FENNTARTHATÓ FEJLŐDÉS
ÉS KÖRNYEZET

SUSTAINABLE DEVELOPMENT
AND ENVIRONMENT

HUNGARY:
INVENTORIES, STABILISATION AND SCENARIOS OF THE GREENHOUSE GAS EMISSIONS AND REMOVALS

Second National Communication on
the Implementation of Commitments under
the United Nations Framework Convention on Climate Change

AZ ÜVEGHÁZHATÁSÚ GÁZOK EMISSZIÓ KATASZTERE, KIBOCSÁTÁSÁNAK KORLÁTOZÁSA ÉS JÖVŐKÉPEI MAGYARORSZÁGON

Második nemzeti beszámoló
az ENSZ Éghajlatváltozási Keretegyezményben
foglalt kötelezettségek végrehajtásáról

UNFCCC Climate Change

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FENNTARTHATÓ FEJLŐDÉS
BIZOTTSÁG

HUNGARIAN COMMISSION ON
SUSTAINABLE DEVELOPMENT

Removal of carbon-dioxide

In forestry, CO_2 is sequester[illegible] the growth of the biomass, increases in stabile hu[illegible] [illegible] material and litter on the ground. The total are[illegible] forest management in Hungary wa[illegible] million hectares and 1608 million hectares in 1991 and 1995, respectively. The total carbo[illegible] and release were almost unchanged while the carbon release decreased by 20% in the investigated time period. One can see from the table below that the annual remo[illegible] CO_2 by fo[illegible]agement was increasing till 1994, and there was a slight decrease in 1995. The emissions from CH_4, N_2O, CO and NO_x from burning of forests decreased by 20% till 1994 in average, and they began to increase in 1995.

Carbon uptake, release and total CO_2 removal

		1991	1992	1993	1994	1995
Total Carbon Uptake	(kt C)	2940	2960	2994	3005	3041
Annual Carbon Release	(kt C)	1645	1504	1304	1294	1350
Release from Burning + Decay	(kt C)	412	413	408	396	383
Total CO_2 Removal	**($GgCO_2$)**	**3239**	**3823**	**4697**	**4820**	**4797**

Policies and measures

National Energy Saving Program

On the basis of the energy policy concept approved by the Parliament in 1993, the National Energy Saving and Energy Efficiency Improvement Program (ESAP) was developed in 1994. Based on this programme an action plan was approved by the Government in December 1995. The Energy Saving Action Plan consists of four major set of measures: (i) penetration of renewables, (ii) energy efficiency improvement, (iii) energy efficiency labelling and (iv) education, information and encouraging technology innovation.

Measures in the energy supply sector: penetration of renewables

The energy policy concept mentioned above includes an objective to increase the share of renewable energy sources in the primary energy balance to 5-6% which is almost the double of the current figures. The estimated total utilisation of the renewables may currently put at 35 PJ which corresponds to the 3% of the total primary energy supply. Although the utilisation of wind, geothermal and solar energy is theoretically possible, the application of biomass resources are of the greatest importance in Hungary. Currently there are over 70 biomass-fired boiler plants where the total installed capacity amounts to 31 MW. The largest chopped-wood-fired heating plant on Central Europe is located at Tatabánya, where the installed boiler capacity is 12 MW. Although some progress has been made, the renewable technologies in Hungary still suffer from a significant cost disadvantage as compared to fossil based technologies in power and heat generation. Experience in ongoing renewable financing initiatives shows that, without funding, these investments are still not competitive with the natural gas.

