6th National Communication to the UNFCCC

Hungary

2013

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1. EXECUTIVE SUMMARY

Basic characteristics of the country

Hungary is a long standing parliamentary democracy, one of the leaders of political and economic transition in the region. Hungary became a member state of the European Union in 2004 and is pursuing economic stability and prosperity. The recent government initiated a thorough political reform which strengthened Hungary's ties to democracy and alligned the country with the fundamental principles of Europe.

Hungary is located in Central Europe; her neighbours are Austria, Croatia, Romania, Serbia, Slovakia, Slovenia and Ukraine. Geographically Hungary is mostly flat terrain, with some hills and low mountains in the Northern regions. Danube and Tisza are the two main rivers of the country; the largest lake is Lake Balaton. The capital city of Hungary is Budapest, with approximately 1.7 million inhabitants. Other major cities are Debrecen, Miskolc, Pécs, Szeged, Győr with around 100-200 thousand inhabitants. Hungarian is the official language. 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, and 17.2% is uncultivated land area. The recent census concluded in 2012 shows that the population dropped under 10 million souls (9.932M in 2012) with an expected lifetime of 71 years for males, and 79 years for females.

The density of population was 107.8 inhabitants/km^2. The climate is characterised as temperate, with cold, humid winters and warm summers. Hungary is Greenwich Mean Time plus one hour. Hungary has a continental climate, with hot summers with low overall humidity levels but frequent showers and frigid to cold snowy winters

In the last two decades since the transition to a democracy and a market economy the Hungarian economy went through a fundamental economic restructuring. This resulted in the qucik decommision of energy intensive industries and the sharp drop in energy use to the level of the 1970's. With the economic transformation the divergence between Hungary and developed EU regions increased, unemployment surged and energy demand decreased. Primary energy use dropped with 17% in two years until 1992 and from then on grew by 0.5% on average annually until 2007 when the global crisis reduced it with 7.6%.

Concerning primary energy the decline of domestic coal mining was coupled with the structural change of an increasing use of natural gas. Fossile energy carriers share in primary energy was 80% in 1990 and 75% in 2009. Hungary's natural gas is covered from Russian imports in 80% through practically only one gas pipeline (Brotherhood) which makes supply vulnerable. The HAG pipeline connects us to the Austrian transit node but its capacity is limited (a doubling is planned). Safety of supply is guaranteed by commercial and strategical reserving, presently domestic storage capacity – uniquely in Europe – surpasses half of the annual consumption (approximately 5.8 billion m^3). The legislation about security storage of natural gas prescribes that at least 600 million m^3 has to be stored in gas containers with a daily output rate of at least 20 million m^3. Safety reserves of crude oil and oil products are sufficient to cover the average consumption of 90 days in Hungary.

Concerning renewable energy use Hungary is among those EU-member countries that have managed to reach its targets in the following sectors: heating and cooling, electricity and transport. Currently the statistical data analysis for the last year is in progress, but according to the currently available preliminary data, the share of renewable energy within the total final energy consumption is on the desired track. Share of renewable energy in total primary energy supply was around 9.3% in 2012. This therefore means that Hungary is in the lower third of the EU members and is not eminent in the circle of countries with similar economic development in our region.

The domestic organizations and institutions backed by significant government support provide a solid background for climate change training and education and through their awareness-raising activities and campaigns contribute significantly to the efforts of the government to accelerate public participation in climate change related efforts.

One third of the dwellings were built before 1960, 21% originates from before World War I. The major part of the present dwellings, approximately 1.5 million flats were built between 1960 and 1980. Privately owned dwellings ratio is 92%, municipality owned flats number is decreasing, around 500,000 flats are in mixed ownership (private-municipal building management. More than 2/3 of the families live in individual buildings (family houses, conventional rural houses).

Considering macroeconomical trends it can be stated that the recession experienced in 2009 and onwards matches the depth of problems which transpired during the economic transition (1990-1995). Economic activity and production plummeted in 2009 reaching its low in the middle of the same year.The recession slowed down in 2010 and turned to a slow growth which at the end of the year reached pre-crisis values. The crisis of the eurozone however inferred a highly unpreferrable international economic environment by 2011 decreasing the growth rate of the Hungarian economy significantly and turning it into recession by 2012 as shown by the 1.4% decrease in GDP.

Ripples of the economic crisis had negative impact on the Hungarian labour market. A low rate of activity coupled with a high rate of unemployment and a relatively stagnant employment rate on the market. In an international comparison the Hungarian employment rate is the lowest in member countries with an unemployment rate slightly over the average. Low employment rate hinders higher growth rate, impairs state budget revenues and lowers households income.

The years of the global crisis did not improve the otherwise not so brave figures of employment, in 2010 it was stagnant, and 2011 was the first year showing the signs of improvement (the number of unemployed slightly decreased with 1.5% to 487 thousand persons (HCSO, 2012)). The number of unemployed in the second quarter of 2013 was 449 lower then the figure in the previous year, with an unemployment rate decreasing to 10.3% (HCSO, 2013).

The economic crisis halted the convergence of the Hungarian economy to the EU average. Per capita GDP of Hungary (on purchase price parity) was 54% in 2010, 63% in 2003 and 65% in 2009 and 2010. The GDP increase in 2011 was 1.7% which was followed with a -1.7% change in 2012 as the economy fell back into recession with a very unexpected quarterly drop of 2.8% in 2012 Q4. This is followed in 2013 by a slight forecasted increase of 0.7% according to the Central Bank of Hungary. However the influence of the boom in German economy has a significant impact on Hungary and the region. Compared to 2007 the gross added value improved in agriculture, information technology and communication significantly, while service sector was similar to 2007 values. Manufacturing industries total production grew with 6.3% while services dropped slightly with 0.6%. Heterogenity characterises sectors of the economy.

Greenhouse gas inventory information

The assigned amount of Hungary has been fixed as 542,366,600 Mg CO_2 eq. on the basis of the base year emissions of 115.4 million tonnes CO_2 equivalent. It is important to note that Hungary's base year is not 1990 but the averaged value for the years 1985, 1986 and 1987 and Hungary has chosen 1995 as its base year for HFCs, PFCs and SF6. Hungary's quantified emission reduction commitment is 94 per cent as included in Annex B to the Kyoto Protocol.

In 2011, total emissions of greenhouse gases in Hungary were 66.1 million tonnes carbon dioxide equivalents (excluding the LULUCF sector) which is the lowest value in the whole time series (1985-2011). Taking into account also the mostly carbon absorbing processes in the LULUCF sector, the net emissions of Hungary were 62.4 million tonnes CO_2 eq. in 2011. The energy sector was responsible for 71.6% of total GHG emissions in 2011, agriculture was the second largest source with 13.2%. The industrial processes sector contributed 9.4% to total emissions while the waste sector represented 5.3% of GHG emissions in 2011. In 2011 the LULUCF sector accounted for 3.8 million tonnes carbon-dioxide removals. The net removals of forests amounted to 2.9 million tonnes CO_2.

Being about 6-7 tonnes, the Hungarian per capita emissions are below the European average.
Emissions were about 43 per cent below the base-year level. Moreover, the emissions of the last three years (2009-11) turned out to be the lowest in the entire time series. Most part of this significant reduction of emissions occurred until the early 90's and was mainly a consequence of the regime change in Hungary (1989-90) which brought in its train radical decline in the output of the national economy. Starting in 2008, the global financial and economic crisis exerted a major impact on the output of the Hungarian economy, consequently on the level of GHG emissions as well. The significant growth in the transport sector stopped in 2007, emissions have decreased by 13 per cent since then. Natural gas consumption of the residential sector has grown to its four-fold until the mid 2000's. Since then, it has dropped by more than 20%.

Policies and measures on climate change
Since the release of the 5th National Communication of Hungary there have been some significant changes in climate and energy policy as follows. Climate policy and energy policy are considered as two areas of vital importance that need to be harmonised and coordinated. Among the new government's first measures was the modification of tasks and responsibilities of ministers. This was influenced by the need of a more dynamic response to global economic challenges and increased focus on specific interdependent problems.

Legislative and policymaking activities climate change and energy sector have been united under the auspices of the Ministry of National Development (1247/2010. (XI. 18.), Govt. decree). This allowed for the first time the establishment of a sovereign State Secretariat of Climate Change and Energy Policy with two aides of the state secretary – a deputy state secretary for energy policy and another deputy for green economy development and climate change.

The most important task of the Secretariat was formation of the long-term National Energy Strategy of Hungary, as well as submission of the National Action Plan for Renewable Energy to the European Commission. These strategic documents provide a foundation for security of supply, competitiveness, sustainability, economic incentives and the elimination of energy poverty and serve the fulfillment of EU obligations.

Projections of emissions and total effect of PAMs
The total effects from policies and measures are summarised in Table 1.1.

Table 1.1. Total effects of policies and measures until 2030.

Gg CO_2-equivalent per year	**2015**	**2020**	**2025**	**2030**
Estimated emission savings from PAMs	13 307,19	23 237,98	32 915,95	41 250,61

Table 1.2. summarises total emissions for the two scenarios (with and without LULUCF).

Table 1.2. Total emissions in the WEM and WAM scenarios (Gg. CO_2 equiv.)

	2010	2015	2020	2025
With existing measures	67 679,05	63 475,56	59 840,24	58 598,03
WEM including LULUCF	63 694,31	60 680,07	58 046,54	56 391,17
With additional measures	67 679,05	61 515,11	56 774,2	55 400,29
WAM including LULUCF	63 694,31	58 719,62	54 980,5	53 193,42

It is visible that the two scenarios do not differ significantly at the end of the forecasting period. This indicates that the WEM scenario already incorporates a large share of potential abatament measures and mitigation options.

Climate change vulnerability and adaptation
In the past climatic conditions, monthly temperature anomaly exceeding 4 °C occurred in about 5–10% of all the winter months, and it hardly ever happened in the other seasons (only summer and winter are shown). According to the PRECIS simulations, this is very likely to change in the future: by the end of the 21st century the monthly temperature anomaly (e.g., the difference from the mean of 1961–1990) exceeding 4 °C will become quite frequent (B2: 35–45% in the winter, 70–80% in the summer; A1B: 50–60% in the winter, 80–85% in the summer, A2: 50–60% in the winter, 85–95% in the summer). The largest probability values can be seen in the summer. The spatial structure of the empirical probability fields is similar, but the values differ, namely, probability values for A2 are larger than for A1B and B2. In summer azonal structure can be recognized, with the largest probability values in the eastern/southern part of Hungary.

Model prediction shows about 20% annual precipitation decrease on average for Hungary by the end of the 21st century in case of A2 and B2 scenarios, but gives practically no change in the annual precipitation in case of A1B. However, if seasonal or monthly simulated changes are evaluated, the largest change is projected for the summer. Namely, significant drying is likely according to the simulations for the whole country (the simulated precipitation decrease is 34%, 43%, and 58% using spatial averages in case of A1B, B2,and A2, respectively). Also, for spring and autumn the projected trend is negative (except for A1B in spring, when it is slightly positive), but it is much smaller than in the summer and not significant at 5% level. The direction of the simulated precipitation change in the transition seasons involves large uncertainties. In the winter a slight increase is projected (in spatial average about 14%), which is significant in case of A2 in the Transdanubium, where the simulated winter precipitation change may exceed 30–40% (Pieczka et al. 2010). The A1B experiment projects a larger, significant precipitation increase (34% in spatial average) for the entire country.

Precipitation is highly variable both in space and time. According to the PRECIS simulations, the year-to-year variation in Hungary will remarkably change in the future. The results suggest a major annual redistribution of precipitation, a significant decrease in summer precipitation, as well as in interannual variation of summer precipitation, and increase of the interannual variation in spring and winter. In the summer, both the seasonal sum and the temporal standard deviation is likely to decrease dramatically, by about 50% in case of A2 and B2 scenarios. The largest decrease of the standard deviation is expected in June, July and September, in the rest of the year the simulated changes are less pronounced. However, the simulated year-to-year variation increase of the monthly precipitation in spring is quite large, especially in May in case of A2 scenario.

Overall, the model PRECIS predicts a drier climate in the Carpathian Basin. The more pronounced changes will probably happen during the winter and summer months. In case of the empirical probability analysis, threshold values –20% and +20% were selected since two of the presented experiments suggest 20% annual precipitation decrease for Hungary. The empirical probability of the negative precipitation anomaly exceeding –20% in past (1961–1990) climatic conditions occurred in about 40–55% of all the autumn months, and 30–40% of all the months in the other three seasons. According to the PRECIS simulations, a drying tendency is projected by the end of the 21st century, especially, in the summer months (the occurrence of the monthly precipitation anomaly exceeding –20% increases significantly to 70–80% in case of B2 and A1B, and 80–90% in case of A2 scenarios). In the winter a less pronounced frequency increase is expected (B2: to 40–60%, A2: to 30–50%), and in case of A1B even a slight decrease can be seen (to 20–30%).

Agriculture in Hungary is one of the most vulnerable sector to these impacts. Climate change impacts can have adverse effects depending on land use, agrotechnical and natural characteristics. Besides warming and draught, meteorological extremes can cause significant damage in plantations, livestock and food-, and water supply. Climate change related risks include floods, inland water, draught, heavy rainstorms, sleet, fog, early and late frost, blizzard, hailstorms, heat waves, increase of UV-B irradiation, forest fires, appeareance of new parasites.

Assistance to developing countries
Hungary's donor activities changed considerably over the past 10 years. Hungary is expected to provide assistance to the least developed countries (LDCs). According to the OECD targets, Hungary should have provided 0.17% of its GNI by 2010, and 0.33% by 2015 as ODA. Common targets such as the Millennium Development Goals (MDG) have strong influence over which countries receive ODA from Hungary, and how much.

Hungary's ODA contributions increased from 22.11 million EUR to 100.76 million EUR between 2003 and 2006. This steady climb from 0.03% of GNI to 0.13% of GNI came to a halt in 2007 only to climb again from 0.08% to 0.10% between 2007 and 2009. Data from 2011 shows a 0.02% increase, though it is only a preliminary estimate. Focusing on the 0.17% commitment to be reached in 2010, Hungary in 2006 seemed to be able to reach it. However, this never came through as ODA was 0.08% in 2010.

Hungary's main participation in development assistance is providing scholarships, training programs, trainer exchange programs, and language acquisition. Hungary also provides know- how, capacity building and transfer of good practices in democratic transition and institutional development. These projects are generally focusing on neighbouring countries such as Bosnia and Herzegovina, Serbia, Montenegro, Macedonia and Ukraine, but also to a lesser degree in Kazakhstan, China, and Vietnam(MFA 2010).

Research and development
The most important Hungarian initiative to date on climate change, focusing on adaptation and vulnerability, has been the VAHAVA project carried out by the Hungarian Academy of Sciences (MTA) and the previous Ministry of Environment and Water, now Ministry of National Development that was already referred to in the 4th and 5th National Communication. It was a nationwide project, involving leading researchers from a number of scientific institutions across Hungary.

The project covered several areas related to climate change, such as agriculture, meteorology, medicine, biology, socio-economic and methodological aspects. Its focus was mainly on adaptation and partly on mitigation, looking at both the potentially positive and the negative effects of climate change. Its results were published first as a book in 2007 ("A globális klímaváltozás: hazai hatások és válaszok" – "Global Climate Change: Impacts and Answers in Hungary"), which not only featured important research results but also helped initiate further research projects. A shortened project report in English of approximately half the size of the original Hungarian report has been published in 2010 .
Using the scientific basis laid out by the VAHAVA project, the Hungarian Parliament has adopted the National Climate Change Strategy (NCCS) for 2008-2025

Both the political and organizational framework conditions for climate change research and observation have advanced significantly since the previous National Communication. After important groundwork done by the VAHAVA project, the importance of research related to climate change has been recognized by Hungary's National Climate Change Strategy adopted in 2008 and also found its way into the country's first National Climate Change Programme.

The coordination of climate change-related research has also become more institutionalized with the establishment of the Office of Climate Change Research Coordination at the Hungarian Academy of Sciences as well as the National Climate Change Committee and the National IPCC Committee.

The research activities themselves have continued to increase in recent years, traditionally strong players in this field have been joined by new institutions and the process towards establishing a dedicated Hungarian research institute for sustainability and climate change has been initiated. The research projects cover an ever wider range of topics related to climate change, although both the political statements and the distribution of research activities clearly indicate a stronger focus on impacts and adaptation research than mitigation- related research.

The domestic organizations and institutions backed by significant government support provide a solid background for climate change training and education and through their awareness-raising activities and campaigns contribute significantly to the efforts of the government to accelerate public participation in climate change related efforts.

2. NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSIONS AND REMOVALS

2.1. Geographical conditions

Hungary is located in Central Europe, her neighbours are Austria, Croatia, Romania, Serbia, Slovakia, Slovenia and Ukraine. Geographically Hungary is mostly flat terrain, with some hills and low mountains in the Northern regions. Danube and Tisza are the two main rivers of the country, the largest lake is Lake Balaton. The capital city of Hungary is Budapest, with approximately 1.7 million inhabitants. Other major cities are Debrecen, Miskolc, Pécs, Szeged, Győr with around 100-200 thousand inhabitants. Hungarian is the official language.

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.

Hungary is a long standing parliamentary democracy, one of the leaders of political and economical transition in the region. Hungary became a member state of the European Union in 2004. The recent government initiated a thorough political reform which strengthened Hungary's ties to democracy and the European Union.

The administration is based on a regional system of 19 counties (each subdivided into subregions) and the capital city, they are the 20 NUTS third-level units of Hungary, and 7 regions qualifying as NUTS' second-level units of Hungary.

There are also 23 towns with county rights, sometimes known as "urban counties" in English (although there is no such term in Hungarian). The local authorities of these towns have extended powers, but these towns belong to the territory of the respective county instead of being independent territorial units. Figure 2.1. provides an administrative map of Hungary.

Figure 2.1. Map of Hungary

Source: ezilon.com

Approximately half of Hungary's landscape consists of flat to rolling plains of the Pannonian Basin: the most important plain regions include the Little Plains in the west and the Great Plain in the southeast. The highest elevation on the latter is only 183 metres above sea level.

Transdanubia is a primarily hilly region with a terrain varied by low mountains. These include the very eastern stretch of the Alps, Alpokalja, in the west of the country, the Transdanubian Medium Mountains, in the central region of Transdanubia and the Mecsek Mountains and Villány Mountains in the south. The highest point of the area is the Írott-kő in the Alps, at 882 metres.

The highest mountains of the country are located in the Carpathians: these lie in the northern parts, in a wide band along the Slovakian border (highest point: the Kékes at 1,014 m/3,327 ft).

Hungary's main river the Danube (Duna) divides the country to two parts, other large rivers include the Tisza and Dráva, while Transdanubia contains Lake Balaton, a major body of water. Lake Hévíz the globally largest thermal lake, is located in Hungary. The second largest lake in the Pannonian Basin is the artificial Lake Tisza (Tisza-tó).

2.2. Climatic conditions

The climate is characterised as temperate, with cold, humid winters and warm summers. Hungary is Greenwich Mean Time plus one hour.

Hungary has a continental climate, with hot summers with low overall humidity levels but frequent showers and frigid to cold snowy winters. Average annual temperature is 9.7 °C (49.5 °F). Temperature extremes are about 42 °C (107.6 °F) in the summer and −29 °C (−20.2 °F) in the winter. Average temperature in the summer is 27 °C (80.6 °F) to 35 °C (95 °F) and in the winter it is 0 °C (32 °F) to −15 °C (5.0 °F). The average yearly rainfall is approximately 600 mm (23.6 in). A small, southern region of the country near Pécs enjoys a reputation for a Mediterranean climate, but in reality it is only slightly warmer than the rest of the country and still receives snow during the winter.

Due to climate characteristics, the primary foreseen impact of climate change is precipitation change and drought.

2.3. Population

At the beginning of year 2009, the population of the country was 10.028 million, of which 6.81 million people lived in urban areas. The recent census concluded in 2012 shows that the population dropped under 10 million souls (9.932M in 2012) with an expected lifetime of 71 years for males, and 79 years for females.

The density of population was 107.8 inhabitants/km^2. Between 1970 and 2009 the population decreased by about 300 thousand people. The population peak was in 1980, with 10,7 million souls, since then a uniform decreasing tendency shows. The age structure of the population is shown on Figure 2.1. This shows that there is a definite aging process in the Hungarian society stemming from decreased childbirths and marriages. Figure 2.2 shows the changes of population between 1970 and 2009.

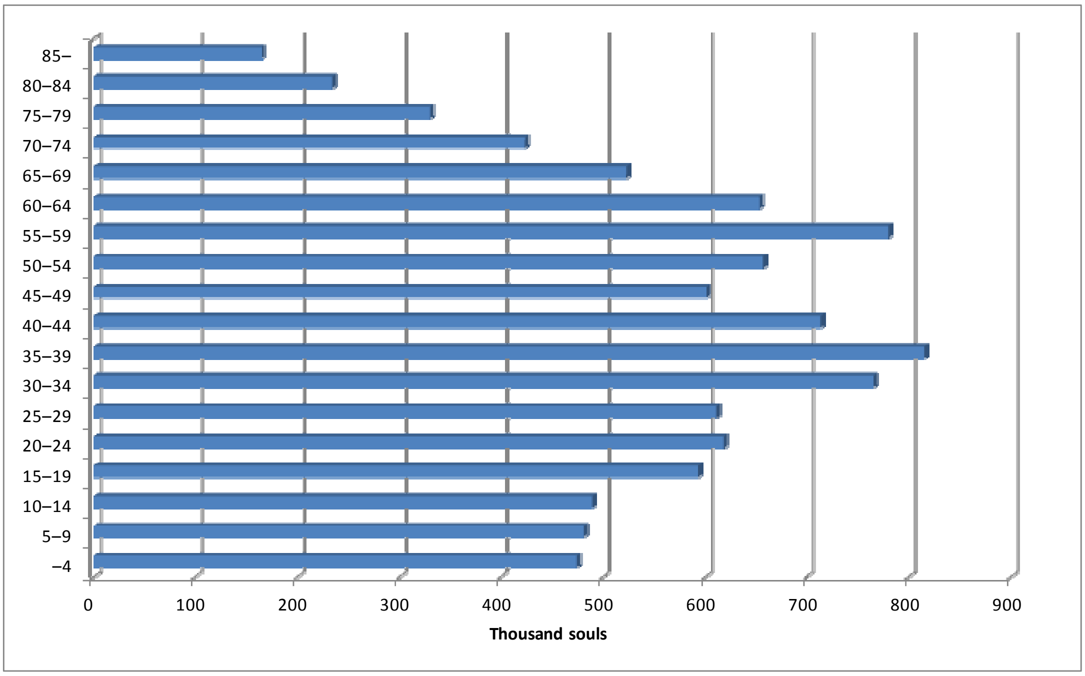

Figure 2.2. Population age tree of Hungary, 2011

Source: Hungarian Central Statistical Office (KSH), 2012

Figure 2.3. presents the dynamics of the population, it is well visible that the tendency is decreasing.

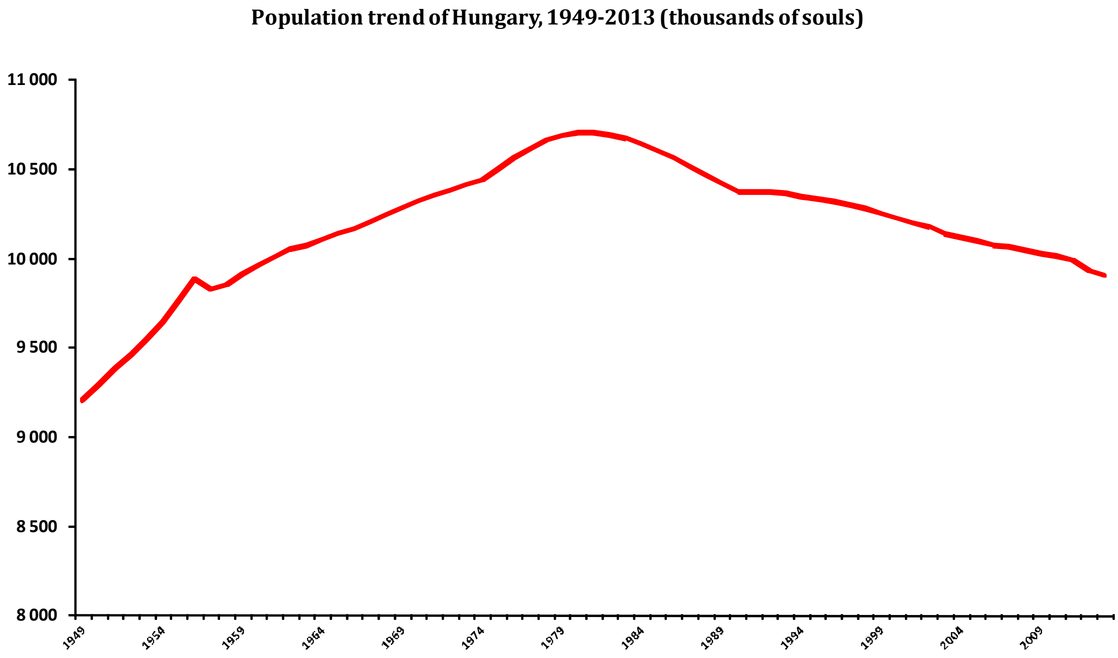

Figure 2.3. Population dynamics in Hungary, 1970-2013

Source: Hungarian Central Statistical Office (KSH)

One of the components of this negative tendency is the decreasing reproduction rate, as shown on Figure 2.4. It is visible that since the early 80's, the rate is negative. The government is trying with full effort to turn this harmful tendency but strong economic incentives would be required.

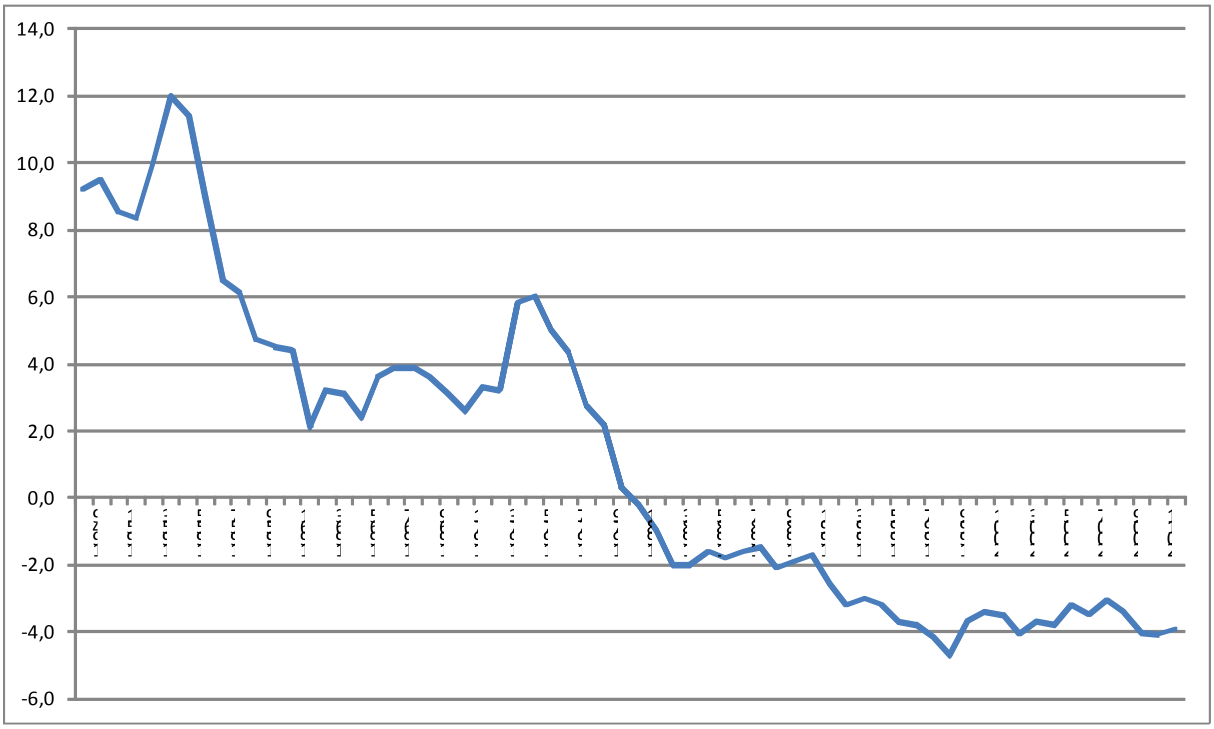

Figure 2.4. Natural growth of population (per thousand souls)

Source: Hungarian Central Statistical Office (KSH)

The labour force is 42% of the population, however unemployment has a rate of 11 % presently (Fall of 2011). Figure 2.5. summarises the evolution of unemployment with a comparison to the EU average.

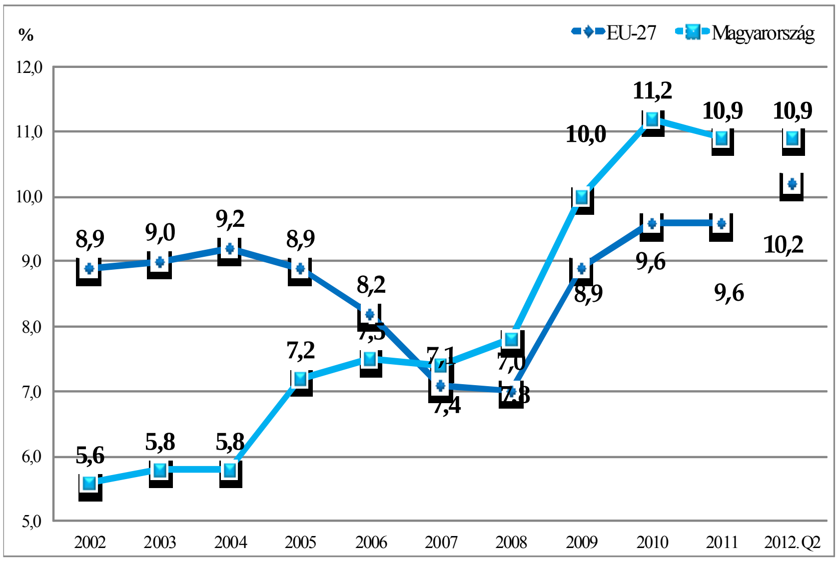

Figure 2.5. Tendency of unemployment in Hungary and the EU

Source: Hungarian Central Statistical Office (KSH), Eurostat

The activity rate has a slightly increasing tendency, this is also a result of the new government's labour policy to increase participation of inactives in the labour force, the trend is shown in Figure 2.6.

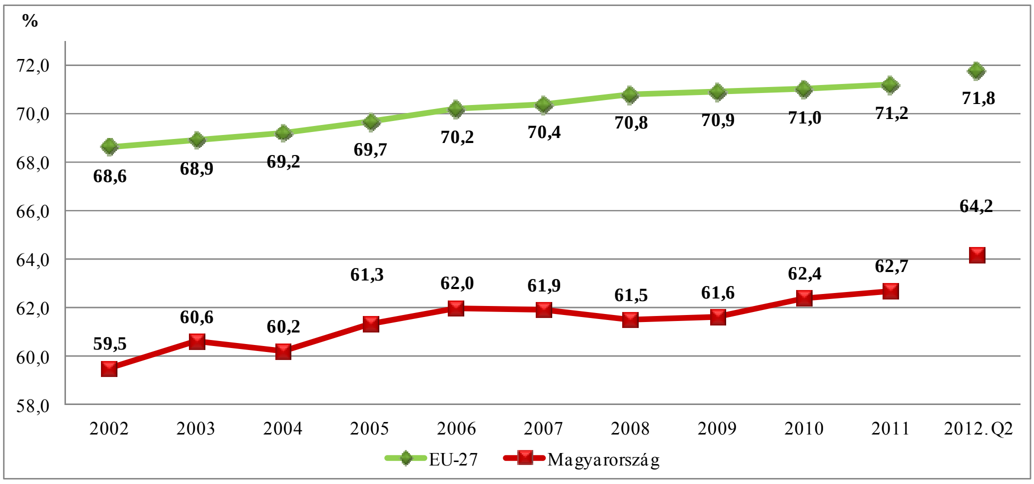

Figure 2.6. Activity rate in Hungary and the EU-27

Source: Hungarian Central Statistical Office (KSH), Eurostat

The impact of the 2007 global economic crisis on the labour market and employment is shown in Table 2.1. It is well visible that employment decreased moderately and unemployment rate has risen from 7.4% to 11.2%.

Table 2.1. Impact of the global crisis on the Hungarian labour market

(data in 1000s)	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**
Employed	3858,8	3819,4	3719,5	3719,49	3742,9	3806,17
Unemployed	311,3	328,5	419,9	474,07	466,74	473,75
Active population	4170,1	4147,9	4139,4	4193,56	4209,63	4279,92
Inactive population	2248,2	2324,6	2309,8	2246,81	2198,93	2067,3
Labour potential (active+inactive)	6418,3	6472,5	6449,2	6440,37	6408,56	6347,22
Activity rate (%) (active/potential)	64,97	64,08	64,2	65,11	65,69	67,43
Unemployment rate (%) (unemployed/active)	7,47	7,92	10,1	11,3	11,09	11,07
Employment rate (%) (employed/potential)	60,12	59,01	57,7	57,75	58,4	59,97

Source: Hungarian Central Statistical Office (KSH)

The regional inequalities in labour force participation and employment are shown in Figure 2.7. for Hungary. As it is visible there is a sharp difference between the eastern and western regions of the country, with the west enjoying the benefits of manufacturing industries including several automotive industry based corporations.

