery. If we had started from the base period (1985-87), a linear trend would have predicted an irrealistically low growth of emissions because of the recession. However, fitting of nonlinear curves in the whole observation period resulted in irrealistically high growth for the next ten years. Most macroeconomic forecasts predict a smooth economic growth in mid-term, therefore we decided to choose the linear trend. Most economists predict an annual 4-5% economic growth for the next ten years, therefore we also accept this assumption for the BAU scenario. As we started the trend calculation in 1994, when the GHG emission level was the lowest, the statistical indices of fitting were very good. The equation of the linear trend of the overall net anthropogenic GHG emission expressed in CO_2 equivalent has been estimated as

$$NETGWP(t)=54621+1840*TREND(t),$$

where $t=1994,\ldots,2012$, $TREND(t)=t-1985$. The t-statistics of the coefficients are 8.53 and 3.34, respectively, i.e. the estimation is very significant. The Durbin–Watson statistics is 2.11, which is also very favorable. Finally, the R^2 is 0.74.

Energy

To determine the energy related emissions, we use the emission factor method, where the fossil fuel consumption has been selected as activity level. It should be mentioned that for the projections we consider only the fossil fuel fired in the country, thus the feedstock's (e.g., gasoline for chemistry, natural gas for ammonia production, bitumen for road-making etc.) and the non-energy use of the fossil fuel (e.g., lubricants, paraffin, etc.) is not taken into account. We take into account the variation of the electrical energy import too, because 1 TWh increase in the electricity import causes roughly 11 PJ decrease in the fossil fuel consumption of the domestic power plants.

Forestry

Carbon sink and emission reduction potential

The Hungarian Government recently approved its Strategy on Climate Mitigation (SCM, 2000). This states that the current afforestation program of the Government is justified from a climate mitigation viewpoint. It was also reported by authorities that further afforestation should be promoted on close to 800,000 ha of croplands that will be taken out of agricultural production after the country's accession to the European Union. The use of wood as renewable material and the efficient and environmental-friendly use of fuelwood are also promoted by the Strategy.

Of the several carbon mitigation options in forestry (that include, in addition to the above mentioned ones, preserving carbon in trees and soil, increasing

of carbon density of stands), only afforestation projects have large potential (Somogyi, 1997). They are also relatively cheap (~8.5 Euro/tC) compared to several other carbon mitigation options.

Methods

To assess the potentials for decision makers, several studies were made in the last few years (Somogyi, 1997, 2000, Szendrodi et al. 1999a,b). These studies showed that of the several conceivable methods, only afforestations could be used to offset carbon emissions. Methods that could be used in existing forests, such as increasing the carbon content (carbon density) of the forests, could be beneficial, however, the amount of carbon sequestered due to these methods is relatively low.

Since carbon cycle processes in forests are very complicated, estimating the carbon sequestration potential of afforestations requires modeling which is the only tool to get predictions for the coming decades. In order to estimate how much carbon could be fixed by various afforestation programs, a model called CASMOR (Somogyi, 1997) was developed from the respective submodel of the model „Comprehensive Mitigation Analysis Processes" (COMAP, 1995) by fitting it to Hungarian conditions. The development was necessary, because

• COMAP uses average values (constants, species characteristics etc.) for regions, thus, these values are difficult or impossible to apply for Hungarian conditions,
• more detailed data are available in Hungary, which makes it possible to increase accuracy,
• the stream of carbon sequestration, costs and benefits is possible to analyze if not average, but actual values, time series are used,
• a more sophisticated management system must be used under Hungarian conditions than that in original COMAP,
• a deeper, more detailed analysis of natural processes and forest management operations was possible and desirable to be able to better demonstrate to foresters, landowners, decision makers and at training courses what will happen in the various scenarios.

An important element of developing a more sophisticated model was also the requirement to have a better understanding and modeling of all the processes that considerably contribute to carbon sequestration or to the release of carbon. This also seems to be useful in demonstrating the use and the effectivity of reducing atmospheric carbon by means of forestry. An important characteristics of the CASMOR model is that, unlike COMAP or other models used by IPCC, sequestration is related to tree age.

VI. Vulnerability Assessment, Climate Change Impacts and Adaptation Measures

A. Expected impacts of climate change

Today the consequences of global warming can be estimated only roughly. The majority of the assumed general impacts of climate change on agriculture may also effect the Hungarian agriculture. In the case of pastures the shifts of the temperature and precipitation conditions may lead to the modification in vegetation period as well as to the displacement of the border-line between the grasslands and the forest areas, and of vegetation and arable zones. The change in precipitation conditions may increase soil erosion and compaction. Crop yield and productivity may grow in certain areas, in other places may decrease. It can be assumed that extreme natural phenomena (floods, drought, heat waves, tropical storms) can rise more often, the risk and damage of the storms, floods and droughts may become more significant. The most serious impacts of climate change may hit the tropical and subtropical areas so it is expected that the Hungarian agriculture will not suffer a major impact. It is expected that the Hungarian agriculture will be able to compensate and utilize the incidentally emerging negative and positive effects through the introduction of different adaptation strategies (new breeds and hybrids, improvement of water management and the irrigation systems, change of the land use technology). At present there are no reliable estimations on the costs of adaptation.

The special literature of the possible impacts of the global warming in Hungary focuses primarily on the research of drought occurrences.

Drought as a returning phenomenon

Drought is a returning natural phenomenon and source of disaster in Hungary like in many other countries in the Carpathian Basin. During history severe drought events have been recorded for each century, especially in the Great Hungarian Plain, but in other areas as well. In a lower intensity of agricultural cultivation and economic activity the drought damages have caused partial or total deterioration of yields and sometimes have led to famine and even death from starvation. This situation only improved in the 19^{th} century, however drought still occurs time to time. In the last decades drought came back more frequently and lasted longer than in the previous periods, and the damages caused became higher and higher because of the higher yields and economic values gained by the development in agricultural production and in the whole economy. The economic risk of drought was growing in the last period and in extreme cases its value coincides with the real drought damages (Nemes-Eke-Holló, 1995).

From the viewpoint of drought frequency in Hungary the period of 1983-1995 was the most unusual: severe drought and water scarcity became almost universal, because from the 13 years only 1987, 1988 and 1991 can be considered as normal in precipitation amount and distribution. No similar dry periods occurred in the Carpathian region in this century. Only the ten years between 1943 and 1952 can be compared with the above-mentioned period (Mika and Nemes, 1992). PAIN (1992) analyzed the drought-causing climatic conditions of the Carpathian Basin with the help of his aridity index (PAT) and found that in 1994 - one of the most severe droughts in the region - drought ruled the entire flat and hilly areas of the Basin. The highest values of the Pálfai Aridity Index (over 12) - meaning extremely severe drought - were found in three larger patches on the Great Hungarian Plain. along the Tisza River, and to a smaller extent over the region called Mezoség in Romania. Values similar to those of the Great Plain were experienced also in the so-called Small Plain along the common, Hungarian-Slovak section of the Duna. The damage caused by dry spells was estimated around 50 billion HUF (equal to 640 million USD) in Hungary in the year 1994.

As far as the future tendencies are concerned, an analysis of climate data on long-term observations demonstrates that there is a significant decreasing tendency of the precipitation amounts and the average soil moisture content in Hungary. Among others Nemes (1990 and 1994) described that the last ten years was the driest period in Hungary since 1881.

Especially the winter and spring precipitation amounts show a significant decreasing trend, with its endangering effect on the deep soil moisture content and on the groundwater table. There is a very dangerous decrease noted also in the series of the ratio of annual precipitation to potential evapotranspiration (P/P^E), according to which the Hungarian territory may be identified as a drought affected country" by the term of the UN Convention to Combat Desertifcation and Drought.

B. Vulnerability assessment

Research of drought occurrences in Hungary

As a result of frequent drought events in the country Hungarian specialists in water management, agriculture and agro-meteorology have been deeply involved in drought investigation. Intensive research work has been extended to the following main topics:

- Developing methods for reduction of harmful impacts of drought
- Evaluation of the effects of drought events
- Determination of the reasons and circumstances in which severe drought occurs - finding out the effects of drought on plant production and animal husbandry
- Developing methods for reduction of harmful impacts of drought

Over time the results of researches have been explained and discussed, but after some serious drought events the experts evaluated the situation in home consultations and symposia. One of the most important evaluations of the experience of the drought of 1983 was made by the special group of the Hungarian Academy of Sciences during the next ten years (Baráth-Gyorffy-Harnos, 1993), in which the experts have made
- Mathematical evaluation of climate data time series and climate-yield correlation,
- Analysis of plant production on the basis of data gathered on several cultivated plots and plants,
- Correspondence analysis of different factors on yield,
- Historical evaluation of drought events and the role of the ever existing Hungarian governments in drought mitigation, and summary on the future tasks and possibilities

Among the final conclusions *there had arisen the strategy of drought mitigation* in agriculture as a complex system of means and measures for the reduction of drought damages in agricultural production. Also the necessity of the establishment of monitoring systems and the use of computerized methods has been emphasized together with the well organized complex research work on different impacts of drought. The Hungarian Academy of Sciences established a special commission for the coordination of these kinds of research activities

In. 1992, there was again a serious drought in the region, the evaluation of its Hungarian impacts was made in a meeting held in the Ministry of Agriculture, organized by the Hungarian Association of Agricultural Sciences and the Hungarian Hydrological Society (Pálfai-Vermes, 1993). In this conference a manifold and interdisciplinary analysis on the reasons and effects of drought has been made with the clear conclusion that *prevention* is most important and *preparedness* should be increased including the help of a better forecast service for drought mitigation. Also a more effective *international cooperation* has been urged, first of all among the countries of the Carpathian Basin.

International meetings and conferences on drought

Parallel with home activities some important international events and conferences influenced the Hungarian activities in drought problems. In 1992 the 15th European Regional Conference of ICID was held in Budapest, and one of its section was devoted to the drought phenomena. All the presented papers and posters of this conference-section gave important examples and contributions to a better understanding of drought on one hand and help in prediction and preparation for a coming drought on the other. Most of the conclusions and recommendations of the ICID conference can be authoritative in our days, too. The participants agreed in a common work of the surrounding countries for the drawing up of an European drought sensitivity map, and recommended the organization of a workshop on drought in the Carpathian Region.

Fulfilling this demand the Hungarian National Committee of ICID took the responsibility and organized the proposed workshop in 1995, in Budapest-Alsógöd, with the participation of the invited representatives of most of the countries concerned in the region. Beside the valuable presentations of the participants one of the most important result of this workshop was to formulate a declaration in which the need for a better international cooperation was pointed out and the recognition was identified that drought effects not only agriculture but the whole society and economy of the nation, therefore drought mitigation processes should be extended to those areas as well (Vermes-Mihályfy, 1995).

After this workshop the European Regional Working Group of ICID has been established, and in the frame of this Working Croup a special task-force has been created for the elaboration of a guideline for the drought mitigation strategy on the basis of the results and experiences of the participating countries. This guideline - after several discussions and corrections, and incorporation of some suggestions from the American experts - was finished in 1998, translated also into Hungarian in 1999 (Vermes, 1998 and 1999), and it is now one of the main material on

which the Hungarian National Drought Strategy is to be developed. Useful and helpful event was the Hungarian-American Workshop on Drought held in Budapest in 1998, and the Balkan Workshop on Drought in Zajecar, Yugoslavia; both meetings strengthened the statements and tendencies of the ICID Guideline to be followed in drought mitigation (Vermes, 1998).

C. Adaptation measures

Practical and institutional measures and means used against drought damages

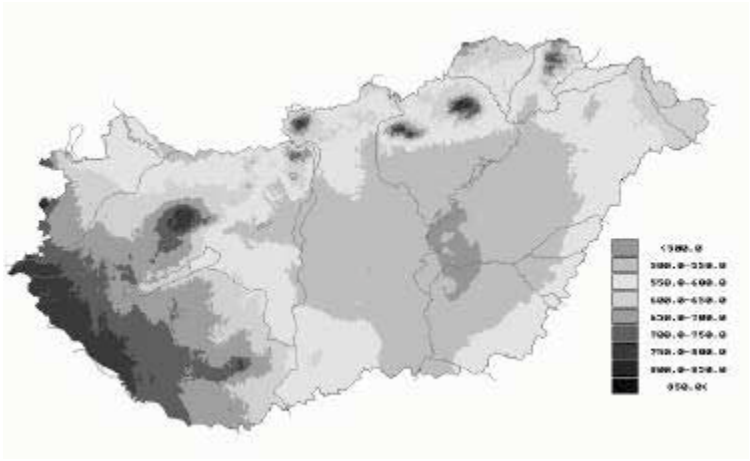
In spite of the relatively active evaluative and research work conducted for solving drought problems in the country, practical actions and governmental interventions remained in most of the cases ineffective, unfounded and not quite well consolidated. Most of the measures against drought damages have been improvized, the steps have been mainly succeeding and not preventing ones; and the actions have been mostly stop-gap type actions with only partial effects. Based on these perceptions and joining to relevant international movements in this topic (mentioned above) we came to the conclusion that more complex and preparative type of work is necessary for an effective drought mitigation in Hungary. Methods have been developed both in hydrology and meteorology for the calculation of drought severity and determination of the processes, which are responsible for the formation of drought in some parts of the country, which might help to establish and produce a more proper forecast.