Measures in demand side: energy efficiency improvement in the private and public sector

The improvement of energy management in municipalities one of the priority area of the ESAP. Support shall be provided for municipalities for the development and implementation of their energy saving concept, organisation of training and events and information supply, as well. In [illegible] residential sector certain initial step has been taken. In the production sectors a growing number of industrial companies realise the interrelation between energy wastes and profit losses. Many of them know at least what ought to be done. Recently, as more and more companies get stabilised, energy efficiency plans developed by companies are started to implement. Certain big companies have shown good progress in energy efficiency programmes on their voluntary basis.

patterns, as well as the alternatives in the accession to the European Union, the reliability of the longer term scenarios is substantially limited. Four scenarios are characterised as follows. In the case of estimating the non-fuel-related emission's projections, different methods and scenario development has been used for several reasons: (i) lack of appropriate data and available methodology in the agriculture-related projections, (ii) about two-third of the GWP is considered by the fuel-related CO_2 emissions, therefore the projections of other emissions may have less importance. Since the preparation of our first National Communication, no updated and advanced estimation for the CH_4, N_2O, CO etc. projections is available, therefore the relevant information presented in the first National Communication are not cited or replicated here.

Main characteristics of the scenarios for the projections of fuel-related CO_2 emissions

	GDP growth (%/year)	Growth in total energy intensity (%/year)	Growth in electric energy intensity (%/year)	Energy saving by specific measures (PJ/year)
B-BAU	1.0	-	-	-
B-REF	1.0	-0.5	-	60
S-MOD	2.0	-1.0	-0.5	110
S-SEF	3.0	-1.5	-1.0	250

Emission outlook of fuel-related CO_2 emissions

The B-BAU scenario can be defined as an unrealistic "all-frozen" option for development, serving only as a basis for comparison. (It is the fact that the mid 1990s was the period of the stagnation in the Hungarian economy. Most of the indicators of the energy, environment and economic performance have shown insignificant fluctuations around the same level. In this sense, the B-BAU is the extrapolation of the very recent tendencies, as well.) The B-REF scenario reflects the structural changes in the Hungarian economy and increase of energy prices which can lead to the improvement of the energy intensity without specific energy saving measures. The S-MOD scenario can be regarded as the most probable outlook of the medium term socio-economic development in Hungary. As a result in implementing the measures prescribed in the ESAP, the increase in energy demand is substantially less than the GDP growth. In the period of 1996-2002 the GDP would rise by almost 15%, while the total final energy consumption would increase by 8% only. The S-SEF scenario supposes a positive feedback between the economic growth, the social welfare and the expenditure of energy efficiency improvement.

Baseline and aggregated policy scenarios (thousand Gg CO_2)

	1990	1992	1995	1997	2000	2002
actual	68.6	59.6	59.4			
B-BAU				62.0	63.9	65.2
B-REF				61.8	63.1	64.0
S-MOD				62.1	64.3	65.9
D-SEF				62.4	65.6	67.8

Projection of carbon sequestration

It is estimated that, in the next 30 years, the cultivation of some 700,000-1,000,000 hectare agricultural fields will become unprofitable, and that most of this area is suitable for afforestation. The increase of the carbon pool would involve the establishment of bioenergy plantations, the increase of the carbon density of stands, as well as preserving carbon in wood products. The current afforestation program was launched in 1991 with the aim to afforest 150,000 hectare by 2000. On the basis of the experiences gained by the implementation of the afforestation programme, afforestation policy scenarios has been set up. In the minimum scenario (I), some 3000 hectare is afforested annually by 2050. In the medium scenario (II) 15,000 hectare is afforested until 2010. In the achievable scenario (III), 11,000 hectare are afforested annually, and in the technical potential scenario (IV), 18,000 hectare by 2050. This last scenario is equal to afforest some 1,000,000 hectare.

Carbon sequestration by the afforestation scenarios (thousand Gg Carbon)

	1995	2000	2005	2010	2015	2020
I.	0	0.1	0.7	[illegible]	6.0	[illegible]
II.	0	0.2	0.5	0.9	1.0	2.0
III.	0	0.1	0.2	2.0	4.0	7.0
IV.	0	0.5	1.0	3.5	7.0	12

International co-operation and rising public awareness

Activities Implemented Jointly

In March 1995, the governments of Hungary and the Netherlands expressed their wish to jointly realise a series of AIJ projects. The aim of these projects would be to gain experiences on practical aspects of AIJ and to promote it as a feasible concept. Two joint projects were therefore designated simulation projects and became subject of a monitoring study.