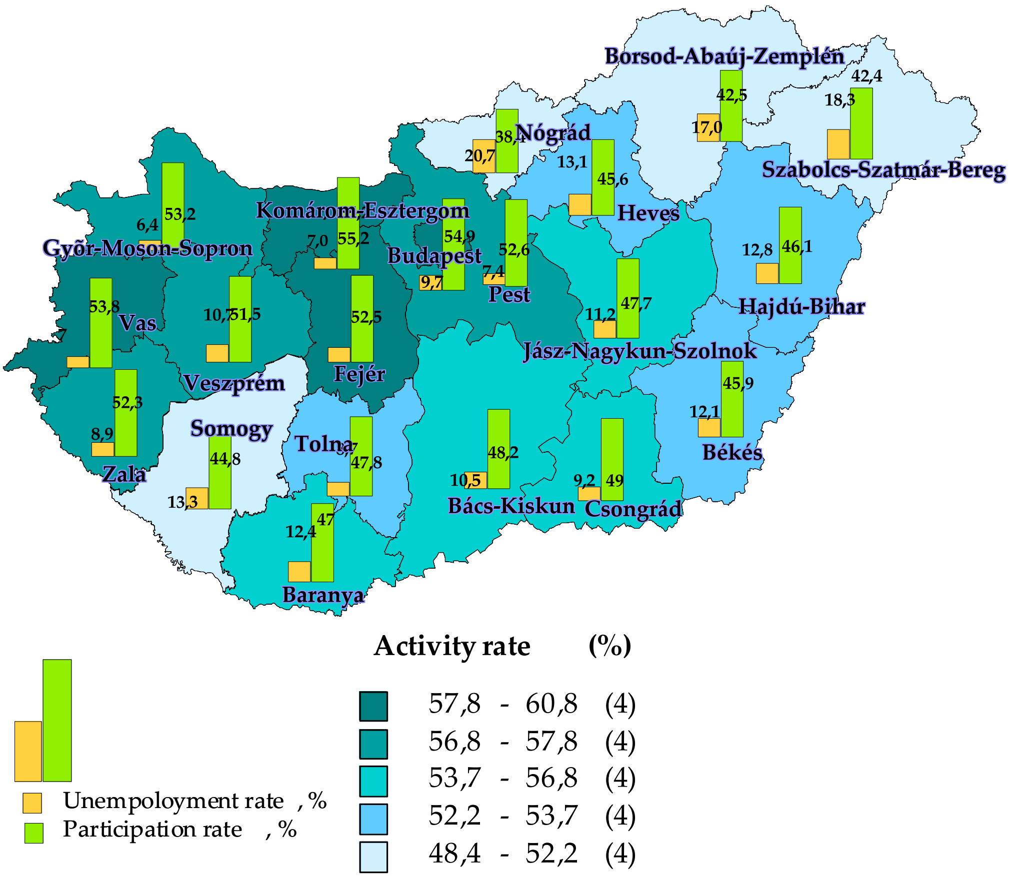

Figure 2.7. Regional inequalities in labour market particpation and unemployment

Source: Hungarian Central Statistical Office (KSH)

For historical reasons, significant Hungarian minority populations can be found in the surrounding countries, most of them in Romania (in Transylvania), Slovakia, Serbia (in Vojvodina). Sizable minorities live also in Ukraine (in Transcarpathia), Croatia (mainly Slavonia) and Austria (in Burgenland). Slovenia is also host to a number of ethnic Hungarians and Hungarian language has an official status in parts of the Prekmurje region. Today, more than two million ethnic Hungarians live in nearby countries.

2.4. Governmental structure

The President of the Republic, elected by the members of the Parliament has mostly a formal role, but he is nominally the Commander-in-Chief of the armed forces and his powers include the nomination of the Prime Minister who is to be elected by a majority of the votes of the Members of Parliament, based on the recommendation made by the President of the Republic.

Due to the Hungarian Constitution the Prime Minister has the executive power as he selects Cabinet ministers and has the exclusive right to dismiss them (similarly to the competences of the German federal chancellor). Each cabinet nominee appears before one or more parliamentary committees in consultative open hearings, survive a vote by the Parliament and must be formally approved by the president.

The Prime Minister is elected by Parliament and can only be removed by a constructive vote of no confidence. The prime minister selects Cabinet ministers and has the exclusive right to dismiss them. Each Cabinet nominee appears before one or more parliamentary committees in open hearings and must be formally approved by the President.

The unicameral 386-member (from the next election, this figure is halved) National Assembly (Országgyűlés) is the highest organ of state authority and initiates and approves legislation sponsored by the Prime Minister. Its members are elected for a four year term. The election threshold is 5%, but it only applies to the multi-seat constituencies and the compensation seats, not the single-seat constituencies.

An 11-member Constitutional Court has power to challenge legislation on grounds of unconstitutionality.

2.5. Settlement structure and building stock

Hungary is subdivided administratively into 20 regions, which are the 19 counties and the capital city Budapest (independent of any county government). There are 3,156 municipalities in Hungary *(ECEE, 2002)*, which are responsible for the provision of most local services, including schools, kindergartens, welfare and healthcare facilities, some office buildings and museums. The operation of these institutions includes supplying energy, except for some hospitals where the running costs are paid for by the central social security fund. Many of Hungary's district heating systems are also owned by municipalities.

Of the 3,156 municipalities, only 23 are considered to be major metropolitan areas and over 2900 are villages. Outside Budapest, the largest municipality in Hungary is Debrecen, with a population of only 300,000 inhabitants. Despite the limited capacity of over 90% of the country's municipalities, however, it should be noted that there are a significant number of non-residential premises that are owned by municipalities. The type and number of public buildings is shown in Table 2.2**.** Of the 51,332 non-residential buildings, over 20,000 of those are in the capital of Budapest.

Table 2.2. Type and age of public buildings

Type	**Total** (2012)	**Pre 1900** (%)	**1901-1959** (%)	**1960-1989** (%)	**After 1989** (%)
Educational	12 924	10.5	34.1	47.0	8.4
Cultural	4 920	15.4	37.4	40.9	6.2
Social and sport service	2358	11.8	35.1	40.9	12.2
Health Service	6287	6.8	32.0	51.8	9.4
Trade, Service and Administration	8407	8.4	34.0	50.0	7.6

Source: Hungarian Central Statistical Office (KSH), 2013

Residential flats

The latest data available on the residential housing stock is from the census undertaken in 2012 of the Central Statistical Office of Hungary.

The number of inhabited flats in dwellings was 3.912M, approximately 20-20% were found in the capital cities and the larger urban areas, in other smaller cities 28% and 32% in villages and smaller settlements. Proportion of flats in houses was 63%, in block houses 20% and 17% in building associations 17%, respectively. One third of the dwellings were built before 1960, 21% originates from before World War I. The major part of the present dwellings, approximately 1.5 million flats were built between 1960 and 1980. Privately owned dwellings ratio is 92%, municipality owned flats number is decreasing, around 500,000 flats are in mixed ownership (private-municipal building management. More than 2/3 of the families live in individual buildings (family houses, conventional rural houses).

The decreasing population and the receding number of newly built dwellings (112,107 in the last five years, with 10,560 in 2012!) result in the decrease of inhabitation intensity, which is reflected in the number of dwellers per 100 flats. This indicator decreased from 274 in 1990 to 226 in 2012. The share of flats built in new family houses decreased to 47.1% by the end of 2004 from 69.3% in 1990 and the share of dwellings in new multi-storey buildings increased to 33.7% by the end of 2004 from 13.9% in 1999. Further data is shown in Table 2.3.

Table 2.3. Flats and dwellings structure in Hungary from 1999 to 2012

(in 1000 units)	**1999**	**2003**	**2005**	**2012**
Total dwellings	3980	4065	4173	4393
Municipality owned dwellings	213	181	117	106
Privately rented	119	113	129	129
Dwellings inhabited by owner	3494	3450	3641	3582
Empty private dwellings	135	313	212	354
Empty municipal dwellings	19	14	14	11
Other		91	38	37
Population (1000 souls)		10142	10077	9932
Number of inhabitants/dwellings		2,49	**2,41**	**2,26**
Total flats in dwellings		3724	3937	3937

Source: Hungarian Central Statistical Office (KSH), 2013

The construction of new dwellings and the penetration of modern, western-style household appliances (air-conditioning, dryer –washers, plasma TVs, etc.) are important factors towards increasing energy consumption.

2.6. Economy

Hungary has made the transition from a centrally planned to a market economy, with a per capita income nearly two-thirds that of the EU-25 average. The private sector accounts for more than 80% of GDP. Foreign ownership of and investment in Hungarian firms are widespread, with cumulative foreign direct investment totalling more than $68 billion since 1989. The government's austerity measures have reduced the budget deficit from over 9% of GDP in 2006 to less than 2% in 2013 (forecasted). Succesful management of short-term debt allowed the government to evade further IMF-credit but resulted in a stagnant economy. The expected GDP-growth in the present year (2013) is expected to be slightly positive however, and there are some promising signs for further expansion, for example foreign direct investment (FDI) was 2251 million euros in 2012, a high value unseen in the last couple of years.

Hungary has a market economy, a well developed stock-exchange and highly export-oriented industry. A structural economic crisis began in the second half of the 80's, which was followed by the transformation of the whole economic and political system in 1990. Similarly to other post-soviet countries, the transition process towards market economy began, the economic depression lasted till 1995. Since then the economy began to develop and the growth rate of the Hungarian economy exceeded the average of the EU. After having joined the EU in 2004, the present concern of macroeconomic analysts and policymakers is the stagnant economy and the preservation of the beneficial budget deficit rate.

The main economic indicators are shown in Table 2.4.

Table 2.4.: Main economic indicators of Hungary in 1990-2012 (%)

	1990	1995	2000	2005	2008	2011	2012
GDP growth rate	-3.3	1.5	5.2	4.1	0.5	1.6	-1.7
Unemployment rate	2.1	10.4	6.4	7.2	9.7	10.9	11
Inflation rate	28.9	28.2	9.9	6.2	6.8	6.8	4.7
Central budget/GDP	0.8	-6.0	-2.8	-4.2	-4.0	-2.8	-1.9

Source: Hungarian Central Statistical Office (KSH), 2013

Macroeconomic environment

Considering macroeconomical trends it can be stated that the recession experienced in 2009 and onwards matches the depth of problems which transpired during the economic transition (1990-1995). Economic activity and production plummeted in 2009 reaching its low in the middle of the same year.The recession slowed down in 2010 and turned to a slow growth which at the end of the year reached pre-crisis values. The crisis of the eurozone however inferred a highly unpreferrable international economic environment by 2011 decreasing the growth rate of the Hungarian economy significantly and turning it into recession by 2012 as shown by the 1.4% decrease in GDP.

Labour market

Ripples of the economic crisis had negative impact on the Hungarian labour market. A low rate of activity coupled with a high rate of unemployment and a relatively stagnant employment rate on the market. In an international comparison the Hungarian employment rate is the lowest in member countries with an unemployment rate slightly over the average. Low employment rate hinders higher growth rate, impairs state budget revenues and lowers households income.

The years of the global crisis did not improve the otherwise not so brave figures of employment, in 2010 it was stagnant, and 2011 was the first year showing the signs of improvement (the number of unemployed slightly decreased with 1.5% to 487 thousand persons (HCSO, 2012)). The number of unemployed in the second quarter of 2013 was 449 lower then the figure in the previous year, with an unemployment rate decreasing to 10.3% (HCSO, 2013). Dynamics of the unemployment rate is depicted on Figure 2.5.

Financial assets and wealth of households

Beginning from the last decade till 2009 the net financing capability of households reduced continously. According to some it meant that household savings reduced but looking behond the scenery the reduction in net financing ability was due to the continous increase in loans borrowed. At the end of 2011 the net financial assets of households was 16.1 trillion forints (approx. 55.51 billion Euros), which was 8.8% less than the year before. Net assets of households are shown in Table 2.5.

Table 2.5. Net financial assets of households

Year	Annual terminal figures (billion HUF)	Annual terminal figures (billion Euros)
2008	14 679	50,62
2009	16 880	58,21
2010	17 740	61,17
2011	16 188	55,82
2012*	17 969	61,96

**Q3 data, Source: Central Bank of Hungary*

Average gross income of full time employed was 213 thousand forints which was 7.2% over the 2008 value. In 2012 this grew to 227 thousand forints (approximately 780 euros). The real effect of the personal income tax reduction on disposable income and consumption was quite beneficial together with the payment of private pension funds' yields to fund members during the nationalisation of these pension funds. Despite this positive impact the income position of households did not improve in a great extent as negative labour market processes, high indebtedness, the weakening exchange rate of the domestic currency together with the increasing loan instalments and increasing consumer prices balanced out the positve effect.

Inflation

In 2012 consumer prices increased 5.4% on the annual average over the previous year. In the first two quarters of 2013 the decline of inflation to a historical low is established as the second quarter inflation rate is 1.8% over the previious year. Although 2011 also brought about a relatively low rate of inflation last experienced in 2006 the present values justify that the economic policy of the Hungarian government coupled with the Central Bank's consistent measures targeting inflation and economic stability are quite effective.

In the last decade the global economic crisis and its consequences (e.g. governmental efforts to balance state budget, price elevations, tax elevations) made inflation to vary in a broad range with consumer price index topping at 8%. The following desinflation's relatively slow pace was caused by increases in global commodity prices (commodities, crude oil, food). The reduction of demand stemming from the global crisis had a great role in cutting inflation. The raise in the expenditure taxes in 2010 together with growing fuel prices and dropback of agriucltural production from the extreme weather again strengthened inflation. Consumer prices were impaired by increases in food, fuel and energy prices. According to the EU harmonised methodology our inflation and CPI was over the commision average in the last years but in 2011 and in the present year Hungary's inflation significantly slowed. Altogether the rate of inflation was approximately 22% compared to 2008 (Q2 values). Figure 2.9 outlines the tendency of quarterly inflation in Hungary.

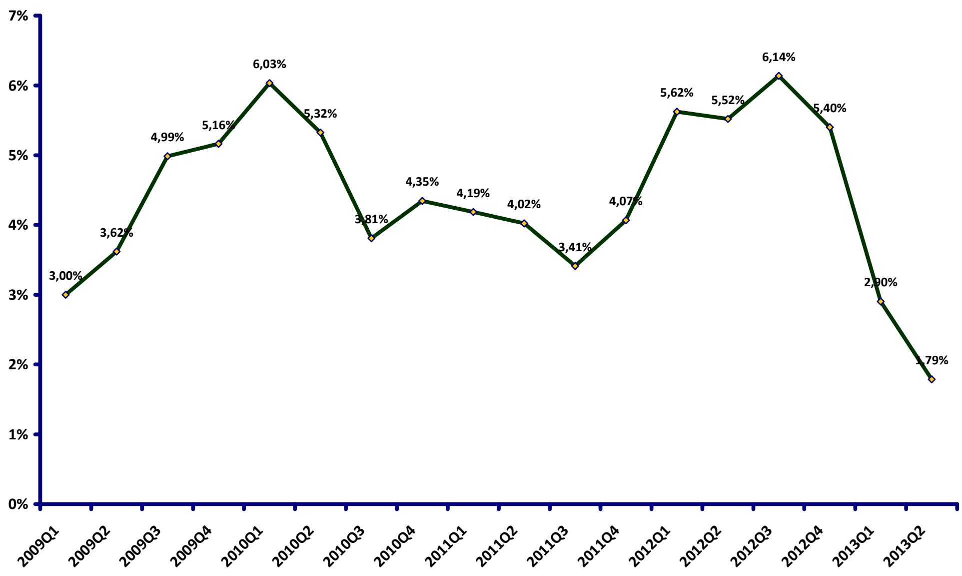

Figure 2.9. Quarterly inflation rates in Hungary

Source: Central Bank of Hungary

The following table summarises the fundamental indicators of the economy and a forecast based on the analysis of the Central Bank of Hungary. From the table it is visible that the smoothing and stabilisation of inflation is expected in the present and next year coupled with a moderate but positive growth. The external balance remains positive throughout the next years with a stagnation of employment and a recovery in the real income of households.

Table 2.6. Actual and projected economic growth and inflation in Hungary

	2012	2013	2014
	Fact	Projection	
Inflation (annual average)			
Core inflation[1]	5,1	3,5	3,8
Core inflation without indirect tax effects	2,5	1,7	2,8
Consumer price index	5,7	2,0	2,4
Economic growth			
External demand (GDP based)	0,8	0,6	1,7
Household consumption expenditure	-1,4	0,4	1,2
Gross fixed capital formation	-3,8	-1,3	7,8
Domestic absorption	-3,7	0,3	2,1
Export	2,0	3,4	5,3
Import	0,1	3,3	5,6
GDP	-1,7	0,7	2,1
External balance[3]			
Current account balance	1,7	3,4	3,3
External financing capacity	4,5	6,6	5,5
Government balance[3,8]			
ESA balance (2012 is preliminary data)	-2,0	-2,6	-2,9
Labour market			
Whole-economy gross average earnings	4,5	3,3	4,5
Whole-economy employment	1,7	0,8	0,8
Private sector gross average earnings	7,2	3,5	3,0
Private sector employment	1,4	0,2	0,4
Unit labour costs in the private sector	6,9	1,5	1,3
Household real income	-3,2	1,1	1,0

Source: Central Bank of Hungary, 2013

Enterpreneurial sector

The number of registered economic enteprises and non profit organisations was 1.806 million of which 1.056 million were individual enterpreneurship. The proportion of SMEs in Hungary is 99.9% of total enterprises, the remaining 0.1% are enterprises with more than 250 employees. Despite this fact 30% of employment and half of total added value comes from large enterprises. The structure of the economy is disbalanced by the overwhelming power of multinational companies who in proportion to their income hardly create more jobs than SMEs. This on the long run can lead unemployment, fall in consumption and state budget disbalance.

Current account balance

Current account balance improved in 2011 and was closed with a surplus of 1.4 billion euros which was due to the positive balance of real transactions while income and transfer balance further declined. In 2012 the surplus was 1.67 billion euros. The external net debt of Hungary which was 44.3% of the GDP in 2011 reduced with 12% from the previous year. The consolidated deficit of the central budget almost doubled compared to the previous year and reached 1.7 billion forints. The takeover of private pension fund improved the gross budget deficit and in 2011 it closed with a 4.3% surplus while in 2012 its deficit was -2%. The proportion of public debt to GDP is slightly under 80% and although it is not of an excessive figure in OECD countries the calculation of the DEWIL (Debt-Wage Index of Liberty) which shows how much an average person would have to work continously to pay back his share of debt has risen from the 2000 value of 12.5 months to 25 months in 2011.

GDP

The economic crisis halted the convergence of the Hungarian economy to the EU average. Per capita GDP of Hungary (on purchase price parity) was 54% in 2010, 63% in 2003 and 65% in 2009 and 2010. The GDP increase in 2011 was 1.7% which was followed with a -1.7% change in 2012 as the economy fell back into recession with a very unexpected quarterly drop of 2.8% in 2012 Q4. This is followed in 2013 by a slight forecasted increase of 0.7% according to the Central Bank of Hungary. However the influence of the boom in German economy has a significant impact on Hungary and the region. Compared to 2007 the gross added value improved in agriculture, information technology and communication significantly, while service sector was similar to 2007 values. Manufacturing industries total production grew with 6.3% while services dropped slightly with 0.6%. Heterogenity characterises sectors of the economy.

External trade

Over average economic growth was primarily from foreign trade on the users side while on production side industry and agricultre are the sectors supplying export. One of the key driving forces is external trade driven basically by pharmaceutical industry and automotive industry. Services also show a stabile growth. Hungary's export is in 75% to the EU member states and import comes in 70% from the common market. The German economy has an emphasised role in this circle as 25% of our exports and imports are transacted with Germany. Our other important export partners are Austria, Netherlands, Italy, France and the United Kingdom while on the import Germany is followed by Austria, Netherlands, Italy, France. The global economic crisis broke the development of trade and brought about a significant drop in our exports and imports. Only in early 2010 was the first sign of growth which nevertheless turned out to be stable and continous. In 2011 the growth was moderated but altogether the annual growth of export was 10% while import grew wit 6.9%. The improvement of trade balance resulted in the highest surpluses in the last decade and an increasing openness of the Hungarian economy to the global economic system. The figures for 2012 show a slowing tendency as the export grew with approximately 3% coupled with 2% growth in imports. Import volume of energy carriers grew only with 3.8% which accompanied with a 24% growth of energy prices significantly increased the value traded in this commodity subset. Export of energy carriers increased with 16% over the previous year to 2012 (although on a much smaller basis).

Industry

The uncertainty in the economy is further strengthened by plummeting investments. National investments accounting for 90% of gross capital formation are still characterised by decline. Investments in machinery and equipment have risen with 8.8% due to purchases from processing industries and transport vehicle purchases of enterprises. Construction investments have decreased with 14%.

Table 2.7. summarises the change in gross capital in 2010-2012 over the preceding years in percentage.

Table 2.7. Gross fixed capital formation by sectors in Hungary, 2010-2012

	2010	2011	2012
Agriculture, forestry and fishing	81,0%	105,0%	111,0%
Mining and quarrying	57,0%	129,0%	69,0%
Manufacturing	101,0%	136,0%	105,0%
Electricity, gas, steam and air conditioning supply	106,0%	112,0%	61,0%
Water supply; sewerage, waste management and remediation activities	121,0%	95,0%	115,0%
Construction	95,0%	85,0%	79,0%
Wholesale and retail trade; repair of motor vehicles and motorcycles	88,0%	97,0%	101,0%
Transportation and storage	79,0%	89,0%	95,0%
Accommodation and food service activities	96,0%	86,0%	101,0%
Information and communication	94,0%	86,0%	110,0%
Financial and insurance activities	97,0%	120,0%	76,0%
Real estate services	82,0%	75,0%	92,0%
Professional, scientific and technical activities	96,0%	116,0%	93,0%
Administrative and support service activities	95,0%	115,0%	98,0%
Public administration and defence; compulsory social security	90,0%	94,0%	142,0%
Education	170,0%	81,0%	64,0%
Human health and social work activities	149,0%	109,0%	61,0%
Arts, entertainment and recreation	132,0%	108,0%	70,0%
Other service activities	92,0%	131,0%	54,0%
Total	**93,0%**	**101,0%**	**99,0%**

Source: HCSO, 2013

In most of the sectors of the economy investments declined although processing industries and manufacturing show continous improvement in the last three years. A significant improvement in automotive industry was the extension of the Audi and Opel manufacturing capacities and the new installation of a Mercedes production unit in Kecskemét. Machinery, metallurgy, pharmaceutical industry, textile and leather production also made new investments. A sharp decline obstructed the computer, electronical and optical industries and electric equipment production. Construction shows a continous decline since 2008 with a drop of 21% in 2012.

Financing investments and securing and maintaining liquidity of enterprises steresses the role of bank loans. As confidence and trust was demolished by the 2008 global crisis the scarcity of short term credit significantly obstructs corporate operation. The stock of loans has been decreasing since the crisis and a forecasted further tapering of credit sources is expected on the market which can, by delaying investments prolong the stagnation and hinder long term performace. The excise tax levied on banks significantly weakens the positions of bank sector and they on the other hand reduce corporate loans impairing economic growth already on the short run.

Altogether the shock from the global crises has passed but there are additional negative processes hindering future development of the economy. In 2013 fortunately the danger of stagflation was avoided but slow recovery still characterises the economy and its major export markets. This might refer to structural problems and issues of competitivity. Major risks effecting the economy can be summarised as follows: lengthy recession and slowing of growth, export demand recession, decreasing investments, bank sector's cut in corporate crediting, and lack of confidence.

The situation at then end of 2012 is characterised with a slight decrease in labour demand, stagnation of sales and external trade and further decrease of investments.

2.7. Energy

Primary energy intensity, that is energy used for a unit of economic output produced is approximately 50% higher than the OECD average while purchace price parity this difference disappears (for the EU the values are 2.4 and 1.22 respectively). Electricity consumption intensity (on PPP) is even less than the OECD average which means that Hungary has simultaneously a relatively low per capita energy consumption and a relatively high energy intensity. Table 2.8. outlines the respective figures for Hungary and major regions of the world.

Table 2.8. Comaparison of energy and energy intensity indicators of Hungary and the major global regions in 2011

Region/Country	Population (millions)	GDP (bill USD_{2005})	GDP (PPP) (bill. USD_{2005})	Energy prod. (Mtoe)	Net Imports (Mtoe)	TPES (Mtoe)	Electr. Cons (TWh)
Hungary	9,97	111,16	172,52	10,78	13,12	24,96	38,84
World	6958	52 486	70 313	13 202	-	13 113	20 407
OECD	1241	38 239	37 906	3 854	1 622	5 305	10 205
Middle East	209	1 271	2 489	1 788	-1 106	647	737
Non-OECD Europe and Eurasia	340	1 597	3 666	1 822	-623	1 176	1 525
China	1 351	4 426	10 286	2 433	408	2 743	4 475
Asia	2 313	3 386	8 749	1 405	252	1 593	1 904
Non-OECD Americas	460	2 298	4 403	797	-186	589	942
Africa	1 045	1 267	2 814	1 104	-390	700	619

Region/Country	TPES/pop. (toe/capita)	TPES/GDP (toe/USD_{2005})	TPES/GDP (PPP) (toe/USD_{2005})	Electr. cons./pop. (kWh/capita)	Electr. cons./ GDP (PPP). (TWh/ bill. USD_{2005})	CO_2/TPES (t CO_2/capita)	CO_2/pop (t CO_2/cap)
Hungary	2,59	0,22	0,14	3895	0,225	1,9	4,75
World	1,88	0,25	0,19	2 933	0,29	2,39	4,50
OECD	4,28	0,14	0,14	8 226	0,269	2,33	9,95
Middle East	3,10	0,51	0,26	3 532	0,296	2,48	7,70
Non-OECD Eur. and Eurasia	3,46	0,74	0,32	4 492	0,416	2,33	8,08
China	2,03	0,62	0,27	3 312	0,435	2,92	5,92
Asia	0,69	0,47	0,18	823	0,218	2,19	1,51
Non-OECD Americas	1,28	0,26	0,13	2 046	0,214	1,84	2,36
Africa	0,67	0,55	0,25	592	0,22	1,38	0,93

Source: IEA, 2013

Concerning primary energy the decline of domestic coal mining was coupled with the structural change of an increasing use of natural gas. Fossile energy carriers share in primary energy was 80% in 1990 and 75% in 2009. Hungary's natural gas is covered from Russian imports in 80% through practically only one gas pipeline (Brotherhood) which makes supply vulnerable. The HAG pipeline connects us to the Austrian transit node but its capacity is limited (a doubling is planned). Safety of supply is guaranteed by commercial and strategical reserving, presently domestic storage capacity – uniquely in Europe – surpasses half of the annual consumption (approximately 5.8 billion m^3). The legislation about security storage of natural gas prescribes that at least 600 million m^3 has to be stored in gas containers with a daily output rate of at least 20 million m^3. Safety reserves of crude oil and oil products are sufficient to cover the average consumption of 90 days in Hungary.

The domestic energy balance is shown in Table 2.9.

Table 2.9. Accumulated domestic energy balance, source: Hungarian Energy Office

	2012	
	In natural units**	**PJ**
I. Production		**438,8**
I.1 Coal	9 290	67,2
I.1/a mining and strip mining	852	9,1
I.1/b lignite from Mátraalja	8 438	58,1
I.2 Crude oil	646	27,1
I.3 Gasole	162	6,8
I.4 Natural gas (dry, net)	2 234	74
I.5 Mining PB	126	5,9
I.6 Hydroelectric Power	213	0,8
I.7 Prod.of Wind Power Plant	771	2,8
I.8 Nuclear Power	15 793	172,3
I.9 Firewood Observed	0	32,6
I.10 Other(vegetal materials and wastes)	0	49,3
II. Imports		**683,4**
II.1 Coal	1 786	51,5
II.2 Briquettes	8	0,1
II.3 Coke	7	0,2
II.4 Crude oil	5 449	227,8
II.5 Petroleum products	2 176	92
II.6 Natural gas	8 173	282,4
II.7 Electricity (import-export balance)	7 966	28,7
II.8 Firewood (observed)		0,6
II 9 Municipal waste		0,1
III. TOTAL ENERGY (I.+II.)		**1122,2**
IV. Less: exports		158,9
V. Stock changes		-34,2
VI. DOMESTIC USE (III.-IV.-V.)		**997,5**

*** kt, Mm3 at 15°C,GWh*

Source: MEKH, 2013

Renewables and their role

Share of renewable energy in total primary energy supply was around 9.3% in 2012. This means that Hungary is in the lower third of the EU members and is not eminent in the circle of countries with similar economic development in our region (Bulgary 9.4%, Czech Republic 7.2%, Poland 7.9%, Romania 20.4%, Slovakia 8.4%, Croatia 13.6%). The significant difference comes from better hydroelectrical potential of some CEE countries and a better rate of afforestation on the one hand. On the other hand however better regulation and policy incentives are also a key to explaining the differences. According to the EU Renewables Directive Hungary has to achieve 13% for the share of renewables, the first stage prescribed (average of 2011-2012 should be at least 6.04%) has been achieved.

Hungary has accepted the Renewable Energy Action Plan in 2010 with a more ambitious program setting targets beyond the EU Renewables Directive. The first stage target is 7.4% until 2012 and by 2020 14.65% share has to be achieved. The Action Plan considers the domestic endowments and emphasises biogenous sources (biomass from agriculture and forestry, biogas, biofuels for agrarian uses), geothermal and solar energy sources. Hungary has not exploited the available domestic renewable potential, a research concluded by the Hungarian Academy of Sciences suggests that theoretically available energy amounts to 2600-2700 PJ/year. The actual level of utilisation are characterised by technical and economical constraints and for a feasible maximum there is no uniform estimation. With the development of technologies these estimations change dynamically. Table 2.10 shows renewable energy consumption in 2012 by sources.

Table 2.10. Consumption of renewable energy by sources in 2012

Renewable Energy Sources	Total Energy (Pj)
Electricity from hydro power	8
Electricity from wind power	28
Geothermal	44
Firewood	326
Other solid wastes	428
Solar (collector + photovoltaic)	3
Biogas	32
Biofuels	58
TOTAL	93
National energy consumption (PJ)	*998*

Source: MEKH, 2013

Natural resources and reserves

Natural resources are state property in Hungary in their natural form and they constitute a part of the national property. They are registered and montired by the Hungarian Office for Mining and Geology. Coal mining was a determining factor in Hungary's energy supply until the late 1960s and quantities mined have been declining since the 1970's. Increased utilisation of domestic coal resources can be and should be supported but a necessary precondition is maintenance of environmental standards in emission and waste management. Table 2.11 presents an overview of domestic fossile and uranium resources and reserves.

Table 2.11. Conventional reserves and resources of Hungary, 2011

(Mt)	Resources	Extractable reserves	Production (2008)	Production (2009)
Crude oil	2 094	184	81	80
Coal	16 251	19 155	-	-
Brown coal	31 980	22 438	139	95
Lignite	57 610	43 563	804	803
Uranium ore	26,8	26,8	-	-
Natural gas (bill. m^3)	3563	2392,9	2,88	3,12

Source: Hungarian Office for Mining and Geology

Natural gas resources are 3563 billion m^3 which includes the unconventional shale gas play in Makó where the technology for extraction is not yet mature. If calculcating with operating locations only then natural gas resources amount only to 45.6 billion m^3, the highest present production rate is at Algyő. Estimated remaining supply of natural gas is only 17 years if present extraction rate is assumed for the future. The largest assets are in the shale gas deposit of Makó (3-6 kms depth), where explorations were started by Falcon Oil and Gas Ltd. from Canada whom was later joined by the Hungarian Oil Companies (MOL) and the daughter of Exxon-Mobil. The estimations show that extractable reserves could cover around 34.2% of domestic needs for 30 years should production start in the future with an extraction rate of 30% of the resources assuming 50 wells drilled annually. Concerning uranium ores Kővágószőlős (southern Hungary) was a location of ore mining in the past and was closed down due to economic reasons in 1997. Uranium ore mining and processing has stopped but market demand raised exploratory interests since 2006 and intensive exploration and research is undertaken in the South-Transdanubian region (Mecsek mountains). Ore deposits are relatively large in an international comparison but ore content is only 1.2 kg/t. Price of uranium-oxide on the international commodity market are between 90-120 USD. According to estimations only a market price of over 150 USD would allow for economic extraction.

Power sector

Hungary's power sector is characterised by a controversial situation. The power sector consist of units which are mostly base load units making system regulation increasingly difficult considering off-peak periods. Presently outdated and inefficient fossile fueled units are used for system regulation and these 200MW units provide the secondary reserves. The power system at its present state can soon face situations what it will not be able to manage due to lack of reserves. The common unified market for electricity can aid this by sufficient crossborder capacities. The daily peak loads and energy demands are shown in Table 2.12.