One of the well-known results of our development is the Pálfai Aridity Index (PAI) designed by Pálfai in 1984, mainly for use in Hungary and in the Carpathian Basin, for the characterization of the severity of an arid situation by a single number derived from only few meteorological and hydrological parameters. In the base-formula to calculate the aridity index the mean value of air temperature of the period from April to August was divided by the precipitation depth summed up by the weighted monthly values of precipitation of the period October to August and multiplied by 100. The monthly weights for the precipitation values were based on the conditions of moisture storage and on the changing general water demand of the crops cultivated. For a more accurate expression of aridity the base-value of PAI0 should be corrected by a) temperature (hot days) correction factor, b) precipitation correction factor, and c) groundwater correction factor. More detailed description of the index can be found in the publication of Pálfai-Petrasovits-Vermes, 1995. The index can be used for making comparison between the wet and/or dry situations of different periods as well as of different areas, and it is also good for some predicting purposes if calculation of PAI values is made continuously. The values of PAI have been calculated for 68 meteorological stations in Hungary between 1931 and 1998; these index data series are provided in the Data Collection recently published by Pálfai-Boga-Sebesvári, 1999.

Another important index is the Agro-Hydro Potential (AHP) which gives the water demand satisfying ability of a certain area for a concrete plant stand existing there by the ratio of the effective water consumption (or actual evapotranspiration) and the water demand (or optimal evapotranspiration) of the given plant stand. According to Petrasovits, this index can show to what degree and how long is a certain land able to satisfy the water demand of the plant stand living on it, and is good for the expression of the occurrence of drought and the different levels of water scarcity as well. It is advisable to use this index together with the PEN Aridity Index (PAI) for a better characterization of the drought situation in a given agricultural area or crop stand. More detailed explanations of the index can be read in the publication of Pálfai-Petrasovits-Vermes, 1995.

Investigations and measurements of droughts in Hungary show that the climate in this country is determined mainly by large-scale circulation patterns of maritime, continental and Mediterranean air masses, modified by the topography of the basin. This results in increased sunshine, less precipitation, weaker wind, greater amplitude of daily and yearly temperature variation range and great spatial variability of precipitation (annual mean maximum is 879 mm, while minimum is only 453 mm). The mean annual temperature is about 10°C and exhibits a zonal pattern modified by the altitude. The distribution of precipitation over Hungary is uneven, as it is apparent from Figure VI.1. The most humid parts of the country in the West receive somewhat less than 900 mm of rain per year, about twice the precipitation of the driest areas in the Hungarian Plain, which is the most important agricultural area of the country. In the Hungarian Plain a tendency for dryness and often insufficient rain for agriculture characterize climate during summer months. The highest monthly precipitation values are measured in June (60-90 mm), and February is the driest month. While, on one hand, monthly precipitation can exceed 100 mm or sometimes even 200 mm in any month, on the other hand months any time in the year might pass without any rain. The growing season (April-September) exhibits even larger variations regarding monthly precipitation sums.

Figure VI.1: Mean annual precipitation in Hungary



Source: Hungarian Meteorological Service

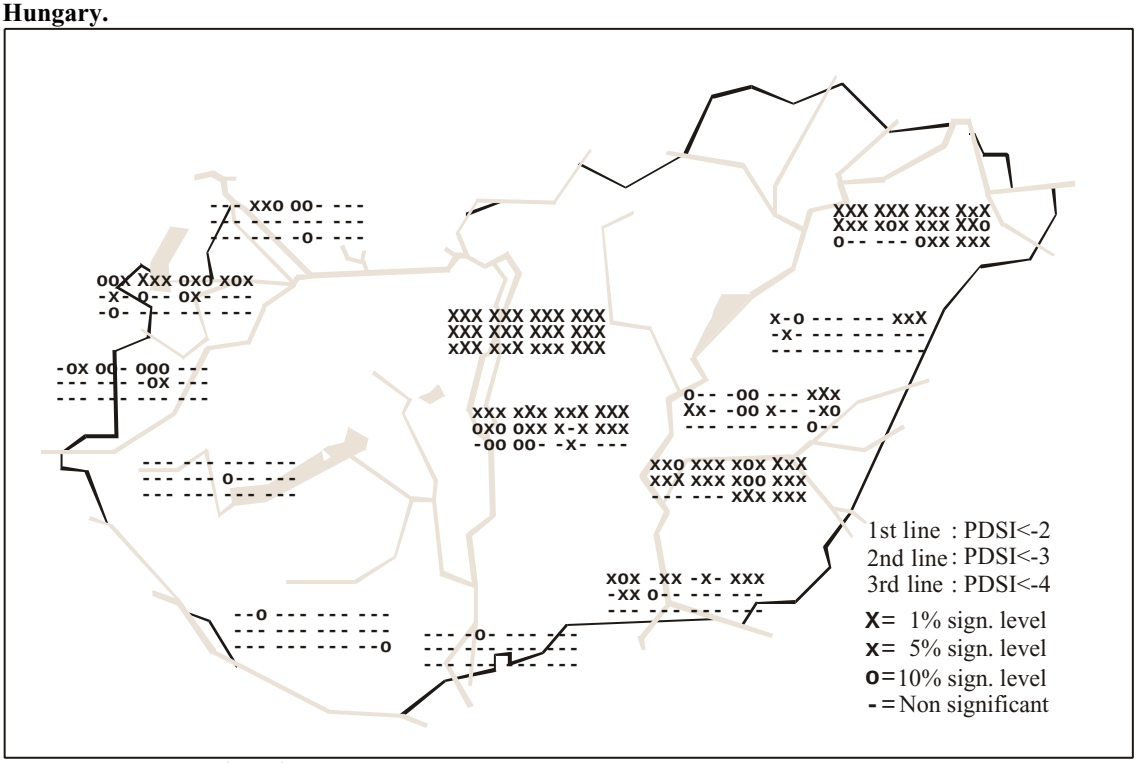
Réthly (1968, 1998) collected historical records of extreme meteorological events for the Carpathian Basin. The occurrence and characteristics of historic droughts in Hungary have been analyzed by Szinell et al. (1998). They found that droughts have been recurring in the past century. Historic references (e.g. Gunst, 1993) suggest that although extremely dry periods occurred already before the beginning of regular meteorological observations, e.g. between 1779 and 1794, the series of severe droughts from 1983 to 1995 is rather exceptional. PDSI series between 1881 and 1995 were analyzed statistically at 15 locations in Hungary. Both linear regression and the Mann-Kendall test resulted in a significant decrease of the PDSI at most of the stations. Analyses of drought occurrence suggested an increase in the frequency of droughts in different severity classes.

At first, the two tests have been applied to the PDSI and SPI index series ending in 1995, then series ending in 1999 were used. Regarding PDSI, the tests indicated significant (1% to 5%/a) increasing drought frequency at a number of stations, mostly on the Hungarian Plains, The second test indicated that droughts tend to occur in spells of years even where the first test failed to indicate drying tendency. This result suggests that successive years in which PDSI values recur under certain thresholds are more probable than individual occurrences. Tests 1 and 2 resulted in similar outcome when applied to PDSI series until the end of 1999. In accordance with the expected behavior, the test statistics are smaller and their significance is sometimes reduced when compared to the previous case due to the recent spell of wet years. However the general characteristics remain the same (see Figure VI.2).

SPI index series of 3, 6, 9 and 18-month time scales have been calculated. SPI's of shorter time scales can characterize water supply changes in short time periods in the year. One advantage of using SPI is its explicit time scale in contrast to the PDS1 which is reported to respond to moisture anomalies on the 6-12 months scale (e.g. Guttman, 1998).

The 3-month SPI revealed different patterns than the PDSI discussed above. They also indicated existing drying tendencies, but at more defined periods of the year. According to these series, drying occur mostly in late spring - early summer months and during late autumn. Both periods play a very important role in agriculture, as the first is the time of germination and sprouting, while the second is after harvest, when soils should fill up with moisture for the next vegetative period. Therefore drying during these important phases can have crucial effects on agricultural production. Tests on longer SPI series also indicated that the recent period has been dryer, but similar to the PDSI results, the significant results occurred in wider interval within the year.

Figure VI.2: Significance of Test 1 for PDSI until 1999 for 13 locations in Hungary.



Source: Hungarian Meteorological Service

Test Z when applied to the SPI series resulted in much fewer significant test statistics than when applied to the PDSI series. This can suggest that the clustering feature found earlier could be associated to the PDSI characteristic, that it has a tendency to be stuck at negative or positive values (e.g. Guttman, 1998. Bussay et al., 2000).

In Hungary, the sequence of years recently shifted from dry to wet period, this change is well represented in the drought index series, which have increased in value from moderately dry category to extremely wet, especially in the eastern and south-eastern parts of Hungary. Despite the above sharp changes, statistical tests indicate significant drying tendency over the past hundred years. The statistical significance of test statistics reduced, but the general picture remained the same, which is a sign of the stability and reliability of the tests as well as their output. Increased statistical significance occurred at some stations and months, which may be explained by the shift of the precipitation maximum between months.

These differences can be connected with dry and wet years and may be the result of climate variability. Results from the suggested periodicity test differed for PDSI and SAM series. This behavior may be the result of PDSI tendency to be stuck to large negative or positive values.

The role of other international activities

One of the major role in the development of drought mitigation actions in Hungary has been played by the ICID European Regional Work Team on Drought (ERWTD), in which Hungarian experts took part as leading and motivating partners, and - as it was mentioned above - in the frame of which the ICID Guide on How to work out a Drought Mitigation Strategy was elaborated (Vermes, 1998). The suggestions and structure of this guide will be followed in the National Drought Mitigation Strategy to be drawn.

As it is well-known in 1994 the United Nations adopted the Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification Particularly in Africa (UN Convention, 1994). The Convention contains regional implementations for other continents too, including special recommendations in Annex IV for the European Northern Mediterranean. These implementations are valid also for other parts of the continent, e.g. for the Carpathian Basin as well. Hungary - after a rather long preparatory phase - officially joined to the Convention in 1999. This obliges the country to do its best for the realization of the nationally and. internationally evident measures which can help us to minimize drought damages in the future. The Convention - among others - requires from the participants to use a strategic planning framework for sustainable development, and for drought mitigation. Affected country Parties should prepare national action programs and, as appropriate, sub-regional, regional and joint action programs, and should establish coordination with other sub-regions or regions on drought mitigation fulfilling the demands complying with the relevant articles of the Convention.

Following the scientific and technical considerations explained above and the already valid legal obligations there is an active organization work going on under the guidance of the Ministry of Agriculture and Rural Development, with the active and promoting participation of the Ministry for Environment and the Ministry of Transportation, Communication and Water Management, the Hungarian Academy of Sciences and other institutions, for the establishment of a National Drought Commission, in which all organizations concerned in drought mitigation will be represented. The present extremely wet period hinder a bit this organization work, but the detailed proposals for the constitution and work plan of the Commission are elaborated, and a final recommendation for the establishment will be presented to the government, hopefully in the nearest future. The main and most urgent task of the Commission will be to work out and realize the National Drought Mitigation Strategy, based on the internationally accepted guideline of ICID, the available foreign examples and experience, including the results of the present workshop, which seem extremely important for the country. Hungary is also interested in an effective international cooperation in drought mitigation, especially among the countries concerned in the Carpathian Basin, and is ready to take any coordination work for that according to the needs and agreement of other countries.

VII. Financial Resources and Transfer of Technology

A. Provision of new additional resources

Energy

Financial resources and programmes

The *Energy Saving Credit Programme (ESCP)* established in 1996 has spent some 1.7 billion HUF (EUR 6 million), of which 1.1 billion HUF were bank loans. So far the ESCP has focused on funding energy saving programmes at municipal level, modernization of district heating systems and the development of energy service company financing. The ECSP is entirely funded from local sources. The funds are provided by a local bank - winner of the annual tender through which the interest rate of the loan (the lowest offer) is set. Part of the subsidy is a grant provided by the Economic Development Fund of the Ministry of Economic Affairs. Applications are evaluated by the bank and by an Inter-Ministerial Committee which analyzes the technical feasibility and the level of energy saving. Main clients of the ESCP are municipalities. While the feedback from municipalities has so far been satisfactory, the upper limit of the Fund (25 million HUF) seems to be on the low side, taking into consideration that investments in heating reconstructions are the main utilization of the Fund, in addition to projects involving the modernization of lighting systems. So far, the ECSP has funded some 540 projects.

Within the new Energy Saving and Energy Efficiency Action Programme of the Government, adopted in September 1999, the number of applications has been increasing dramatically, which may pose challenges to the evaluation and funding process.