Energy efficiency improvement for municipalities and utilities

In this simulation study a number of energy efficiency projects that are initiated by local governments are analysed. In most cases, these projects are identified based on expert advice provided earlier through the Dutch bilateral PSO programme and through twinning arrangements with Western European cities within the EU – PHARE/ECOS/UVERTURE "urban twinning" programme. A total of 62 projects are monitored in 12 different cities. Additionally, a combination of a small-scale cogeneration (CHP) project and a Demand-Side Management (DSM) project at the Technical University of Budapest is incorporated. These projects were developed by the Dutch utility Westland and the Budapest gas utility Főgáz and are implemented by a joint venture of both companies. The implementation of the measures is financed by the local governments themselves. This is done either from own resources or by attracting external funds. These external funds can be commercial loans, but also soft-loan arrangements (e.g. the German Coal Aid Revolving Found) or third party financing (TPF) have been used by the local governments to generate the financial resources required. These varying financing mechanisms generate additional experience and input for the AIJ-simulation.

RABA/IKARUS compressed natural gas fuel engine project

This project transfers technology, which enables Hungarian industries to produce buses with compressed natural gas engines. The technology is provided by Deltec, a producer of gas fuelled engines and the TNO research organisation, both of the Netherlands. Participating firms are Hungarian RABA, a producer and installer of bus engines, and IKARUS, the Hungarian bus manufacturer. It can be stated that the installation of CNG engines on all Budapest buses that currently have a D2156 Old Diesel type engine would prevent the emission of 6.4 kton CO_2 per year. Using this method, the AIJ partners estimate, by way of an example, that all full-size buses (90 passengers or more) together in Budapest cause a CO_2 emission of 120 kton per year. Note, however, that the project itself only aims to install CNG engines in a limited number of buses (about 5). The emission reduction figures are only meant as examples and do not reflect the emission reductions that can be achieved by the project. On the basis of the same methodology the total annual emission of different sorts of pollutants can also be computed.

GEF/UNEP project on the economics of greenhouse gas limitation

The primary aim of the project is to analyse the costs and benefits of several actions to mitigate the greenhouse gas emissions in twelve countries, including Hungary. The world-wide project is funded by the GEF, and RISO National Laboratory (Denmark), as the regional UNEP Centre, is charged with co-ordinating the project. The Hungarian sub-project is divided into the following parts: (i) overview of present social-economic situation with special regard to the energy consumption of the public and residential sectors and the role of forest management; (ii) compilation of medium and long-

Table 3.16. Activity data ol carbon release: forest and grassland conversion

	Area Converted Anually (kha)					Annual Loss of Biomass (kt dm)				
	1991	1992	[illegible]	1994	1995	1991	1992	[illegible]	1994	[illegible]
Grassland -> Forest	6.7	7.1	3.2	2.9	4.2					
Other-Evergreen						97.3	94.9	102.2	140.5	127.[illegible]
Other-Deciduous						767.8	690.9	580.4	561.9	605.9

	Area Converted 10 year average (kha)					Loss of Biomass 10 year average (kt dm)				
	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995
Grassland -> Forest	7.5	7.3	7.4	7.1	6.7					
Other-Evergreen						110.8	113.2	114.1	112.4	109.5
Other-Deciduous						810.8	815.4	808.3	780.4	750.5