Table 2.12. Capacity and energy data of the Hungarian grid on the days with highest demand

	1960	1970	1980	1990	2000	2001	2002	2003	2004
Maximum daily gross load (MW)	1 295	2 983	5 184	6 534	5 742	5 965	5 980	6 140	6 357
Daily energy demand (GWh)	267	604	105	1 448	1 243	1 313	1 304	1 285	1 307
Load factor (h)	20,6	20,2	20,3	22,2	21,6	22,0	21,8	20,9	20,6
	2005	2006	2007	2008	2009	2010	2011	2012	2013
Maximum daily gross load (MW)	6 439	6 432	6 602	6 388	6 380	6 560	6 492	6 463	6246*
Daily energy demand (GWh)	1 334	1 355	1 376	1 375	1 368	1 352	133 954	1 328	129.76*
Load factor (h)	20,7	21,1	20,8	21,5	21,4	20,6	20,6	20,5	20,3*

**estimated*

Source: MEKH, 2013

The global economic crisis impaired income of domestic power plants significantly, according to analyses wholesale price of electricity reduced with 40%. Share of imported electricity increased and certain power plants with low efficiency were completely crowded out from the market. On the demand side consumption grew with 21% in the two decades before the global economic crisis, but fell back with 6% in just one year. From 2010 demand started to grow again with 2-3% annually.

The balance of the power system is presented in Table 2.13.

Table 2.13. Balance of power system units in 2011

	Installed capacity MW (gross)	Power produced (GWh)	Heat produced (TJ)	Energy used (TJ) by fuel type: Solid fuels	Liquid fuels	Gaseous	Nuclear	Renewable	Other	Efficiency
Paks	2000	15685	508	0	0	0	170967	0	0	31,30%
Dunamenti	1928,7	1588	825	0	241	12715	0	0	0	48,40%
Tisza	900	1242	0	0	178	11859	0	0	0	34,60%
Mátra	950	6517	179	58204	271	1723	0	6025	0	31,60%
Oroszlány	210	1023	346	9133	287	0	0	3833	0	25,90%
Pécs	132,5	54	715	0	0	1039	0	0	0	85,10%
Ajka	101,6	90	2645	3047	0	9	0	1470	0	61,20%
Borsod	136,9	99	0	55	0	34	0	1668	0	16,20%
Tiszapalkonya	200	11	444	558	0	61	0	0	0	73,50%
Csepel	410	1870	1052	0	1	14855	0	0	0	51,50%
Gönyű	433	1015	0	0	21	6567	0	0	0	54,40%
Kelenföld	185,9	448	2477	0	17	5131	0	0	0	77,60%
Kispest	114,1	394	1900	0	0	3853	0	0	0	84,50%
Újpest	110	408	2488	0	0	4674	0	0	0	83,20%
Debrecen	95	304	796	0	0	2521	0	0	0	75,00%
Bakonyi GT	120	12	0	0	14	87	0	0	0	37,10%
Lőrinci	170	9	0	0	103	0	0	0	0	31,50%
Litér	120	5	0	0	60	0	0	0	0	30,00%
Sajószöged	120	4	0	0	49	0	0	0	0	29,40%
ISD Power	69	11	4300	0	9	7068	0	0	0	65,30%
Bánhida	100	-	-	-	-	-	-	-		-
Large PPs	8636,6	30889	16675	70997	1251	72196	170967	12996	0	37,10%
Small PPs	1472,2	5095	21386	226	65	28411	0	25192	0	74,10%
Domestic PPs	10108,8	35984	40061	71223	1316	100607	170967	38188	0	42,30%
Import balance	-	6642	-	-	-	-	-	-	23936	100%
Total	**10108,8**	**42626**	**40061**	**71223**	**1316**	**100607**	**38188**	**23936**	**23936**	**45,70%**

Source: MAVIR, 2012

According to the Hungarian Grid Operator the installed capacity of the Hungarian grid is 10,1 GWs, available capacity was 9142,4 MW. Significant changes occurred in the large power plants, the Tiszapalkonya PP (200MW) and the Borsodi PP (136,9MW) are constantly out of operation. New installed capacities are Gönyű PP (433 MW, gas turbine), two open cycle gas turbines in the Ajka PP, and the G3 unit of Dunamenti PP (410,5MW).

The domestic situation and the lack of wholesale market competition does not enforce continous technological developments resulting in an outdated production structure with higher primary energy needs and labour costs than the European average. Our existing coal power plants are still playing a major role in electricity production but are well beyond their planned lifetime, their efficiency and environmental parameters are not comliant with the requirements of today. Younger units built after the transition are also lagging behind in variable and fix costs of operation and are internationally not competitive. The exceptions are the recently installed gas turbine units and the Paks Nuclear Power Plant (Paks NPP). The Paks NPP plays a decisive role in power production by supplying over 40% of the total domestic electricity on the cheapest prices. It is a key element of competitive and climate friendly power supply. The lifetime extension of the Paks NPP was accepted by the Parliament and ratified in 2009 (25/2009. (IV. 2.) Parl. decree) allowing for an extra 20 years of operation over the planned initial 30 years.

The future capacity needs are highlighted in Table 2.14 which shows the remaining capacity of the present system until 2027. It is visible that the present stock of large power plants (8600 MW) will be reduced to 5300 MWs in ten years and will reach 4400 MW in 20 years. While these units are not the youngest by today's standards in twenty years this nominal capacity is only expected to be available in 50% - the replacement has to be started at the earliest possible date.

Table 2.14. Total remaining installed capacity

	2011	2017	2022	2027
Large PPs	8637	5718	5348	4358
Small PPs	1472	1352	1259	1124
Total capacity	10109	7070	6607	5482
In percentage	-	70%	65%	54%

Source: MAVIR, 2012

Concerning renewables approximately 8% of total electricity supplied came from renewable sources which in 68,5% consists of biomass. A large share is due to co-firing of lignite and firewood in low efficiency power plants. Windpower has a share of 13,4%, hydroelectricity amounts to 9,7%, biogas to 2,2% and communal waste to 6,2% of renewable electricity production. Present situation of renewables can and need to be supported by the obligatory takeover system (KÁT) which allows for a feed-in tariff. Combined heat and power units were also subject to this subsidy but were removed from the beneficiaries in 2012. Additonal improvement could be achieved by harmonising and simplifying bueorocratic procedures for renewable capacity installation. From the technical engineering side the real time regulation capability of the grid has to be improved in order to accommodate further renewable capacities without jeopardising grid stability.

The trend of RES-based power production is shown in the following chart over the last decade.

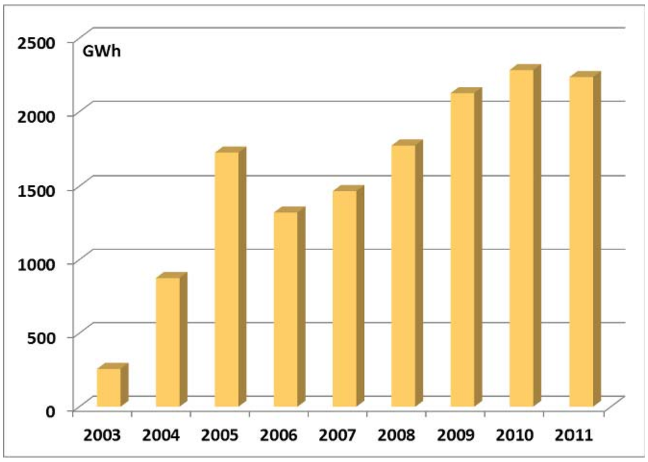

Figure 2.10. RES-E based power production

Source: MEKH, 2012

Table 2.15. shows the short term tendency in renewables in power production for 2011 and 2012. Waste accounts for 5 GWh while co-firing decreased due to the depletion of allowances of the Vértes PP and the suspension of operation of the AES Borsod PP. Behind the increase of pure biomass fired renewable electricity production is the restart of operation of the DMB's Szakoly PP. Wind power capacities did not increase, the better production is due to better wind conditions. As a new element solar PP appeared in the renewable power generation. Total installed capacity under KÁT reached 555 MW (pure renewable sourced: 547 MW) due to the capacity reduction of co-firing units.

Table 2.15. Electricity sold in the framework of the obligatory takover system (GWh)

	2011	2012	Change (%)
Wind energy	600,96	742,49	23,55%
Hydroelectricity	212,20	203,14	-4,27%
Biomass firing	510,33	600,48	17,66%
Coal-biomass co-firing	401,48	151,31	-62,31%
Biogas	79,10	118,29	49,55%
Depony gas	35,24	44,26	25,60%
Wastewater gas	1,00	1,23	23,49%
Solar energy	0,00	0,33	-
Renewable altogether	**1840,30**	**1861,53**	**1,15%**
Waste	13,01	5,23	-59,8%
CHP	2150,23	-	-
Other fuels	4,22	0,19	-95,38%
Total renewables, waste and other:	**1857,52**	**1866,96**	**0,51%**

Source: MEKH, 2013

Following the Renewable Directive an obligatory share of bioethanol is blended into fuels sold at gas stations. The following table summarises the share of renewables in the transport sector. The increase is not significant yet if we compare the declining turnover in fuels it still shows a stabile tendency.

Tables 2.16a. and 2.16b. show actual renewable energy use in transport sector and in heating and cooling applications.

Table 2.16a. The actual renewable energy use in the transport sector

Unit: ktoe	**2009**	**2010**
Bioethanol/bio-ETBE	46	57
of which imported	7	44
Biodiesel	123	119
of which imported	21	21
Renewable power	16	15
of which road transport	0	0
of which other transport	16	15
TOTAL	**185**	**191**

Source: MEKH, 2013

Table 2.16b. The actual renewable energy use in the heating-cooling sector (ktoe)

	2009	**2010**
Geothermal (low potential heat utilised by heat pumps excluded)	96	99
Solar	5	5
Biomass	844	951
of which solid biomass	836	942
biogas	8	9
liquid bio-fuels	0	0
Total	945	1 055
of which district heating/cooling	58	66
of which domestic biomass use	581	658

Source: MEKH, 2013

Heat energy

Approximately 40% of total energy is used in our buildings mainly for heating and cooling. Around 70% of the stock of 4.3 million dwellings is outdated and does not comply with technical and thermal standards. Public buildings show similar figures. Hungary's average energy consumption for households is among the ten highest in European comparison (EU average of 2000-2007 was 220kwh/m2/year while for Hungary this is 247 kWh/m2/év). The household energy efficiency programmes concluded in the last years improved the situation but the extent is not precisely known as monitoring is not available for the investments. Roughly 80% of household energy use is for heating purposes (hot water, space heating and cooking) which is supplied through natural gas, firewood and district heating. The high proportion of natural gas used in winter gives special tasks for the energy industry and faces decision makers with security of supply concerns. This situation could be improved by new energy saving programmes, with measures aiming at insulation and efficiency improvement. In addition, switching to renewables should also be subsidised. Table 2.17 shows energy intensities of different building types and dwellings.

Table 2.17. Energy use of typical dwellings

	Family house	Industrial blockhouse flats	Public buildings	New constructions
Average area (m2/dwelling)	90	55	1200	80
Average energy intensity of heat use (kWh/m^2/year)	320	200	340	100

Source: National Energy Strategy, 2012

The current domestic financial and technological practices allow for 10-40% energy savings, compared to the presently possible 85%. This is due to the fact that complete renovation of a building is uneconomical and the presently undertaken suboptimal renovations can lock Hungary on a high energy intensity and high carbon emissions trajectory. This has to be considered when designing programmes of buildings refurbishment. It is a political decision to decide if we want to reduce double as many consumers bills with 40% or half as many consumers bills with 80%. The proportion of district heating in TPES was reduced from 12% in 1990 to 8% in 2010. Presently, 15% of the dwellings are connected to the district heating network, with most of them built with industrial technology. Heat supplied from district heating is purchased also by public entities (12%) and industrial consumers (25%). Flats heated with geothermal energy are of very small proportion (6000 dwellings). Renewable share of heat use in households are very difficult to track as firewood purchases are individual and informal (and many times illegal). Figure 2.11. shows the share of households together other sectors in TPES.

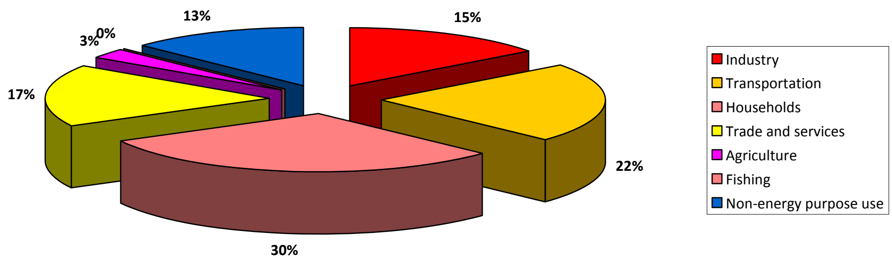

Figure 2.11. The shate of energy using sectors in energy consumption, 2011

Source: National Energy Strategy, 2012

Table 2.18. presents the values of domestic energy use by source and sectoral breakdown of primary TPES in TJs.

Table 2.18. Sectoral breakdown of TPES (TJ)

Primary energy production	451 063
Import	734 621
Export	-185 217
Bunker fuel (international aviation)	-9 976
Stock change	53 335
Domestic primary energy use	**1 043 826**
reclassifications	-47
statistical differences	22 534
Energy transformation	**-232 073**
Energy sector self consumption	**-47 779**
Losses (grid)	-24 618
TPES	**761 843**
Industry	**111 559**
Transportation	**168 885**
road	162 903
railway	5 982
Other	**383 302**
Households	230 973
Trade and services	131 780
Agriculture	20 524
Fishing	25
Other	0
Non-energy purpose use	**98 096**

Source: MEKH, 2012

2.8. Industry

Major industries of Hungary are information technology and consumer electronics, chemical industry (esp. pharmaceuticals), motor vehicles production, mining, metallurgy, construction materials, processed foods, textiles. The industry of Hungary is fundamentally high technology based high efficiency sector oriented towards and driven by exports.

Developments in the manfacturing industry

In 2010, Audi announced the expansion of vehicle production in its Győr plant. With an investment of EUR 900 million, 1,800 new jobs would be created in Győr. Because of the growing demand for Audi-products, the need for new employees has been increased to 2,100. As a result of the development, four different Audi models will be completely produced in Győr. The factory will cover the whole production activity, beginning with the bodywork, through paintwork until the assembly. Working at full capacity from 2013, Audi will have a major influence on the Hungarian Economy. After the expansion project, Audi – including its own headcount, suppliers and service providers – will ensure a livelihood for over 15,000.

From 2013 on, 125,000 cars will roll off the manufacturing line in Győr each year including the Audi TT Coupés, Roadsters, A3 Cabriolets and a further version of the A3. Through the continuous factory enlargement and developments, Audi constantly needs skilled and quality workforces. For this reason, Audi has invested significant amounts into education and vocational training. Cooperating with Győr's more vocational schools, in the framework of dual education, annually, 100 students complete their practical studies at Audi.

On 14th April 2011, the foundation stone for a new Opel / Vauxhall engine plant in Szentgotthárd was laid. Starting production in late 2012, the plant has a production capacity of 500,000 engines per year. With an investment of EUR 500 million, Opel created 800 jobs. The new engine plant is located at an existing site that will be considerably expanded. The manufacturing programme will consist of families of small and medium petrol engines, and a family of medium-sized diesel engines. The new engine range will fulfil EURO 6 emission standards, add direct injection to the petrol powertrain, secure a low power to weight ratio, providing smoother running and substantially reduce fuel consumption and CO_2 emissions.

Daimler AG announced on the 18th June 2008, the establishment of a new car manufacturing plant, producing the new generation Mercedes A and B models in Kecskemét, Hungary. The factory is one of the biggest greenfield investments in the history of Hungary, where the new generation A and B-class models of Mercedes will be produced at a rate of 100,000 cars a year. Besides the 2,500 new employees, once at full capacity, it is estimated that it will create about 10,000 indirect jobs on the supply side.

Suzuki Hungary enlarged its production capacity to 300,000 units per year, with an investment of HUF 50 billion in 2007. The company introduced its new Swift model in 2010, with new models in preparation for the future.

From the world's top TIER 1 suppliers following companies are present in Hungary: Asahi Glass, Autoliv, Benteler, BorgWarner, Bosch, Bridgestone, Brose, Continental, Dana, Delphi, Denso, Faurecia, Federal Mogul, Gedia, Hammerstein, Hankook Tires, Johnson Controls, Knorr-Bremse, Lear, Linamar, Magna, Michelin, Nemak, Schaeffler, Sumitomo, Valeo, Webasto, ZF Group.

Hungary took significant steps to promote the industry in fulfilling requirements for globalisation. As a result, and because of cost-effective reasons, the OEM's and TIER1 suppliers are outsourcing even more, non-strategic activities to their lower-level suppliers. To make the Hungarian SMEs suitable for these procedures, Hungary has made significant efforts in the conscious development of Hungarian automotive supply companies. This means the enhancement of innovation and R&D potential at lower-supplier level, with further development of connections to universities and colleges and help in the reception of high-skilled workforces at company level.

Bosch AG made the decision to develop new R&D investments in Hungary, and laid the foundation-stone of the new Budapest Centre, being built from a budget of HUF 6 billion. It provides the base for the 350 employees, working in the fields of development, marketing and administration of Robert Bosch Kft. and Bosch Rexroth Kft. The first stage of the development in Budapest was finished by Spring 2013, while the second stage of the project for the Budapest Development Centre will start this year and finish in 2015.

The following incentives are offered for manufacturing projects.

- Subsidy based on individual Government decision,
- EU co-financed tenders,
- Development tax allowance,
- Training subsidy,
- Job-creation subsidies,
- Other, personal-type subsidies.

Overview of trends

Industrial production in 2012 fell behind the previous year's values with 7.6%. This fallback is primarly due to the reduction of demand for IT products, electronic devices and the reduction of production in the automotive industry driven by external trade. The volume index for December 2012 shows a 3.4% drop. The overall annual average production was 1.7% smaller than in 2011. Manufacturing and processing industry dropped with 8% compared to the previous year while decrease in mining was 10.9%. Energy industry's output was 3.3% less than in 2011. Heat demand increase from the colder weather conditions in winter could not balance up the reduction of industrial heat demand.

A retrospective overview is given on Figure 2.12. of industrial output in current prices and million HUF.

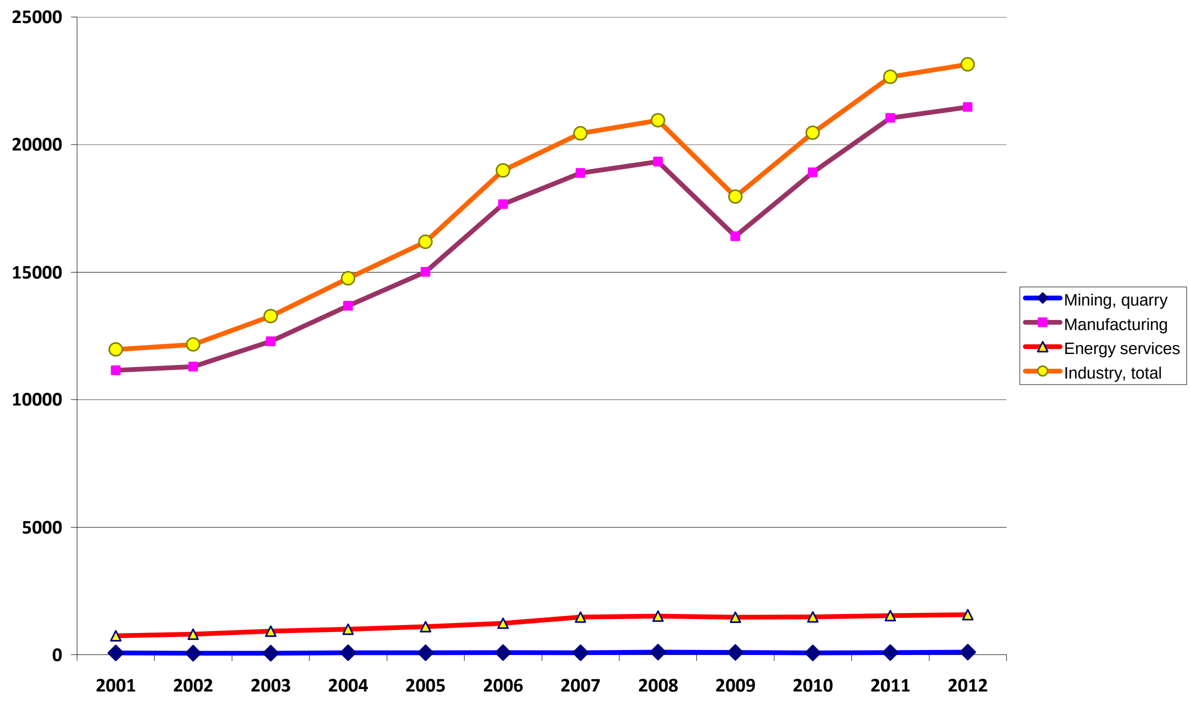

Figure 2.12. Dynamics of industrial output by sectors (M HUF, current prices)

Source: Hungarian Statistical Office, 2013

Industrial production in Hungary decreased in 2012, in which the recession of the Euro region and the restrained behaviour of market actors played a major role. In 2012, total industrial production – after a 5.6% increase in 2011 – dropped by 1.7%. Sales in foreign markets decreased by 0.7%, and the volume of domestic sales, which has shown a downward trend for five years now, lagged by 3.9% behind the figure one year earlier. In 2012, the output of manufacturing industry generating more than nine-tenths of industrial production was 1.6% lower than one year earlier. Of the export-oriented engineering industry sub-sectors generating nearly one-half of the output, the volume of vehicle production grew by 8.5% in 2012, at a smaller rate than in the previous year, while the output of the computer, electronics and optical products manufacturing industry – considered to be the most important sub-sector earlier – declined by approx. 18%. The production volume of electric equipment as well as machine and machinery was around the previous year's level. All engineering industry sub-sectors are characterised by heavy export exposure. Of the four sub-sectors, only vehicle production saw an increase (11%) of the export sales volume, while in the other sub-sectors, a reduction between 0.5 and 17% occurred. Providing more than one-fifth of the production, chemical industry had an output which decreased by 2.5% in 2012 as against the previous year. (In 2011, the growth was 4.6%.) Within the chemical industry, it was only the pharmaceuti-cal industry mostly exporting to foreign markets, where gross output grew by 4.3%. Being the third largest in production, food industry raised its gross output by 4.4% in 2012, after a 3.1% growth in 2011. Export sales increased by 10.4% and domestic sales by 1.3%. Similarly to the previous two years, industrial pro-ducer prices were 4.3% higher on average in the year 2012 than one year earlier, as a result of a 5.3% growth of domestic sales prices and a 3.6% growth of export sales prices.

The output of the construction industry has seen a decline since 2006, and the production in the sector lagged by 5.9% behind the previous year’s figure in 2012. Of the main construction categories, the construction of buildings dropped by 7.6% in 2012, still caused by the decrease in home constructions and by the lack of large scale investments. The construction of other buildings decreased by a smaller rate (4.0%), because the decline of utilities constructions (8.5%) was mostly balanced by the rising output of road and railway construction enterprises. In recent years, home construction and the number of construction permits have dropped dramatically. Home con-struction was characterised by a prolonged decrease in 2012, but the rate of decline diminished. In 2012, as many as 10,560 new homes were built, as much as 17% less than in 2011. The number of new home construction permits issued was 10,600, as much as 15% less than one year earlier.

2.9. Transport

2.9.1. Infrastructure

Hungary's central location in Europe and the dense motorway network is one of its most important competitive advantages. Four vital European transport corridors pass through Hungary, providing unparalleled access to all parts of Europe, including major European ports and the fast-growing CIS market. In order to exploit these benefits, Hungary is determined not only to preserve, but also to enhance its infrastructural network and to improve its integration into the European network.

Road Network
As a result of intensive construction works along main transport corridors, major motorways and trunk roads reach national borders, ensuring faster and safer transportation. Hungary has an extensive road system, centred in Budapest, and the most developed highway network among new EU member states. 70 % of the road traffic is passing through the motorways and main roads of the country. The length of the country's expressway network is 1,110 km. The improvement of the highway network and four-lane motorways linking all the major cities in Hungary will result in an approximately 40% decrease of driving times on the main inter-city routes. Figure 2.13 shows the present and planned motorways in Hungary.

Motorways are marked by 'M', international roads (European transit roads) are marked by 'E'. Seven of the eight main roads start from Budapest (designated by single digit numbers, running clockwise from the Vienna motorway M1) and all of them link up with the European road network. A top priority of the Hungarian government is to further extend and reconstruct the road network in Hungary.

Road transport and the transport network are in a contradictory and continuously changing situation in Hungary. This can be characterised by the following factors:

- the network of good quality and rapidly expanding expressways and almost 500 dead-end settlements are present at the same time in the country
- in the central and western, whereas in the south-western and south-eastern parts of the country the problem is caused by the saturation of the public roads and by delayed accessibility, respectively
- while the traffic problems of the large towns – congestions, parking difficulties, air pollution – remind us to the developed countries, the access of peripheral areas has hardly improved in 50 years

There are many, relatively new difficulties: deterioration of the main and secondary road network has grown to dangerous dimensions in the last 10 years. On the national public road network the average period of pavement renewal has been extended from an 8-15 year-interval to 47 years.

Railway Network
The railway network covers the whole country and is an integral part of the international railway network, thus providing easy access by international express trains from the neighbouring and numerous other European countries.

Fast connection to sea ports
Several scheduled block train lines connect Hungary with the sea ports of Hamburg (D), Bremen (D) and Rotterdam (NL) on the North Sea, with Koper (Sl) and Trieste (I) on the Adriatic and soon with Constantza (RO) on the Black-Sea. The Koper, Trieste and Constantza seaports also offer alternative shipping routes from Asia. Lead time from these ports to Hungary is within 16-36 hours by road or direct train.

Over 20% of freight is transported by rail in Hungary, well above the EU average. Záhony and its region at the Hungarian-Ukrainian border is the junction and reloading centre for European standard-gauge railways and the wide-gauge system of the CIS states .

Figure 2.13. Road network in Hungary: existing and planned motorways

Source: Hungarian Chamber of Commerce

Inland Waterways
Hungary is landlocked but has access to the Black Sea and the North Sea via the river Danube. Major inland ports are located in Győr-Gönyü, Budapest, Dunaújváros and Baja. The opening of the Danube-Rhine-Main channel in 1992 made possible the performance of export-import traffic with the countries along the Rhine and the maritime ports in the North, too.

Air

The main International Airport in Hungary is the Liszt Ferenc International Airport in Ferihegy, Budapest. Budapest is serviced by numerous major international airlines, with significant growth in the charter air service market to closer destinations in the region. Budapest is also accessible by several low-cost airlines. Larger cities maintain airports for private aircrafts. New airport development projects are foreseen for transforming former military airfields into cargo airports.

2.9.2. Factors affecting emissions from transportation

When comparing the age and average quality of the domestic fleet of vehicles we can examine similar indicators of EU countries and analyse the dynamics of these indicators. In general vehicle density lags behind the European average but even behind the average of New Member States. This handicap can be an indication of a low level of GDP but checking Denmark's respective indicators the connection between GDP and vehicle stock might be indirect only. Hungary improved both in absolute and relative terms in car density between 2000-2009.

While the average European dynamics showed 10% increase the Hungarian figure was 30%. This however is dwarfed by Latvian, Polish and Romanian growth (respectively 70%, 68%, 59%)

Average age of car fleet and its change can on the other hand allow for deductions on quality and technical condition. It improved beneficially but the global crisis brought about a disadvantegous consequence of a radical drop in new car registrations. The new registrations dropped by 2010 to one third of the 2008 value and we arrived to the 2000 niveau of an average age of 12 years in 2011.

The stock of cars is decreasing constantly in the last 3 years despite the fact that the rate of scrapping also declined beneath 2004-2007 values. Statistics of the Central Statistical Office shows that the stock of new cars (vehicles under the age of 1 year) started to grow in 2010 after the continous fall from 2004 which climaxed in a 70% drop in 2009. The stock of personal vehicles dropped with an annual average of 1.2% in the last years due to the historical low in the sales of new and used cars (it is worth mentioning that growth rate between 2001-2003 was 5.5% and even between 2004-2008 it was 1.9%).

Concerning the composition of the car stock 79% was equipped with petrol engine in 2010 (2000 – 90%) . The change in vehicle stock was therefore fundamentally due to the reduction of gasoline combustion vehicles, the number of petrol cars has been continously reducing since 2003 and the absolute numbers are falling since 2009 (2,2% and 2% in 2010).

The stock of Diesel-engine vehicles has increased from 10% in 2000 (230 855) vehicles to 21% by 2010 (619 807 vehicles). This is due to the better consumption and increasing performance and happens despite the increasing cost from deNOx-measures already manifesting in (higher) consumer prices. For fuel use trends see Table 3.14.

Other fuel driven vehicles are in insignificant numbers (8000 units in 2010, 0,3% of total vehicle stock), approximately half of these are hybrids and the rest is mixed combustion.

For CO2 emission intensities (g/km) the average values of the 2005-2010 period can be considered. The continous upgrading and retirement of old vehicles improved average emissions with 13% between 2000-2010. Most significant improvement was in the age group over 16 years followed by new cars indicating the efficiency improvement in the automotive industry's newest models. Figure 2.14. shows the difference between age groups in 2000 and 2010.

The diminishing income of households forces them to run their cars beyond their expected lifetime. The average frequency of retirement was 6% in 2001 and reduced to 3.1-3.3% by 2010. The estiamted average age of retired (scrapped) vehicles is 23 years, slightly higher than the average age of the cars retired in Slovakia or Romania in the framework of their junk-the-car programme.

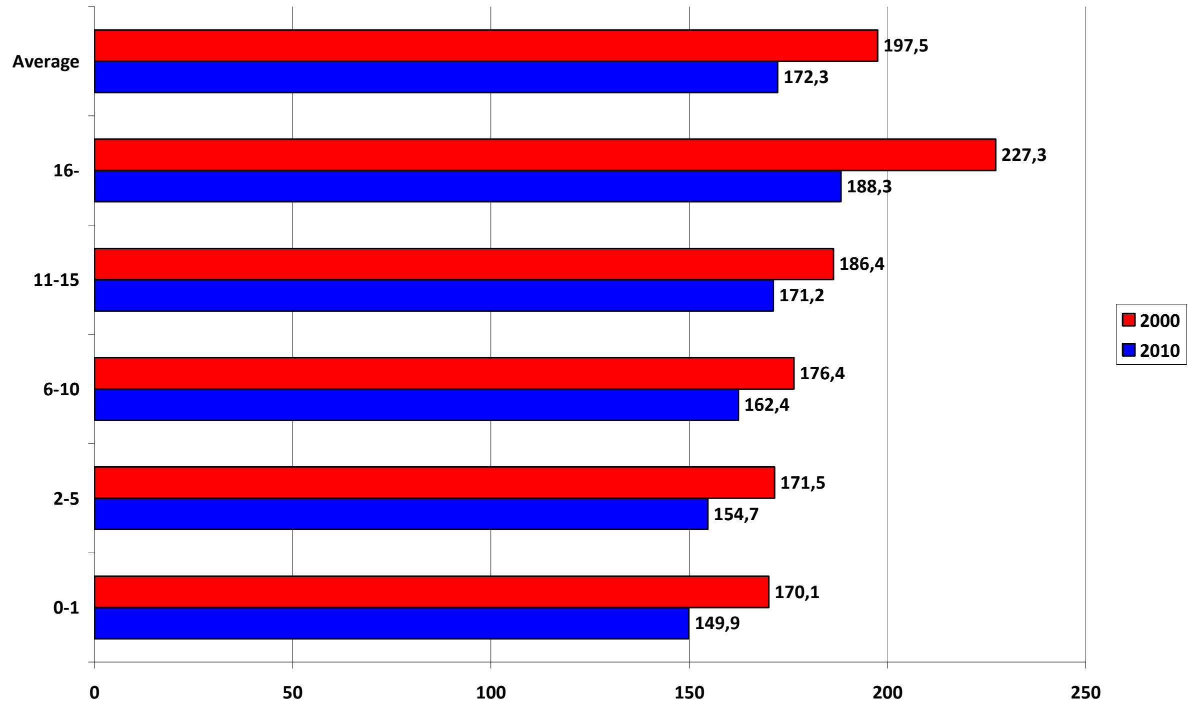

Figure 2.14. Average CO2 emission intensities (g/km) in 2000 and 2010

Source: GKI Energia, 2012

The increasing number of vehicles and the changing utilisation patterns have significant impact on future fuel consumption and energy use.

2.10. Agriculture

The natural endowments of Hungary, soil quality and climate are quite beneficial for agricultural production. This allows for high quality products and high yields through an agriculture of milennial tradition. The qualitative and quantitative indicators in the traditionally strong sector were among the world leaders in the 1970s and ’80s.

Following the transition of 1990 the political and socio-economic developments had a negative impact on Hungary’s agriculture. Production decreased between 1990 and 2000: employment and indices of production’s gross volume significantly dropped in agricultural cooperations and farms. Livestock had also dramatically decreased with a drop of 50%.