In addition to the Energy Saving Credit Programme, various other funding schemes for energy efficiency exist in Hungary. Some of them originate from before 1995, and apparently have been important catalysts in shaping the Government's energy efficiency programmes.

The first program of this kind established in Hungary is the *German Coal Aid Fund*, which came into force already in 1991 and has spent to date more than 7 billion HUF (EUR 26 million) on energy efficiency projects. The Government estimates that this program has so far induced an annual reduction in energy use amounting to 4.6 PJ (110 ktoe), and has resulted in annual savings of 19 million EUR.

The initial capital of the German Coal Aid Fund was a (non-repayable) grant from the German Government of 30 million DM. The Fund works as a revolving fund (loan repayments return to the fund for new loans). Interest rates are approx. 50% of the national bank primary interest rate. During 1991 and 2000, the Fund has provided 50 loans annually, with an average amount of 20 million HUF. The Fund provides loan facilities up to 80% of the project costs, maximum loan is 80 million HUF. Out of 450 projects funded, only 10 failed, usually because of bankruptcy of firms. Typical projects are related to heating systems, building insulation, new production technologies, fuel substitution, etc. The Fund operates under the responsibility of the Ministry of Economic Affairs, with the assistance of the Energy Center (the former Energy Information Agency).

The German Coal Aid Fund is one of the most popular and successful funding sources in Hungary, mainly due to the fact that its eligibility criteria are very broad with few restrictions in addition to a very transparent modus operandi (the Fund is open for all kind of interested parties and has evolved as an important funding source for SMEs).

In the framework of the PHARE Programme, the *PHARE Revolving Fund* established a preferential credit scheme of some 5 million USD for the energy sector. The Energy Efficiency Co-financing Scheme (EEFS) established under the PHARE Revolving Fund started in 1998 and provides a grant component from the revolving fund together with interest subsidies to matching loans provided from commercial banks. The volume of the PHARE component to the loan must be between 20 000 and 400 000 USD and may not exceed 25% of the total eligible project cost. By mid 2000 almost 80 loan applications were submitted to the two banks operating the EEFS. The total cost of all projects is over 37.6 million USD, with a total loan amount of about 23.6 million USD, including 6.2 million USD interest free PHARE component. Beneficiaries are typically municipalities, private and municipality owned companies and in 10% of the cases third party financing agents. Technologies are mainly efficient street lighting, small-scale combined heat and power systems, improvements of production processes and – to a lesser extent – projects involving renewable energies. Total savings are estimated at 1613 TJ/year of primary energy, corresponding to a reduction of CO_2 emissions of about 110 kt/year.

Agriculture

Corresponding to the European Union tendencies, according to the forecasts the role of direct payments, to a smaller extent the supports will also become decisive in the agri-environment and rural development in the long run in the Hungarian agriculture policy. The elaboration of such an economic regulation, incentive payment system is in progress that compensates the income decrease stemming from the validation of environmental protection and nature conservation aspects. The financial resources of the agri-environmental measures may be covered from the national budget, and after the accession to the European Union from the support system of the Union.

Forestry

Financial resources

Financing large forestry programs has always been a considerable burden for the Hungarian state budget. However, it has always been regarded that afforestations are important strategical measure with many mid- and long-term benefits. Therefore, until the end of the 1980-90's, when the country's economy experienced a severe recession, resources were available for the programs. Beginning with the last year, large resources have been allocated for afforestations again.

Allocating enough resources for the forestry sector will be an economic necessity, too. Tourism is becoming a major economic sector, which requires healthy and peacful landscapes, where tourists can feel themselves close to nature. This especially holds true for regions which may be touristically attractive, have little other choices to the local people to make a living, and where forestation rate is low.

In addition, even more resources are expected to be spent for afforestations when the country becomes a member of the Europen Union, possibly in 2004. There may be three external sources of resources. One is the direct support of the EU. Another may be that European Countries with large emissions will engage in Joint Implementation programs: costs are and will remain somewhat lower in Hungary than in many EU-member states, and it is easy to find areas here to afforest. Finally, if Hungary is a member of the EU, investors of other countries, such as the USA, may regard Hungary as a country where long-term projects, like and afforestation, can be conducted at a low risk rate.

B. Assistance to developing country Parties that are particularly vulnerable to climate change

In the present situation, Hungary is one of the emerging market economies of the ex-Soviet block countries. The country is still a net assistance receiver, therefore there has been no projects or actions yet aiming at provision of assistance to any other developing country Parties.

C. Provision of financial resources

Energy

The *Pilot Panel Programme* or Soft Loan System for Panel Reconstruction, established in 1996, makes low-interest funding available for the energy-efficient refurbishment of buildings constructed from prefabricated panels, including insulation and heating system modernization. The interest rate is set at below 10%. The budget is approx. 10 million US$.

The *Hungarian Energy Efficiency Co-finance Programme (HEECP)* was launched in 1997 by the International Finance Corporation (IFC) Environmental Projects Unit with a total of 5.0 million USD funding from the Global Environmental Facility (GEF). The funds are allocated as follows: 4.25 million USD as guarantee reserves. USD 300 000 for technical assistance and USD 450 000 for program administration and operations over a four year period. After successful termination of the pilot phase, the guarantee facility has been expanded to 16 million USD.

Under the guarantee program, participating local financing institutions execute so-called Guarantee Facility Agreements with the IFC. HEECP provides partial guarantee support to credits provided by the financial institutions for energy efficiency projects (50% in the pilot phase and 35% under HEECP-2). The rationale of the project is to overcome barriers to energy efficiency project finance which are due to (i) credit risk barriers, including weak or uncertain end-user credit, (ii) the gap between perceived and real credit risk due to capital market inexperience with energy efficiency investments and (iii) lack of properly structured and creditworthy projects seeking financing, coupled with the relatively high transaction costs and risks associated with energy-efficiency project development. While the guarantee program addresses the problems associated with credit risk, the technical assistance component aims to provide

technical expertise and to make available small grants for: (i) marketing of services by participating financing institutions, (ii) project identification, development and investment preparation, (iii) general energy efficiency market promotion activities (iv) and program evaluation activities.

Credit guarantees have so far been provided to 15 energy efficiency projects (street lighting and heating systems) with a total investment of approx. 3.7 million US$.

Technical assistance funds are also provided to ESCOs. HEECP also seeks ways to promote expanded energy efficiency markets in Hungary in co-operation with other commercial, governmental and NGO agencies.

The *SCORE Programme* is a mechanism funded by the Dutch Government which makes 165 million HUF available for the development of energy efficiency institutions and networks and demonstration projects. In addition to these funding mechanisms, there have been various EU initiatives, including support under the THERMIE, SAVE and SYNERGY programs.

In parallel to the *National Energy Saving and Energy Efficiency Action Programme*, the UNDP/GEF Public Sector Energy Efficiency Programme aims at helping Hungary to improve energy efficiency in the public sector. The program seeks to remove barriers to improved energy efficiency in municipal buildings, including schools, hospitals and other public buildings. The main objectives of the program, which started in 2001 are: (i) to improve the development of energy efficiency policy, increase awareness and improve coordination of energy efficiency policy, (ii) the identification, development and financing of energy efficiency projects in municipalities and (iii) to improve the knowledge base on energy management and energy efficiency technologies. The Energy Center is the implementing agency of the project, under the authority of the Ministry of Economic Affairs. To manage and implement the project – and help to build the capacity of the Energy Center – the project funds ten additional staff situated at the Energy Center. The Program also intends to reach out to municipalities and local advice centers and networks. The managing director of the Energy Center is also the director of the program. The budget of the program is approx. 1.5 million USD.

Another GEF program is the *IFC/GEF Efficient Lighting Initiative (ELI)*, which is part of a three-year, USD 15 million program designed by IFC and funded by GEF to accelerate the penetration of energy efficient lighting technologies into emerging markets in Argentina, the Czech Republic, Hungary, Latvia, Peru, the Philippines and South Africa. ELI has allocated USD 1.25 million to lower market barriers to efficient lighting in Hungary. The program was initiated in 2000.

D. Activities related to transfer of technology

Forestry

Research on carbon issues in the forestry sector became a priority after the U.S. Country Studies Program in 1995. Several papers were published before, however, intensive research begun only when external resources could be used for research. Since then, many reports, conference papers, and research papers have been produced. International contacts were established in various areas.

The possibilities of JI projects must still be explored. Unfortunately, the rules of such projects, and those of emission trading have not been finalized yet, therefore, and because of other reasons, only study tours have taken place so far in Hungary for the interested parties (for example, from the US and Austria) to see what possibilities exist for joint programs. In these tours, we demonstrated the Hungarian site conditions, the species and silvicultural methods that are available, the possible utilization of wood as source of energy, and the vast areas the country posesses. Our methods to estimate and inventory the amounts of wood and carbon in the various forests and plantations were also demonstrated, as well as possible reactions of various NGOs on carbon-related forestry projects were also discussed.

Another very important activity of the country currently is the participation in the work of the COST E21 Action („The contribution of forests and forestry in the mitigation of greenhouse gases"). This action has lasted already three years, and several workshops have taken place so far with many presentations. The second whole action meeting was organized by Hungary in April 2001, when 85 participants from Europe and the US came to Budapest and also participated in the study tour with a forestry program. In this program, we introduced the participants, among others, the possible afforestation programs in the country.

VIII. Research and Systematic Observation

A. General policy on research and systematic observation

While Hungary is a small country with a population of 10 million and its GDP per capita is below that of most other OECD countries, it has been at the forefront of world research achievements in several fields. Since climate change is a new field, its research workshops and educational centers are gradually being built up in the country. In this chapter, we summarize the key research, observational and educational activities and institutions in Hungary.

Climate change is a complex field encompassing a broad spectrum of topics whose boundaries are difficult to draw. Therefore, while this and the following chapters attempt to be comprehensive, they cannot cover all directly or indirectly relevant activities in the country.

The present section contains a brief insight into governmental research policy, followed by a description of systematic observations and related research activities. The following section highlights several among Hungary's research activities in the climate change field. The chapter is concluded by a list of recommendations for Hungarian climate change related research.

Research policy and funding related to climate change

Since climate change is a new area of environmental science, there are no specific governmental guidelines or policies for research support in this field. From 1998 there are certain national schemes to which Hungarian researchers can apply for R&D funds, to which climate change related research is eligible. However, calls for applications have not been targeting climate change research specifically, or identified it as a priority area.

This low emphasis in national R&D on climate change has been changing recently. The science of climate change is the first priority area in the environmental subprogram of the National Research and Development Programme adopted by the Government in 2000. After the calls for application in 2000 and 2001, almost 300 mHUF (over a million Euros) have been allocated to support the various research projects related to climate change.

The National Environment and Nature Protection Research Programme of the Central Environmental Fund has launched a revised call for proposals from 1999. Among others, the impacts of climate change on the sustainable utilization of Hungarian natural resources, on Hungarian ecosystems, economy and society were among the priority areas of the call. The proposals are funded by up to 20,000 Euros.

Researches on the revision of the methodology of agricultural greenhouse gas inventory are in an initial stage. The most important aim of the project is to elaborate the national emission factors based on the IPCC methodology. Researches on the evaluation of the efficiency and costs of the possible emission reduction measures are in a preparatory phase.

B. Research

Due to the cross-cutting nature of the subject of climate change, and the interconnectedness of research and educational initiatives, activities are classified in two ways. This chapter reviews the key research projects organized according to the subject taxonomy used by the IPCC reports. Since there are many research and educational activities which cannot be attributed to a project but more to an institute, the following chapter reviews the key institutions contributing to the research and public education of climate change in Hungary, and a summary of their activities.

Atmospheric Chemistry and Climate Change

A group at Veszprém University is engaged in understanding the role of atmospheric aerosols in climate change.

The impact of climate change on hydrology and water resources

The Hungarian Academy of Sciences (HAS) established a multi-institute research group for exploring the strategic issues related to water management and hydrology at the turn of the millennium in Hungary. Within the framework of this research project, the expected impacts of climate change on hydrology and water management in Hungary have been explored as well. The research group has been directed by László Somlyódi of the Budapest University of Technology and Economics. Other institutes

participating in the project include the Szt. István University in Gödöllo.

The Research Institute for Water Management (VITUKI) of the HAS has been active in research related to the impact of climate change on hydrological resources. One of their projects is aimed at understanding the link between climate change and floods in Hungary. This topic has become especially timely with the heavy floods taking a major toll during the last few years.

VITUKI, in co-operation with other institutions and consultancies in Hungary, have been conducting a research project in order to understand the impacts of climate change on the elements of environments influenced by surface and subsurface flows in plain areas.

The Hungarian Meteorological Service (HMS) is working in many areas related to climate change, as described above. Among their projects, their activities in drought monitoring belong to this section. The main aim of the drought project of the European Climate Support Network (ECSN) is to investigate the drought tendencies, application of different drought indices, and their comparison in Portugal, Spain and Hungary.