Table 3.17. Carbon uptake, release and total CO_2 removal

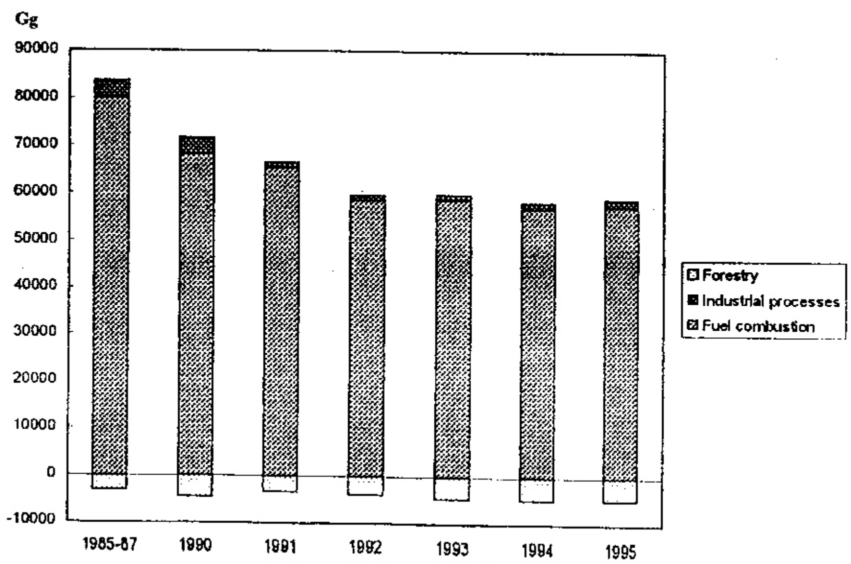
		1991	1992	1993	1994	1995
Total Carbon Uptake	(kt C)	2940	2960	2994	3005	3041
Annual Carbon Release	(kt C)	1645	1504	1304	1294	1350
Release from Burning + Decay	(kt C)	412	413	408	396	383
Total CO_2 Removal	**($GgCO_2$)**	3239	3823	4697	4820	4797

Table 3.18. Emissions from on-site burning of forests (Gg)

	1991	1992	1993	1994	1995
CH_4	0.280	0.255	0.221	0.228	0.238
N_2O	0.002	0.002	0.002	0.002	0.002
CO	2.453	2.228	1.935	1.991	2.080
NO_x	0.070	0.063	0.055	0.057	0.059

The tendencies in net actual carbon-dioxide emissions in Hungary are summarised in Figure 3.4. Due to the recent decline of the economy, the CO_2 emissions from combustion sources has fallen by 18% between 1985 and 1994. The first year of increase was 1995 (by 1%). As a result of an economic recovery the overall net CO_2 emissions began to increase in 1995. However the net CO_2 emission level in 1995 is just 73% of that of the base period (the average of the years 1985-1987).

Figure 3.4. Total CO_2 emission and removal



fertiliser use we applied the median emission coefficient 0.0036, given in the IPCC Reference Manual (page 4.79).

Table 3.13. N_2O emission from agricultural soils (Gg)

	1991	1992	1993	1994	1995
Emission	1.68	1.63	1.46	1.80	1.61

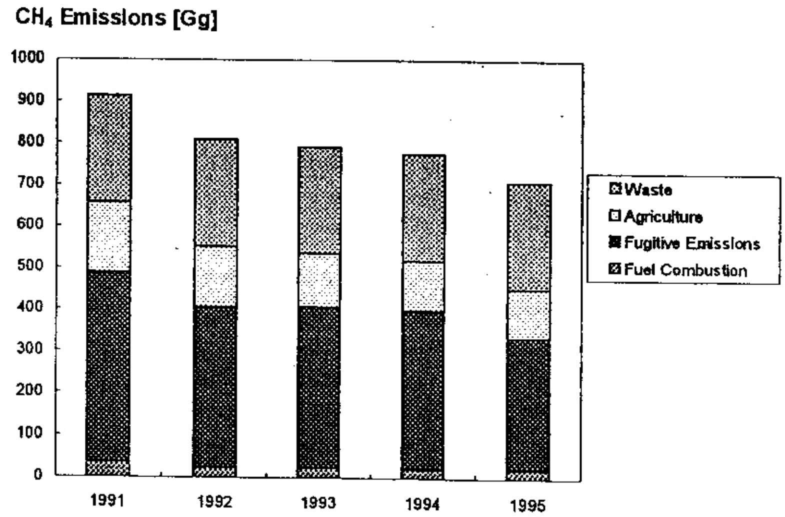
3.3.4. Non-CO_2 emissions from field burning of agricultural residues

The calculations of emitted non-CO_2 trace gases from field burning of agricultural residues are presented in Table 3.14. It should be noted that these emissions reached the lowest values around 1992-1993 and an increase can be observed afterwards. Finally, the overall sources of CH_4 are presented in Figure 3.3.