After the accession to the European Union the Hungarian agriculture faced a different frame of conditions. Despite the difficulties however legal harmonisation with the EU legislation framework was achieved, the necessary institutional background was created by establishing the Rural Payment Agency and crossborder Animal Health and Food Control Stations, and by coaching experts and preparing producers.

Despite these measures a part of agricultural producers were not ready for the EU accession in 2004 which fundamentally changed the structure of subsidies and our market position. As a result the reduction in the number of agricultural units was 30% (approx. 350,000 units) and the number of registered farms declined with 20%. Hungarian agriculture suffered enormous losses on both import and export markets.

Another adverse effect for the sector was that new Member States could receive 100% of the direct Union payments only gradually after a 10-year transition period, with subsidy level starting from 25% of the older EU member states. Top-up of subsidies may be provided up to 30% as a complement.

Opening of the markets in both directions resulted in a disbalance of the agricultural trade balance. On the common market the competitivity issues of swine and poultry industry surfaced sharply and the esteemed beneficial impacts on fruit and vegetable production came also later than expected. The share of plant production increased against the share of livestock husbandry in gross production. Concentration of food processing industry and retail together with the dominance of foreign capital had also adverse effects on the position of domestic producers. Enormous efforts were and are still necessary in livestock husbandry to comply with animal welfare and environmental regulations.

Economic significance
The share of agriculture in Hungarian GDP was on average 3.3% in the period of 2008-2012 (with 3.2% in 2012). In consumption it was 24.5% (2011-24.5%) in export it was 8.8% (2011-10.1%), in investments it was 5.3% (2012- 5.8%), in employment 4.7% (2012- 5.2%) in foreign trade its balance was 674.1 billion HUF (2012-1043 billion HUF).

Share of business related to agriculture (itself, activities producing inputs for it, processing and retail industries using its outputs) amounts to 16.0% of the total economic output, 15.0% of employment and 12.0% of gross added value respectively. Compared to 2008 the above indicators grew uniformly: for output 0.5 percentage points, for gross added value 0.4 percentage points, for employment 0.5 percentage point was the respective increase. The main role in this growth was due to the agricultural sector (food industry and agriculture) as its share surpassed its past value in all three dimensions. The role of the sector in employment is higher than its figures in statistics as major part of labour input (roughly 80%) is unpaid family workforce.

Export of agrarian products and excess trade balance in 2012 was significantly larger than in 2011 which itself was a record year showing a growing macroeconomical importance of agro-exports. Employment in agriculture declined until 2008, the recovery continues in 2012 with a growth of 8.2% (15 000 persons). Share of agriculture and food industry in total employment grew with 8.5%.

Land use
Concerning land use out of the total area of Hungary (93,033 km2) 79.3% is agricultural area (48.4% arable land, 0.9% garden, 1.0% orchard, 0.9% vineyard, 8.2% grassland, 20.8% forest, 0.7% reed and 0.4% fishpond) and 20.7% is uncultivated land area. The decline in agricultural areas experienced in earlier years halted and turned back in 2012, agricultural area amounted to 5 338 thousand hectares in 2012 and 5339.5 thousand hectares in 2013. Growth is basically due to extensions in arable land and orchards. Vineyards and gardens reduced while grasslands remained the same, for vineyards the rate of reduction slowed.

In the period of 2008-2012 the private farms significantly increased the area under their production while area used by agricultural enterprises declined. As a result, out of the total area of the country 47.2% (30.3% in 2008) is managed by private farms 39.7% (40.7% in 2008) is managed by agricultural enterprises, and 13.1% (29.0% in 2008) is unidentificable

Crop production
In 2012 on 2758 thousand hectares altogether 10.4 million tons of cereals was harvested. Harvested area was 1.3% larger than in 2011 but total harvested production reduced with 24% and was smaller with 21% than the average of 2007-2011. Harvested area of oil seeds (sunflower seed and rape seed) was 780 thousand hectare, harvested production was 10% less than in 2011. From sugar beet 882 thousand tons was produced on 19 thousand hectares, average yield was 47.1 t/ha, which was 6% less than the last five years' average. Potato production was 548 thousand tons. Area used for legumes increased with 1.3%. Hungary is a leading producer of sweet corn in the European Union.

Animal husbandry
Stock of ruminants increased in 2012 while stock of monogastric animals decreased further due to ascending prices of forage.

Number of cattles increased to 753 thousand in 2012 which is a 9% increase over 2011. Reduction of cattle population lasting for decades halted only in 2011 and data from 2012 also justifay that the sector shows stabile growth. The stock of cows grew with 3% over 2011, to 336 thousand in 2012. The number of dairy cows stagnated while population of beef cattle increased with 7%. Swine stock followed the trend of the last years and decreased further to 2956 thousand in December 2012. This is 2% less than in last year. The number of sows was 6% under last year amounting to only 198 thousand. A positive change can be that the government accepted the swine strategy and increased subsidies for animal welfare together with a more beneficial provision of loans to swine farmers. The stock of poultry decreased with 8% to 38.2 million in 2012, stock of sheep was 6% higher in 2012 than in the previous year with the amount of 1.1 million. This again is a positive tendency as the number of sheep declined continously since 2005. Stock of goats was 88 thousand, 11% over the 2011 stock, horses are also found in an increasing number (2012: 76 thousand heads).

Forestry and game management

The afforested area continously grows in Hungary, the afforestation rate was 20.8% in 2012, the second largest after arable lands. Out of the total 67.2% is of economic designation, 36.2% is of protective designation and 1.1% is of public welfare (healthcare, social, touristical and educational). Proportion of protective forests has been increasing in the past years.

Stock of large game grew further in the last years, especially the number of wild boars is increasing while stock of small game is stagnating.

Manure and fertiliser use

Areas fertilised with farmyard manures amounted to 328.5 thousand hectares on average in 2008-2012, the tendency shows decline (2012: 249 thousand hectares). Fertiliser use and especially use of nitrogenous fertilisers slightly increased after the earlier drop. Amount of fertiliser used on average in 2008-2012 is 74 kg/ha.

Subsidies

Agrarian and rural development subsidies paid out in 2012 totalled to 648.9 billion forints (approximately 2.238 billion euros). Share of EU subsidies constantly grew in the last years, while state budget funding decreased. National budget supplied 21% of the subsidies and 79% came from EU sources (European Agricultural Guarantee Fund, European Agricultural and Rural Development Fund, European Fishing Fund). For national subsidies altogether 71.1 billion forints were distributed.

For programs and projects implemented under the common financing of EU and the state budget 244.7 billion forints (approx. 0.84 billion euros) were utilised. Significant share of this amount was used for the implementation of the measures outlined in the Darányi Ignác Plan (earlier: New Hungary Rural Development Programme).

Future prospects

Hungary is fundamentally interested in a strong and competitive agriculture. A fundamental principle that the countryside is not sustainable without agricultural production. Agriculture also contributes to regional cohesion and is an important element to social cohesion in a world with strong urbanisation tendencies. The excellent ecological potential of Hungary can provide more and supply ever growing global needs. An accentuated objective is the improvement of the position of animal production. Innovation, research, and education has to be given a central role as these can lay down the fundaments of an agriculture that can supply the quantity and quality demanded and simultaneously be environmentally sustainable and climate friendly. Hungary's prime interest is that its EU membership through the common market and the community policies contribute to the modernisation of agriculture and the preservation of natural environment.

2.11. Waste management

To describe situation of waste management three basic indicators are used: the change in annual waste generated, and the relation of waste to GDP and population by sources or aggregately.

Judging by these indicators the development in domestic waste management is promising however it has to be stated that the reduction in the amount of waste is not caused only by preventive measures. This is due to the fact that the indicators do not allow for the distinction between material usage change in production and consumption and efficiency measures and population or consumption pattern changes.

The waste generated was approximately 40 Mt/year in 2000 and has declined under 20 M tons/year in recent years. The nominal GDP value has increased from 13,345.3 billion Ft (2000) to 27,886.4 billion Ft (2011). The waste generated from 1000 Ft value of GDP produced has declined from 3 kg to 0.66 kg. GDP growth was not coupled by growth of waste materials, on the contrary a decreasing tendency is present. Table 2.19. presents characteristic figures of waste generation, Table 2.20. shows share of sources in waste generation.

Table 2.19. Tendency of waste generation and relevant indicators, 2009-2011

	2009	2010	2011
Total waste (kt/year)	19758	18621	18596
Change in waste from previous year	87	96	98
GDP (Billion HUF)	25 626.4	26 607.3	27 886.4
Change in GDP from previous year	933	1 013	1 016
Amount of waste for 1000 Ft GDP produced	0.77	0.69	0.66

Source: VM-HIR, KSH

The decrease in the amount of waste generation was a result of the changing industrial and agricultural production structure after the transition from an outdated inefficient model to modern and more energy and material efficient development methods. This led to some of the sectors applying the most update state-of-the-art production technologies (multinationals). Hungary nevertheless is not characterised by mainstream waste efficient technologies or recycling of production wastes as there weren't sufficient incentives for this. Also, primary resources were not considered valuable enough and depositing was not disadvantageous in a sufficient level. Recycling technologies were not present either when the country joined the EU in 2004. The initial boom in the economy turned to bust when the crisis reached Hungary. The waste generated in the future will be a result of the dynamics of economic development and the waste management regulations. To obtain transparent waste management goals all stakeholders are needed to take measures.

Table 2.20. Waste generated by source (ktons), 2009-2011

	2009	2010	2011
Agricultural and food industry waste	964.8	773.5	743.7
Industrial and business waste	6,186.1	5,805.6	5,927.5
Construction waste	3,925.5	4,166.9	4,415.4
Toxic waste	851	569	777
Municipal solid waste	4,311.9	4,033.1	3,808.9
Municipal liquid waste	3,518.9	3,272.7	2,923.1

Source: VM-HIR, KSH

The 23% decrease of Agricultural and food industry waste is primarily due to the global crisis. The decline in the verticuum and other advers processes e.g. plummeting process industry, decrease in livestock, and that those wastes which are directly recycled to production are not indicated anymore in the statistics since 2007.

Industrial and business waste is the largest source in waste generation. The reduction of waste can be directly from the shrinking of economy, or the appeareance of modern low material intensity industries and measures aiming at waste generation prevention. The decreasing tendency (~4%) seems to halt at around 6 M tons.

The amount of construction and decommission waste is affected by the sector's continous decline, the delay of building investments, although a slight increase is already noticable. It is visible that the amount of construction waste surpasses communal waste both in growth and in absolute terms. This indicates that the adverse coupled movement of the two waste streams have stopped, construction waste deposited in communal waste disposal sites is reducing.

Generated toxic and hazardous wastes have not decreased practically since the halting of large state detoxification projects (e.g. red mud incident at Ajka).

Communal solid wastes grew slightly in the 2000-2006 period and have since decresed with 11% to under 4 Mt. This can be caused by the constraining of consumption from economic reasons and by more conscious consumer behaviour.

Generation of municipal liquid waste (household wastewater not treated by public waste management plants) is in connection with the advancement of national waste drainage projects and by more conservative household use of freshwater. After the appeareance of the new waste management legislation (see below) liquid municipal waste does not belong to the broad category of waste generated.

Table 2.21. Generation and treatment of wastes (without sludge) 2009-2011

	2009		2010		2011	
	ktons	%	ktons	%	ktons	%
Amount of waste (kt)	19 758		18 621		18 596	
Material utilisation (recycling)	4 584	23,2	5 682	305	5 001	26,9
Energetical utilisation	787	4	824	44	822	4,4
Combustion	75	4	160	9	91	5
Disposal	8 536	43,2	7 475	401	8 580	46,1
Other	5 777	29,2	4 480	241	4 101	22,1

Source: VM-HIR, KSH

Table 2.21. indicates that the rate of disposal is over 40% which is unfavourable. The generated waste shows a decresing tendency however the rate of recycling/reuse does not move from the annual figure of 30%.

Legislative background

The EU's 98/2008/EC directive regulates waste management in Member States. It prescribes the recycling rate for solid household wasete to be over 50% in mass by 2020, for construction wase the reutilisation and recycling rate should be over 70%. Detouring wase from disposal should be aided by the implementation of a seperated waste collection system for glass, metal, plastic and paper. The Directive further specifices that by July 2016 the amount of biodegradable organic waste should be decreased to 35% of the respective level of 1995.

For implementing these goals Hungary has to completely reform the legislative background of waste management to achieve long term efficiency and to support R&D in waste management.

The domestic legislation for waste management is the Act on Waste Management (2012. /CLXXXV). The Act specifies a waste hierarchy to prioritise waste management practices. According to this hierarchy the best practice is prevention of waste generation. If it is not feasible then reutilisation has to be targeted followed by recycling. Only at the end comes disposal or incineration.

An operative programme for prevention is the National Waste Prevention Programme. This strives to achieve to goals of waste reduction by promoting materials and quality products in manufacturing chains which ensure longer lifetime or reutilisation potential. This is aided by the extension of manufacturers' responsibilities.

The formulation of seggregated waste disposal is undertaken in practically all settlements aiding waste recycling and reducing deposition rate.

Energetical utilisation was 4.4% of the total waste in 2011. Waste incineration is coupled with environmental impacts independent if combustion is energetically utilised. The main recipients of the releases are soil, landscape, surface waters but primarily air. Burning chlorine based compounds (e.g. PVC) emits dioxine in the air. Altogether waste incinceration is not in compliance with the goals set down in the EU directive and the Waste Management Act. After the seperation of high calorific value waste components from communal waste incineration will loose its role.

Disposal rate is 67% in Hungary meaning that 2/3 of the waste generated is deposited in communal waste disposal and not utilised. The rate of disposal is 3.7% in Austria and under 1% in Germany and The Netherlands. Material re-utilisation rate is 60% in Belgium 65% in Germany and 69% in Austria. Thus, instead of utilising waste as a resource Hungary disposes of it and lets resources to go wasted and unexploited.

The Act therefore stipulates a waste disposal fee which is functioning in the neigbouring countries making disposal more expensive than other methods. The amount paid can be used for dedicated purposes on waste management set in the 318/2013. (VIII. 28.) Govt. Decree.

The Act also gives broader enforcement rights to authorities. It specifies that waste disposed in selective waste containers is not public property, it belongs to the public utility collecting it and appropriation is not allowed. Those who are violating the law face confiscation and forfeiture of the vehicles or means involved in illegal disposal of waste in public or private property.

2.12. Forestry and land-use change

There is a detailed system in Hungary to continuously collect data on forests and forestry, run by the Forestry Directorate of the Central Agricultural Office (CAO FD, or NÉBIH in Hungarian**)**. A detailed description of forestry-related databases of CAO FD in English can be found at http://www.nebih.gov.hu/szakteruletek/szakteruletek/erdeszeti_igazgatosag/supplementary_inf_ERT. All statistics presented in this document are from this database if not otherwise reported. A general description of the Forest Monitoring and Observation System that collects data for the database in a cadastre-type system, as well as the Hungarian forests and forestry can be found in English at http://www.nebih.gov.hu/data/cms/140/962/FMOS_final.pdf and http://www.nebih.gov.hu/szakteruletek/szakteruletek/erdeszeti_igazgatosag/supplementary_inf_ERT/forest-db.html. Note that all statistical data on forests that are reported in this document were taken form the official statistics of the Forestry Directorate of the Central Agricultural Office, if not reported otherwise.

In general, forests in Hungary have been managed sustainably for about a century (Ministerial reports 2006-2007; MCPFE, UNECE, FAO 2007). Concerning forest area, the fact that the management was sustainable is well demonstrated by the constant increase of the area covered by forests (see Figure 2.15). Of the total area of the country (9 303 000 ha), 1 927 702 ha were covered by forests in 2011, which corresponds to a forest cover of 20.7 %. This figure includes temporarily un-stocked areas; the total area of stocked forests amounted to 1 881 033 ha in 2011. The total area managed by forestry companies amounts to 2 050 662 ha. All figures have been increasing for decades, and all of this area is managed based on forest management plans.

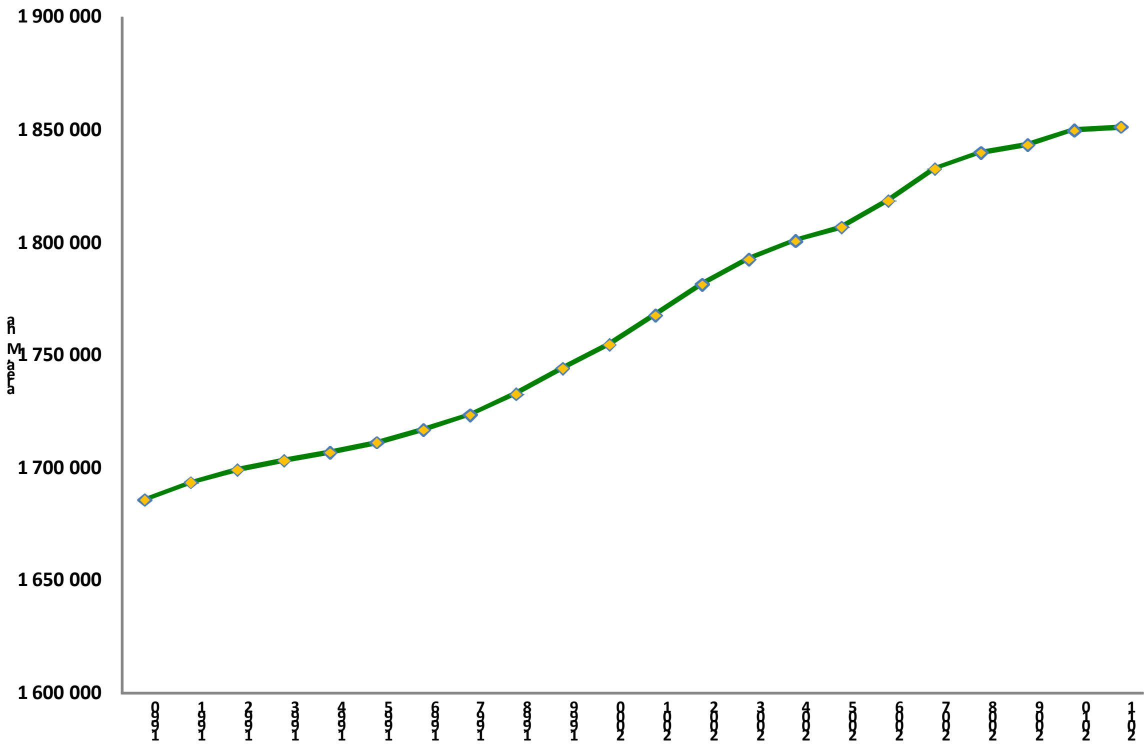

Figure 2.15. The development of the area of stocked forests since 1990

Source: CASMOFOR,2013

Figure 2.15 demonstrates that forest area has been steadily increasing for decades. In fact, almost 800 thousand ha new forests were established in the last eight decades, and more than 160 thousand ha since 1990. These forests have added much to the sink capacity of our forests. The sink of the forests established since 1990 have reached 1258 GgCO_2 a year (NIR Hungary 2013, available at http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/7383.php). These figures show how effective afforestation can be in terms of sequestering carbon from the air.

In contrast, there is no much pressure on our forests in terms of deforestations. We have deforestations each year (Table 2.22.), but their area is small and conversion can only occur if authorities identify good reason for it (such as road building, other infrastructure etc.).

Table 2.22. The area of deforestations and resulting emissions from biomass cleared in Hungary (NIR Hungary 2013).

calendar year	area (ha)	emissions from biomass (Gg CO_2)	calendar year	area (ha)	emissions from biomass (Gg CO_2)
1990	613	77	2005	411	51
1991	240	30	2006	509	63
1992	126	16	2007	245	30
1993	329	41	2008	294	27
1994	218	27	2009	455	58
1995	358	45	2010	208	28
1996	346	43	2011	277	46
1997	522	65	2012	500	46
1998	402	50	2013	500	46
1999	395	49	2014	500	46
2000	719	90	2015	500	46
2001	521	65	2016	500	46
2002	638	79	2017	500	46
2003	593	74	2018	500	46
2004	944	117	2019	500	46
2005	411	51	2020	500	46

Source: National Inventory Report, Hungary, 2013

No major changes have taken place in the ownership structure of the forests for the last decade. Most of the changes in the ownership structure are due to afforestation, as by far the most new forests are established in the private sector. The share of private forests amounts to 42.5%, whereas forests owned by local governments only amount to 1%. Most forests (56.5%) are thus still state owned. (The ownership of some 0.2% of forests is unaccounted for).

Most forests, i.e. 63%, are classified as production forests. The share of protection forests is 36%, whereas forests serving predominantly social, touristic, educational and scientific purposes amount to 1%.

Sustainability is also demonstrated by the fact that the stock volume of the Hungarian forests has continuously increased in the last several decades (from 257 million m^3 in 1981 to 362 million m^3 in 2011). This increase is partly due to the fact that forests have been predominantly young, but partly due to the continuing afforestation programmes, which have substantially increased forest resources since 1930 when they started. A third reason is that, for the last several decades, the wood increment of the forests has always topped the sum of all harvests and mortality due to disturbances and self-thinning (Figure 2.16): the amount of harvests has only been some 70% of the annual allowable cut that is set in the forest management plans. The amount of salvage loggings (1995: 552 thousand m^3; 2000: 427 thousand m^3; 2005: 530 thousand m^3; 2011: 393 thousand m^3) has not shown any increasing (or decreasing) trend.

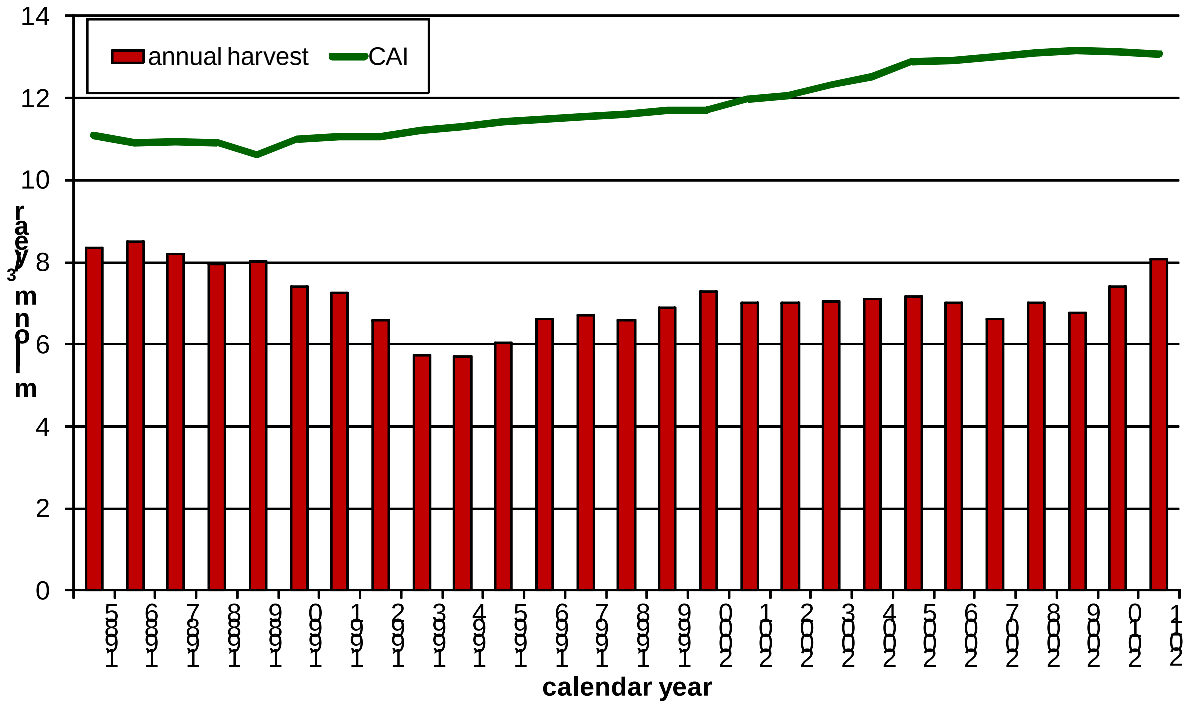

Figure 2.16. The total amount of annual harvest and the estimated current annual increment (CAI) over time in Hungary.

Source: KP-LULUCF Report, Hungary, 2013

3. Greenhouse Gas Inventory Information

3.1. Summary tables

Table 3.1. Greenhouse Gas Emissions of Hungary, BY-2011

GREENHOUSE GAS EMISSIONS (CO_2-eq. Gg)	Base year	1990	1995	2000	2005	2009	2010	2011
Energy	79,331.6	68,252.8	59,227.2	56,597.5	56,963.4	48,737.3	49,035.9	47,364.1
Industrial Processes	14,637.4	11,572.7	7,876.8	8,159.4	8,936.7	5,973.9	6,431.8	6,194.0
Solvent and Other Pr. Use	284.4	226.2	205.1	213.6	366.3	340.1	268.9	309.6
Agriculture	19,043.9	15,477.5	9,296.0	9,533.8	9,195.9	8,577.5	8,531.3	8,758.7
LULUCF	-2,600.3	-2,018.9	-5,575.2	-682.7	-5,135.0	-3,989.8	-4,084.7	-3,787.5
Waste	3,075.9	3,451.5	3,690.6	3,935.7	3,991.4	3,751.8	3,677.5	3,521.4
Total (including LULUCF)	**113,773.0**	**96,961.8**	**74,720.4**	**77,757.2**	**74,318.7**	**63,390.9**	**63,860.7**	**62,360.3**

GHG EMISSIONS (CO_2-eq. Gg)	Base year	1990	1995	2000	2005	2009	2010	2011
CO_2. without LULUCF	85,429.2.	73,154.2	62,477.0	59,467.9	60,476.8	51,055.3	51,608.4	49,740.0
CH_4. without LULUCF	13,474.1	12,653.1	9,986.1	9,991.2	9,263.2	8,680.4	8,677.8	8,459.6
N_2O. without LULUCF	17,128.4	12,814.9	7,472.3	8,359.8	8,590.2	6,541.4	6,464.3	6,774.5
HFCs	0.0	NA.NO	23.9	213.6	675.4	880.2	959.0	987.6
PFCs	268.5	270.8	166.8	212.2	210.3	2.9	1.0	1.7
SF_6	73.1	87.6	169.6	195.3	237.7	220.6	234.9	184.4
Total (excluding LULUCF)	**116,373.3**	**98,980.7**	**80,295.7**	**78,440.0**	**79,453.7**	**67,380.7**	**67,945.4**	**66,147.7**

Source: National Inventory Report, Hungary, 2013

The assigned amount of Hungary has been fixed as 542,366,600 Mg CO_2 eq. on the basis of the base year emissions of 115.4 million tonnes CO_2 equivalent. It is important to note that Hungary's base year is not 1990 but the averaged value for the years 1985, 1986 and 1987 and Hungary has chosen 1995 as its base year for HFCs, PFCs and SF6. Hungary's quantified emission reduction commitment is 94 per cent as included in Annex B to the Kyoto Protocol.

3.2. Descriptive summary

Key developments

- In 2011, total GHG emissions of Hungary were the lowest in the whole time-series of the inventory (1985-2007). Emissions were about 43 per cent below the base-year level.
- Moreover, the emissions of the last three years (2009-11) turned out to be the lowest in the entire time series.
- Most part of this significant reduction of emissions occurred until the early 90's and was mainly a consequence of the regime change in Hungary (1989-90) which brought in its train radical decline in the output of the national economy.
- Starting in 2008, the global financial and economic crisis exerted a major impact on the output of the Hungarian economy, consequently on the level of GHG emissions as well.
- The significant growth in the transport sector stopped in 2007, emissions have decreased by 13 per cent since then.
- Natural gas consumption of the residential sector has grown to its four-fold until the mid 2000's. Since then, it has dropped by more than 20 per cent.

Greenhouse gas emissions in 2011

In 2011, total emissions of greenhouse gases in Hungary were ***66.1 million tonnes*** carbon dioxide equivalents (excluding the LULUCF sector) which is *the lowest value* in the whole time series (1985-2011). Taking into account also the mostly carbon absorbing processes in the LULUCF sector, the net emissions of Hungary were 62.4 million tonnes CO_2 eq. in 2011. Being about 6-7 tonnes, the Hungarian per capita emissions are below the European average.

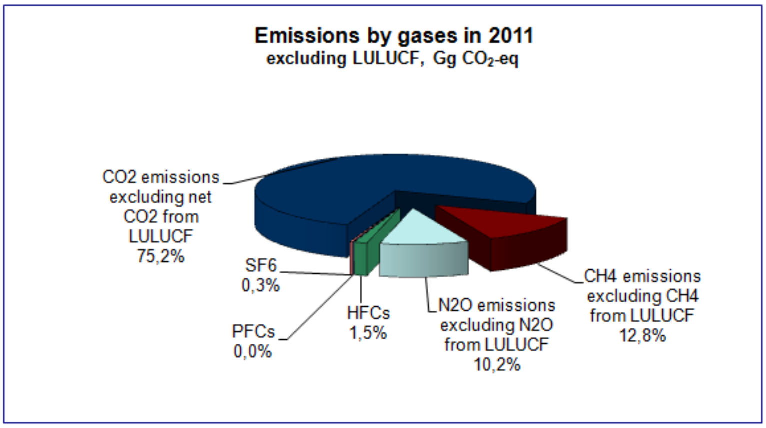

Figure 3.1. Emissions by gases in 2011

Source: National Inventory Report, Hungary, 2013

The most important greenhouse gas is carbon dioxide accounting for 75.2% of total GHG emissions (see Figure 3.1.). The main source of CO_2 emissions is burning of fossil fuels for energy purposes, including transport. CO_2 emissions have decreased by 41.8% since the middle of the 80's. Methane represents 12.8% in the GHG inventory. Methane is generated mainly at waste disposal sites and in animal farms, but the fugitive emissions of natural gas are also important sources. CH_4 emissions are by 37.2% lower than in the base year. Nitrous oxide contributes 10.2% to the total GHG emissions. Its main sources are agricultural soils, and manure management. N_2O emissions are 60.4% lower compared to base year. The total emissions of fluorinated gases amount to 1.8% but their steadily growing tendency seems to level off since 2008. However special attention is still needed as their applications in the cooling industry and the use of SF_6 in electrical equipments, first of all in switchgears for insulation and arc quenching are still popular.

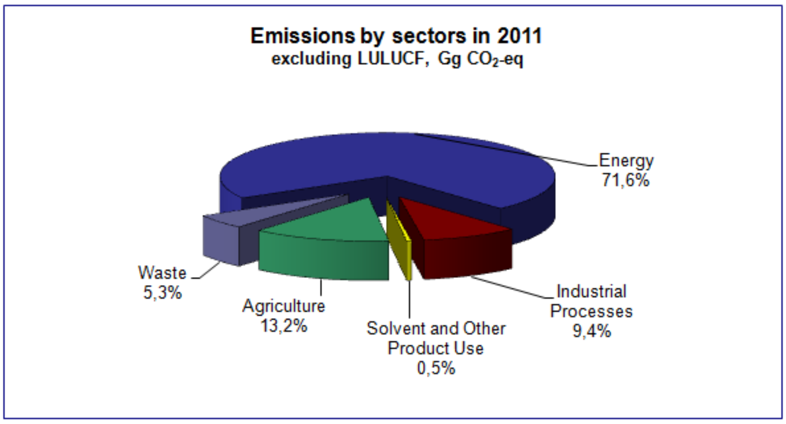

Figure 3.2. Emissions by gases in 2011

Source: National Inventory Report, Hungary, 2013

Figure 3.2. shows sectoral breakdown of greenhouse gas emissions. By far, the biggest emitting sector was the energy sector contributing 71.6% to the total GHG emission in 2011. Agriculture was the second largest sector with 13.2% while emissions from industrial processes (with solvent and other product use) accounted for 9.8% and the waste sector contributed 5.3%. Compared to the base year, emissions were significantly reduced in the energy (-40.3%), agriculture (-54.0%), and industrial processes (-57.7%) sectors. In contrast, emissions in the waste sector have increased since 1985 (+14.5%). Solvent and other product use and land use, land-use change and forestry (LULUCF) sectors show fluctuating behavior.

The e***nergy sector*** was responsible for 71.6% of total GHG emissions in 2011. Carbon dioxide from fossil fuels was the largest item among greenhouse gas emissions contributing 94.3% to sectoral emission. Considering fuel use in combustion processes, gases had the highest proportion (51.2%), liquids and solids represented 26.1% and 12.4%, respectively. It is worth mentioning that the share of biomass in fuel combustion grew to 9.4%. The most important subsector was energy industries with a proportion of 33.8% within the energy sector, followed by other sectors (29.2%) and transport (24.1%). Fugitive emissions from fuels played only a small role with 4.9% out of which 71.1% originate from natural gas production, processing, transmission and distribution.

In 2011, ***agriculture*** was the second largest source of greenhouse gas emissions in Hungary. Emissions from agriculture include CH_4 and N_2O gases: 87.4 per cent of total N_2O emissions were generated in agriculture in 2011.

The ***industrial processes*** sector was the third largest sector, contributing 9.4% to total GHG emissions in 2011. (Solvent and other product use added further 0.5% to total emissions.) The most important greenhouse gas was CO_2, contributing 80.1% to total sectoral GHG emissions, followed by F-gases with 18.9%. Within this sector, 36.2% of the emissions came from iron and steel industry, 19.9% from mineral products, followed by 18.9% from consumption of halocarbons and SF_6 and 15.4% from non-energy use of fuels.