The impacts of climate change on ecosystems

The Department of Botany and Plant Physiology, Szt. István University, Gödöllo, hosts the "global climate change and plants" (GCCP) EU long-term experimental ecological station. The GCCP (2400 m2 in the Botanical Garden of the Department) was established in 1994 to investigate the effects of increasing CO_2 concentration and temperature on herbaceous plants and vegetation. The GCCP was developed in collaboration with the EC-ESPACEgrass project, funded by the EC Environment work program. The station consists of twenty open top chambers to grow plants at present and elevated CO_2 concentrations. Plants/vegetation exposed in this facility to elevated air CO_2 concentration include crops and weeds, coniferous and deciduous trees and transplanted monoliths of loess and sandy grasslands.

These projects are included in the Global Change & Terrestrial Ecosystems Core Research Programme by the International Geosphere and Biosphere Programme (IGBP). GCCP is also a participant in the EU COST ACTION 619 "Effect of atmospheric CO_2 increase on carbon fluxes in grassland-ecosystems"; and COST ACTION 627 entitled "carbon storage in European grasslands"1. In addition, the GCCP provides the facilities for the function of Research Group of the Hungarian Academy of Sciences at the department entitled "Global Climate Change and Plants".

Emission inventory

The Institute for Environmental Management has been developing a strategy for the research and monitoring tasks related to emission inventories required by international agreements.

Systemexpert Ltd. has been modeling the impact of GHG mitigation strategies on emissions based on ENPEP models.

Mitigation: economics, policies and instruments

Hungarian institutions and researchers have been involved in several international initiatives aimed at capacity building and methodology development related to the assessment of greenhouse gas mitigation potentials, economics and policies. These projects included the US Country Studies Programme effort and the UNEP's Greenhouse Gas Mitigation Costing Studies initiative. Most of these activities were completed during the second communication period (see the Second National Communication of Hungary to the UNFCCC). The following list highlights some activities in these areas in the present reporting period.

- During the present reporting period, researchers at the Budapest University of Technology and Economics have examined the issue, of Hungary's carbon-dioxide emission mitigation in connection with the country's EU accession.
- A research group under the auspices of the HAS is assessing the relationship between atmospheric emissions from the electricity and heat sectors and EU accession. Another group is examining energy policy strategies warranted by an increased penetration of combined heat and power generation.
- MAKK has conducted an analysis in 1998 related to the implications of the ratification of the Kyoto Protocol for Hungary, for the Ministry of the Environment.
- Several institutions and researchers are active in contributing to the development of a national policy related to the flexibility mechanisms: Joint Implementation (JI) and Emissions Trading (ET). Among others, MAKK, Env-In-Cent, and the National Society of Conservationists (MTVSz) have prepared studies related to this issue.

An international CO_2 emission rights simulation was organized by the International Energy Agency (IEA) and the California Institute of Technology in the summer of 2000. The aim of the simulation was to test the international emission rights trading system drawn up in the Kyoto Protocol, between 2000-2012. 24 participants from 19 countries took part in the project, during which 387 transactions were made on the virtual market. Each country complied with her Kyoto commitment; moreover, Hungary (represented by MAKK) has obtained significant profits as a result of the simulation.

Mitigation: energy efficiency

Improving the efficiency of energy production and consumption is perhaps the single most important way of reducing Hungary's greenhouse gas emissions. Despite improvements since 1990, Hungary's energy intensity (TPES/GDP) is still lagging behind most other OECD countries. While advanced reforms in the energy sector, including the lifting of subsidies, privatization, and the planned liberalization have removed most of the legacies of the planned economy which have contributed to these high energy intensities, further targeted policies are needed.

There are several universities and institutions active in a wide array of projects related to energy efficiency in Hungary. For the description of the key institutes, please refer to the section describing institutions below. Since the spectrum of projects related to energy efficiency are very broad, this section will only highlight to a few examples in the field.

- Researchers at the Central European University (CEU, http://www.personal.ceu.hu/departs/envsci/) are following the trends of energy (and carbon) intensity developments since the economic transitions in Central European Countries, including Hungary. The goals of the research are to understand of the impacts of economic and energy sector reforms on energy and carbon efficiency in the region.
- The Energy Center has been exploring the role of energy efficiency in environmental protection in Hungary.

Mitigation: renewable energy

Research is a critical issue of renewable energy development. This is mainly due to its considerable equity demand, low rate of return and high risk. Highlights from the country's renewable energy research projects during the present reporting period are as follows:

- Arising from Hungary's favourable agricultural endowments, detailed research work has been focused on the use of biomass for energy production. The detailed examination of technical, agricultural, economic and environmental effects, and the numerous feasibility studies made show that operating plants could be found in Hungary for the application of nearly all kinds of important energy from biomass utilization processes in the 1990s. This statement stands even now if we disregard biodiesel production. Outputs of most of the comprehensive assessments in this area are included in the book of Dr. István Láng "Possibilities of Complex Use of Biomass" published in 1985 and in the final report of the project "Potential Use of Biomass in Hungary" (1999) coordinated by László Zsuffa and financed by The World Bank.
- Hungary is one of the leading countries in the world in the utilization of geothermal energy. However, without a sound way for utilising geothermal water resources this energy form can have undesirable environmental impacts, and can lead to the depletion of water resources.
- Several research groups in Hungary supported by national R&D schemes are active in exploring methods of the utilization of geothermal energy resources in an environmentally acceptable way. Among others, VITUKI has been analyzing the possibilities of recharging geothermal water resources after the extraction of energy.
- As mentioned above, Hungary's geomorphologic structures are unique from the perspective of geothermal resource potentials. Researchers are investigating further possibilities for the utilization of this resource in Hungary. Among others, experts at the Nyíregyháza College are assessing Szabolcs-Szatmár-Bereg County's geothermal resources.

In the case of research regarding renewable energy, benefits other than technical development do not emerge at the place of research. Therefore, most fields of research are not attractive for contractors, and at the same time development is hindered by lack of research information, which may spoil competitiveness and may also cause the increase of consumer’s prices. State subsidy of primary research is absolutely necessary, because this activity is financed by the citizens, and also serves their benefit. These benefits appear at the consumers side only partially (through the use of cheaper, better available, environment friendly

energy sources ensuring higher comfort), as social benefits are dominant. These are as follows.

- Research can directly create a considerable number of workplaces at universities and research institutes, and enables better utilization of the existing infrastructure.
- Establishment of new background industries required for the implementation of research outputs will be followed by the creation of new workplaces, mainly in backward regions. Higher living standard and better infrastructure may also motivate other contracting activities and raise prices of local estates.
- Being environment-friendly means higher chances in participating both in international and in domestic regional development tendering processes. Due to the decrease of harmful emissions, foreign capital can also become active in the domestic environment protection sector, and this enables some state funds to be redistributed to social purposes.

Regarding technical innovations, profit interest is a strong motivation for the industry, however lack of equity remains the main barrier of development, therefore progress in this field can be achieved by mixed financing – state subsidies through tenders and probably with the support of multinational enterprises.

Frame of the scientific research work was constituted by the basic research of the Hungarian Academy of Sciences (MTA), doctoral dissertations and research reports of several research institutions. Sixteen doctoral dissertations on the issue of renewable energy have been defended so far and 6-8 university students are preparing their thesis on the same issue now, mainly in Sopron, Budapest and Gödöllo. Due to shortage of leading teachers connected to this subject and lack of professional conferences, development at other universities is expectable in long term only.

Mitigation: transport

Transport is especially important for Hungary from the perspective of CO_2 emissions. While in most sectors of the economy, along with other economies in transition (EITs), Hungary is lagging behind other OECD countries from the perspective of energy intensity (i.e. primary energy necessary to produce a unit of economic output), the specific energy consumption indicators in the transport sector were better in EITs than in OECD countries after the fall of communism. This was the result of the high share of organized means of transport, such as public transport and rail freight shipping. Since the economic transitions there is a strong shift in the direction of individual transport modes, which, combined with a boost in mobility, can fundamentally influence the country's CO_2 emissions for the close future. Therefore, research, development, and careful policies in this sector have a special priority.

The Institute of Transportation Research engages in projects in this sector. One of their key projects having an impact on climate change mitigation is aiming at developing Hungary's transport strategy based on the recommendations of the UN-EGB's regional conference "Transport and Environment". Among other initiatives, they have conducted an impact assessment study related to the proliferation of gas-fuelled vehicles.

Mitigation: forestry

Research on carbon issues in the forestry sector became a priority after Hungary's participation in the U.S. Country Studies Program in 1995. An important activity of the country is the recent participation in the work of the COST E21 Action ("The contribution of forests and forestry in the mitigation of greenhouse gases"). Within the framework of this program, the Hungarian Forest Research Institute organized an international workshop ("Second whole action meeting") in Budapest in 2001, where around 30 presentations were given (see http://www.bib.fsagx.ac.be/coste21/report/2001-04-26.html). The COST E21 action, as well as the Kyoto process talks made it necessary and possible for Hungary to try to take part in EU research projects. It is not easy, of course, to get financing for these projects, and several project proposals have been unsuccessful. "CARBO INVENT" has recently received high ranking and has a very good chance to get financed. As an integral part of this project, researchers will have the opportunity to make a concerted effort to develop carbon inventories in forests. In addition, an integrated research program on climate change related forestry problems starts in 2002. This research program is financed by a scientific fund of the country, and will concentrate on growth, genetics, and other complex fields in relation to the changing climate.

Researchers from the Hungarian Forest Research Institute, including Dr. Zoltán Somogyi, have played an important part not only in the research, but also in the policy setting and international negotiations of the country related to climate change. In addition, he is representing Hungary in the current work of IPCC to develop good practice guidance for the land use, land use change and forestry activities.

Research also focuses on the Kyoto process. These talks are important because research can assist decision-makers with relevant information, and political and technical requirements of the decisions in the various COPs trigger various research programs.

Participation in cross-cutting initiatives

Hungarian researchers have been actively participating in international research activities related to climate change. This section will highlight some of the main crosscutting initiatives and projects to which Hungarian scientists have contributed in a major way. Hungarian scientists are working actively in a wide range of international initiatives, including the International Geosphere-Biosphere Program (IGBP); the International Human Dimensions Program (IHDP), and START.

Consumer Choice and Carbon Awareness (4Celectricity)

Researchers at the Central European University are participating in the multinational EU project 4CElectricity, supported by the European Commission's Altener Program, coordinated by Oxford University's Environmental Change Institute. The purpose of the project is to investigate the feasibility of an information label for aiding the choice in electricity purchasing in liberalized markets. The ultimate goal of the project is to raise the consciousness of the public related to the carbon content of the electricity they are using, and to promote the increased consumption of low-carbon electricity options through an informed choice. The project aims to provide an input to the development of the relevant EU directive. More information on the project is included at http://www.electricitylabels.com/index.html.

Participation in COST activities

"COST" stands for the European Co-operation in the field of Scientific and Technical Research. Hungarian researchers have been participating in almost all actions of COST. Several of the actions have direct or indirect relationship with climate change. Since reference is given to related COST projects in the relevant sections of this document, only the summary of the relevant COST actions is provided here. For more information, please refer to http://cost.cordis.lu/src/home.cfm.

The key cost actions relevant to climate change are as follows:

- COST 620: "Vulnerability and risk mapping for the protection of the karst aquifers"
- COST 623: "Soil erosion and global change"
- COST 626: "European aquatic modeling network"
- COST 621: "Groundwater management of coastal karstic aquifers"
- COST 624: "Optimal management of waste water systems"
- COST 627: "Carbon storage in European grasslands"

Participation in EU 5th Framework Projects

JOINT - *Joint Implementation for International Emissions Reductions through Electricity Companies in the European Union (EU) and in the Central and Eastern European Countries*

The Project involved 15 EU and Central and Eastern European countries. From Hungary the coordinator of the Country Team was Systemexpert Consulting Ltd., with active participation from the Ministry of Environment, Ministry of Economic Affairs, and the North-Transdanubian Power Company (ÉDÁSZ). The Project goal was to facilitate commercial investments in the electricity and CHP sectors using Joint Implementation (JI) in order to meet the United Nations Framework Convention for Climate Change Kyoto Protocol targets and other international and national environmental obligations. The proposed activity sought to help set the total framework for Joint Implementation between countries in the EU and the five Accession States of Central and Eastern Europe (CEEC) through the electricity and CHP markets. It further sought to initiate JI activities between partner electricity and CHP companies in the European Union and the CEEC, through "learning by doing", thereby demonstrating the modalities for implementing such activities, providing key practical experience in cross-border implementation, and illustrating the economic and environmental benefits of market-based, least cost JI.

The project results can be summarized as follows. The JOINT Project methodology essentially followed the "learning by doing" approach, whereby each country has a country team composed of key government stakeholders (UNFCCC focal points, other key ministries and government agencies), key industry stakeholders and associations, and key Climate Change agencies and institutes. It is therefore *a process* rather than a discrete set of results.