Table 3.14. Non CO_2 emissions from field burning of agricultural residues (tonnes)

	1991	1992	1993	1994	1995
CH_4	4.5	3.1	2.5	3.7	3.7
N_2O	0.0	0.0	0.0	0.0	0.0
CO	95.3	65.0	52.3	78.7	78.7
NO_x	1.0	0.7	0.6	0.8	0.8

Figure 3.3. Main sources of total CH_4 emission



3.4. Forestry

As far as forest and grassland conversion is concerned, the following comments should be made:

- there is no conversion from forest to grassland. Biomass loss occurs in the form of residues from harvest (5% of this is burned on-site, 95% is left to decay);
- new afforestations, as a form of land use change, are also included in the calculations. This, however, results in no loss but gain in biomass (i.e. 'negative' loss);
- only data for decay are summed;

- long term emission from soil is estimated as negligible, because there is [illegible]ange of land use from forest to any[illegible]ing else in Hungary, and although there is some emissi[illegible] all clearcuts, it is offset by the [illegible]ation or reforestation of the area;
- there are no aban[illegible]lands;
- [illegible] and all other biomass data, only the above-ground [illegible] is considered. Net annual growth rate (i.e., total growth minus density-dependent and density-independent self thinning) is estimated as being 95% of total, i.e.. gross growth:
- the dry matter conversion ratios are for air-dry organic matter. [illegible] carbon fraction of dry matter, the default value of 0.45 is used. This is approximately the same as was found in the literature for air-dry wood;
- it is supposed that all traditional fuelwood harvested. In Hungary, some 20% of wood is lost in thinnings and harvests. It is considered that this wood - and its carbon-content - decays.

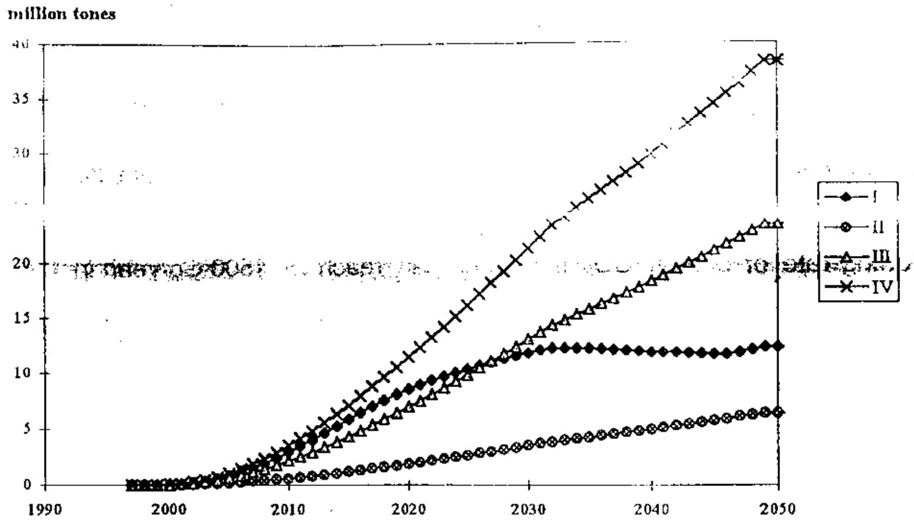
In forestry, CO_2 is sequestered by the growth of the biomass, increases in stabile humus in the soils and the accumulation of dead organic material and litter on the ground. The total area under forest management in Hungary was 1564 million hectares and 1608 million hectares in 1991 and 1995, respectively.

Table 3.15. and Table 3.16. provide the activity data as concerns the forestry-related emissions and removals. Table 3.17. and Table 3.18. summarise the carbon uptake, release and the emissions from on-site burning. It can be seen, that the total carbon uptake and release were almost unchanged while the annual carbon release decreased by 20% in the investigated time period. One can see from the above results that the annual removal of CO_2 by forest management was increasing till 1994, and there was a slight decrease in 1995. The emissions from CH_4, N_2O, CO and NO_x from burning of forests decreased by 20% till 1994 in average, and they began to increase in 1995.