The ***waste*** *sector* represented 5.3% of total national GHG emissions in 2011. The largest category was solid waste disposal on land, representing 79.3% in 2011, followed by wastewater handling (17.1%), waste incineration (2.8%), and composting (0.9%).

In 2011 the **LULUCF sector** accounted for 3.8 million tonnes carbon-dioxide removals. The net removals of forests amounted to 2.9 million tonnes CO_2.

Trends of emissions (1985-2011)

Figure 3.3. shows the net emissions from the base year until the last year assessed, taking also removals into account. The straight line in the figure indicates the reduction target.

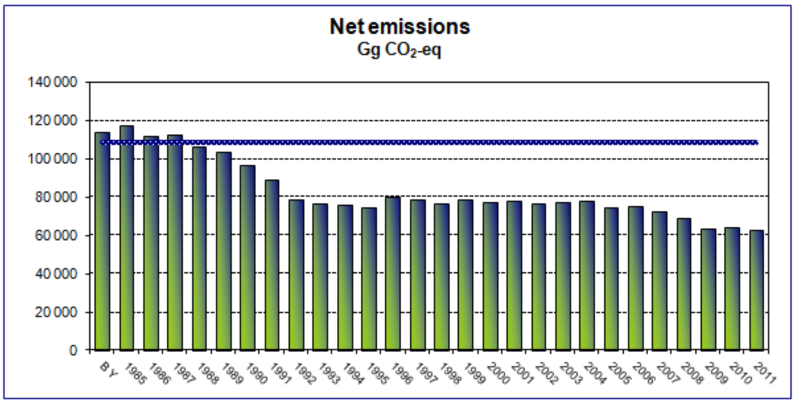

Figure 3.3. Net emissions in CO_2 equivalent, 1985-2011

Source: National Inventory Report, Hungary, 2013

By ratifying the Kyoto Protocol, Hungary committed to reduce its GHG emissions by 6%. Now, our emissions are 43.2% lower than in the base year (average of 1985-87). For the most part, this significant reduction was mainly a consequence of the regime change in Hungary (1989-90) which brought in its train radical decline in the output of the national economy. The production decreased in almost every economic sector including also the GHG relevant sectors like energy, industry and agriculture. Then, between 2005 and 2011, after a period of about 14 years of relatively stagnant emission level (1992-2005), GHG emissions fell again quite significantly by 16.7 per cent.

The global financial and economic crises exerted a major impact on the output of the Hungarian economy, consequently on the level of GHG emissions as well. After a quite significant drop of 8.4% between 2008 and 2009, our emissions in the following three years (2009-11) remained the lowest in the entire time series. Although the decline in economic output stopped in the first quarter of 2010 and Hungary had a moderate growth of 1.6%, emissions fell again by 2.6% in 2011 after slight increase (+0,8%) in 2010.

Compared to the base year, emissions were significantly reduced in the energy (-40.3%), agriculture (-54.0%) and industrial processes (-57.7%) sectors. In contrast, emissions in the waste sector have increased since 1985 (+14.5%). Solvent and other product use and land use, land-use change and forestry (LULUCF) sectors show fluctuating behavior.

For a better understanding of the Hungarian emission trends, the time interval of the inventory should be split into three periods with different emission relevant economic processes in the background. The first period (1985-95) would be the years of the regime change in Hungary, whereas in the second period (1995-2005) the rules of the market economy became decisive. The second period can also be characterized by the decoupling of GDP growth from the GHG emission trend which is undoubtedly an important development. By 1999, the GDP reached the pre-1990 level; however, emission levels remained significantly below the levels of the preceding years. Thus, the emissions per GDP were decreasing.

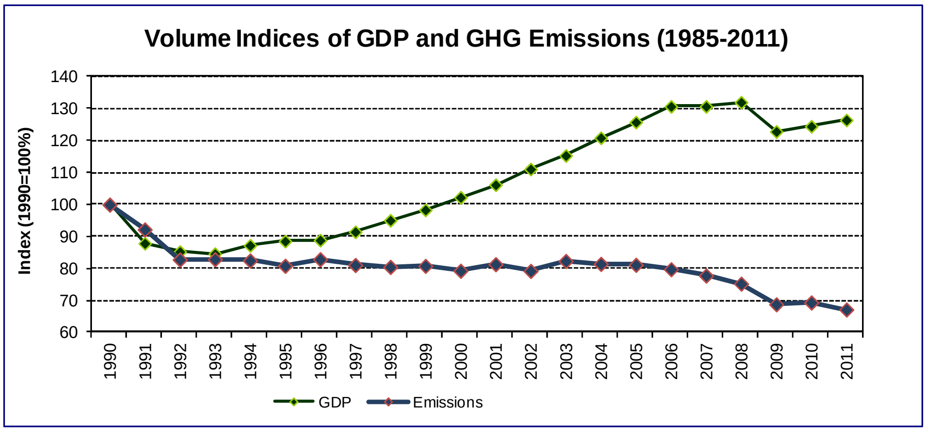

Figure 3.4. Growth of GDP and GHG emissions, 1990-2011

Source: National Inventory Report, Hungary, 2013

In the third period, after 2005, Hungary experienced an emission reduction of 16.7%, out of which 7.4% occurred in the first 2-3 years up to 2008: basically due to mild winters, higher energy prices, and modernization in the chemical industry. Then in 2009, the global financial-economic crisis made its radical influence felt which can also be seen at the dropping GDP values in Figure 3.4. From 2010 on a slight recovery of the economy could be observed, the emissions, however, remained at a relatively low level.

Starting with the first period, the process of transition into market economy brought in its train radical and painful decline in the output of the national economy. The production decreased in almost every economic sector including also the GHG relevant sectors (energy, industry and agriculture). Consequently, GHG emissions decreased substantially in these years by around 35 million tonnes CO_2 equivalent. Between the mid 80's and the mid 90's emissions fell back in the *energy* sector by around 25%, and even more, by around 50% in the *industrial processes* and *agriculture* sectors as Figure 3.5. shows.

The most significant drop in energy use occurred in the industry especially in the energy-intensive industrial sectors (manufacture of basic metals and machinery, mining etc.). The industrial output of 1992 was two third of that of 1989. Several factories were closed down, capacity utilization was reduced, consequently the production decreased more or less drastically in each industrial sector. Some examples:

- Iron and steel production: two out of three plants were provisionally closed down;
- Aluminium: two out of three plants were closed down in 1991 (aluminium production stopped in 2006 eventually);
- Ferroalloys: ceased to exist (1991);
- Ammonia: four out of five plants were closed down (1987, 1991, 1992 and 2002);
- Nitric acid: three out of four plants were closed down (1988, 1991 and 1995).

The agricultural sector suffered a similar decline. As a result of the political and economic processes, the number of agricultural farms was reduced by more than 30%, the number of employees by more than 50%, the volume index of the gross agricultural production by more than 30%, the livestock by about 50%, and the use of fertilizers by more than 60%. As a consequence, the share of the agricultural sector in total GHG emissions decreased from 16.4% to 13.2%.

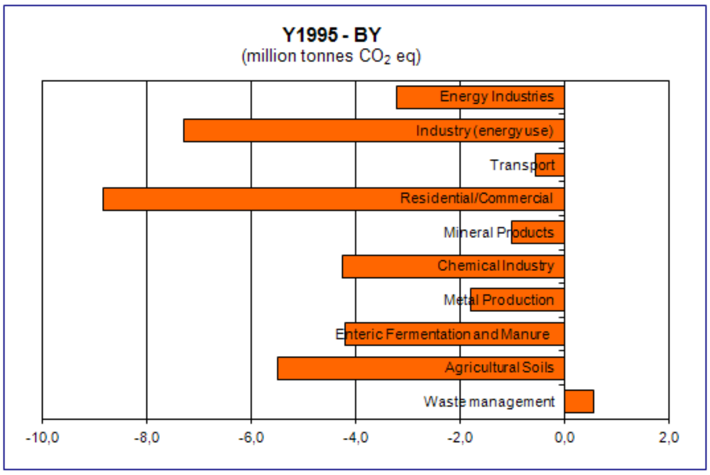

Figure 3.5. Changes of emissions by sector from the base period to 1995

Source: National Inventory Report, Hungary, 2013

The small increase of emissions in the *Waste* sector is exceptional among all the sectors, and it is attributable to the slightly increasing quantities of waste generated and collected but more importantly to the applied calculation method which assumes that the degradable organic component in waste decays slowly throughout a few decades.

After the mid 90's, emissions seemed to have stabilized around 79-80 million tonnes CO_2 equivalent. However, behind the quite stable emission level opposite processes could be observed which can be illustrated by the relatively bigger changes in the e*nergy sector*. The fuel use of industry decreased further and had only a 15% share in CO_2 emissions. In contrast, emissions from transport increased significantly by almost 5 million tonnes CO_2 equivalent which represented a growth of 63.6% as shown in Figure 3.6.

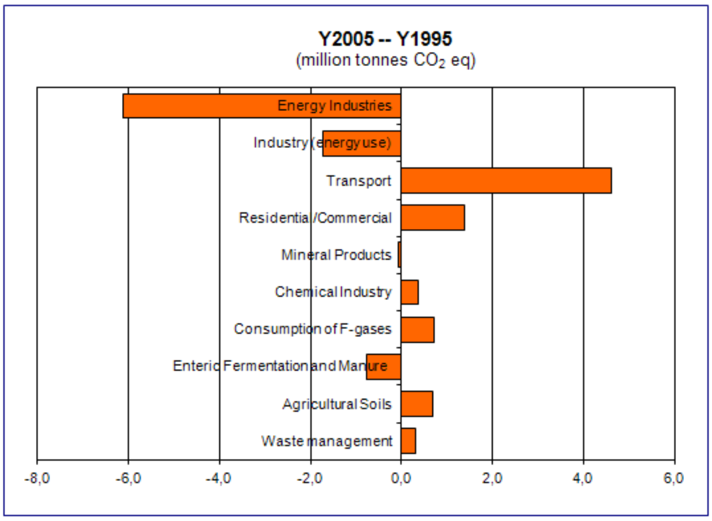

Figure 3.6. Changes of emissions by sector from 1995 to 2005

Source: National Inventory Report, Hungary, 2013

In the third period, after 2005, emissions fell by 13.3 million tonnes or 16.7% shown in Figure 3.7. About 44 per cent of this decrease occurred between 2005 and 2008. The decreasing energy use by other sectors and manufacturing industries, and the diminishing process related emissions in the chemical industry were the main drivers of these changes. Most importantly, total fuel consumption in the residential sector decreased by almost 20% (including a 13% decrease in natural gas use) - mainly due to extreme mild winter in 2007 but probably the growing energy prices and the support for modernization of buildings might have played a role as well. Decreased production volumes and modernization in the chemical industry led to an emission reduction of about 80%. In contrast, emissions from energy industries and transport grew further. Then in 2009, the Hungarian economy was hit hard by the global economic crisis that exerted a significant effect on the emission level. Emissions (excluding LULUCF) decreased by 8.4% (-6.2 million tonnes) between 2008 and 2009. In comparison with 2008, emissions in 2009 were lower in all major sectors. The highest relative reduction (-12.7%) occurred in the industrial processes sector mainly due to lower production volumes especially in mineral product manufacturing (-28.9%). Parallel to that, also energy use decreased in manufacturing industries and construction, consequently GHG emission fell by 24.5% here. Regarding absolute changes in emissions, out of the 6.2 million tonnes reduction, fuel combustion was responsible for about 4.7 million tonnes. Although the energy demand increased in the heating season due to less favorable weather conditions, the fall in the production of energy intensive sectors led to an overall decline in energy use.

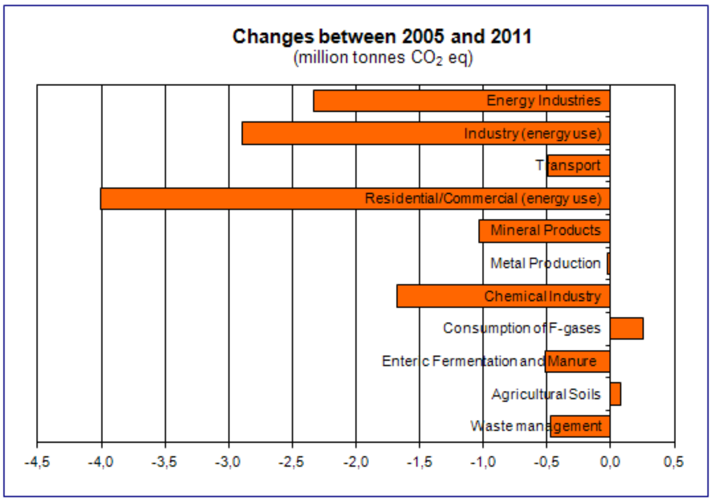

Figure 3.7. Changes of emissions by sector from 2005 to 2011

Source: National Inventory Report, Hungary, 2013

The decline in economic output stopped in the first quarter of 2010. Mainly driven by the growth in export-oriented industrial production, the GDP grew by 1.3% in 2010. The change in GHG emissions was less pronounced, still it increased by 0.8% above the 2009 level. The trend is shown in Figure 3.8.

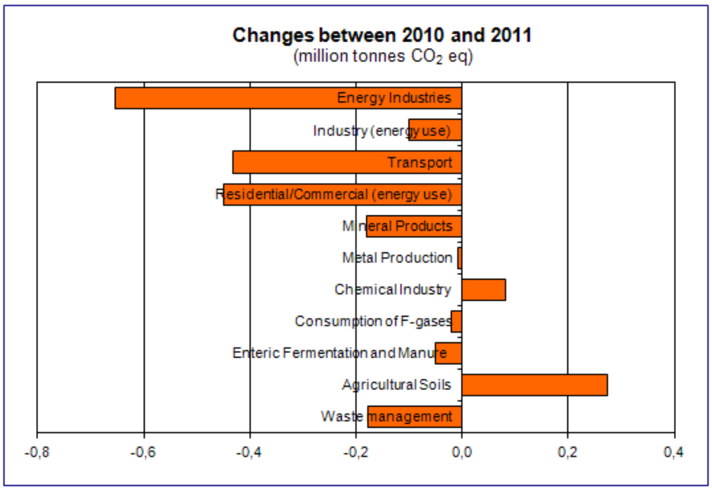

Figure 3.8. Changes of emissions by sector from 2010 to 2011

Source: National Inventory Report, Hungary, 2013

In 2011 decrease can be seen almost everywhere. Transport emissions have fallen by 3.6%, mineral production by a further 12.8%. Natural gas consumption of the residential sector has dropped by 9.0%. Chemical industry and agricultural soils are the two exceptions. In agriculture we had higher fertilizer use, and greater crop production (hence higher emissions from crop residues). In this respect, it is worth noting that the economic growth in 2011 was mainly driven by agricultural production.

Description and interpretation of emission trends by gas

The drop in CO_2 emissions during the early 1990's was attributable to the reduction of fuel uses in conjunction with the decline of the national output. From the second half of the 1990's, emissions showed stagnating or slightly decreasing tendencies reflecting the effects of restructuring following the economic growth. The changes in the fuel-mix resulted in reduction of the specific emission levels.

Concerning CH_4 emissions, agriculture, fugitive emissions, and waste management are the trend setting sectors. Most importantly, reductions in the livestock resulted in lower emissions. On the other hand, fugitive emissions increased as gas supply via pipelines became more and more widespread. Besides, emissions from waste disposal had grown until 2005, but started to decrease recently. This is the reason why the resultant trend was relatively stagnating until the first half of the last decade, and why it has been slowly decreasing since then.

Due to the above factors, also N_2O emissions significantly decreased in the beginning of the period. Later it showed a slightly rising trend, followed by another drop primarily reflecting the fluctuations in agricultural output and the modernization of nitric-acid production. These tendencies are shown in Figure 3.9.

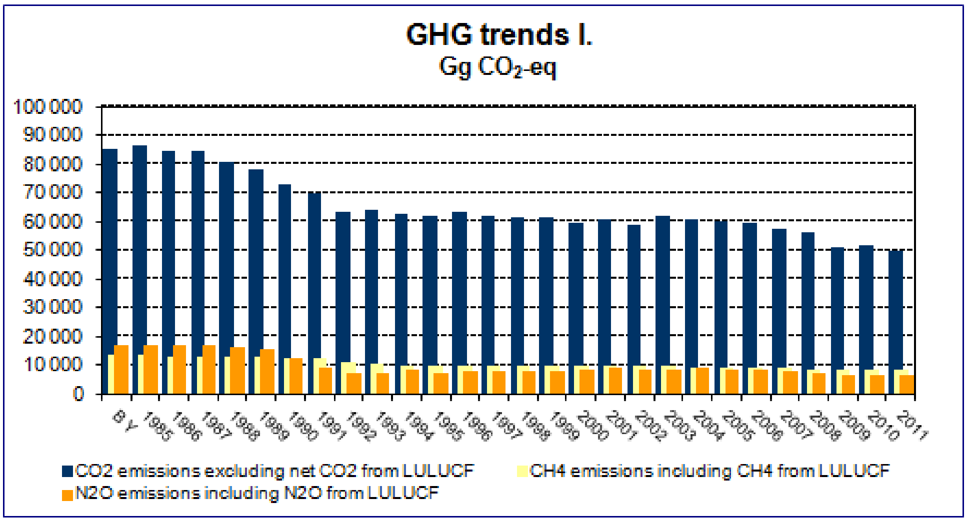

Figure 3.9. Changes of emissions by gas from the base period to 2011

Source: National Inventory Report, Hungary, 2013

The use of HFC gases became more intensive in the second half of the 1990's in conjunction with the restriction of the use of chlorofluorocarbons as refrigerants. The rise of emissions is obvious, even if their steadily growing tendency seems to level off since 2008.
PFCs emissions are principally related to aluminium production processes. Therefore, the tendencies of PFC emissions reflect the changes in aluminium production. Following a drastic reduction in the beginning of the period, the levels showed a slow but steady increase. Then the aluminium production ceased suddenly in 2006.

SF_6 emissions primarily depend on the uses in electricity transmission, as it is mainly used in electrical equipments, first of all in switchgears for insulation and arc quenching. So, the growth of the electricity consumption results in an increasing application of SF_6, however the tendencies vary according to the manufacturing/application needs, as depicted in Figure 3.10.

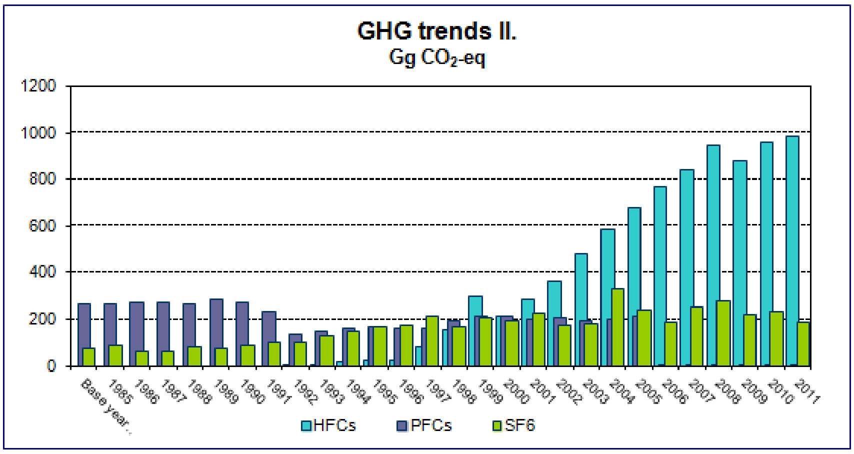

Figure 3.10. Changes of emissions by F-gas from the base period to 2011

Source: National Inventory Report, Hungary, 2013

Description and interpretation of emission trends by category

Emissions by the ***energy sector*** decreased in the first part of the period as a result of reduced energy consumption and use of fuels with more favorable composition. Between 2005 and 2008 growing emissions from energy industries and transport could be observed, which were more than offset by the drastic reductions in the residential sector and manufacturing industries. And then came the economic crisis. The significant reduction in emissions between 1987 and 1992 was mainly due to the economic transformation which caused sudden decrease in energy demand. In addition, ongoing changes in fuel-structure, i.e. solid fuel as the most important source in the 80's had been replaced by natural gas, led to further decrease of total emission. The most pronounced fuel switch could be observed in the residential/commercial sector. Solid fuels almost disappeared while the share of natural gas reached 77%. These changes are shown in Figure 3.11.

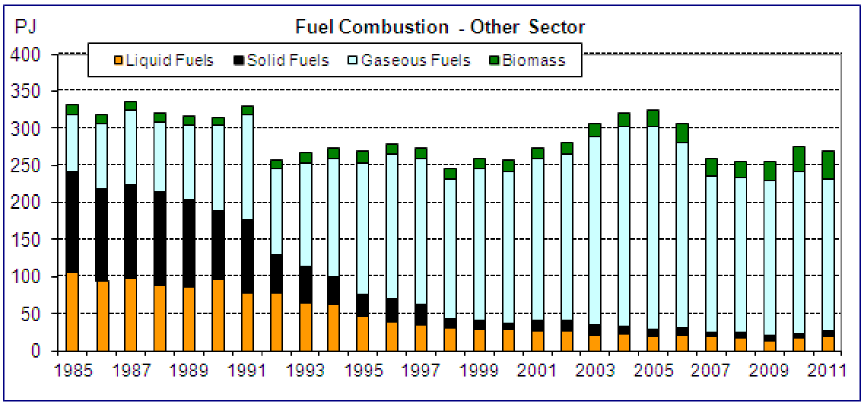

Figure 3.11. Changes of emissions from combustion by fuel source, 1985-2011

Source: National Inventory Report, Hungary, 2013

Public electricity and heat production is responsible for almost 90% of fuel use in energy industries. Moreover, for electricity production 382 PJ energy was used which is 36% of total domestic consumption. The energy source consumption of power plants was 5% less than in previous year. 44.7% of consumed energy sources was nuclear fuel, 26.3% was natural gas and 18.6% was coal in 2011. The wastes and renewable energy sources used in power plants gave 10% of total energy source consumption of power plants. Domestic electricity production showed an overall increasing trend; even during the years of the regime change around 1990, whereas import suffered a more severe drop from 28% to 10%. The share of import is a highly variable figure, in the last decade it changed between 8% (2001) and 18% (2004), and in 2011 it amounted to 16% as shown in Figure 3.12.

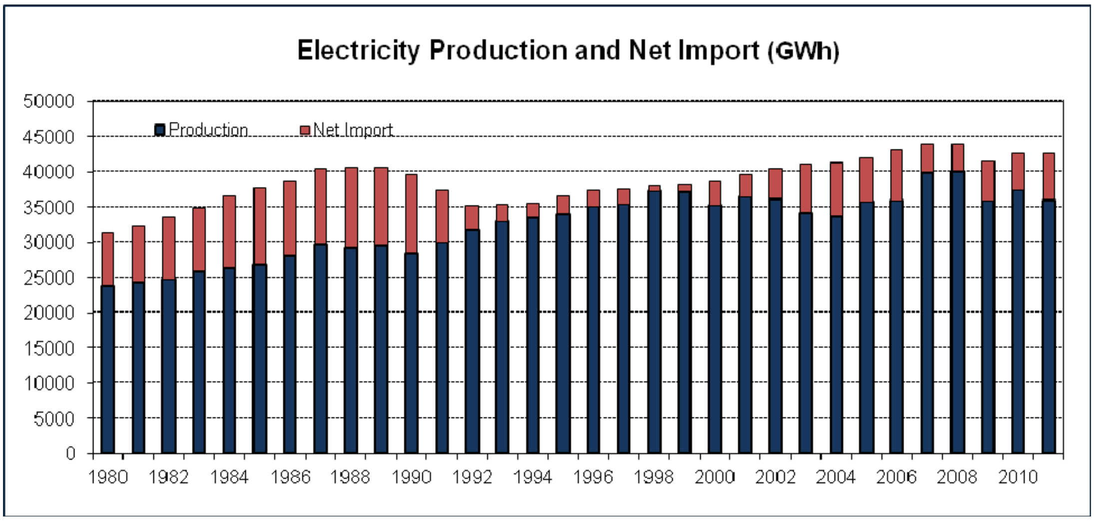

Figure 3.12. Electricity production and net imports, 1985-2011

Source: National Inventory Report, Hungary, 2013

Naturally, as domestic emissions are related to domestic production, the yearly fluctuation of production is one of the decisive factors. Not less important is the way how electricity is produced, e.g. what energy source is used. In Hungary, this sector consumes the deterministic part of our solid fossil fuel production. However, some uneconomical coal-fired power plants of low efficiency were stopped, and blocks of combined-cycle-gas turbine units were installed. For example, new 150 MW combined cycle gas-turbine units were installed (Újpest, Kelenföld, Százhalombatta, Nyíregyháza Power Plants), and aged coal fired units (Inota, Bánhida) of low efficiencies were taken out of service or blocks have been converted to the combustion of biomass (Pécs, Kazincbarcika, Ajka Power Plants). The demand for fossil fuel decreased about 150 PJ in the electricity sector between 1980 and 1990 because of the penetration of the nuclear electricity into the electricity market. This means that the fossil fuel consumption of public power plants is smaller now than it was before the introduction of nuclear electricity generation, in spite of much higher domestic electricity production. As a promising new development, increasing use of renewable sources could be observed by some public power plants. All these developments are demonstrated in Figure 3.13.

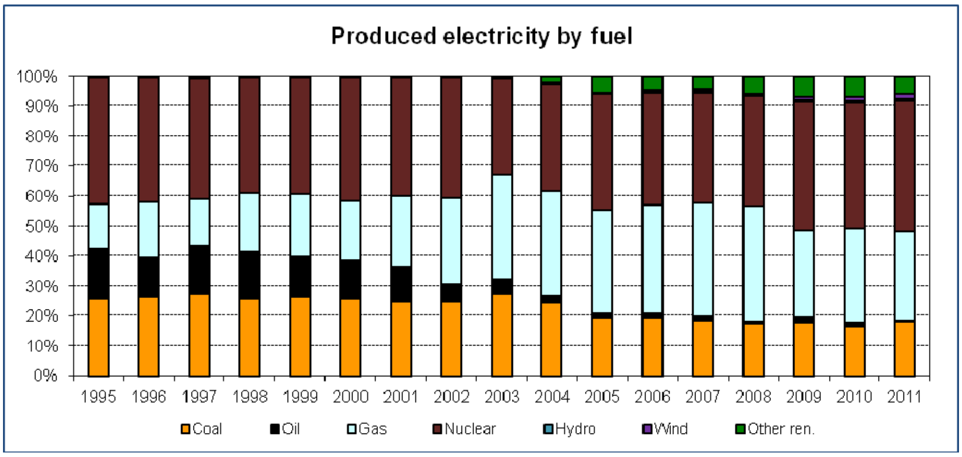

Figure 3.13. Electricity production by fuel, 1995-2011

Source: National Inventory Report, Hungary, 2013

Transport related emissions almost doubled between 1994 and 2007. Since 2007, however, a decrease of 13.0% could be observed. Since 1985, gasoline use has never been at such a low level as in 2011. In addition, natural gas consumption of the residential sector has decreased by 9.0% which naturally led to lower emissions. This trend is shown in Figure 3.14.

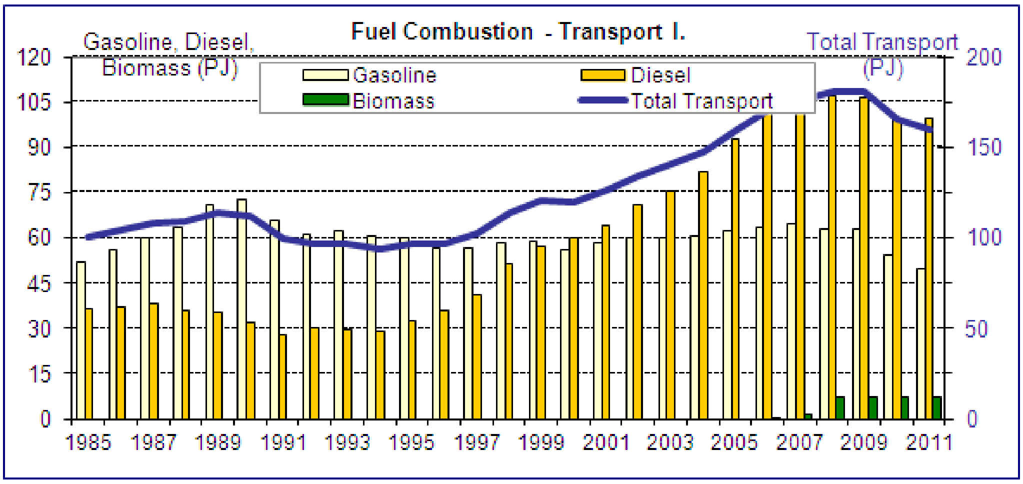

Figure 3.14. Fuel use in transportation, 1995-2011

Source: National Inventory Report, Hungary, 2013

Fugitive emissions from fuels played only a small role with 4.9% out of which 71.1% originate from natural gas production, processing, transmission and distribution. While the fugitive emissions connected to natural gas operations show an increasing tendency (53% increase compared to the base year in subsector 1.B.2.b – Natural Gas mainly due to the spread of distribution network), the emission in subsector 1.B.1 – Fugitive emissions from solid fuels are 99% smaller than the base year caused by the huge recession of coal mining in Hungary. The aggregate change of sector 1B – Fugitive emissions is 19.9% decrease compared to the base year.

Emissions from **agriculture** have decreased by 54% over the period of 1985-2011. The bulk of this decrease occurred in the years between 1985 and 1995, when agricultural production fell by more than 30 percent, and livestock numbers underwent a drastic decrease. The contribution of agriculture to total emissions decreased over the period 1985-2011 from 16.4% to its present share of 13.2%.

Between 1996 and 2008, agricultural emissions had stagnated around 9.5 Mt with fluctuations up to 4%. Behind this trend there were compensatory processes. While the number of livestock decreased further leading to lower emission, the use of fertilizers increased by 67.5% until 2007 which caused growing nitrous-oxide emissions from agricultural soils. In 2008 the significantly rising fertilizer prices led to lower fertilizer use, which resulted in some reduction in the emission levels. Figure 3.15. presents these movements.

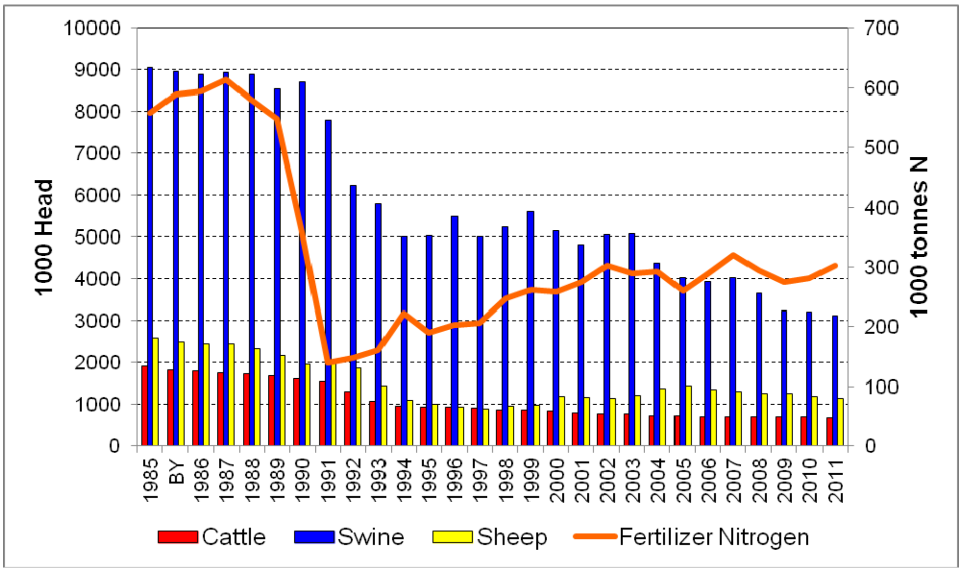

Figure 3.15. Activity indices of livestock and fertiliser use, 1995-2011

Source: National Inventory Report, Hungary, 2013

Agricultural emissions decreased both in 2009 and 2010. A major reduction in emissions occurred in 2009, when emissions decreased by 6 per cent due to the lower N_2O emissions from agricultural soils. The main reason for this is the lower fertilizer consumption. The continued decline in animal husbandry also contributed to the emission reduction. In 2009, the swine population reduced by 11 per cent and in 2010 the cattle population fell by 5 per cent, resulting in lower CH_4 and N_2O emissions levels from animal husbandry. Although the fertilizer consumption was slightly higher in 2010 compared to 2009, there was a decline in the total agricultural emissions again, resulting in the lowest emissions levels in the whole time-series.

Agricultural emissions have slightly increased in 2011, due to the 7 per cent higher N-fertilizer use, and higher emissions from crop residues resulting from greater crop production.

Total emissions from **industrial processes** amounted to 9.4% of the total national emissions in 2011 compared to 12.8% in the base year. Total sectoral emissions decreased by -57.7 % between the base year and 2011, and decreased by -3.7% between 2010 and 2011 (see Figure 3.16.).