Each of the Central and Eastern European (CEE) country teams identified potential JI projects. Industry partners from the CEE countries and from the EU and Norway then define their interest in those projects. If a project is selected by the industry partners, it is then put to the country teams for review. If the country teams agree to the projects, the projects are then put through the complete JI cycle by the JOINT Project Team. Project pre-feasibilities form the focus for examining all aspects of creating and developing a JI project, from defining environmental and investment additionality, to running baselines, to engaging key government agencies in all aspects of verification, accreditation, crediting, etc., and, finally certification and communication between the two governments concerned and the UNFCCC.

Thus, the JOINT project attempted to develop JI within as "real" a context as possible, with the intent to get JI up and running, and, to have specific projects that provide governments and private stakeholders with the kind of information and experience to guide and streamline future JI projects. It did so with all key stakeholders participating so that confidence and experience could be gained through a large-scale pilot that involves all concerned governments, and all concerned stakeholders working towards the same goal.

The need for targeted capacity building in the CEECs in terms of institutional issues, modalities and monitoring systems was highlighted through the project. Building of networks between CEECs, delivery through local mechanisms and with support from beneficiaries in the EU. For EU / Norway partners, a need for further awareness building and promotional support was identified.

A consistent conclusion of the JOINT project is the need to keep the costs of engaging in JI to a minimum whilst maintaining the environmental integrity and the credibility and monetary value of the ERU as a market commodity. A need exists to keep the project cycle short and predictable for participants, and introduce streamlined, standardized processes based on internationally agreed guidelines to ensure transparency. This is turn reduces the transaction costs to industry, and encourages a larger deal flow in the JI “marketplace”. However, this is likely to be possible only for smaller projects for example employing replicable renewables technologies such as solar, wind and small-scale hydro. This is workable only where effective compliance mechanisms exist with clear sanctions for non-compliance.

BASE - Baselines for Accession States in Europe – Promoting Clean Energy Investments through Joint Implementation in Central and Eastern European Countries (CEECs)

BASE is direct continuation of the JOINT project, currently in progress. The primary objective of the BASE project is to unblock the barriers that currently exist in the evaluation and approval of Joint Implementation (JI) projects in the electricity sector in the five participating candidate states of Central and Eastern Europe/CEE (Estonia, Poland, the Czech Republic, Hungary and Slovenia). Electricity production accounts for over 40% of all greenhouse gas emissions in these countries. JI is recognized by each of these governments, and by all EU Member States, as a cost-effective means for reducing GHG emissions in these economies in transition and thereby mitigating the effects of Climate Change.

However, progress in the JI field is being hampered by a lack of consensus amongst key stakeholders in government on what constitutes an eligible JI project in terms of qualifying on environmental grounds under the Kyoto Protocol. Furthermore, progress is hindered by lack of agreement and understanding of what procedures, models, frameworks, and guidelines should be used to judge and evaluate the merits of proposed JI investments. Lack of consensus and agreed methodologies is resulting in lengthy delays in project implementation and consequently high development costs for investors. This, in turn, is discouraging potential investors from investing in clean energy technologies that could significantly reduce GHG emissions in these countries using the Kyoto JI "flexible mechanism".

The project seeks to work with these governments (the UNFCCC "focal points" in each country) and other key stakeholders (e.g., industry, research institutions) to develop a set of baseline tools, methodologies and guidelines that will be tailored to the Climate Change objectives of each country. The project aims to help develop a consensus amongst the key stakeholders (particularly those ministries most relevant to promoting and approving JI projects) regarding the processes necessary to satisfy minimum requirements for environmental and other "additionality" for JI applicants.

In doing so the project will help speed up the process of JI investment as well as help the candidate countries with their commitments under the Kyoto Protocol. Developing agreed upon national methodologies for defining the eligibility for investments under the Joint Implementation designation will result in reduced project

development costs for investors, while simultaneously providing both investors and other key government agencies responsible for promoting investments clear guidance and guidelines on JI project eligibility.

Additionally, by helping these countries accelerate investment in clean energy in the electricity sector (thereby improve environmental performance), this will help to speed up these countries' accession to the EU. The participating governments view JI as an important tool to help in the accession process, particularly by speeding up investment in "clean" energy, and thereby transferring new technologies and know how to their economies to facilitate that transition. In summary, the BASE project aims to:

- Familiarize all key stakeholders in the participating candidate accession states with the "additionality" requirements for JI projects;
- Help build consensus amongst all key government stakeholders on the methodologies to be applied to proposed JI projects to determine their eligibility under JI;
- Help build up the data, information and tools by which to evaluate JI projects;
- Help define the guidelines and procedures by which to evaluate and rank JI projects,
- Determine the benefits (e.g., GHG offset credits) that should accrue to eligible projects;
- Help define how those benefits should be allocated (e.g., between the two participating countries)
- Help set out transparent guidelines for both investors and other government stakeholders on how to design, develop and approve good, eligible JI projects;
- Help build up the capacity of those environmental agencies responsible for Climate Change as set out under the UNFCCC;
- Ultimately, accelerate investments in good JI projects, particularly in the electricity sector, but additionally in all sectors.

Recommendations for future research activities

In general terms, Hungary needs to strengthen its research and educational activities in the field of climate change (CC). Since the impacts of CC might be significant in Hungary, especially in the Great Plains region, the fields of impacts and adaptation require greater emphasis in Hungary's research agenda. In addition, since Hungary's energy intensity is well above that of OECD countries and thus has significant energy reduction potential, there is a wide scope of opportunities for CO_2 emission reduction measures. After the completion of internationally sponsored projects aimed at mapping CO_2 conservation potentials and costs mentioned above (inc. the US Country Study project and the UNEP GHG abatement costing project reported in the previous National Communication), there are very limited activities in this field.

Further unexplored research areas prioritized by Hungarian researchers are as follows:

- The establishment of a national climate change research and education center orchestrating, harmonizing and integrating the relevant research, policy-development and educational activities of Hungarian institutions is highly recommended. Alternatively, sufficient mandate and resources should be assigned to an existing center to co-ordinate and/or carry out CC work.
- Regarding the hydrological and water management implications of climate change in Hungary, it is very difficult to conduct research in this problem within a national framework. Since 95% of the national surface water resources originate outside of the territory of Hungary, ranking Hungary among the three most dependent nations in the world on "imported" surface water, the hydrological system and water management cannot be effectively studied in an isolated setting. The cross-boundary nature of this problem warrants a strong international co-operation on the hydrological impacts and adaptation methods with participation of researchers from countries in the river basins of the Tisza and the Duna, or from the Carpathian Basin.
- The frequency of weather extremes, including droughts is expected to increase with serious consequences on agricultural production. Under these conditions proper plans for efficient use of water will be of crucial importance. Although necessary information is partly available (i.e. those provided by the meteorological/hydrological sciences), there is an obvious lack of knowledge on the water requirement of crop plants, in contrast with the obviously emerging need for the balance between the economical and ecological-sociological constraints. Combined micrometeorological and field ecophysiological studies have the potential to provide such information and to contribute to the planning of optimal use of water. Such studies are underway in developed regions of the world, but less so in developing countries requiring an operative knowledge of the subject to the same degree. These conditions are to be considered when planning the research and education activities in these regions.

- Climatological research needs a longer-term perspective in Hungary. Today the majority of the related activities comprise short-run projects, usually low-cost projects, which do not have sufficient time and financial resources at their disposal to get appropriate data and therefore broad results.

C. Systematic observation

The Hungarian Meteorological Service (HMS, http://www.met.hu/) is the largest meteorological and climatic information provider of the country. The scope of the provided information extends to the past (trends, changes, analyses), to the present (measured and observed meteorological and environmental data), and also to the future (forecasts on meteorological and climatic time-scales).

Besides the HMS, significant scientific and educational activity is expressed in the field of climatic change by the Meteorological Department of the Eötvös Loránd University. Their activities include: statistical down-scaling from circulation patterns; effects of ENSO in the region; surface-atmosphere (SWAT) modeling and others.

While leading Hungarian meteorological and climate scientists are cautious in acknowledging the existence of the climate change problem, Hungarian researchers are at the forefront in the global efforts to understand the observations related to climate change. For instance, in 1999 the WMO Executive Council conferred the Norbert Gerbier - MUMM International Award on two Hungarian researchers, Ms. Katalin Molnár and Mr. János Mika for their paper "Climate as a changing component of landscape: recent evidence and projections for Hungary", published in Zeitschrift für Geomorphologie in August 1997. The purpose of the Award is to encourage and reward annually an original scientific paper on the influence of meteorology in a particular field of the physical, natural or human sciences, or conversely, the influence of one of these sciences on meteorology.

Carbon cycle measurements

Hungary joined the global co-operative GHG monitoring network managed by the National Oceanic and Atmospheric Administration (U.S.A.) in 1993. The air samples taken at Hegyhátsál area analyzed in Boulder, Colorado, for carbon dioxide, carbon monoxide, methane, nitrous oxide and sulfur hexafluoride, as well as for the stable isotope composition of carbon dioxide. Hungarian principal investigator of the program is L. Haszpra (Hungarian Meteorological Service). A detailed description of the program, the global network and the data can be found at http://www.cmdl.noaa.aov/ccqg/flask/.

There is some evidence of a large carbon sink in Eurasian terrestrial ecosystems. To quantify this sink a research program (CarboEurope) was initiated in Europe in 1999. CarboEurope is supported by the European Union 5th Framework R&D Program. CarboEurope is a project cluster of 11 research projects, which will develop methodologies to quantify and verify the European carbon balance in view of the Kyoto Protocol of the UNFCCC. Hungary joined the AEROCARB (Airborne European Regional Observation of the Carbon Balance) project of CarboEurope in 2000. The Hungarian principal investigators are L. Haszpra (Hungarian Meteorological Service) and Z. Barcza (Eötvös Loránd University, Budapest). In the framework of the project a monitoring site is operated in West Hungary where the vertical mixing ratio profile of carbon dioxide is continuously measured from 10 m to 115 m elevations. The profile is extended up to 3250 m by means of occasional aircraft measurements. The measurements are used to calculate the biosphere/atmosphere exchange of carbon dioxide on local and regional scale and its dependence on environmental variables. A new proposal is under consideration at the European Union, which would extend the research project to several other greenhouse gases.

Climate data homogeneity

The main tasks of the HMS's climatic activities are securing 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 time series of data. The station locations, the instrumentation and observing standards have changed from time to time and these changes introduce inhomogenities into the time series. These inhomogenities should be filtered out to distinguish between natural and artificial change and variability. In addition, international seminars for homogenization were organized at the Hungarian Meteorological Service in 1996, 1998, 2000. These seminars were supported by the World Meteorological Organisation and it is planned to continue this successful serial in 2003. The proceedings of the Third Seminar for homogenization are available on the Internet at the address:

http://omsz.met.hu/ismeretterjesztes/rendezvenyek/rendezveny_hu.html

Regional climate change scenarios

Climatic impact analysis requires proper regional scenarios for different levels of the expected global warming. Current global climate models still do not incorporate important scales of physical processes driving local climate. Hence, their output fields should be downscaled, which requires the application of further statistical or physical approaches. This means a transformation of the useful (i.e. consistently forecasted and largely differing from noise) large-scale information, produced by the GCMs into climate elements of the region in question.

In the HMS's research the focus is on how the climate change effects the cloud and precipitation formation. The following effects are being investigated: increase of the amount of the greenhouse gases and aerosol particles; change of the soil quality and surface vegetation; and change of the vertical profile of temperature and moisture.

Stochastic weather generator

A project by the HMS demonstrates stochastic simulation of diurnal local weather parameters beyond the max. 2-3 week limit of the principal deterministic predictability. A statistical multi-dimensional model is developed, to simulate an internally consistent set of the meteorological variables, which are identical to the observed ones in statistical sense. Statistical tools, performing this objective, are referred as Stochastic Weather Generators (SWG) in the literature.

The structure of the model is adapted mainly to data requirements of the most frequent application, i.e. the impact studies specifying and estimating regional risks of global climate changes. This means simulation of arbitrarily long diurnal series of meteorological variables, representing climatic input data of the involved agricultural, hydrological, etc. models. A common set of the various potential applications had been selected including nine meteorological variables, which is far more than dimension of the present SWGs.

Climate impact studies

Regional climate scenarios obtained by the above-described methodology are included in a series of climate impact studies. The expected regional changes are abstracted from 0.5~ K increase of the hemispherical mean temperature. The approximately 100 quantitative estimations are performed by the corresponding experts for three different problems: wild ecology (sandy grass), subsurface and surface hydrology. A strong vulnerability to the expected changes in evapotranspiration and precipitation is indicated in the analysis. Robust changes of the targeted parameters are of 10% magnitude for ca. 0,5 K global warming, whereas frequency of some extreme events may increase by as large as 100%.

Key institutional capacities in Hungarian climate change research and education

Finally, we account for the key institutions that contribute to Hungary's research, educational and public awareness raising activities related to climate change. The purpose of the chapter is to point to institutions whose profiles include important climate change related activities. Due to the very complex nature and wide spectrum of the field, this selection clearly cannot be considered as complete, but attempts to introduce the reader to a selection of the key workshops active in climate change education and research.