Table 3.15. Activity data of carbon uptake: forestry and grassland conversion

		Area of Forest/Biomass Stocks (kha)					Commercial Harvest (1000 m³ roundwood)					Total Traditional Fuelwood Consumed (kt dm)				
		1991	1992	1993	1994	1995	1991	1992	1993	1994	1995	1991	1992	1993	1994	1995
Plantations	Evergreen	216	217	218	218	216										
	Deciduous	151	150	152	151	153										
Commercial	Evergreen	29	29	30	31	30										
	Deciduous	887	876	871	890	887										
Other		281	298	318	310	322										
	Oak						384	349	332	303	370	255	232	221	258	246
	Turkey oak						408	366	318	257	284	353	317	275	276	246
	European beach						307	294	291	273	275	90	86	85	84	81
	Hornbeam						117	111	100	93	106	113	108	97	85	103
	Black locust						514	478	358	303	365	606	563	422	414	430
	Other hardwood						58	52	51	37	46	63	57	55	44	50
	Poplar						1088	933	747	777	834	106	91	73	46	81
	Other dec.scftw.						202	171	145	166	161	15	13	11	24	12
	Conifers						372	362	390	[illegible]	487	21	21	22	45	28
	Other						0	0	0	0	0	0	0	0	0	0
TOTAL		1564	1570	1589	1600	1608	3450	3116	2732	2748	2928	1622	1488	1261	1276	1277

Figure 5.5. Carbon sequestration by the afforestation scenarios.



The scenarios were analysed by running the CASMOR model of the carbon cycle of forestry. The main conclusions are as follows:

- in all afforestation scenarios, the use of fast growing species (black locust, poplar) is assumed;
- most carbon is stored in the aboveground biomass, but large amounts are stored away in the belowground and dead biomass pools, too;
- the amount of soil carbon, accumulated in thousands of years, is very large, therefore, this pool is to be preserved by all possible means;
- if oak is planted instead of black locust, the carbon sequestered in the achievable scenario decreases by some 20%;
- the greatest costs of the program are the investment costs that incur at the launch of the program. The cost of carbon sequestration is about the same, some 7 $/tC, in each scenario.

5.4. Cost of mitigation

On the basis of the experiences gained from the successful operation of the German Coal Aid Revolving Fund (see in Chapter 4.1.1.) a detailed analysis has been made to study the potential mitigation costs in Hungary. The analysis is the part of the research conducted in the framework of UNEP/GEF project entitled "THE ECONOMICS OF GREENHOUSE GAS LIMITATION" (see in Chapter 6.2.).

Table 5.3. Overview of the conservation potential and related costs

Measure	Savings			Investment costs	
	primary fuel	**CO_2**	**energy cost**	**Total investment**	**Justified by energy cost savings**
	PJ	Gg	billion HUF	billion HUF	billion HUF
Modernisation of the space heating (residential sector)	97	7500	87	1350	540
Modernisation of the space heating (the public sector)	24	1900	23	346	149
Efficiency improvement of home electric appliances	37	2700	51	467	226
Electric efficiency improvement of the public sector	23	1800	16	150	116

The main assumptions are as follows:

- primary fuel savings are calculated taking into account the losses of generation/transmission;
- CO_2 savings are calculated on the basis of the present fuel mix of the studied sectors. CO_2 savings related to electricity savings are calculated on the basis of the present fuel mix of the Hungarian power sector;
- micro level energy cost savings are calculated on the basis of the present retail prices, exclusive of VAT;
- the total investment costs represent the costs the end-users are supposed to pay. No VAT is considered. No subsidies, grants, etc. are taken into account;
- the last but one column of Table 5.3. shows the part of investment costs justified by energy cost savings. An investment was meant to be justifiable if the net return (exclusive of inflation effects) is 9%.

The preliminary results show that state intervention into energy saving can be highly cost-efficient. Projects implemented by the help of the German Coal Aid Revolving Fund have proven that investment in energy efficiency improvement can be more cost-effective than the development of the supply-side infrastructure.