Greenhouse gas emissions from the industrial processes sector fluctuated slightly in the beginning of the inventory period then a considerable decline happened: emissions reached their minimum in 1992, which was mainly due to economic crisis. Later on, emissions had been fluctuating again until 2005. Since then, emissions have been showing a decreasing tendency again until 2009 and aggregated emissions decreased by 41.0% between 2005 and 2009. 2010 has been the first year since 2005 when emissions increased again, but after the slight growth of the last year, GHG emissions from industrial processes sector were 3.7% (238 Gg) lower in 2011 than in 2010. Solely in the chemical industry could be observed a growth of 15.7%, but all the other industrial branches have shown lower emissions, which is connected to the still falling production. Especially mineral industry is struggling the recession: for example clinker production has fallen by 57% since 2007. Despite last year's recovery, the emissions in this year decreased by 0.3% from iron and steel production, by 1.8% from consumption of halocarbons and SF6 and by 10.3% in non-energy use of fuels.

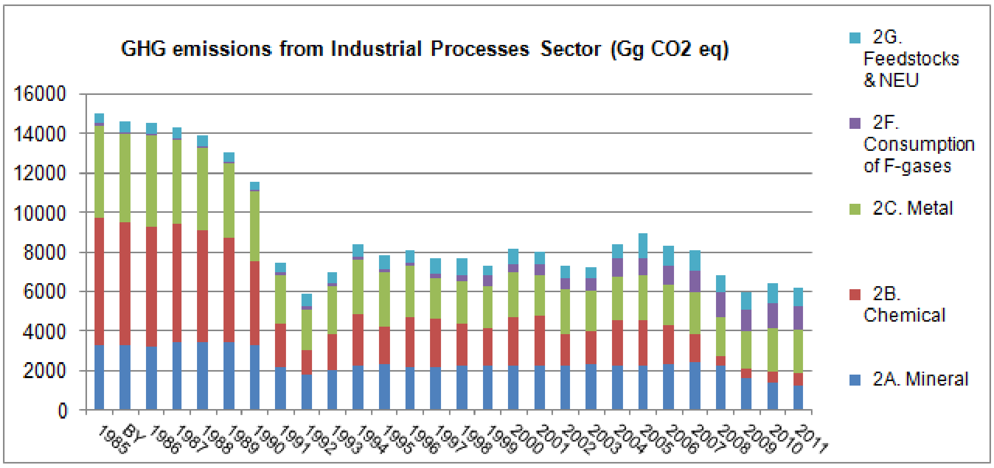

Figure 3.16. GHG emissions from industrial processes, 1985-2011

Source: National Inventory Report, Hungary, 2013

Chemical industry was the most important emitter in the beginning of the inventory period, especially N_2O emission from nitric acid production (for details see there). Between 1990 and 2005 chemical industry, mineral industry and metal production were fluctuating around the same level. After the significant fall of emission in the chemical industry thank to the N_2O abatement technology introduced in nitric acid production in 2007, and the hard recession of the mineral industry, metal production took up the leading role.

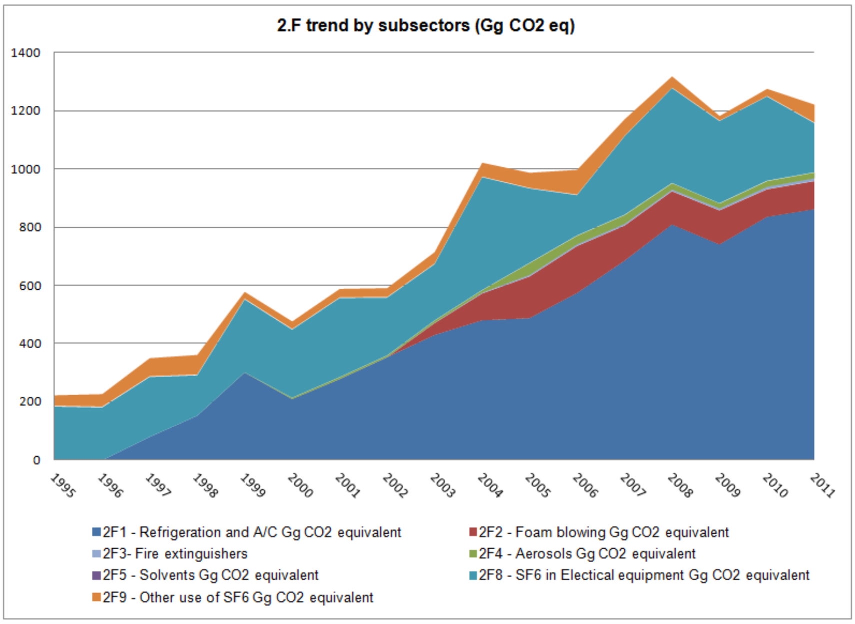

Figure 3.17.F-gas emissions, 1995-2011

Source: National Inventory Report, Hungary, 2013

Although emissions of F-gases represent only 1.8% of the total GHG emissions, their trend shown in Figure 3.17. requires special attention. As these gases are harmless for the ozone layer, the use of HFCs in the refrigeration and air conditioning industry got widespread thus their emission steeply increased until 2008.

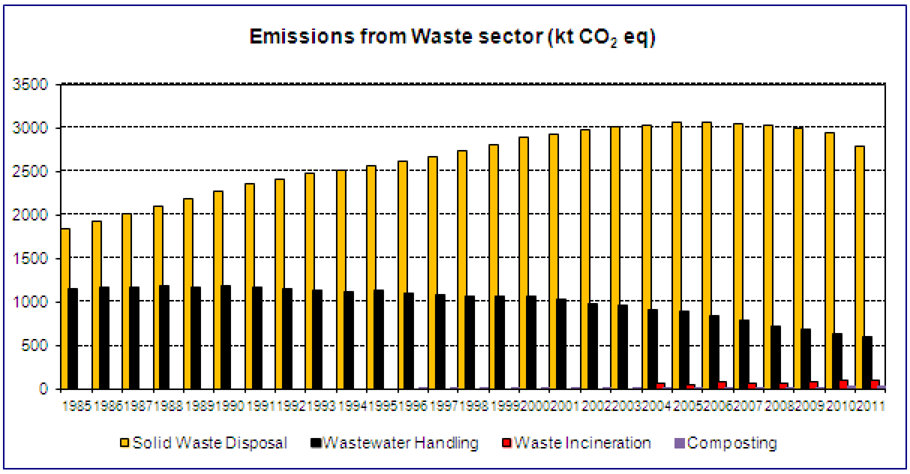

Figure 3.18. Emissions from waste sector, 1995-2011

Source: National Inventory Report, Hungary, 2013

In contrast with other sectors, emissions from the **waste** sector are by 14.5% higher now than in the base year. However, the growth in emissions had stopped in the last decade, and a reduction of 11.8% could be observed between 2005 and 2011 as shown above on Figure 3.18.. The degradation process in solid waste disposal sites is quite slow which means that waste that were disposed many years earlier have still an influence on current emission levels. However, the amount of disposed waste had decreased so significantly since 2005 (-32.5%), that methane emissions started to decrease as well. GHG emissions from wastewater handling have a pronounced decreasing trend due to a growing number of dwellings connected to the public sewerage network.

In the ***Land Use Land-Use Change and Forestry*** sector, using the currently available data, carbon uptake of the forests living biomass, non-CO2 emissions from burning of slash on-site, and for the last couple of years, forest wildfires are reported. Overall, the sector is a sink of carbon because of the huge amount of carbon uptake of forests, due to continuous afforestation efforts and sustainable forest management. The complex dynamics of the land use and land-use changes leads to highly fluctuating estimates of sectoral removals. Our estimates indicate an average annual 3.2 million tonnes removal, CO2-eq. net removals range from 0.07 million tonnes in 1985 to 5.6 million tonnes CO2 in 1995. In 2011 the LULUCF sector accounted for 3.5 million tonnes carbon-dioxide removals. The removals of forests amounted to 2.9 million tonnes.

Our mineral soils in Cropland remove a small amount of carbon (0.3 Mt in 2011), as the abandonment of croplands and the replacement of conventional tillage method by new soil conservation tillage methods represent favourable processes that increase the soil carbon content.

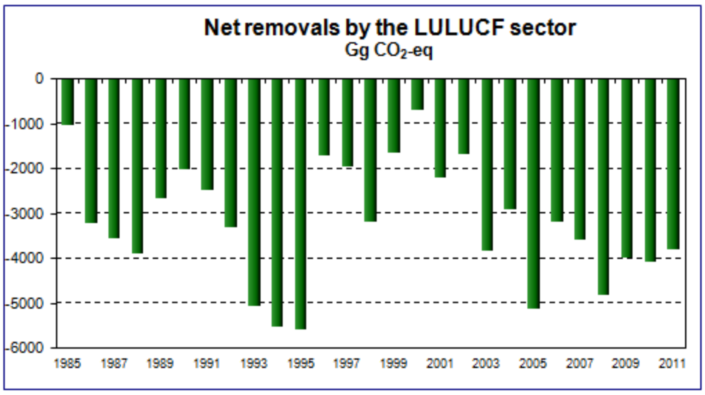

Figure 3.19. Net removals by the LULUCF sector, 1985-2011

Source: National Inventory Report, Hungary, 2013

As regards KP-LULUCF, the activities under Article 3.3 represented a net sink of 1.2 million tonnes CO_2-eq. mainly due to afforestation and reforestation in 2011. Similarly, the activity under Article 3.4, i.e. forest management, was also a net sink of 1.5 million tonnes CO_2-eq. Figure 3.19. shows these data.

3.3. National systems in accordance with Article 5, paragraph 1, of the Kyoto Protocol

Pursuant to the United Nations Framework Convention on Climate Change (UNFCCC), Hungary, as Party of the Convention, has been preparing annual inventories of greenhouse gas emissions using the IPCC methodology since 1994. The aim of a greenhouse gas (GHG) inventory is to give a complete and accurate as possible, state of the art estimation of anthropogenic emissions by sources and removal by sinks of greenhouse gases not controlled by the Montreal Protocol. In accordance with the Kyoto Protocol, the following direct greenhouse gases are taken into account: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). The quality of the inventory is controlled by Hungarian and international experts regularly.

(a) Since the last National Communication, some institutional changes have occurred in the field of inventory preparation. Last time we reported that in January 2006, the Ministry of Environment and Water took over the responsibility of GHG inventory compilation and also the staff from the National Directorate for Environment, Nature and Water. About a year later, the Hungarian Meteorological Service, an institute of the central government under the supervision of the Ministry of Environment and Water, started to participate in the process of inventory preparation. From 2007 on, the GHG inventory has been compiled by the Hungarian Meteorological Service, based on a mandate of the Minister of Environment and Water.

After the elections in spring 2010, the Ministry of Environment and Water was abolished and its tasks have been taken over by the Ministry of Rural Development. The designated single national entity is now the Ministry of Rural Development. The minister responsible for the environment, i.e. the head of the above mentioned ministry, has overall responsibility for the Hungarian Greenhouse Gas Inventory and the Hungarian National System for Climate Reporting. He is responsible for the institutional, legal and procedural arrangements for the national system and the strategic development of the national inventory. As a new feature, the national system has to be operated by the minister responsible for the environment as earlier but, as prescribed by legislation, in consent and cooperation with the ministers responsible for energy policy and forest management. Within the Ministry of National Development, i.e. the ministry responsible for energy policy, a Climate Policy Department has been established that plays some coordinating and supervisory role in the national system. The head of this department is Hungary's current UNFCCC Focal Point.

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(b) At the end of 2006, a Greenhouse Gas Inventory Division (GHG division) was established in the Hungarian Meteorological Service (OMSZ) for the preparation and development of the inventory. This division is responsible for all inventory related tasks, compiles the greenhouse gas inventories and other reports with the involvement of external institutions and experts on a contractual basis and supervises the maintenance of the system.

At the very end of 2009, a new government decree on data provision relating to GHG emissions was put into force. This decree confirmed the designation of the Hungarian Meteorological Service as the compiler institute. As a new element, the participation of the Forestry Directorate of the National Food Chain Safety Office (NFCS, Forestry Directorate, formerly known as Central Agricultural Office) together with the Forest Research Institute is formalized by this decree. These two institutes are responsible for the forestry part of the LULUCF sector and for the supplementary reporting on LULUCF activities under Articles 3.3 and 3.4 of the Kyoto Protocol by making recommendations to HMS of the content of the inventory.

The Hungarian Meteorological Service is a central office under the control of the Ministry of Rural Development. The duties of the Service are specified in a Government Decree from 2005. The financial background of operation is determined in the Finances Act. OMSZ has introduced the quality management system ISO 9001:2000 for the whole range of its activities in 2002 to fulfill its tasks more reliably and for the better satisfaction of its partners. The GHG Inventory Division functions as part of the Climate and Atmospheric Environment Department.

The GHG division of the Hungarian Meteorological Service coordinates the work with other involved ministries, government agencies, consultants, universities and companies in order to be able to draw up the yearly inventory report and other reports to the UNFCCC and the European Commission. The GHG division can be regarded as a core expert team of four people. The division of labor and the sectoral responsibilities within the team are laid down in the QA/QC plan and other official documents of OMSZ. The Head of Division coordinates the teamwork and organizes the cooperation with other institutions involved in inventory preparations. He is responsible for the compilation of CRF tables and NIR. Within the team the experts are responsible for different sectors. Besides, a QA/QC coordinator and an archive manager have been nominated.

Some parts of the inventory (mainly energy, industrial processes and waste are prepared by the experts of the GHG division themselves. The calculations of agriculture and LULUCF (except forestry) sector are compiled by the HMS with contribution of external experts / institutions on contractual basis as follows. The forestry related parts are compiled by the Forestry Directorate of the National Food Chain Safety Office and the Forest Research Institute as laid down by the above mentioned government decree. For the calculation of emissions from agricultural soils the Karcag Research Institute of University of Debrecen (Department of Soil Utilization and Rural Development) was contracted like in the last three years. The Research Institute for Animal Breeding and Nutrition had been heavily involved in the calculations for the agriculture sector of the inventory for several years. The following table summarizes the institutional arrangements:

Table 3.2. Functional areas of national inventory preparation

Function	Institution	Responsibilities
Single national entity	Ministry of Rural Development (in consent and cooperation with Ministry of National Development)	• Supervision of national system • Official consideration and approval of inventory
Inventory coordination and compilation	OMSZ GHG division	• Provision of work plan • Contracting consultants • Inventory preparation of Energy, Industry and Waste sector • Completion of CRF and NIR • Archiving • Coordinating QA/QC activities • Reporting to UNFCCC secretariat
Inventory preparation of Forestry and LULUCF activities under the KP. (by law)	National Food Chain Safety Office (NFCSO, Forestry Directorate) Forest Research Institute	• Data collection, choice of methods and EFs, inventory preparation
Contribution to the inventory preparation of Agriculture sector	Research Institute for Animal Breeding and Nutrition	• Data collection, choice of method, development of country specific emission factors • Background studies
Agricultural soils	Karcag Research Institute of University of Debrecen	• Data collection, choice of methods and EFs, background research and studies

(c) The annual inventory cycle is carried out in accordance with the principles and procedures set out in the Revised IPCC Guidelines and the IPCC Good Practice Guidance.

Data is collected in several ways and throughout the whole yearly cycle of the inventory preparation. Sector specialists of the core team (or external experts on contractual basis) are making the data inquiry and collection in addition to the data arriving based on the reporting obligation set up by Govt. Decree 345/2009 (XII.30) as described below in more detail). Data are collected from the emitter if it is possible (especially in case of power stations, heating stations and industrial technologies) but statistical databases are also heavily used as source of information. The most important statistical publications are the Statistical Yearbook of Hungary, the Environmental Statistical Yearbook of Hungary and the Environmental Report of Hungary published by the Hungarian Central Statistical Office (HCSO) and the Energy Statistical Yearbook published by the Energy Efficiency, Environment and Energy Information Agency or recently by the Hungarian Energy Office. Since the use of ETS data has several advantages, the inventory team was granted access to the verified emissions database held by the National Inspectorate for Environment, Nature and Water. In addition to statistical data, contacts were established with the representatives of a number of major emitting sectors. Moreover, information from the web sites of international associations (e.g., International Iron and Steel Institute, IISI) is used as well. For the calculation of fluoride gas emissions, import data from the Customs Office and Police were used together with data obtained directly from companies importing and using fluorinated gases and information from cooling industry associations, the Hungarian Monitoring and Certification Body

(OMKT-HMBC), the Hungarian Electrotechnical Association (MEE) and the National Directorate General for Disaster Management, Ministry of the Interior (NDGDM).

The Act LX of 2007 on the implementation framework of the UN Framework Convention on Climate Change and the Kyoto Protocol thereof aims to give direct data collection authorization to the Ministry of Rural Development in order to collect data for the national system for climate reporting and gives a permanent status to the system. Relevant paragraphs for data collection are the following: "The state authorities having disposal of the data necessary to operate the National Registration System and the organizations emitting at least 100 tons of carbon dioxide equivalent per year shall provide these data for the National Registration System in accordance with the provisions of a separate legal instrument." "The data (…) necessary to fulfill international data supply shall be provided for the National Registration System irrespective of the fact that they are qualified as individual data pursuant to the relevant provision of Act XLVI of 1993 on statistics." This separate legal instrument, the above-mentioned government decree 345/2009 (XII.30) on data provision relating to GHG emissions prescribes compulsory data provision for GHG inventory purposes for numerous governmental bodies and emitters. QA/QC Activities connected to data collection are regulated by the updated QA/QC Plan included in Annex 6.

As a general method of preparing the inventory, the procedures described in the IPCC Guidelines are applied and the latest CRF Reporter software is used. Usually, the sectoral experts are responsible for the choice of methods and emission factors. According to the recommendations of the IPCC Guidelines, the calculation methods are chosen by taking into account the technologies available in Hungary whenever possible. The calculation of emissions occurs basically by using the formula: AD x EF, where the activity data (AD) can be raw material or product or energy use etc. Part of the available data (e.g. production data) can directly be entered into the IPCC tables; others required previous processing and conversion. For example, energy data are not always available in the required depth and resolution. The default emission factors (EF) are being gradually replaced by country-specific emission factors characteristic of domestic technologies. Efforts are made to use the highest possible Tier method, especially in case of key categories. After preliminary quality control of the basic data, the necessary calculations are carried out with the coordination of the core team. The sectoral data are compiled and - after repeated checks - unified by using the CRF Reporter software.

The inventory cycle can be summarized with the following table:

Table 3.3. Cycles of national inventory preparation

Date/deadline	*Item*	*To*
From May to November	Overview of sectors to identify areas for possible improvements; Data collection, choice of methodologies, Start of calculations Repeated checks	
From September to December (and April)	Calculations from external expert	
From September to December (and April)	Calculations, checks, archiving	
08 January	Main features for National Inventory Report (CRF tables and part of NIR) for approval	National Authority
15 January	Official submission	EU
Between January and March	QC procedures including EU internal review	
08 March	National Inventory Report final version for approval	National Authority
15 March	National Inventory Report, Official submission	EU
Between March and April	QC procedures in the process of finalizing the NIR and CRF tables	
08 April	National Inventory Report for approval	National

Date/deadline	Item	To
		Authority
15 April	Official submission	UNFCCC
From 15th of April to October	Archiving, QA/QC and Development Plan	internal

(d) The key source categories are determined using both Tier 1 and Tier 2 methodology provided in the GPG. In order to identify the key categories, both the LEVEL and the TREND analysis are performed with and without LULUCF.

In the 2013 April submission of the NIR, the TIER1 key category analysis was performed on a new, more disaggregated list of source categories which makes possible the more specific identification of the categories, where the available resources should be concentrated. The list was set up giving more detailed insight into the most emitting sectors and taking into account country specific properties.

Key category analysis using TIER2 methodology followed the practice of last year. For TIER2 methodology the aggregation level of source categories suggested by GPG2000 and GPG2003 (for LULUCF) was used adding the missing sectors significant in Hungary and aggregating some sectors. In this way the sectors assessed cover the total emissions (with LULUCF). The threshold of Key source categories in Tier 2 analysis is 90% as it is suggested in GPG2000 Chapter 7.2.1. The required uncertainty values for TIER2 Key category analysis methodology were determined using TIER1 uncertainty analysis on the basis of the GPG2000 and GPG 2003, but estimates of data supplier institutions and experts were used as well. Both LEVEL and TREND assessments were made with both methodologies.

Table 3.4. TIER1 and TIER2 in IPCC source categories

	TIER1 (without uncertainties, including LULUCF) Number of key category / number of categories	TIER2 (with uncertainties, including LULUCF) Number of key category / number of categories
LEVEL	38/ 194	14 / 61
TREND	39/ 194	17 / 61

IPCC Source Categories	GHG	Tier1 KCA
1A1aga Energy - Stationary Combustion - Public electricity and heat production - Gas	CO2	L1 T1
1A1ali Energy - Stationary Combustion - Public electricity and heat production- Liquid	CO2	T1
1A1aot Energy - Stationary Combustion - Public electricity and heat production- Other	CO2	L1 T1
1A1aso Energy - Stationary Combustion - Public electricity and heat production- Solid	CO2	L1 T1
1A1bga Energy - Stationary Combustion - Petroleum refining - Gas	CO2	L1
1A1bli Energy - Stationary Combustion - Petroleum refining - Liquid	CO2	L1
1A2ga Energy - Manufacturing Industries and Construction - Gas	CO2	L1 T1
1A2li Energy - Manufacturing Industries and Construction- Liquid	CO2	L1 T1
1A2so Energy - Manufacturing Industries and Construction - Solid	CO2	L1 T1
1A3bld Energy - Mobile combustion - Road transportation	CO2	L1 T1
1A3blg Energy - Mobile combustion - Road transportation	CO2	L1 T1
1A3cli Energy - Mobile combustion - Other: Civil Aviation, Railways, Navigation	CO2	T1
1A4ga Energy - Stationary Combustion - Other - Gas	CO2	L1 T1
1A4li Energy - Stationary Combustion - Other - Liquid	CO2	L1 T1

1A4so Energy - Stationary Combustion - Other - Solid	CH4	T1
1A4so Energy - Stationary Combustion - Other - Solid	CO2	L1 T1
1B1a Energy - Fugitive Emissions from Fuels - Solid Fuels	CH4	T1
1B2b Energy - Fugitive Emissions from Fuels - Oil and Natural Gas	CH4	L1 T1
1B2d Energy - Fugitive Emissions from Fuels - Oil and Natural Gas	CH4	L1 T1
2A1 Industrial Processes - Mineral Products - Cement production	CO2	L1 T1
2A2 Industrial Processes - Mineral Products - Lime production	CO2	T1
2A3 Industrial Processes - Mineral Products - Limestone and dolomite use	CO2	L1 T1
2A7 Industrial Processes - Mineral Products - Other	CO2	T1
2B1 Industrial Processes - Chemical Industry - Ammonia production	CO2	L1 T1
2B2 Industrial Processes - Chemical Industry - Nitric acid production	N2O	T1
2C1 Industrial Processes - Metal Production - Iron and steel production	CO2	L1 T1
2Fa1HFCs Industrial Processes - Refrigeration and air conditioning equipment	HFCs	L1 T1
2G1 Industrial Processes - Feedstocks	CO2	L1 T1
3d Solvent and Other Product Use - Other	N2O	L1 T1
4A1ca Agriculture - Enteric Fermentation /Cattle	CH4	L1 T1
4B13so Agriculture - Manure Management /Solid	N2O	L1 T1
4B1ca Agriculture - Manure Management /Cattle	CH4	L1 T1
4B8sw Agriculture - Manure Management /Swine	CH4	L1 T1
4D1.1. Agriculture - Agricultural Soils - Direct soil emissions /Synthetic Fertilizer	N2O	L1 T1
4D1.2-4. Agriculture - Agricultural Soils - Direct soil emissions / Animal Manure and other	N2O	L1
4D3 Agriculture - Agricultural Soils - Indirect emissions	N2O	L1 T1
5A1 LULUCF - Forest Land - remaining	CO2	L1
5A2 LULUCF - Forest Land - converted to	CO2	L1 T1
5B1 LULUCF - Cropland - remaining	CO2	L1 T1
5B2 LULUCF - Cropland - converted to	CO2	L1 T1
5C1 LULUCF - Grassland remaining Grassland	CO2	L1 T1
5C2 LULUCF - Land converted to Grassland	CO2	L1 T1
6A Waste - Solid Waste Disposal on Land	CH4	L1 T1
6B2 Waste - Wastewater Handling - Domestic and Commercial	CH4	L1
6B2 Waste - Wastewater Handling - Domestic and Commercial	N2O	L1

Notation key:

L1= Level Assessment using TIER1 methodology

T1=Trend Assessment using TIER1 methodology

IPCC Source Categories		GHG	Tier2 KCA
1. A.	Stationary Combustion - Coal	CO2	L2 T2
1. A.	Stationary Combustion - Gas	CO2	L2 T2
1. A.	Stationary Combustion - Oil	CO2	T2
1. A. 3. B.	Mobile Combustion - Road	CO2	L2 T2
1. B. 2.	Fugitive Emissions from Oil and Gas Operations (Main Source: Gas Distribution)	CH4	L2 T2
2.	HFCs Emissions from Industry	HFCs	T2
2.	SF6 Emissions from Industry	SF6	T2
4. B	CH4 Emissions from Manure Management	CH4	L2 T2
4. B.	N2O Emissions from Manure Management	N2O	L2 T2
4. D. 1.	Direct N2O Emissions from Agricultural Soils	N2O	L2 T2
4. D. 3.	Indirect N2O Emissions from Nitrogen Used in Agriculture	N2O	L2 T2

5.A.1	Forest Land remaining forest Land	CO2	L2 T2
5.A.2	Land converted to Forest Land	CO2	T2
5.B.1	Cropland remaining Cropland	CO2	L2 T2
5.B.2	Land converted to Cropland	CO2	L2 T2
5.C.1	Grassland remaining Grassland	CO2	L2 T2
5.C.2	Land converted to Grassland	CO2	T2
6. A.	CH4 Emissions from Solid Waste Disposal Sites	CH4	L2 T2
6. B.	Emissions from Wastewater Handling	N2O	L2 T2

Notation key:

L2=Level Assessment using TIER2 methodology

T2= Trend Assessment using TIER2 methodology

(e) Recalculation of some data-series of the inventory can be justified by several reasons. Just to name a few, QA/QC procedures, ERT recommendations, changing for higher Tier methodologies can lead to a recalculation. As a basic rule, whenever new information emerges that improves the quality or accuracy of the emission data, the emissions are recalculated. Recalculations are always documented in the relevant chapter of the national inventory report.

(f) The national system has to ensure high quality of the inventory, i.e. to ensure that the inventory is transparent, consistent, comparable, complete and accurate. These principles guide the internal expert team that maintains the system. QA/QC activities are performed in two levels: based on the ISO 9001 standards and following the IPCC recommendations. The updated QA/QC Plan that entered into force in 2013 aims to integrate these two set of requirements.

ISO activities

The Hungarian Meteorological Service introduced the quality management system ISO 9001:2000 in 2002 for the whole range of its activities which was quite unique among meteorological services. However, GHG inventory preparation was not among its activities in that time. Therefore, the scope of our ISO accreditation had to be modified and lots of efforts have been made to bring also the national system under the umbrella of the ISO QM system. Several regulatory ISO documents were created, among others: ISO procedure on the activities of the GHG Division; QA/QC plan; registers and records for quality checks and documentation. Of course from that time general, HMS level QA/QC activities apply for the GHG Division as well, such as general quality objectives, application of QA/QC Manual of the HMS, QA/QC regarding contractors, etc. Further information on quality management system of the HMS is available in English at: http://www.met.hu/en/omsz/minosegiranyitas/

In 2012 the ISO procedure of the GHG division was reviewed, and the former QA/QC Plan with the archiving manual was integrated into it. So, from now on this new ISO document that entered into force on 4th January 2013 can be regarded as the QA/QC Plan required for inventory preparation. In addition the records used for documentation of QA/QC and other standardized activities have also been renewed. The renewed QA/QC Plan contains detailed description of the data collection, inventory preparation and reporting processes, regulates the documentation and archiving activities in order to ensure transparency and reproducibility of the inventory.

Documentation and archiving: As it is mentioned above, the Hungarian Meteorological Service is a central office under the control of the Ministry of Rural Development. Strict documentation and archiving is a basic requirement by the institution. The HMS has a documentation and archiving manual valid for the whole institution, which defines that all the incoming letters and emails containing data have to be registered in the central registry system of HMS. This ensures that every document is traceable. In additional data, data sources and calculation files and background documents for every inventory submission need to be documented and archived by the sectoral experts.

Data quality check. Besides self-checking, the entries of data providers and external experts are checked regularly which is an interactive process during the whole inventory cycle. Significant changes compared to previous data shall be explained. A new QC record was created for standardized documentation of evaluation of data quality by the data providers which can be regarded as a continuous development. The QA/QC plan prescribes the obligation of filling in the records mentioned before, including Development Plan, where first of all the recommendations of the last years' reviews conducted by the expert review team of the UNFCCC have to be taken into consideration as much as possible every year.

Having an ISO system in place has an advantage of being subject to regular internal and external audits. During our last external audit the activities of the GHG Division were audited as well. Our system was audited favorably in the end of March 2007; and our ISO certification has been renewed in January 2012 and a comprehensive external audit was again performed in January 2013. On the 5th April 2013 an internal audit has been performed too. In both cases the result was a few non significant recommendations. Therefore we can claim that the GHG inventory is subject to and our procedures are in line with ISO 9001:2008.

As part of the QA and verification activities there is an ongoing QA procedure between the two institutes involved in the forestry part of the inventory. Peer-reviews will be conducted depending on available resources

In 2012 the EU carried out a comprehensive individual technical review concentrating on the years 2005, 2008, 2009 and 2010, which can be regarded as an additional QA activity. The recommendations of this review are included in Annex 8.

Further QA and verification activities to be continuously performed and/or planned:

- Checking the results of the EU's internal review for the EU15, and analyze its relevance for Hungary.
- Checking the differences in activity data to increase the consistency between different emission databases, especially the GHG inventory, LRTAP inventory, ETS data, NAMEA data, and the E-PRTR data.
- Incorporation of ETS data in broader extent for revision of the used EFs and for better sectoral allocation of emissions.
- Comprehensive consistency checks between national energy statistics and IEA time series.
- R+D projects. The Hungarian Meteorological Service funds research and development projects for the improvement of the inventory whenever possible.
- Active participation in the support project organized by EU DG Climate for the „Assistance of Member States for effective implementation of the reporting requirements under the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC)"

<u>Other QA/QC activities</u>

Besides ISO requirements, other QA/QC activities are carried out, as well. For every sector of the inventory, there is a responsible person within the core team in the Meteorological Service. These sectoral responsibilities are laid down in a QC record. Especially in case of external experts, this responsible member of our team conducts several quality checks on the provided calculations. Moreover, this exercise can be regarded as an interactive process throughout the whole inventory cycle, since the used methodologies, early results are discussed during the process of the emission/removal calculations. This QC procedure also led to a few recalculations. The used parameters and factors, the consistency of data are checked regularly. Completeness checks are undertaken, new and previous estimates are compared every time. Data entry into the database is checked many times by a second person. If possible, activity data from different data sources are compared and thus verified. In response to our request, several data suppliers made declarations as regards quality assurance systems in place during the collection of the data and a new QC record has been introduced for the documentation of evaluation of data quality by data providers. Experts involved in emission forecast consulted in many areas with inventory experts of the Hungarian Meteorological Service to reach better consistency, which in turn represented some sort of QA procedure for the inventory itself.

(g) To summarizing the above, the two main compiler institutes are: (1) Hungarian Meteorological Service (HMS) and (2) Forestry Directorate of the National Food Chain Safety Office, the latter is responsible for the forestry part of the inventory.

The Meteorological Service, where an inventory team is located, is authorized by law to collect the necessary data. Calculations are either carried out by the GHG Division of the HMS or by external experts on contractual basis. The inventory report is approved by two ministers: (1) minister for national development approves before official submission to the EU, (2) minister for rural development approves before submission to the UNFCCC.

4. NATIONAL POLICIES AND MEASURES

4.1. Policy making process

Climate policy and energy policy as two areas of vital importance that need to be harmonised and coordinated. Among the new government's first measures was the modification of tasks and responsibilities of ministers. This was influenced by the need of a more dynamic response to global economic challenges and increased focus on specific interdependent problems.

Legislative and policymaking activities climate change and energy sector have been united under the auspices of the Ministry of National Development (1247/2010. (XI. 18.), Govt. decree). This allowed for the first time the establishment of a sovereign State Secretariat of Climate Change and Energy Policy with two aides of the state secretary – a deputy state secretary for energy policy and another deputy for green economy development and climate change.

The most important task of the Secretariat was formation of the long-term energy strategy of Hungary, as well as submission of the National Action Plan for Renewable Energy to the European Commission. These strategic documents provide a foundation for security of supply, competitiveness, sustainability, economic incentives and the elimination of energy poverty and serve the fulfillment of EU obligations.

In the following part, the framework of climate change policies will be outlined. Primarily the Programme of National Cooperation has to be mentioned as the general context of policy development. A cornerstone of climate change policy is the National Climate Change Strategy. The National Sustainable Development Strategy has recently been reformulated and accepted by the government and is an importan element together with the National Environmental Programme. The New Széchenyi Plan is an economic development programme and as such provides an operative background for the realisation of strategic objectives.