Research and other governmental institutions

The Hungarian Meteorological Service

As demonstrated in the above sections, the HMS is participating in a wide range of activities related to climate change. For more information, please refer to the sections above on systematic observations, or to the website http://www.met.hu/.

Forest Research Institute (FRI)

FRI is active in climate change related research, as well as in developing national climate change policy. Its representative has participated in several COPs recently, and is participating in the current effort of IPCC to work out good practice guidance for the LULUCF sectors.

Energy Centre, Hungary

The new national energy efficiency agency founded by government decree 1031/2000 was established in order to focus on tasks and capacities of

government bodies, agencies and other institutions. The Agency is a legal successor of Energy Center (former EU - Hungarian Energy Center, established in 1992) and the Energy Information Agency. As a non-profit company owned by the Ministry of Economic Affairs, the Ministry for Environment and the Hungarian Energy Authority the role of the agency is to provide a sound institutional basis to facilitate energy efficiency activities and to operate the energy statistics system of Hungary. Main sources of financing are separated budget lines of the founders and operational costs of projects along with other market activities.

The tasks and responsibilities of the Agency warranted the establishment of three main divisions: (a) Project Development and Management on Energy Efficiency and Environment; (b) Energy Statistics and Information; and (c) Energy, Environment and Efficiency policy preparation, awareness raising and greenhouse-gas mitigation.

The Energy Center has been active in the preparation of studies, information dissemination, and conducting training and awareness raising campaigns in the fields of energy efficiency, renewable energy and climate change. The Energy Center has implemented its actions through various EU programs (THERMIE, PHARE, and SYNERGY) in collaboration with EU and Hungarian experts and institutions, Hungarian professional associations, universities, and consultants. In addition, the Center is currently working on a major UNDP/GEF project aimed at the reduction of GHG emissions from the public sector through the improvement of municipal energy efficiency. One of the important components of the project is the raising of energy efficiency related awareness on the municipal level.

The Agency has a wide-ranging working relation and experience with the NGOs and municipalities. In 1999, the Energy Center has completed the PHARE Energy Advice program where environmental, scientific and SME non-profit civil organizations provided assistance for 7 municipalities and for domestic sector in energy efficiency. In 2000, under the SCORE Dutch-Hungarian bilateral program the Energy Center implemented a pilot project called "shops for energy efficiency" aiming at the energy efficiency advising in shops selling electric appliances. The Center coordinated the elaboration and training for 14 NGOs in order to give Energy Efficiency advice on a qualified, certified basis.

Beyond the policy research and awareness raising activities of the Center related to lowcarbon energy, the Center has recently completed two studies related to Joint Implementation. The study "Preparatory study for the application of the Joint Implementation in Hungary" gives a detailed description about the JI market in Hungary and investigates the costs of the greenhouse gas mitigation projects. Beyond the cost-benefit analysis of the specific project types this study also estimates the overall costs and benefits of the JI for Hungary. The last part of the study includes an action plan and this identifies the most important tasks for the government. The second study, "Strategy of the Hungarian participation in Joint Implementation", provides a basis for the preparation of the Hungarian legislation in this field. The document investigates the Hungarian possibilities for the participation and the possible project types in this field, and describes the possible institutional setup for JI.

For more information on the Energy Center, consult http://www.energiakozpont.hu/ekh.htm.

Private institutions

EGI Contracting/Engineering Co. Ltd.

EGI-Contracting/Engineering Co. Ltd. has been traditionally active in the field of energy efficiency, renewable energy and climate change mitigation research and policy support. Established in 1948, EGI is a Hungarian company in the field of energy management and environmental engineering with a workforce of 200. EGI's mission is energy conservation and environmental protection in the energy sector. The company works both on the supply and the demand side. On the supply side EGI offers efficient and environmentally benign solutions for power generation, heat supply, and district heating. On the demand side the main focus is on assisting energy end-users in improving efficiency. EGI's Energy Efficiency Department provides complex solutions in the field of energy auditing, consulting, management and turnkey contracting services for municipalities, industrial plants, or any other end-users. EGI has been involved in a large number of climate change and low-carbon energy programs administered, among others, the EU's Phare Program, the World Bank, EBRD, USAID, UNEP, and SCORE. For more information, please see www.egi.hu.

Env-in-Cent Environmental Consultancy

The major area of the company's activities is to assist the preparation and implementation of

environmental strategies and programs and international cooperation both at the level of the government, municipalities and private sector. Env-in-Cent has been participating in several projects related to climate change, like assessment of the capacity building needs related to the mitigation of climate change in Hungary under the UNDP/GEF Capacity Development Initiative (UNDP/GEF subcontract), environmental, economic and social assessment of climate change mitigation in Hungary, elaboration of the national climate change strategy having formed a basis for the relevant climate change government act. A strategy related to climate change under the framework of the National Research and Development Plan was assigned to Env-in-Cent by the Ministry of Education in order to elaborate the Hungarian research and development. In collaboration with MAKK and the Energy Center, the company has developed the strategy and procedures of Joint Implementation in Hungary. An analysis of the benefits and costs of ratifying the Kyoto Protocol was undertaken to aid preparation of the government proposal for ratification. Elaboration of the Climate Change Action Program under the framework of the National Environment Program has also to be mentioned together with a development of an information system for public access on the Internet. This project is ongoing. For more information, refer to www.env-in-cent.hu.

MAKK Consultancy

The MAKK research institute carries out applied research and consults in the field of environmental economics with the appropriate background of practical and theoretical knowledge. Their aim is to develop economically efficient environmental protection, to create knowledge that helps citizens, state decision makers and participants of business life recognize the real value of natural resources and environmental services so that they can suitably incorporate them in their decision making.

The institute was established in 1998, on the basis of a four-year Harvard University program (HIID) that supported The Ministry of Finance and the Ministry of Environment. The MAKK researchers are convinced that having understood natural and social processes, it is possible to develop economic regulation systems, which are capable to protect and enhance environmental assets. In addition the joint research efforts with Env-in-Cent Environmental Consultancy listed above, MAKK carried out the following projects recently: application of the Joint Implementation mechanism of the Kyoto Protocol where the major aim was to identify and quantify the social costs and benefits of JI for Hungary, participation in and analysis of the International Energy Agency simulation of a CO2 emission rights trading regime.

Systemexpert Consulting Ltd.

Systemexpert was founded 9 years ago, formed from the Central Mining Development Institute's Applied Mathematics and Systems Analysis and Geostatistics Division. The main profile of the company is the application of methodologies from engineering, economics and mathematics to environmental research, including the definition of mitigation strategies, risk assessment, power sector analysis and strategic planning, software development in the field. For more information, please refer to http://home.hu.inter.net/-sysexp

Among other related research activities, Systemexpert was the country coordinator for the Hungarian Climate Change Country Study; and have contributed to the development of Hungarian Climate Change Action Plan, together with the development of CO_2 emissions inventories and sinks in Hungary. Systemexpert also plays a key role in the preparation of the series of the Hungarian National Communications. A baseline for the power sector was developed recently outlining the possible effects of future capacity expansion pathways with the aid of comparative assessment of different energy options. Recent research of major importance include EU 5th Framework projects aiming at Joint Implementation, namely JI project development, qualification, and methodological research in baseline development.

Non-governmental organizations

While there are over two dozen registered NGOs in Hungary whose goals relate to the improvement of environmental conditions, only two have been active in the field of climate change.

Energy Club

The mission of the Energy Club is to promote renewable energy sources, energy efficiency, as well as engaging in anti-nuclear issues. The key climate change related raising activities of Energy Club Hungary (www.eneraiaklub.hu) are included above.

In addition to their educational activities, the Club has been closely following the international climate negotiations, and participated in several of the COPs. Based on the results of COP5/6, the Energy Club prepared and discussed a common position paper proposal with the 10 members of Green Energy Network on recommendations for the

Hungarian Climate Change Policy. This position paper was adopted by The Hungarian Greens. In co-operation with the Hungarian National Society of Conservationists (MTVSz), the Club has written and released an urging open letter to the Minister of Environment on the necessary climate protection steps. The Club has also been active in influencing Hungarian policy development related to the flexibility mechanisms.

National Society of Conservationists (MTVSZ)

MTVSZ is an umbrella organization with group and individual members from all over Hungary. It is active in national and international environmental policy formulation (such as related to climate change or genetically modified organisms) and all related issue areas that have considerable influence on the state of the environment (e.g. economic globalization, EU integration, regional development). Its climate change program has started in 1999, consisting of campaigns (public awareness raising, educational) and research elements. The activities of the NGO aiming at climate change awareness raising are described above in the public awareness section.

The Society co-operates actively and closely with other environmental NGOs (first and foremost the Energy Club) on lobbying the national and international actors responsible for climate change policy, including a joint press conference on the state-of-affairs at the international negotiations after the Marrakesh session, open letters to President G. W. Bush and the Hungarian ministries; and demonstration after the US denouncement of the Kyoto Protocol.

Research activities include the analysis of the possibilities of Joint Implementation in Central and Eastern Europe as a collaborative research with the Green Library (Latvia) and the Polish Ecological Club (Poland). After the preparation of national reports (both in the native language and in English) an international conference (Budapest, September 2000) discussed the results and the possibilities in other CEE countries with the participation of 40 NGOs representatives, researchers and members of governmental delegations to the COPs. A report on the conference is available at http://www.mtvsz.hu/zoldleve1/0010/0010b.htm.

The national report on "JI in Hungary" is published both in Hungarian and English, and can be accessed from http://www.mtvsz.hu/klima/index.htm.

MTVSZ has been represented in the Hungarian national delegation to the UNFCCC negotiations at COP5, the 13th Meeting of the Subsidiary Bodies, COP6, and COP6b. Additionally, campaigners from MTVSZ participated in the public demonstrations organized at COP6bis in Bonn. Currently, it is engaged in an international project aiming at analyzing the access to climate related information in Central and Eastern Europe jointly with the Regional Environmental Center (REC) and the World Resources Institute (WRI).

CEE Bankwatch

The NGO has carried out two consequent one-year research and advocacy projects with the support of Friends of the Earth International. The projects dealt with the Hungarian framework of Kyoto protocol related legislation especially, regarding the applicability and legal framework of the flexible mechanisms. The project results are summarized in studies.

E-misszió Environmental Association

The E-misszió Environmental Association is a grassroots NGO in Eastern Hungary. It is active in organizing environmental awareness raising campaigns.

The NGO publishes a periodical "EnerGaia", including articles related to climate change mitigation. For more information on Emisszió or EnerGaia, please consult http://www.e-misszio.hu/.

IX. Education, Training and Public Awareness

Environmental awareness of the public and climate change literacy in Hungary

The level of environmental awareness in Hungary at the turn of the millennium can be stated as low. A study published in 1998 in the Hungarian Academy of Sciences Strategic Research at the Turn of the Millennium series, assembles understanding of the development of environmental awareness of the Hungarian population since the fall of communism based on all major surveys during this period (Füzesi and Tistyán 1998). The study refers to the 1992 "Health of the Planet" survey executed by Gallup, in which Hungarians placed the lowest importance on environmental problems among all countries (22) in the international survey. While in some countries as many as 39% of the population identified environmental issues as one of the most concerning problems, in Hungary less than half percent of the citizens were on the same opinion. In comparison, 1% of Poles and 9% of Russians classified environmental problems among the most important ones on people's agenda. Therefore, Hungarians maybe among the least environmentally concerned among the economies in transition.

In a TÁRKI (Hungarian Society Research Institute) survey from 1996, Hungarians considered several environmental problems as serious. However, environmental problems without direct immediate impact on the population were not considered so grave. "Global warming" was ranked as having the lowest severity among 10 listed environmental problems, with only 9.4% of the respondents considering it a serious issue, whereas 8 out of the 10 problems were judged important by over 20% of the population.

In summary, while the level of environmental awareness of the population is increasing, as shown by the Füzesi et al. study (1998), high priority for environmental problems can not be found.

Unfortunately there are no widely available studies on the awareness and understanding of climate change issues in the Hungarian population. However, based on the experiences of the author of this report during graduate study admission interviews with hundreds of university graduates, often even scientist with fresh Masters degrees lack the understanding of the link between carbon-dioxide (greenhouse gas) emissions and climate change. Thus, it is very probable that the general public, while informed about the basic risk of the climate change problem, is unaware of the key causes and mitigation measures. Therefore, the increasing of climate change literacy of the general population, and related education at all levels are key for the introduction of national level climate change policies in Hungary.

Government activities related to environmental and climate change education

The Hungarian government acknowledges that the level of environmental awareness of the public is insufficient. According to the evaluation of the situation in Act 2031/1998 of the Government, "the majority of the environmental problems in Hungary originate from the fact that the level of environmental awareness is inadequate.". Therefore "educational activities in the educational and cultural institutions play an essential role in promoting public participation and the environmental awareness of the population." As a result, the development of the environmental and nature protection components of the National Base Curriculum (NAT) is indispensable, as stated by The National Environment Program.

One of the principal goals of the Program is that by the end of the first phase in 2003, all students in higher education should receive some form of environmental education. The National Environment Program facilitates the achievement of this goal.