4.1.1. The Programme of National Cooperation

Although the Programme of National Cooperation is not focused on the GHG mitigation, the implementation of the Programme includes several such elements, and the Programme itself has some priorities that serve this purpose. These are briefly summarised here:

- In reviving the economy, the construction industry has an important role. It is stated in the programme that one means to boost the construction industry is to promote the European initiative to employ "green" technologies and to develop the energy efficiency of buildings and the construction materials.
- A large scale energy efficiency program is to be launched with components such as deep reconstruction of pre-fab buildings (reduce consumption by 80%), thermal insulation projects of other buildings, reconstruction of public buildings etc.
- Investments in renewable energy have to be encouraged.
- Environmental considerations shall be integrated in the national development policy.
- Environmental protection shall be taken into consideration in the public procurement procedures.
- In order to boost the economy, new take-off points need to be found. Green economy and the utilisation of renewable energies are among the possible take-off points.

4.1.2. National Climate Change Strategy

The National Climate Change Strategy 2008-2025 (NCCS) was adopted by the Parliament unanimously in the early 2008 (Parliamentary resolution 29/2008. (III. 20.) OGY). It has not been changed since, although its review is currently underway. The NCCS was presented in detail in the previous National Communication. Only its key points are summarised here:

- The GHG emission reduction target is 16-25% of the 1991 levels by 2025.
- The responsibility of the government is to create the necessary regulatory-legal framework; to review and adjust the subsidy systems; to raise the awareness of the society by giving priority to sustainability and providing good example.
- The residential sector is a key field of change: peoples' lifestyle needs to be changed; a large scale reduction of demands for energy and materials must be achieved (by subsidised energy efficiency projects, among others);
- Industry and other enterprises also need to reduce their energy consumption, adopt emission reduction measures, to "green" their profile, products, services.
- NGOs, civil organisations shall have increased role in the dissemination of information, awareness raising and civil control.
- Main areas of intervention are:
    - Energy efficiency in buildings
    - Renewable energy utilisation
    - Transport (road tolls, other economic incentives, modal split change)
    - Afforestation

4.1.3. National Sustainable Development Strategy

As the new EU Sustainable Development Strategy adopted by the European Council on 15/16 June 2006 requires, Hungary prepared the country's first National Sustainable Development Strategy (NSDS) and submitted to the Council in 2007. The EU strategy requires that the Member States would revise their National Strategies regularly, subsequent to the revision of the EU SDS, in order to ensure consistency, coherence and mutual supportiveness. In 2009 the Commission adopted the 2009 Review of EU SDS, and in the light of this document the revision of the Hungarian NSDS has been carried out. The new NSDS has been adopted by the Hungarian Parliament in 2013.

4.1.4. National Environmental Protection Programme 2009-2014

The Act LIII of 1995 on the General Rules for the Protection of the Environment stipulates that a regularly (every six year) revised and updated National Environmental Protection Programme (NEP) would be prepared. The first such programme was approved by the Parliament in 1995 and has been updated regularly. The second National Environmental Protection Programme 2009-2014 (NEP-III) was adopted by the Parliament in 2009 (Resolution of the Parliament 96/2009. (XII. 9.) OGY). Similarly to the previous programmes, the NEP-III identifies general objectives, which are then broken down to specific actions, so-called thematic action programmes or TAPs. The general objectives are the following:

- Improving the quality of the environment and life locally
- Preservation of naturals resources
- Promotion of sustainable lifestyle, production and consumption
- Improvement of environmental safety.

From among the TAPs the following have relevance from the aspect of GHG mitigation:

- Reinforcing environmental awareness
    - Education, training within the education system from the elementary school to the university
    - Environmentally conscious production and consumption
    - Access to environment-related information, information dissemination
    - Combating climate change
    - Reduction of GHG emissions (EU-ETS system, improvement of energy efficiency [NEEAP],
    - Reducing the environmental impact of transport (reducing demand, restructuring modal split, alternative fuels)

  - Reducing emissions from the agriculture (improvement of production efficiency)
  - Afforestation according to the National Afforestation Programme.
- Environment and health
  - Transport and environment (Reverse the tendency of shifting to individual transport)
- Protection and sustainable utilisation of waters
  - Utilisation of the energy of geothermal waters
- Waste management
  - Prevention (reduction of waste quantities)
  - Utilisation of wastes and recycling
  - Reduction of landfilled waste

4.1.5. The New Széchenyi Plan

The New Széchenyi Plan (NSZP) is the economic development programme of the Hungarian government. This programme translates the economy-related objectives of the Programme of National Cooperation into a concrete programme. The main objectives of the New Széchenyi Plan starting on the 15th of January, 2011 are to improve the competitiveness of Hungary and to create one million new jobs over the next ten years with the help of seven take-off points. As of today the six take-off points of the New Széchenyi Plan are:

- Healing in Hungary – Health industry
- Renewal of Hungary – Development of green economy
- Transport – Transit Economy
- Network economy – Development of business environment
- Knowledge economy – Science – Innovation – Growth
- Employment

The New Széchenyi Plan is also a tool to provide financing for the implementation of all strategic goals. The operative programmes are financed through the New Széchenyi Plan, and in this regard it is an important “umbrella” policy for all other relevant strategies including the Energy Strategy, Transport Strategy, Energy Efficiency Action Plan, etc. In this regard it is important to review the key programmes and principles of the NSZP – being the latest decisive strategy document – as it indicates the actual priorities of the government.

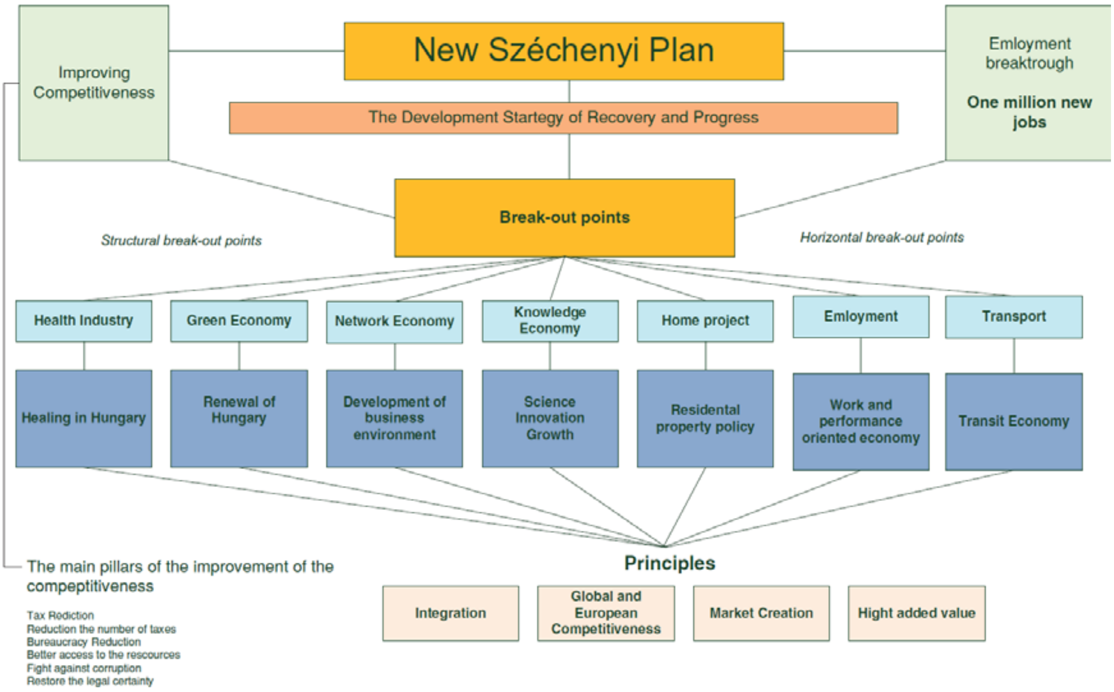


Figure 4.1. The structure of the New Széchenyi Plan

Source: Ministry of National Development

The programmes in the period of 2014-2020 of the NSZP concerning GHG mitigation are as follows:

1. Energy policy

- Energy policy is to serve economic growth and job creation, together with security of supply, resource diversification, and the reduction of import dependence.
- Production and utilization of renewable energies is to be encouraged. The following measures are planned to stimulate the utilization of renewable energies through domestic support funds:
    - Revision of discounts on fossil fuels (e.g. discounts on gas consumption, carbon tax, etc.);
    - Restructuring of the actual support system (revision of investment support, preference of domestic added value, introduction of a green certificate);
    - Modification of the support mechanism to promote the renewal/adaptation of heating systems;
    - Facilitation of renewable energy producers' network connection.
    - The Plan regards projects affecting the climate change and projects of mitigation and adaptation in connection with the energy sector as of supreme priority. These include reduction of greenhouse gases emissions, promotion of climate-friendly investments, as well as projects increasing social acceptance and awareness of environmental protection issues. To this end, the Plan works out and implements measures and development projects to support the National Climate Change Strategy.
    - Nuclear energy is given high priority due to its favourable impact on the security of supply and GHG mitigation.

2.Transport

- Creating the financial resources necessary for a sustainable transport system.
- Encouraging intermodal transports.
- Enforcing environmental and climate policy considerations

- Increasing environmental awareness, economic policies striving to achieve (more) local operation spreading throughout Europe.
- Transformation of the primary energy mix – a greater proportion of renewable energy is necessary.
- The advantages of Hungary's geographical situation can be realized only with having an adequate traffic and transport system, nodes as well as intermodal and multifunctional logistics centres and related industrial parks established in these nodes. This would make it possible to reduce road transit and ensure added value.

4.1.6. Green Investment Scheme (GIS)

The Kyoto Protocol of the UNFCCC made carbon trading possible. Due to the restructuring of the economy and the retirement of energy intensives industries in the past twenty years Hungary is in the position to sell emission rights or allowances (so-called assigned amount units, or AAUs). Due to criticisms from the international community who are doubtful about the true mitigation effects of such "hot-air" sales, nowadays such trading requires that the revenues from the sales would be spent on emission reduction measures – the more concrete and quantifiable the results, the better. In order to make such transactions and the consequent mitigation measures transparent, such deals and their revenues are to be managed through a dedicated financial facility, the green investment scheme (GIS).

Hungary was the first to sell AAUs in 2008 and also among the first ones to create a transparent GIS. The legal background for the GIS is provided by the amended Act LX of 2007 on the implementation framework for the United Nations Framework Convention on Climate Change and its Kyoto Protocol, whereas the details of its operation are regulated by Government Decree 323/2007 (XII. 11.) on the implementation rules of Act LX of 2007. The latter unambiguously states that all revenues of the GIS, including interests can only be used to support in form of grand, interest support, loan or other payments the following GHG mitigation efforts:

- Improvement of building energy efficiency;
- Increasing the utilisation of renewable energies;
- Improvement of efficiency of district heating systems;
- Promotion of the construction of low-energy consumption buildings;
- Energy efficient modernisation of indoor and outdoor lighting systems;
- Promotion of creating carbon sinks;
- Emission reduction in the transport sector;
- Replacement of old inefficient household appliances and electronic devices with new certified low energy consumption equipment;
- Other emission reduction.

Maximum 5% of the GIS revenues can be used for covering the administrative costs of the GIS. It is also required by the regulation that the supported project should be additional (i.e. not implemented without the support). Further details of the operation of the GIS including the responsible organisations, procedure of contracting, process and rules of application for support, reporting procedures etc) are regulated by the Ministerial Instruction 18/2011. (III. 29.) NFM.

Thus the areas where the carbon trade revenues can be used are not only controlled by the sales contract but also restricted by the law, and the entire operation of the GIS is properly regulated.

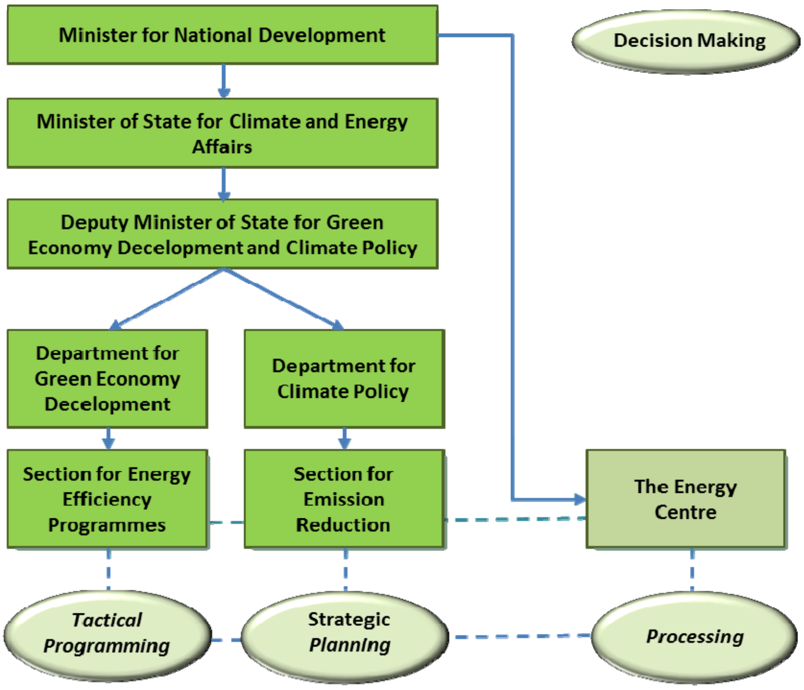


Figure 4.2. The organisational structure of the Green Investment Scheme in 2011

Source: Ministry of National Development

The GIS is considered to be a key source of funding GHG mitigation projects and efforts. Several of the policies described in this report have been or will be financed at least partly from GIS sources. The GIS is planned to be restructured with the following priorities in mind:

- Complex (deep) energy efficiency revamp of multi-flat and family houses, to increase the approximately 40% energy saving achieved by GIS programmes so far to at least 60%,
- Support for the construction of new highly efficient buildings,
- Loan guarantee for the investors of the above projects, so that they could take loans at better conditions to provide their own share for the other supports from the GIS.

4.1.7. Policymaking in the forestry sector

In Hungary, the ministry responsible for developing and implementing forest policies related to climate change has been the Ministry of Rural Development since 2010. The development of policy and regulations in the forestry is subject to negotiations between state authorities, land owners, forestry companies and civil organizations. In the future, more attention has to be paid to considering the evolution of the carbon sequestration capacity of forests as an immediate value. Decisions with respect to this value to be taken at the forest stand level where management decisions are usually made. An important obstacle of development has been the lack of clearly set priorities for forest management both at national and regional level, thus, it seems to remain a key issue. In order to optimize forest management for carbon sequestration as well as for adaptation, the flow of information to and among forestry staff, including forestry authorities, as well as guidance from policy makers have to be improved. Aimed at the promotion of discussion on the relevant climate change related issues, a stakeholder consultation process was initiated in 2008 by the Hungarian Forest Research Institute. This consultation attracted many interested parties and yielded a fruitful cooperation, but should be further developed to achieve the required effects.

4.2. Domestic and Regional Programmes and/or Legislative Arrangements and Enforcement and Administrative Procedures, Intersectoral Policies and Measures

4.2.1. General legal background

The general legal background of all GHG mitigation policies is provided by:

- Act LXXXVI of 2007 on electric power;
- Act XL of 2008 on natural gas;
- Act LIII of 1995 on the General Rules for the Protection of the Environment;
- Act LX of 2007 on the implementation framework for the United Nations Framework Convention on Climate Change and its Kyoto Protocol;
- Act CCXVII of 2012 on the participation in the European Union emission trading system and in the implementation of effort sharing decision;
- Act XXXVII of 2009 on forests, forest protection and forest management;
- Act CLXXXV in 2012 on waste.

and their implementation decrees.

The major role of these pieces of legislation is to ensure the legal base for emission reduction measures. All this legislation is still in place and their major GHG related stipulations that serve this purpose were discussed in the previous NC. Minor changes and amendments of the legislation, however are constantly made, but these have not affected the legal base of the GHG mitigation so far. Stipulations of the legislation with specific GHG policy relevance are explained in the description of the individual policies later in this report.

4.2.2. National Energy Strategy

The current National Energy Strategy was adopted by the Parliament in October, 2011 by 77/2011. (X.14.) Decree of the Parliament and the final document was published in 2012. Compared to the previous strategy document the basic priorities and strategic goals have not changed. In line with the European strategy they are still threefold: safety of supply, competitiveness and sustainability. Thus the strategy relies on the following pillars:

- **Security of energy supply**: The most efficient and effective way, also viable in the short term, of increasing the security of supply is to reduce consumption and to treat energy savings and energy efficiency as priorities. However, the securing of natural gas supply from diverse sources and along alternative routes and the continuous maintenance of the existing infrastructure must also be continued. Further contributors to the security of supply: the still significant hydrocarbon, coal and lignite reserves, the Paks Nuclear Power Plant accounting for 42 percent of the Hungarian electricity production, the significant renewable energy potential and Hungary's commercial and strategic natural gas storage capacities.
- **Increasing competitiveness**: the energy sector can promote the long-term competitiveness of the Hungarian economy by integration into the single internal energy market of the European Union and its prevailing prices; the development of new industries in relation to renewable energy use and sources, the improvement of energy efficiency and the related research and development activities; the appropriate management of domestic supplies and resources (utilisation of geothermal resources, afforestation and energy crop programmes)
- **Sustainability**: sustainable energy management must strike a balance between environmental (resource-efficient, climate-neutral), social (secure, accessible, not harmful to health) and economic (cost-effective) considerations. It is based on the reducing of energy consumption and the production and transmission of the required energy in the most efficient manner possible, preferably from

renewable sources, under strict conditions. Its implementation also requires a critical review of consumption patterns and their changing through awareness-raising. The development of sustainable energy management is facilitated by the quantification of the externalities related to the modes of energy production, particularly the use of fossil fuels (e.g. the trading of GHG emissions).

- **Energy efficiency and energy conservation**: The most efficient ways of maintaining or even reducing the level of energy consumption are the minimisation of losses and the non-consumption of energy. Energy efficiency can be improved at the lowest cost, while achieving the highest social and climate protection benefit, through energy renewal projects in the construction industry. The implementation of an energy efficiency programme encompassing an entire supply chain enables the reduction of increasing demand, particularly for heat energy, and the simultaneous reduction of the expenses of citizens.
- **Renewable energy sources**. In European comparison, Hungary has a relatively good renewable energy potential in the fields of the utilisation of biomass, biogas, geothermal and solar energy. Reserve capacities also exist in the fields of hydro energy and waste to energy utilisation. In terms of utilisation, decentralised practices must be distributed and the required incentives must be provided, which should result in the increase of the share of renewable energy at least to the extent required by Hungary's international commitments.
- **Nuclear energy**. The use of nuclear energy makes a substantial contribution to the maintenance of the security of supply and, through its low operation cost, to the competitiveness of the national economy. The need for the replacement and the potential expansion of the existing capacity by new units is underpinned by the need to replace the existing obsolete power stations, the expected average 1.5-percent annual increase of demand for electricity, the meeting of the increasing electricity demand as a result of the desired electrification of transport and heating/cooling and the shrinking of import.
- **Regional infrastructure platform.** Cooperation with the neighbouring countries (particularly in the framework of the North-South High-Level Group, the V4 and V4+) aims at ensuring price stability, the diversification of resources, the security of supply and the increasing of regulatory network capacities. The integration of the networks, market and trading systems of neighbouring countries enables the establishment of a regional infrastructure platform and the resulting price competition.
- **New system of the government's energy institutions and tools**. A system of institutions ensuring the predictability of the investor environment must be established. Permitting processes should be predictable, transparent and simple for the investors. It is of crucial importance that the stability and credibility of the system of the government's energy institutions should be ensured in the long term in order that it should be able to put the Energy Strategy into practice and to monitor its implementation on an ongoing basis.

In terms of means to achieve the strategic goals, the key elements of the energy strategy from the aspect of GHG emission mitigation are the following:

- Limitation of the increase in energy demand until 2030 and the simultaneous reduction of GHG emissions. With the aid of energy efficiency programs, the country's primary energy use should be limited to 1,150 PJ/year by 2030, and growth rate of electricity consumption should be limited to 1.5% annually.
- According to the most realistic scenario of the strategy, heat demand could be reduced by 111 PJ compared to 'Sitting and waiting' or BAU scenarios through a building refurbishment program.
- Modernisation of electric power stations and the grid: by replacing the current low-efficiency power stations by 2030, 78 PJ primary energy could be saved as compared to the current situation. With particular regard to the fact that financing sources are currently very limited, cost-effectiveness is one of the critical factors during the first half of the period up to 2020, while the depth of retrofit will have to be steadily increased after 2020. During the initial period, the average depth of retrofit is 50 percent. From 2020, it will reach 70 percent and even 85 percent in certain cases by the end of the 2030 timeframe.

- The improvement of the energy efficiency of industrial and other economic stakeholders will make a great contribution to the achievement of energy efficiency targets. According to research, the most cost-effective solution is the application of energy management systems and regular energy audits. More specifically, the commitment of industrial stakeholders to energy saving is increased by their long-term agreements (LTA) with the government.
- Agriculture also has a significant potential in terms of increasing energy efficiency. First, there are significant differences in the energy demand of various agricultural technologies, as the different operational structures and cultivation intensities represent different consumption structures of mostly fossil fuels. On the other hand, the preference of local production and consumption may help cut back on transportation costs and energy as well as reduce emissions.
- Apart from technological development and the use of economic incentives, awareness-raising and personal involvement are also important. (Smart metering, transparent billing.)
- The share of renewable energy in primary energy use will increase from the present 7% to the neighbourhood of 20% by 2030. The system of incentives concerning the utilisation of renewable energy sources should be developed in a way that co-generating biogas and biomass power plants are given priority in the case of the co-generation of heat and electricity and that geothermal energy, also of primary importance, should primarily, but not exclusively, be used for heat generation. In accordance with and in compliance with the criteria of sustainability and energy efficiency, the local energy utilisation of the by-products of agriculture (e.g. straw and maize stalk) and sewage water and sludge in biomass power and biogas plants, among other options, are treated as a priority.
- Reduction of carbon intensity of the energy sector from 370 g CO_2/kWh to below 200 g CO_2/kWh, depending on scenario, by 2030 through.
    - Nuclear power generation
    - Renewables in cogeneration plants
    - Shutting down old, inefficient capacities
- Increasing the share of district heating within heat supply along with the modernisation of the district heating systems and much larger utilisation of renewable energies.
- Strong increase of the share of renewables in individual heat supply.
- Reduction of residential heat demands by some 30% through (building) energy efficiency programmes.
- Improvement of the energy efficiency of transport
    - by promoting railway cargo transport and
    - by converting public transport to locally produced, sustainable fuels.
- Promoting decentralised power generation.
- Reliance on regional cooperation in diversifying sources, increasing the network buffer capacities.

4.2.3. Second National Energy Efficiency Action Plan (2nd NEEAP)

Directive 2006/32/EC of the European Parliament and of the Council on energy end-use efficiency and energy services and repealing Council Directive 93/76/EEC (ESD) required Member States to prepare and periodically review a National Energy Efficiency Action Plan for the period of 9 years between 2008-2016 in accordance with the substantial and formal requirements set out by the European Commission. The 2nd NEEAP was adopted by the Government in October 2011, and a third NEEAP is to be prepared using the results and experience gained by 30 June, 2014.

The major objectives of the 2nd NEEAP are:

- To achieve the highest possible savings in the final energy use by 2016 by using available resources efficiently.
- To achieve altogether 9% of energy savings in energy end-use.
- Target value to be achieved by 2016: 57.40 PJ/year (15 955 GWh/year).

The target values of the individual sectors are the followings:

Table 4.1. Target values

Sector	Target value of Cummulative savings by 2016 (PJ/year)
Residential	**21.00**
Public sector	**17.45**
Industry, productive sectors	**13.05**
Transport	**4.60**
Horizontal and cross-sectoral (other)	**4.00**
Total	**57.40**

The individual measures foreseen by the 2nd NEEAP are described in detail in the next chapter.

4.2.4. Renewable Energy Action Plan

The Renewable Energy Action Plan (the official title is: Hungary's Action Plan for the Utilisation of Renewable Energies 2010-2020, in the context of this document: NREAP, for short) was published early 2011. The key points and targets are as follows.

The NREAP reconfirms Hungary's overall target for the share of renewable energies and identifies the key areas of intervention, stating individual quantitative targets. It sets more ambitious targets than originally set by the European Union in order to support the overall economic objectives (job creation, improving competitiveness, reducing energy import dependency) through boosting "green" economy. While the RED Directive (2009/28/EC) of the EU set the renewable target for Hungary as minimum 13% of the total gross final energy consumption, the objective defined by the NREAP is 14.65%. The targets of the individual sectors and the actual values achieved are summarized in the following tables:

Table 4.2. Projected share of renewable energies in various sectors according to the NREAP

Share of renewables	2005	2010	2020
Heating and cooling	5.40%	9.00%	18.90%
Electric power	4.30%	6.70%	10.90%
Transport	0.22%	3.70%	10.00%
Total	**4.20%**	**7.40%**	**14.65%**

The actual results achieved by 2011 are the following:

Table 4.3. Results achived by 2011 in renewable utilisation

	PJ
Hydro power generation	0.8
Wind power generation	2.3
Geothermal energy production	4.1
Forewood use	29.8
Other solid waste use	40.9
Solar energy generation (collectors + PV)	0.2
Biogas	2.0
Biofuels	6.9
Total	**87.1**
Total domestic energy consumption	1 072.0
Share of renewables and wastes in total domestic energy consumption	8.1%

Source: MEKH, 2013

The development of actual renewable use and NREAP goals are shown in Figure 4.3.

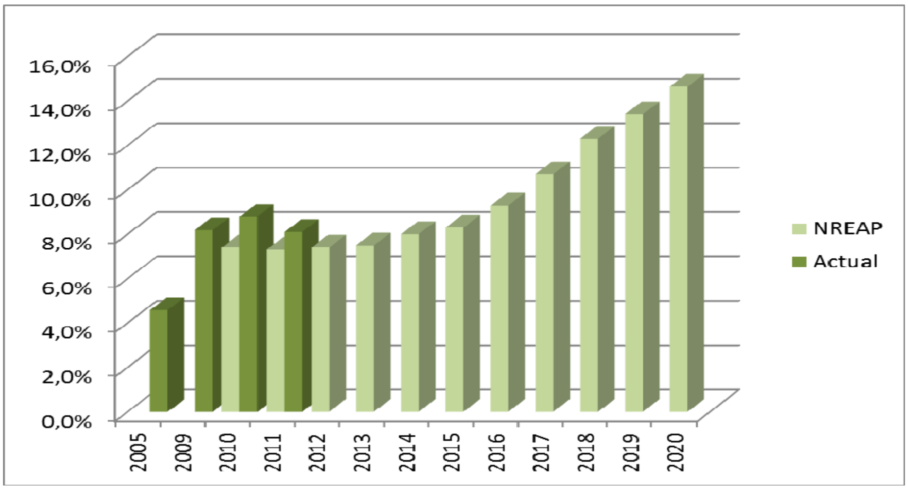


Figure 4.3. Share of renewables within total gross domestic energy consumption (forecast and actual)

Source: MEKH, 2013

Projected installed capacities for renewable energy production are listed in Table 4.4. Despite the expected increase in installed wind capacity wind energy's share will not increase significantly in total renewable production.

Table 4.4. Projected installed capacities of the various RES technologies according to the NREAP

	Installed capacity, MW		Share in total renewable power generation	
	2010	2020	2010	2020
Hydro power	51	67	6.8%	4.2%
Geothermal	0	57	0.0%	7.3%
Solar PV	0	63	0.1%	1.4%
Wind power	330	750	24.3%	27.6%
Solid biomass	360	500	65.8%	48.0%
Biogas	14	100	3.0%	11.4%
Total	**755**	**1537**	**-**	**-**

Source: NREAP

Table 4.5. shows the heating and cooling utilisation of renewables projected for 2020.

Table 4.5. Projected shares in the total renewable final net energy consumption in the heating-cooling sector

	2010	2020
Geothermal	10.9%	19.2%
Solar	0.6%	4.4%
Solid biomass	87.8%	65.8%
Biogas	0.0%	3.0%
Heat pumps	0.6%	7.7%

Source: NREA

Table 4.6. Projected shares in the total renewable final net energy consumption in the transport sector

	2010	2020
Bioethanol/bio-ETBE	22.7%	35.3%
Biodiesel	73.3%	59.3%
Hydrogen from renewables	0.0%	0.0%
Renewable electric power	4.0%	4.5%
Other (biogas in public transport)	0.0%	0.9%

Source: NREAP

The NREAP identifies a set of policies and measures that are to serve to achieve the objectives. These PAMs and measures are only listed here and will be described later in detail:

1. Support schemes:
   a. Direct subsidy of individual investments between 2011-2014
   b. A new dedicated operative programme from 2014
   c. Investment programmes financed from the EU-ETS
   d. More active participation in community financed programmes
   e. Development of green economy
2. Other financial incentives:
   a. R+D in renewable energies

   b. Compulsory take-over (subsidy) of renewable power
   c. Preferential prices for heat pump power (“Geo-tariff”)
   d. Compulsory share of biofuels in motor fuels
3. Legal/regulatory tools
   a. New act on sustainable energy management
   b. Creation of proper conditions to feed biogas to natural gas grid
   c. Revision and simplification of licensing procedures
   d. Compulsory share of renewables in building energy use.

Similarly to NEEAP, the expected or forecast savings and emission reduction projected to be achieved through these measures, are not described here, but at the detailed description of the individual PAMs and the results are included in the WEM and WAM scenarios of the projections.

The review of the NREAP
The review of the (NREAP) is in progress and is planned to be accomplished in 2013. According to Governmental Decree 1491/2012. (XI.13) Korm. the review is to be finished by 31 December, 2013. The constant development of new technologies in renewable energy production and the changing economic environment – oil price changes as an example - make it necessary to review the NREAP and make minor changes if it is necessary. Furthermore, there are constantly new elements in the EU regulation and further ones are to be expected. The European Union enters into a new budget planning cycle from 2014 that can open new investment supporting opportunities. All these circumstances make it necessary and justified to follow the changes and take the necessary steps toward the adaptation of these changes. The NREAP is not a rigid statistical frame, but a dynamic, flexible plan that is able to adapt to the changes.

Hungary is among those EU-member countries that have managed to reach the 2009, 2010 and 2011 targets as well, in the following sectors: heating and cooling, electricity and transport. Currently the statistical data analysis for the last year is in progress, but according to the currently available preliminary data, the share of renewable energy within the total final energy consumption is on the desired track. The main aim of the NREAP revision is to maintain this positive trend. The review does not affect the target for 2020, the quantitative target remains 14.65% for 2020.

4.3. Policies and measures and their effects

4.3.1. Power generation

4.3.1.1. Promotion of renewables
The basic objective of promoting the renewables is to reduce GHG emissions but also to decrease the energy import dependence of the country. As discussed in several points of this document, various policies with the aim of promoting the utilisation of renewable energies are already in place, and others are planned in order to meet the goals of the various strategy documents. The general framework and main components of such policies are set in the NREAP, described in the previous chapter. The goal is to be achieved through the following measures:

Compulsory take-over of renewable based power at subsidized prices

The policy (abbreviated in Hungarian as the KÁT-system) as described in the previous Biennial Report in detail is still in place. The actual subsidised take-over prices are the following:

Table 4.7. Takeover prices (HUF/kWh)

<table>
<tr><th colspan="2">Category of the generation facility</th><th>Peak</th><th>Off-peak</th><th>Night rate</th></tr>
<tr><td rowspan="2">Licensed before 01.01.2008. (expect hydro power > 5 MW)</td><td>Solar and wind power</td><td>33.76</td><td>33.76</td><td>33.76</td></tr>
<tr><td>Non-solar and non-wind</td><td>37.72</td><td>37.72</td><td>37.72</td></tr>
<tr><td rowspan="5">Licensed after 01.01.2008. (Except: hydro power >5 MW and other power plants >50 MW)</td><td>Solar power (20 MW or smaller)</td><td>32.18</td><td>32.18</td><td>32.18</td></tr>
<tr><td>20 MW or smaller power plants (non-solar)</td><td>35.96</td><td>32.18</td><td>13.13</td></tr>
<tr><td>20 – 50 MW power plants (except wind power)</td><td>28.76</td><td>25.75</td><td>10.50</td></tr>
<tr><td>20 – 50 MW wind power plant</td><td>35.96</td><td>32.18</td><td>13.13</td></tr>
<tr><td>Plants including old equipment</td><td>22.36</td><td>14.31</td><td>14.31</td></tr>
<tr><td colspan="2">Hydro power >5 MW and other power plants >50 MW</td><td>22.36</td><td>14.31</td><td>14.31</td></tr>
</table>

Source: NREAP

Direct financial support for renewable projects

In line with the objectives and foreseen tools of the NREAP, direct financial support is provided to help realise renewable projects through various existing operative programmes. These programmes and their dedicated objectives are the following:

- Renewable energy based regional development (KEOP-2011-4.3.0)
- Development of building energy systems in combination with renewable energy utilization (KEOP-2011-4.9.0, KEOP-2012-5.5.0/B – currently suspended)
- Supplying local heat, cooling and power demands from renewable energy sources (KEOP-2011-4.2.0-A, KEOP-2011-4.2.0-B, KEOP-2012-4.10.0/A, KEOP-2012-4.10.0/B – currently suspended)
- Renewable based power or CHP generation, bio-methane production. (KEOP-2011-4.4.0 and KEOP-2012-4.10.0/C - currently suspended)

Support for planting energy crops and forests

The relevant decrees of the Minister for Agriculture - 71/2007. (VII. 27.) FVM and 72/2007. (VII. 27.) FVM – that regulate the subsidy for creating new energy crop or energy forest plantations, which are described in detail in the previous Biennial Report are still in effect. Thus subsidy is available for planting herbaceous species and creating such plantations is in the value of maximum EUR 735 thousand but not more than 40%-60% of the project cost. Similar conditions apply for wood-type energy plantations. The upper limit of support is also maximum EUR 735 thousand, and 40-60% of the total project cost may be applied for. However, the grant shall not exceed HUF 160,000/ha for locust and HUF 200,000/ha in case of other species.