Under the framework of the second phase of the program (2003-2008), a new climate change action program is under preparation. Among other components of this action program, the public awareness related to climate change is to be improved in order to promote public participation in the subject. Therefore, a climate protection awareness campaign will be launched.

In 1999, the Ministry of Education and the Ministry of Environment have developed an agreement for co-operation on the implementation of government tasks related to environmental education. As a result, the two ministries have developed a joint concept document on Environmental Education, and established a Program Office for Environmental Education and Communication (KöNKomP). The mission of the Office is to integrate the cross-cutting activities of

the different ministries related to environmental education. In addition, the Office supports relevant professional activities, and aims at ensuring high standards in governmental work concerning environmental education. The Office maintains an Internet-based information resource at http://www.prof.uf.hu/konkomp/, offering fresh information on related events in Hungary; on national and international services and publications; on the plans and activities of governmental institutions related to environmental education; and includes calls for proposals for the current financial support opportunities. The Office has developed guidelines aiding the teachers to enhance their environmental components of their education while implementing the Framework Curriculum.

The Hungarian National Base Curriculum (NAT) requires the provision of integrated environmental education, sustainability approach, improving environmental responsibility in school education. The Framework Curriculum is called to detail the environmental coverage of particular subjects.

The main objectives of Hungarian environmental education are:

- Education for system approach
- To attain an alternative, problem solving way of thinking
- To understand global contexts
- To show values necessary to choose a sustainable lifestyle
- To form and improve norms of life
- To make the importance of nature, life and biodiversity understood
- The importance of organic agriculture in sustainable development

Primary and secondary education

Since mentality and behavior can mainly be formed in the childhood, the presentation of the problem of climate change would have specific significance in the basic levels of public education, probably even in the kindergarten. Through this, a wide-range and nearly fully comprehensive education might be achieved, since 87% of the relevant age-group attend kindergarten, 98% primary school and 60% secondary school (Central Office of Statistics, 2000). The currently valid and compulsory National Base Curriculum assigns the teaching of environmental information within the framework of every subject possible. Climate change related knowledge can form components of a wide spectrum of subjects such as physics, chemistry, biology, geography, history and technology.

Climate change related issues are marginally covered by either the Base or the Framework Curriculum. According to the national guidelines, the subject matters listed below are directly or indirectly related to climate change in the elementary school curriculum. Items directly related to the education of climate change are listed in Italics.

1st
Environment
weather elements, water forms

3rd
Environment
the impacts of changing environment on plants, the impacts of changing environment on humans

Singing and Music
folklore traditions and drama plays on weather, seasons, nature

4th
Environment
pollution sources in the environment and their impacts on humans, possibilities of prevention and protection

5th
Nature
elements of weather and climate

7th
The Earth and Our Environment
desertification in Africa, industrial zones, agglomeration in America, the European countries' connection to the environment

Techniques and Lifestyle
fossils, power plants, renewable energy resources (solar, wind, biomass, geothermal energy), environmentally sound transportation, energy efficiency in our homes

History
ecological matters, problems of the consumer society, population growth

Physics
calculations on electricity consumption, efficiency of electrical equipment, the strategic importance of global energy economy and its implementation in our everyday life

Chemistry
inorganic compounds, environmental chemistry (energy economy, natural and artificial coals, firewood, petroleum, nuclear energy, electricity, renewable resources), air pollution (*the greenhouse effect,* acid rain, smog)

The Earth and Our Environment
Geography of Hungary, our nature's attributes, resources, flood and snowfall, processes in the population

Techniques and Lifestyle
Exploitation of nature and sustainability, solar cells, energy efficiency, consumer society and commercial advertisements

The further implementation of the general guidelines depends on local school decisions related to organizational and methodological questions. Environmental education is not confined only to the lessons, but involves non-lesson and after-school activities, competitions and quizzes.

In summary, it has been demonstrated above that the risks related to climate change are only marginally covered in elementary school curriculum. The curriculum of secondary education is similar from this perspective.

Environmental courses for teachers are organized by the Program Curriculum Development Center of the National Institute of Public Education, however they do not deal with climate change.

The limited levels of environmental education were fully justified by the assessment made by the Szt. István University in the 7-8th class of several elementary schools in Pest and Bács-Kiskun counties in 2001. As a consequence, by the support of the Ministry of Economy, teachers of 20 schools will expectedly get a 5-6 page informative paper with figures on general environmental and renewable energy issues, called "teachers' books" which later will be included by the curriculum. An extension of this program is planned. According to the Ministry of Education, the subject of "Environmental education" will compulsorily be introduced in teachers training colleges.

Participation in the GLOBE program

Hungary has joined the GLOBE (Global Learning and Observations to Benefit the Environment, http://www.globe.gov) network in 1999. The Globe program is an international environmental educational initiative, aimed at increasing the environmental awareness of students in secondary education. The program was launched in 1994 in the USA, and attempts to help the young generations to understand global problems, and facilitates global networking of young people participating in the same program around the planet. In the framework of this program, Hungarian students participate in regular monitoring and measurement activities in their environments in the various fields of science, with the leadership of trained teachers and scientists. The program is supported by the Hungarian government.

Specific environmental and climate change activities in Hungary's higher education

There are no programs directly related to climate change in the higher education system of Hungary. However, educational programs around the country cover some aspects of climate change. We highlight below some relevant teaching activities.

The Department of Environmental Sciences and Policy of the Central European University (http://www.personal.ceu.hu/departs/envsci/) is engaged in a graduate level education of the entire climate change problem, encompassing the wide spectrum of issues related to the science, monitoring, impacts, mitigation and policy setting in this complex area. Each year several Masters and PhD theses are conducted in connected fields; especially on subjects related to the regional policy challenges of the climate change problem for countries in transition.

The Budapest University of Technology and Economics is engaged in climate change related education in several disciplines. For instance, the doctoral school of the Civil Engineering Faculty runs a course on the hydrological impacts of climate change. However, more relevant courses should be offered at this key university, especially at the undergraduate level.

The Szt. István University in Gödöllo is engaged in several educational activities related to climate change. Among others, 5th year students have an opportunity to study the application of mathematical models in climate change mitigation.

Sixteen doctoral dissertations have been defended on the issue of renewable energy so far and 6-8 university students are preparing their theses currently, mainly in Sopron, Budapest and Gödöllo. Due to the shortage of leading lecturers in this subject and to the lack of professional conferences, development at other universities can be expected in the long term only.

The Physics Department of the Eszterházy Károly College in Eger offers relevant courses and laboratory practices in its subject "Environmental Physics". The course is compulsory for environmental science majors and elective for physics majors.

Renewable energy

Without the outputs of research work and updated technologies, problems in the use of renewable energy may mainly be caused by the lack of user's market. As long as most people do not know these energy sources or do not see any reason of their use, penetration, even under favorable economic conditions can not be considered. General knowledge is developed in three ways: at different educational institutions, through the media and professional conferences.

As the view of life can mainly be formed in the childhood, presentation of renewable energy would have specific significance in public education, probably even in the kindergarten.

Renewable energy sources may theoretically be presented in the frame of physics, chemistry or biology, however environmental education is limited by the great amount of knowledge and necessity of self-education. Should this plan be implemented, other areas (nature preservation, bio-farming, biodiversity, etc.) than renewable energy will mainly be taught. Environmental courses for teachers are organized by the Program Curriculum Development Center of the National Institute of Public Education, however they do not deal with renewable energy sources. These negative tendencies were fully justified by the assessment made by the Szt. István University in the 7th-8th class of several elementary schools in Pest and Bács-Kiskun counties in 2001. As an effect of this, supported by the Ministry of Economy, teachers of 20 schools will expectedly get a 5-6 page informative paper with figures on general environmental and renewable energy issues, called "teachers' books" which later will be included by the curriculum. An extension of this program is planned. According to the Ministry of Education, the subject of "Environmental education" will compulsorily be introduced in teachers' colleges which has the aim to give high grade professional knowledge to every teacher in training. This includes the necessary knowledge on renewable energy as well.

Regarding university education, the situation is a little better. Nine university faculties and a high school teaches renewable energy related subjects (see Table IX.1). It is welcome, that renewable energy issues are taught by a separate faculty in Sopron, an independent doctoral program in Gödöllo and a postgraduate training at the St. Stephen University and at the Laszló Németh Central European People's Academy. It is experienced that students are very much interested in these subjects generally. Due to the expected considerable increase of energy prices and strengthening role of environment protection, a significant demand on renewable energy experts will be experienced which would require the development of this training. Within the frame of the Széchenyi Plan (SZT-EN-6), max. 5 million HUF grant can be given for projects developing energy saving awareness which amount would be sufficient, however most educational institution can not afford the minimal own share of 25% of the costs.

Current renewable energy related events can be followed through daily papers and media in Hungary as well. This is especially so, when energy price increase occurs or when these are connected to political actions (e.g. biodiesel program). Scientific and detailed information are available in a number of periodicals, however there are only a few of them which deals with this issue specifically (e.g. Heating technology, Renewable Energy Sources). A couple of books have also been published recently including comprehensive and detailed information on this issue (e.g. I. Barótfi: Handbook of Energy Management, 1993, Kacz-Neményi: Renewable Energy Sources, 1998). The public is kept informed through some short, easily intelligible brochures. Sometimes certain awards (e.g. "Champion of Energy Saving", "Solar Energy Prize", etc.) are set to make the use of renewables more attractive, however they are available for a smaller number of participants (e.g. conference participants) only. Regarding the Internet, solar energy use has only its own homepage, however its content is very promising.

Scientific conferences both on special bioenergy and general issues may offer good opportunities for contact keeping and obtaining new information. Professional presentations are often held by the Hungarian Biomass Association and other partner organizations. However, these have the following disadvantages:

- Participants are mostly the same, but contacts and transfer of information to new possible actors would be desirable.
- These meetings are mostly concentrated to the Western region of the country and Budapest, which may preserve a Western-oriented development.

Agriculture

Within the frame of the National Agri-Environmental Programme a network for education, planning, consultancy and demonstration is planned to be established. The network would deal with planning, education, research, consultancy and demonstration tasks connected to the agri-environmental programs.

According to the plans the network will be established by the agri-environmental institutional system, the agricultural universities and agricultural research institutes and the agricultural and environmental organisations dealing with the control and consultancy.

Forestry

Education and PR work on the relationship between forestry and climate change issues are not satisfactory. These issues cannot be prioritized as long as economic and agricultural issues, as well as emission issues are considered much more important. However, this does not mean that the interested public cannot get information. A recent paper (Faragó and Somogyi, 2001) is an example for a report on the achievements and back-sets in the Bonn and Hague climate summit. Several papers have been recently published for the professionals to realize that carbon issues are a new aspect of forestry that cannot be disregarded (e.g. Somogyi, 2001a-c).

Similarly, climate change related forestry issues are among the hot topics of the higher education at the Faculty of Forestry of the Sopron University. Additionally, climate change was discussed in various special events that were organized by the Forestry Commission of the Hungarian Academy of Sciences and the Hungarian Forestry Association.

Experience shows that the Hungarian foresters are ready to change their practices to adjust to climate changes. They are also ready to embark on joint projects to mitigate climate change. However, more international participation would be needed to gain momentum, and to pursuade local and international decision makers to start financing forestry projects.

Professional training and development

The main forum for professional development in the field of climate change is national and international conferences and expert workshops. Some important events have been referred to during the relevant research sections above. In addition, there is an increasing number of events related to the understanding of the implications of flexibility mechanisms in economies in transition, and to the development of national policies for Emissions Trading and Joint Implementation. Examples include a conference with the participation of 13 European countries and Hungarian experts organized in 2001 by Systemexpert on Joint Implementation projects in the EU 5th Framework Research Programme, a conference attended by over 100 corporate leaders as well as policy-makers organized by the Hungarian Energy Office in December 2001, focusing on the potential of flex-mex investments in the energy sector in Hungary. Professional presentations are often held by the Hungarian Biomass Association and other partner organizations. However, national workshops have the following familiar disadvantages:

- Participants are often the same, but contacts and transfer of information to new possible actors would be desirable.
- These meetings are mostly concentrated to the Western part of the country and to Budapest, which may conserve a Western-oriented development in the country.

Detailed scientific information is disseminated through a number of periodicals, however there are only a very limited number of them, which engage in this issue specifically (such as Heating technology, Renewable Energy Sources). A few books have been published recently in Hungarian including comprehensive and detailed information on this issue. Examples include: T. Pálvölgyi: The Challenge of the New Millennium: Climate Change, 2000; Z. Somogyi, Z. 2001. Fuben-fában karbon (Carbon in trees and herbs). In: Erdo nélkül? (Without forests?) L'Harmattan; I. Barótfi: Handbook of Energy Management, 1993, and Kacz-Neményi: Renewable Energy Sources, 1998.

Activities towards raising public awareness and literacy related to climate change

In 1998, 13 non-governmental organizations (NGOs) engaged in environmental education in Hungary have summarized the achievements in this field, and have formed the National Environmental Educational Strategy. However, only few NGOs are involved directly in activities aimed at raising public climate change awareness. In this section we summarize the main educational initiatives from the NGO sector, while the chapter describing institutions below provides further information on these NGOs and their other related activities.

Activities of the Energy Club

From among the Hungarian green NGOs, the Energy Club has been the most active in raising the public's awareness related to climate change. The Club has been engaged in the following initiatives:

- The Energy Club produced brochure in the first quarter of 2001 on the causes, needed actions and the international negotiations on climate change. The brochure is distributed at various environmental events, such as the Earth Day, and with other Energy Club publications, as well as in packages to co-operating NGOs.
- In April - May 2001 the Club organized and delivered four lectures in public and in secondary schools as a pilot phase for their climate change education program. This was a practical step for their 2002 program containing the development of a climate change teaching support package.
- At the event "Students' Island" in every August (more than 300 000 visitors/week) the Energy Club organizes Green Events. In 2002 the Club organized a climate change event with lectures on the causes of and solutions to climate change.
- Continuing the practice that Energy Club follows very closely the climate negotiations, during and after CoP7 in Marrakech the Club informed the media on the events.

National Society of Conservationists (MTVSZ)

MTVSZ's climate change program started in 1999, consisting of both campaigns (public awareness raising, educational) and research elements. The main public awareness raising activities of MTVSZ have included the preparation of an informative booklet in Hungarian on the meaning and consequences of climate change. The NGO tried to connect this scientifically complex issue to the everyday choices of the public as consumers and household owners. The booklet has been distributed at NGO events, among schools by mail, and posted on the Internet at: http://www.mtvsz.hu/klima/forro.htm.

MTVSZ offers in its website a collection of Hungarian media coverage of climate change at: http://www.mtvsz.hu/klima/index.htm.

CEE Bankwatch

The NGO has carried out two consequent one-year research and advocacy projects with the support of Friends of the Earth International. The project results are summarized in studies. In addition, the grants provided an opportunity to produce publications on climate change for the wider public, in collaboration with MTVSz (above).

E-misszió Environmental Association

In 2001 the Association successfully applied for the tender of the Hungarian Power Companies (MVM) to organize a campaign for the 2001 International Environment Day (5th June). The scope of the campaign was to prepare a 30-second cartoon communicating the hazards of global climate change and the role of road transport in it. The cartoon was broadcast on Hungarian National Television and on the Duna Television for a few days before 5th of June, as a social related advertizing.

The E-misszió Environmental Association also organized an extensive communication campaign in the frame of the international Efficient Lighting Initiative financed by the Global Environment Facility (GEF) through the International Finance Corporation (IFC). The aim of the campaign was to decrease CO_2 emission through increasing the market penetration and use of CFLs (compact fluorescent lamps) in the residential sector. The campaign used the above-the-line media, i.e. direct mailing, school presentations and sales promotion as campaign tools.

In addition, the NGO publishes a periodical "EnerGaia", including articles related to climate change mitigation. For more information on Emisszió or EnerGaia, please consult http://www.e-misszio.hu/

Other sources: the Internet

For the adult population not attending any schools, the press and the Internet are the only widely available sources for getting information related to the issue. Below, we summarize a few key Internet sites, which are available for the public in Hungarian on the topic. Unfortunately, until today the funding available for the establishment of internet-based information resources on the subject has been limited, if non-existent, thus most of these resources are developed on a voluntary or private basis, and thus do not necessarily reflect an objective, balanced national perspective.

- The Internet site http://www.klimavaltozas.hu/ hosted by a Hungarian scientist and journalist contains references to a wide variety of issues, legislation, reports and articles related to climate change. The majority of the documents are in Hungarian. While it is an obvious site for information on climate change due to its simple related address, at the time of the writing of this document, fewer than 1300

hits have been counted at the site. Thus, unfortunately, Internet is not playing yet a major role in transforming public awareness related to climate change in today's Hungary.

- Internet site http://www.levegokornyezet.hu/04b.htmhosted by an air pollution monitoring and research consultancy, answers commonly emerging questions related to mid-term climatic change in Hungary. The site also contains figures on historical climate statistics.
- Junior body of the Hungarian Nuclear Association, Youth for Nuclear Energy (FINE), in collaboration with the Young Generation Network, have been following the climate negotiations, and have sent their representatives to COP7. In addition to reporting on the recent developments in the climate negotiations at http://www.kfki.hu/~hnucsoc/cop7levelek.htm they also have an informative web page answering the 45 most frequent questions related to climate change in Hungarian at http://www.kfki.hu/~hnucsoc/45/45kerdes1.htm.

Climate Change Awareness and the Hungarian press

As mentioned above, the adult population not educated on climate change in school years, have two key means for obtaining information related to the problem of climate change: the Internet and the press.

The press has a fundamental role in this subject, since it is primary source of information on the problem for the population who is not actively seeking knowledge in the subject.

While generally the coverage of environmental issues play an insignificant role in the Hungarian media, the COP in Kyoto initiated an increasing concern and discussion on the climate change issue. The coverages have been either related to extreme weather event (such as the increasing frequency and severity floods, or the dropping levels of Lake Balaton), or are analyses authored by a handful of experts and dedicated journalists concerned about increasing the public's literacy in the climate change field. The article collection of one of such journalists, physicist-philosopher Mr. Miklós Zágoni, can be downloaded at http://www.klimavaltozas.hu/.

Recommendations in the field of climate change awareness and education

As shown above, the literacy related to climate change, its causes, potential impacts and mitigation options is limited in the Hungarian population. Thus, it is clear that much more is needed to be done in this area, since without a supportive voter base, political actions in this area will also remain limited. In addition, in absence of climate-conscious consumers, industry and businesses are also not motivated in contributing to climate-friendly corporate practices and in developing green products. Since this area is just being formed, the suggestions below represent only a few highlights from a wide spectrum of ideas.

- As suggested by several researchers, NGOs and journalists during the preparation of this document, a concerted effort is needed to develop Internet-based information resources in the subject. An official national site integrating the realm of knowledge in the field in Hungarian, linking to the documentation of other climate-change related information clearinghouses, legislation and initiatives is highly recommended.
- The Hungarian translation of the key documents developed during the climate change negotiations and Hungarian policy-making, such as the texts of the UNFCCC, the Kyoto Protocol and the COP documents, should be widely available on the Internet.
- Both the National Base and Framework Curricula should contain more directly the components of climate change, including references to the science, causes, impacts and mitigation strategies.
- There must be a stronger emphasis on the national implications and local mitigation and adaptation strategies in the relevant undergraduate and graduate educational programs. These activities could be orchestrated by a national center on climate change suggested in the chapter on research.
- For the mobilization of the public it would be very important to share the research results on short- and long-term climate change impacts in Hungary, in a clear, publicly understandable language to the widest audience possible. What are the expected implications on precipitation, extreme climatic events and key agro-meteorological parameters? Which mitigation measures are at the disposal of the general public, agricultural sector, SMEs, and the industry? What adaptation strategies are available in the key sectors of the Hungarian economy?
- The training of government decision-makers on market based regulatory opportunities could make a positive impact on regulatory effectiveness in the field. According to MAKK's experience, some environmental

policy-makers are averse to economic regulatory instruments mainly because they are unfamiliar with these concepts and instruments. This aversion can be eased with the presentation of advantages and disadvantages and therefore the spectrum of regulatory opportunities considered by the decision-makers may widen.

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X. Appendices

Appendix 1

1995 IPCC global warming potential (GWP) values* based on the effects of greenhouse gases over a 100-year time horizon

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_2F10	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	$C_2H_4F_2$ (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-C_4F_8	8 700
Perfluoropentane	C_5F_{12}	7 500
Perfluorohexane	C_6F_{14}	7 400
Sulphur hexafluoride	SF_6	23 900

* As provided by the IPCC in its Second Assessment Report.

Appendix 2

TIER 1 KEY SOURCE CATEGORY IDENTIFICATION
1999
By Activity

	GREENHOUSE GAS SOURCE AND SINK CATEGORIES	GHG	CO2 equivalent (Gg)	Level Assassment	Cummulativ Total
1. Energy	A. Fuel Combustion 1. Energy Industries	**CO_2**	23 613,91	0,27	0,27
1. Energy	A. Fuel Combustion 4. Other Sectors	**CO_2**	13 384,51	0,15	0,43
4. Agriculture	D. Agricultural Soils	**N_2O**	10 278,86	0,12	0,55
1. Energy	A. Fuel Combustion 2. Manuf. Industries and Constr.	**CO_2**	9 923,97	0,11	0,66
1. Energy	A. Fuel Combustion 3. Transport	**CO_2**	9 567,75	0,11	0,77
1. Energy	B. Fugitive Emissions 2. Oil and Natural Gas	**CH_4**	6 073,90	0,07	0,84
6. Waste	A. Solid Waste Disposal on Land	**CH_4**	2 143,76	0,02	0,87
2. Industrial Processes	A. Mineral Products	**CO_2**	2 053,06	0,02	0,89
1. Energy	B. Fugitive Emissions 1. Solid Fuels	**CH_4**	1 878,55	0,02	0,91
4. Agriculture	A. Enteric Fermentation	**CH_4**	1 679,61	0,02	0,93
6. Waste	B. Wastewater Handling	**CH_4**	1 118,63	0,01	0,94
4. Agriculture	B. Manure Management	**CH_4**	721,09	0,01	0,95
6. Waste	C. Waste Incineration	**CO_2**	600,00	0,01	0,96
2. Industrial Processes	C. Metal Production	**PFCs**	560,39	0,01	0,97
2. Industrial Processes	B. Chemical Industry	**CO_2**	496,92	0,01	0,97
4. Agriculture	B. Manure Management	**N_2O**	483,39	0,01	0,98
1. Energy	A. Fuel Combustion 5. Other	**CH_4**	420,00	0,00	0,98
2. Industrial Processes	B. Chemical Industry	**N_2O**	341,00	0,00	0,99
6. Waste	A. Solid Waste Disposal on Land	**CO_2**	285,00	0,00	0,99
1. Energy	A. Fuel Combustion 4. Other Sectors	**CH_4**	179,65	0,00	0,99
2. Industrial Processes	C. Metal Production	**CO_2**	159,38	0,00	0,99
2. Industrial Processes	F. Consumption of Halocarbons and SF6	**HFCs**	154,27	0,00	1,00
2. Industrial Processes	F. Consumption of Halocarbons and SF6	**SF_6**	101,20	0,00	1,00
1. Energy	A. Fuel Combustion 1. Energy Industries	**N_2O**	57,59	0,00	1,00
1. Energy	A. Fuel Combustion 3. Transport	**CH_4**	57,47	0,00	1,00
1. Energy	A. Fuel Combustion 3. Transport	**N_2O**	40,67	0,00	1,00
3. Solvent and Other Product Use	3. Solvent and Other Product Use	**CO_2**	32,01	0,00	1,00
1. Energy	A. Fuel Combustion 4. Other Sectors	**N_2O**	31,52	0,00	1,00
4. Agriculture	F. Field Burning of Agricultural Residues	**CH_4**	21,75	0,00	1,00
1. Energy	A. Fuel Combustion 2. Manuf. Industries and Constr.	**N_2O**	18,96	0,00	1,00
1. Energy	A. Fuel Combustion 2. Manuf. Industries and Constr.	**CH_4**	14,22	0,00	1,00
2. Industrial Processes	B. Chemical Industry	**CH_4**	13,93	0,00	1,00
2. Industrial Processes	F. Consumption of Halocarbons and SF6	**PFCs**	13,32	0,00	1,00
4. Agriculture	C. Rice Cultivation	**CH_4**	9,48	0,00	1,00
4. Agriculture	F. Field Burning of Agricultural Residues	**N_2O**	6,36	0,00	1,00
5. Land-Use Change and Forestry	5. Land-Use Change and Forestry	**CH_4**	5,51	0,00	1,00
1. Energy	A. Fuel Combustion 1. Energy Industries	**CH_4**	5,24	0,00	1,00
5. Land-Use Change and Forestry	5. Land-Use Change and Forestry	**N_2O**	0,56	0,00	1,00
TOTAL			**86 547,41**	1,00	

By GHG

		CO2	**60 116,52**	0,69	0,69
		CH4	**14 342,81**	0,17	0,86
		N2O	**11 258,90**	0,13	0,99
		PFCs	**573,71**	0,01	0,99
		HFCs	**154,27**	0,00	1,00
		SF6	**101,20**	0,00	1,00
TOTAL			**86 547,41**	1,00	

By Sector

1. Energy			**65 267,92**	0,76	0,76
4. Agriculture			**13 200,55**	0,15	0,91
6. Waste			**4 147,39**	0,05	0,96
2. Industrial Processes			**3 893,48**	0,04	1,00
3. Solvent and Other Product Use			**32,01**	0,00	1,00
5. Land-Use Change and Forestry			**6,07**	0,00	1,00
TOTAL			**86 547,41**	0,00	

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