Type of policy instrument (Promotion of Renewables):
Economic, fiscal, regulatory

Status of implementation:
Implemented, planned

Monitoring indicators:

- Number of projects
- Quantity of electric power fed to the grid (kWh)

- Fuel use by the plants (GJ) where applicable
- amount of subsidy used
- renewable energy used (where applicable);
- quantity of generated heat/electric power;
- calculated emission reduction.
- area of new and existing plantations

Monitoring method:
Representative sampling surveys

Effects and impacts
The expected general results of promoting renewables are shown by line (B) of the projected the gross RES energy consumption table of the NREAP, as shown in the figure below (unit is ktoe):

Table 4.8. Projected gross final RES energy consumption

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Expected consumption of RES for heating and cooling	949	941	944	955	990	1049	1248	1421	1600	1743	1863
Expected consumption of electricity from RES	244	246	269	299	350	333	297	366	439	465	481
Expected consumption of energy from RES in transport	150	200	226	236	250	266	290	330	379	425	535
Expected total RES consumption	**1344**	**1387**	**1439**	**1490**	**1590**	**1648**	**1835**	**2117**	**2418**	**2633**	**2879**

Source: NREEAP

Based on the projected RES figures of the NREEAP and calculations for the nuclear option, the following effects are projected:

Table 4.9. Cummulative emission reduction

	2015	2020	2025	2030
Cummulative emission reduction k t_{CO2}/year	5600.3	8821.2	11299.1	13061.0

Source: NREEAP

Support for combined heat and power generation
As discussed in the previous biennial reports, a system of compulsory take-over of cogenerated power at subsidised prices, similar to that of RES-based power was in place. This policy, however, already in 2010 was considered to have had achieved its goals and in order to avoid further increase of general electricity prices and burdens of the consumers, the subsidy was heavily cut (restricted to special situations only) and then stopped altogether from 30 March, 2011.

4.3.1.2. Extension and enlargement of the Paks Nuclear Power Plant

The two main components of the policy are:

- the extension of the technical lifetime of the existing nuclear capacities in the Paks facility (already accomplished) and
- capacity enlargement of the Paks nuclear plant.

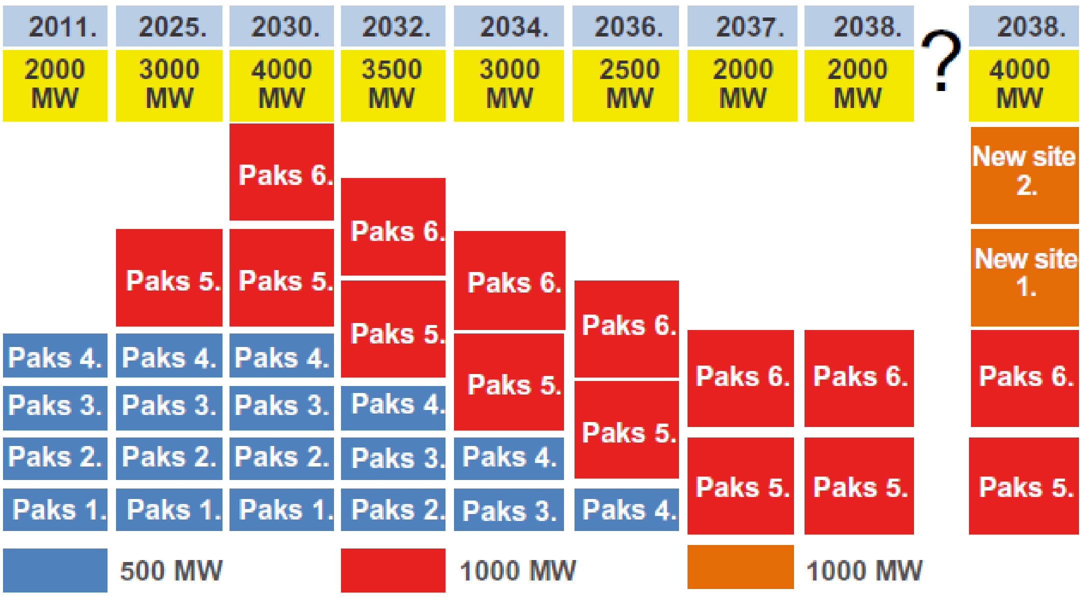
As a result of the lifetime extension the availability of the existing nuclear units will be the following:

Table 4.10. Lifetime extension

	Start of unit's operation	End of original lifetime	500 MW capacity on-line	End of extended lifetime
Unit 1	14 Dec. 1982	2012	19 Jul. 2007	2032
Unit 2	26 Aug. 1984	2014	05 Dec. 2008	2034
Unit 3	15 Sep. 1986	2016	13 Nov. 2009	2036
Unit 4	09 Aug. 1987	2017	28 Sep. 2006	2037

In accordance with the National Energy Strategy, it is assumed that two new units of approximately 1,000 MW each will be put into operation by 2030, i.e. the 4 Paks units currently in operation (2,000 MW) and the two new units (2,000 MW) will be operating parallel between 2032 and 2037 (the four current Paks units will be decommissioned by 2037). The National Energy Strategy foresees the availability of the nuclear capacities as follows:

Table 4.11. Availability of nuclear capacities



It is to be noted that the capacities of Paks 5 and 6 is just a conservatively estimated value in the forecast, as the actual unit size (1000-1600 MW) will depend on who the supplier of the reactors will be.

The operation of the nuclear plant obviously substitutes fossil fired power generation capacities with zero GHG emission technology. The emission savings can be calculated if the actual/planned situation is compared to a baseline, which, in this case is a scenario without the capacity increase and lifetime extension. In calculating the emission reduction due to these measures, the following assumptions were considered:

- Only the exported power of the Paks NPP is considered and not the total generated power in order to exclude self-consumption.
- In order to be conservative it is assumed that without nuclear power the same quantity of power would be generated in a modern natural gas fired combined cycle plant with an efficiency of 52%.
- Similar stabile operation, self consumption figures and utilisation factors are assumed as were actually measured between 2005-2011.

Type of policy instrument: other (technical).

Status of implementation: Lifetime extension: Implemented, Capacity increase: Planned

Monitoring indicators: Quantity of electric power generated

Effects and impacts
The forecast emission reduction achieved was calculated with the assumptions above and shown in the following table:

Table 4.12. Estmation of emission reduction (Mt CO_2 equiv)

	2010	2015	2020	2025
Cummulative emission reduction from 2005	2.76	5.17	7.88	10.6

4.3.2. Residential Sector

4.3.2.1. "Liveable panel buildings" sub-program

Objectives and description
The general purpose of the policy is the implement complex upgrading projects in existing pre-fab buildings that are supplied with district heating. The upgrading include external thermal insulation, replacement of doors and windows, metering-based billing, enabling the control of heating in every flat (room), operation of ventilation systems by solar panels, modernisation of substations, and installation of heat pump and solar panel applications. The policy is to be implemented through the following measures.

ZBR Climate Friendly Home Panel I. and II. Sub-programs
This is a subsidy program, part of the Green Investment Scheme (GIS, or ZBR with its Hungarian abbreviation), provided for the end-users through a tendering procedure, or through state owned ESCOs. The primary objective of the Sub-Programme is to achieve climate protection through energy savings. This contains the renovation of residential buildings constructed by industrialised technologies to achieve quantifiable emissions savings and energy savings, as well as the modernisation of their engineering systems and equipment. For the purposes of application the following can be regarded as industrialised residential buildings: residential buildings constructed through the use of panel, block, tunnel-mould, cast wall, reinforced concrete skeleton and other prefabricated technologies.

In particular following project types are supported:

- Energy efficient refurbishment or replacement of windows;
- Thermal insulation of the building envelope
- Modernisation of HVAC systems and electrical equipment (elevators)
- Utilisation of renewable energy sources
- Passive solar energy utilisation.

The results of the subsidy program achieved until 2012 are shown in the following table:

Table 4.13. Results of the subsidy program

Number of projects	Number of homes affected	Total investment cost billion HUF	Subsidy provided billion HUF	Estimated saving achieved GJ/year
Panel I (2009-2010)				
950	47 823	46.4	14.6	265 432
Panel II (2010-2011)				
336	29 722	n/a	16.47	341 166

The distribution of project types within the total number of projects was the following:

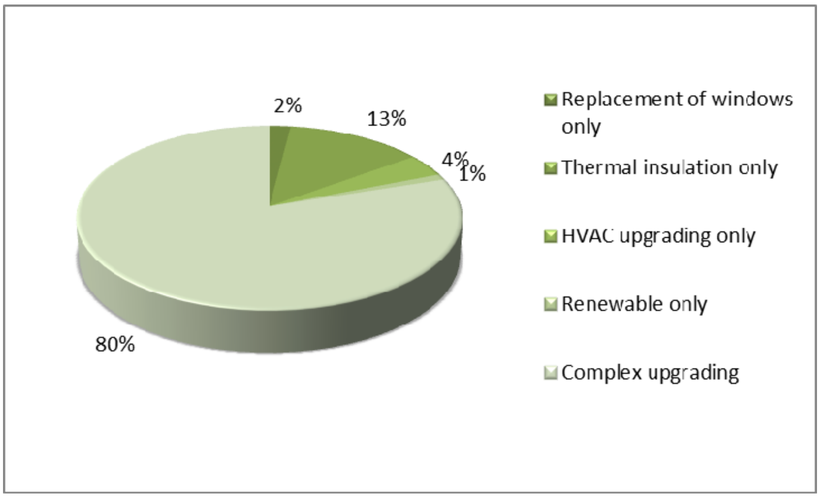


Figure 4.4. Distribution of projects by activity supported

Individual measurement and control in district heating

Act XVIII of 2005 on District Heat Supply provides for the measurement of the amount of heat at the heat reception station apart from measurements at the substation. The quantity of used district heat can be measured for each flat as well. The planned improvement of the substation measurement system, which can currently be regarded as commonly applied, involves the elaboration of the control of heating systems in each flat and the measurement of heat quantity received per flat. Apart from possibly resulting in significant energy savings, this system will introduce consumer costs proportional to the amount of service. In particular the following measures are supported:

- Installation of equipment for individual temperature control (thermostatic valves, thermostats, room thermostats)
- Installation of individual metering equipment (heat meters or electronic cost allocators)
- Conversion of the heat distribution system in the buildings (flow controllers, radiator by-pass lines in single pipe systems, new double-pipe systems)

Regulation on energy performance and efficiency of buildings

This is a 'horizontal measure' affecting not only this policy. According to TNM Decree No 7/2006 (V.24.) new requirements on the energy performance of buildings will be enforced regarding new buildings and the significant renovation of existing buildings with a total useful floor area over 1000 m^2 during the official authorisation procedure relating to construction. Besides the minimum requirements on the heat transfer of building envelopes there is a requirement on the total energy consumption of buildings, taking into account used energy sources. Provisions are around 30% stricter compared to previous heat demands. In order to realise achievable savings, fulfilment of requirements must be monitored closely. The European Union has published the recast of Directive 2002/91/EC. Directive 2010/31/EU includes further restrictions, which must be transposed into the Hungarian legislation in the period between 2012 and 2013.

According to the current plans, the compulsory values of the various energy performance parameters will become stricter gradually, in 2012, 2015 and in 2019. In order to demonstrate the foreseen progress, the suggested values of the U-value of some building structures are quoted here:

Table 4.14. U-values for structural elements of buildings

(W/m^2K)	**2012**	**2015**	**2019**
External walls	0.30	0.26	0.22
Glazing	1.10	1.00	0.80
Glazed window (wood or plastic frames)	1.30	1.15	1.00

The regulation is to become also stricter in relation to the regular inspection of HVAC equipment, certification process, and the overall energy performance. As to the latter, in line with the Directive, it is foreseen that all newly constructed public buildings after 31 December, 2018, and all other new buildings after 31 December, 2020 will have to be zero energy buildings.

Energy certification of buildings

This is another horizontal measure, affecting also other policies. Implementation of the provisions set forth in Directive 2002/91/EC of the European Parliament and of the Council, as a first part of which TNM Decree No 7/2006 on the specification of the energy-related characteristics of buildings, and Gov. Decree No 176/2008 (VI.30.) were created. The provisions of the latter are effective as of 1 January 2009. As a result of the measure, energy-related certificates will be prepared for buildings or flats, which will also give a summary of the energy and energy efficiency characteristics of the building. This data sheet will make it possible for the owner of the building, or the buyer in the event of a change in ownership, to gain information quickly and efficiently about the energy efficiency characteristics of the building, which may influence their decision favourably. The application of Directive 2010/31/EU is expected to lead to further savings in this field.

Operation and development of an energy efficiency consultancy network

As a further horizontal measure, affecting several sectors and policies, further to the 2nd NEEAP, the Government is to establish an energy efficiency consultancy network and plans to perform the following activities via the network:

- Information supply, consultancy and awareness-raising for the population, the local governments and the economic sector on the subject of investments in energy performance.
- Information supply on investments realised from non-budgetary assistance and their capacity and volume to the Energy Statistics System via the green database.
- Realisation of control and classification relating to investments in energy performance.
- Practising of more efficient and more comprehensive tender coordination in this field.
- Approval of the energy strategies of counties in accordance with the national strategy.
- Optimisation of energy strategies and investments of counties according to the needs emerging in the country or in the macro-region and the available resources.
- Supporting of county tender consultancy in the light of national and county energy strategies, regional energy demand and takeover potential.
- Supplying of county offices with information and data.
- Coordination of the establishment of the education and training system of the green economy. The organisation of training would be reasonable on regional level (in the Carpathian Basin), which would obviously facilitate regional market penetration as well.

- Establishment of a knowledge base via awareness-raising and campaigns for the population, the local governments and economic participants, which would bring green technologies and economic rationalities directly affecting them closer to the population.
- Organisation of online and offline awareness-raising campaigns in the course of which the population is familiarised with energy saving and renewable energy solutions and possibilities and adaptation methods to the consequences of climate change.
- Organisation of national "road shows" and the editing of publications, through which we familiarise the population with green solutions, including technologies, innovations, processes and tender opportunities.
- Coordination of the establishment and operation of a national energy efficiency auditing and monitoring system for the purpose of controlling the efficient utilisation of KEOP sources allocated for energy rationalisation. The system will show and certify CO2 emission mitigation originating from energy efficiency investments, thus helping the sales of allowances in the Emissions Trading Scheme.

Energy efficiency training material for schools

As laid down in 2nd NEEAP the education and training system relating to energy performance will also be extended and reformed resulting in a further horizontal measure.

Within the framework of the measure the establishment of a short-, medium- and long-term training system elaborated on the basis of a uniform green training syllabus and course material should be supported, which would be realised under an area-based consortium cooperation of training and traineeship facilities. Higher education and training facilities should be supported in organising the further training of specialised teachers and establishing the training requirements of traineeship facilities. Working out energy efficiency-related training materials for application in primary and secondary education will also be the part of the measure. Education is the most efficient instrument in developing awareness. The appearance of energy efficiency in primary and secondary education will reflect the societal recognition of the role of energy efficiency. Government Decree No 243/2003 (XII. 17.) on the Issuing, Introduction and Application of National Core Curriculum and OM Decree No 17/2004 (V.20.) on the Issuing and Application of the Educational Plan includes the elements necessary for acquiring energy awareness. The curricula cover knowledge on intelligent energy use for all grades (grades 1–12). Elements concerning intelligent energy use have been incorporated into subjects on the knowledge of environment, knowledge of nature, physics, chemistry, geography, do-it-yourself and home economics. These educational forms have an effect on the energy use habits of the future generation and energy saving results will appear already in 2016.

Type of policy instrument: Economic, regulatory, information, education

Status of implementation: Implemented, planned

Monitoring indicators:

- Number of projects
- Calculated energy saving
- Number of issued building energy certificates.
- Number / heated volume of new or reconstructed housing.

Monitoring method:

- Processing of tender databases and preparation of annual reports by ministerial order.
- Representative sampling surveys

Effects and impacts

Based on the projected energy savings of the 2nd NEEAP, which takes into account the expected effects of both the implemented and planned support schemes and all other measures, the following effects are projected:

Table 4.15. Projected energy savings in the measure

	2015	2020	2025	2030
Cummulative emission reduction k t_{CO2}/year	509.7	953.5	1374.1	1592.7
Change in energy saving PJ/year	1.4	1.1	1.1	0.2
Cummulative energy saving PJ/year	6.4	12.0	17.2	20.0
Change in emission reduction k t_{CO2}/year	110.1	84.8	83.7	15.0

4.3.2.2. "Our home" reconstruction sub-program

Objectives and description

The general purpose of the policy is the implement complex upgrading projects in existing buildings constructed by traditional technologies that are not district-heated, but have individual or central heating. The measures include upgrading projects covering thermal insulation, replacement of doors and windows, modernisation of heat production (boilers), application of renewable energy production (heat pumps or solar panels), several horizontal measures. The policy is implemented through the following concrete measures.

Investment subsidies (NEP program, ZBR Climate Friendly Home Energy Efficiency Sub-Programme)

The subsidy scheme is the continuation of the former NEP programs, described in detail in previous biennial reports. The aim of the Climate Friendly Home Energy Efficiency Sub-Programme initiated on 15 December 2009 from the resources of the Green Investment Scheme (GIS or ZBR) is climate protection and the quantitative mitigation of CO_2 emissions by improving the energy use of residential buildings, through which the burdens of the population concerning energy would be reduced. The applicants for the GIS Climate Friendly Home Energy Efficiency Sub- Programme are almost the same as the applicants for the previous NEP 2009 tender scheme. However, the ZBR Climate Friendly Home Energy Efficiency Sub-Programme supports wider modernisation activity with higher aid intensity (e.g. the construction of new energy-efficient houses). It is an essential requirement in the GIS Climate Friendly Home Sub-Programme that after the investment buildings have substantially lower CO_2 emissions and higher energy efficiency than before.

The programme supports energy efficient refurbishment of traditional buildings, resulting in GHG emission mitigation. The following project types are supported:

- Refurbishment or replacement of windows if proper individual heating controls are already in place or is simultaneously installed;
- Passive solar energy utilisation;
- Passive cooling solutions (sun shades);
- Heat recovery in ventilation systems;
- Thermal insulation of building envelope if proper individual heating controls are al-ready in place or is simultaneously installed;
- Modernisation of heating and DHW systems, energy efficient boilers;
- Utilisation of renewable energy sources
- Construction of new, highly energy efficient homes.

The results of the ZBR subsidy program achieved until 2012 are shown in the following table:

Table 4.16. ZBR program

Number of projects	Number of homes affected	Subsidy provided billion HUF
1191	1 913	1,99

Support for the construction of energy efficient new buildings

Pursuant to Directive 2010/31/EU, Hungary has the obligation to take measures for constructing “nearly zero-energy buildings” when constructing new residential buildings and public buildings (Hungarian legal framework: TNM Decree No 7/2006 (V.24.) and amendment of Gov. Decree No 176/2008 (VI.30)). In order to achieve this purpose, it is necessary to support energy-efficient residential buildings (family homes and multi-occupied residential buildings), regarding which criteria on buildings are drawn up in order to comply with EU directives (in respect of both design and construction requirements and energy performance (energy efficiency and energy savings)).

Complex (in-depth) reconstruction of buildings of traditional technologies, including the use of renewables

These are investments with the purpose of energy efficiency improvement that also allow for utilising renewable energy sources, within the framework of which comprehensive intervention covering several simultaneous energy efficiency improvement activities can be carried out (e.g. insulation, replacement of doors and windows, technical building system renovation, modernisation of heat production, boiler replacement, etc.). These means also cover the replacement of boilers for improving energy efficiency.

Minimum efficiency criteria and regular inspection for household boilers

The relevant regulation (7/2006.TNM, see point 2.3.7.1) already defines minimum requirements for the energy performance of buildings, of which the parameters of household boilers are a very important component. The planned changes with more stringent criteria of building energy performance will include specific criteria for HVAC systems, including boiler efficiency.

Pursuant to Directive 2010/31/EU Hungary has an obligation relating to the modernisation of heat production (heating-cooling) and air conditioning equipment. In order to achieve this purpose, it is necessary to install highly efficient heaters (condensing boilers) with the intention to replace aged traditional boilers with an age of more than 15-20 years, operating with low efficiency and having harmful environmental effects. Governmental Decree on the regular inspection of heat generation and air-conditioning equipment (264/2008. (XI. 6.) Korm.) creates the legal background to finding and replacing old, inefficient equipment. Some financial support is will be available for projects that include the replacement of boilers (e.g. the ZBR Climate Friendly Home Program for households described above).

Regulation on energy performance and efficiency of buildings

Horizontal measure with impact also on non-district heating homes.

Energy certification of buildings

Horizontal measure with impact also on non-district heating homes.

Operation and development of an energy efficiency consultancy network

Horizontal measure with impact also on non-district heating homes.

Energy efficiency training material for schools

Horizontal measure with impact also on non-district heating homes.

"Eco" labelling of household boilers and water heaters

The major part of household fuel use is accounted for by energy demand for space and water heating purposes, and within electricity demand the energy use of air conditioners is on the increase. The introduction of labels provides great help for consumers, enabling them to choose energy-saving appliances when purchasing new ones or replacing existing ones. The drafting of relevant legislation is a requirement for the introduction of labelling.

Type of policy instrument: Economic, regulatory, information, education.

Status of implementation: Implemented, planned.

Monitoring indicators:

- Number of projects
- Calculated energy saving
- Number of issued building energy certificates.
- Number / heated volume of new or reconstructed housing.

Monitoring method:

- Processing of tender databases and preparation of annual reports by ministerial order.
- Representative sampling surveys

Effects and impacts
Based on the projected energy savings of the 2nd NEEAP, which takes into account the expected effects of both the implemented and planned support schemes and all other measures, the following effects are projected:

Table 4.17. Projected effects of measures

	2015	2020	2025	2030
Cummulative emission reduction k t_{CO2}/year	402.9	844.4	1324.6	1861.8
Change in energy saving PJ/year	1.6	1.7	1.8	2.0
Cummulative energy saving PJ/year	7.8	16.1	25.1	35.1
Change in emission reduction k t_{CO2}/year	83.1	93.2	97.4	105.5

4.3.2.3. "Power saving households" program
The general purpose of the policy is to mitigate GHG emissions and reduce energy demand by implementing measures in the fields of lighting, household appliances, stand-by consumption and smart metering – smart grid systems. The policy is based on the following measures:

Promotion of energy-efficient lighting equipment
Energy consumption for lighting constitutes less than 10% of household electricity use; however, its importance is far higher from the point of view of electric power management. Currently Hungarian households use energy-saving compact light tubes and other energy saving lighting devices (LED, halogen) only in a very low proportion. The distribution of traditional light bulbs over 100 W was terminated as of the end of 2012, and there is a subsidy for replacing incandescent, obsolete lighting with CFLs, with the goal to accelerate the spread of energy-saving lighting devices. The results of this ZBR efficient lighting subsidy program achieved until 2012 are shown in the following table:

Table 4.18. ZBR lighting program

Number of projects	Number of homes affected	Subsidy provided (million HUF)
257	20 274	450

Source: Ministry of National Development

"Eco" labelling of electric household water heaters and air conditioners
Most Hungarian households use electric or gas boilers for hot water supply. The energy efficiency labelling of such appliances allows for the orientation of consumers towards purchasing and using energy-saving models. The introduction of labelling makes it necessary to draft the relevant legislation.

Energy efficiency training material for schools, operation and development of an energy efficiency consultancy network

Education plays an important role in forming the energy awareness of society. The integration of the topic of energy efficiency into education is necessary for primary and secondary school students; however, this topic has to appear in all forms of training where aspects of energy efficiency have to be enforced during the performance of work.

It is a frequent problem during the preparation of energy-saving tenders that applicants do not have the necessary professional and tendering skills regarding energy performance. It also poses a problem that energy-saving possibilities, technical solutions, support programmes and relevant information do not reach energy consumers and potential applicants regularly. Therefore, it is necessary to establish and operate an energy efficiency consultancy network, which is suitable for the successful information and aiding of energy consumers and the creation and preparation of projects.

Type of policy instrument:
Economic, regulatory, information, education

Status of implementation:
Implemented, planned

Monitoring indicators:
- Number of projects
- Calculated energy saving

Monitoring method:
- Processing of tender databases and preparation of annual reports by ministerial order.
- Representative sampling surveys

Effects and impacts
Based on the projected energy savings of the 2nd NEEAP, which takes into account the expected effects of both the implemented and planned support schemes and all other measures, the following effects are projected:

Table 4.19. Projected effects of measure

	2015	**2020**	**2025**	**2030**
Cummulative emission reduction $ktCO_2$/year	535.4	1117.1	1439.7	1573.6
Change in energy saving PJ/year	0.4	0.5	0.1	0.1
Cummulative energy saving PJ/year	2.2	4.6	5.9	6.5
Change in emission reduction $ktCO_2$/year	96.6	121.7	26.4	26.8

4.3.3. Public Sector

4.3.3.1. Renewable Public Institutions Sub-Programme

Objectives and description
Buildings of the administration and public institutions comprise a fairly large part of the Hungarian building stock, around 30%. Therefore upgrading of these buildings, improving their energy performance is an important policy of reducing GHG emissions. The policy is aimed at the improvement of the energy performance of these buildings though complex buildings upgrading projects, similarly to those in the residential sector described above. This policy covers both district heated buildings and buildings with

individual or central heating. The upgrading covers thermal insulation, replacement of doors and windows, metering-based billing, modernisation of heating substations, and heat pump and solar panel applications.

Investment support (New Széchenyi Plan, KEOP operative programs, ROP)

The energy-efficiency development of public institutions is a priority within the framework of the New Széchenyi Plan (in accordance with EU directives). SMEs and local governments can implement upgrade projects that cover both the improvement of the energy performance of buildings and the utilization of renewable energy sources via the New Széchenyi Plan and KEOP schemes.

The investment support priorities include:

- Improvement of thermal performance of buildings, reduction of heat losses, including external insulation, replacement of doors and windows, installation of heat recovery for the ventilation systems.
- Modernisation of the heating, cooling and DHW supply systems in public institutions and SME including the following:
    - Replacement of boilers with high efficiency equipment.
    - Automatic heating control systems.
    - Control system of heating and DHW systems, individual metering.
    - Energy saving measures in cooling systems.
    - Small scale local cogeneration or trigeneration.
    - Waste heat recovery.
    - Conversion of heat distribution systems from steam to hot water.
    - Hooking up to district heating systems.

- Modernisation of lighting systems. Including replacement of light sources and ballasts and better control of lighting.
- Utilisation of renewable energies, including:
    - Solar collectors for DHW generation and/or heating.
    - Biomass for DHW generation and/or heating.
    - Utilisation of geothermal energy.
    - Heat pumps for DHW or heating.
    - Solar PV panels for power generation mainly for local use.
    - Wind power projects (max. 50 kW capacity, or not connected to grid)
    - Hydropower projects: construction or revamping of max. 2 MW hydropower plants
    - Biomass based combined heat and power generation.

Some of the Regional Operative Programmes (ROPs) are also provide for energy efficiency improvements. The typical target groups of the ROPs are municipalities, public institutions, churches and civil organisations. The ROPs designed for 2007-13 included support for the following project elements:

- reduction of energy use in public institutions
- modernisation of indoor and outdoor lighting systems
- improvement of thermal performance of buildings
- modernisation of secondary (demand-side) systems of energy supply
- reduction of energy use in streetlighting.

Regulatory support for ESCO-type projects

Lack of financial sources to fund energy efficiency improvement projects in the public sector is the biggest barrier. This can be overcome by the third-party financing or ESCO (Energy Service Company) scheme. In the ESCO scheme the achievable energy savings cover the debt service of the bank loan taken up for the investment. ESCO investments are investments in the modernisation of the energy performance of buildings realised within the enterprise and financed by long term energy service (10 to 15 years) combined with energy cost savings guaranteed within the framework of operation.

Increasing energy awareness of municipalities, energy advice

Establishment of a consultancy network operating within the framework of an energy agency system and long-term energy performance training scheme based on the experience of the local government energy efficiency programme under Sub-Programme 6 of the New Széchenyi Plan. Energy-awareness can be realised in the public sector with the help of the network.

Type of policy instrument:
Economic, regulatory, information

Status of implementation:
Implemented, planned
Monitoring indicators
- Number of projects
- Calculated energy saving

Monitoring method:
- Processing of tender databases and preparation of annual reports by ministerial order.
- Representative sampling surveys

Effects and impacts
Based on the projected energy savings of the 2nd NEEAP, which takes into account the expected effects of both the implemented and planned support schemes and all other measures, the following effects are projected:

Table 4.20. Projected effects of measures

	2015	2020	2025	2030
Cummulative emission reduction k t_{CO2}/year	366.6	722.1	1058.1	1360.4
Change in energy saving PJ/year	1.6	1.3	1.3	1.2
Cummulative energy saving PJ/year	7.3	14.4	21.1	27.1
Change in emission reduction k t_{CO2}/year	81.3	66.2	66.3	59.0

4.3.3.2. Reduction of electric power demand of public institutions

Objectives and description

In the public sector electric power use represents a larger share within the total power consumption than in the residential sector thus addressing the reduction of power use has higher importance. The main target areas of the policy are lighting, office equipment, stand-by consumption and smart metering – smart grid systems. The individual measures to implement the policy are the following:

Investment support (New Széchenyi Plan, green economy development program)

Energy-saving renovation of public institutions (New Széchenyi Plan tender mechanism). The Renewable Public Institution Sub-Programme operating within the framework of the Development of Green Economy Programme of the New Széchenyi Plan covers central budgetary and local governmental public institutions as well. Several EU Directives in effect stipulate the exemplary role of the public sector's frequented buildings in the field of energy efficiency (Directives 2002/91/EC, 2006/32/EC, 2009/28/EC); therefore, it is important that complex buildings renovations initiated within the framework of the Sub-Programme also cover the mitigation of electricity use.

Subsidy is provided through operative programmes, such as KEOP-2012-5.6.0 (Energy efficiency projects for central budget financed institutions) which provides 50-1000 million HUF for the implementation of EE projects in public institutions.

Encouraging energy saving measures in the Regional Operative Programs (ROPs)

As already referred to, ROP assistance target groups are primarily represented by local municipalities, institutions, churches and civil organisations; moreover, in the case of social-type town rehabilitation, they include residential energy-saving investment projects that can be financed in the joint ownership sections of panel buildings. Activities eligible for support include the reduction of the energy consumption of institutions and public buildings, modernisation of outdoor and indoor lighting systems, improvement of the heating capabilities of buildings through subsequent heat insulation and the replacement of external doors and windows, modernisation of secondary energy supply systems and reduction of the amount of energy used for street lighting. Thus, these programmes contribute to the reduction of the electricity use of public institutions.

Increasing energy awareness of municipalities, energy advice

This horizontal measure is described in the previous sub-chapter (4.3.3.1).

Minimum efficiency requirements for office equipment

The energy use of office equipment constitutes a significant amount of the electricity use of public institutions. The total power of equipment used in an average office (desk lamp, computer, monitor, printer, telephone, fax, copy machine) for older machines is 400W; approximately 60% of this energy could be saved with modern equipment. This justifies that the determination of energy efficiency requirements must be extended to office equipment as well. Therefore it is planned to establish minimum criteria for typical office equipment (copiers, computers, air conditioning equipment etc.). This is expected to lead to gradual phasing-out of obsolete, low efficiency equipment and eventually savings in energy consumption and GHG emissions.

Type of policy instrument: Economic, regulatory, information.

Status of implementation: Implemented, planned.

Monitoring indicators:

- Number of projects
- Calculated energy saving

Monitoring method:

- Processing of tender databases and preparation of annual reports by ministerial order.
- Representative sampling surveys

Effects and impacts

Based on the projected energy savings of the 2nd NEEAP, which takes into account the expected effects of both the implemented and planned support schemes and all other measures, the following effects are projected:

Table 4.21. Projected effects of measures of support schemes

	2015	2020	2025	2030
Cummulative emission reduction k t_{CO2}/year	495.3	972.8	1451.6	1866.4
Change in energy saving PJ/year	0.5	0.4	0.4	0.3
Cummulative energy saving PJ/year	2.0	4.0	6.0	7.7
Change in emission reduction k t_{CO2}/year	109.8	90.9	99.0	72.2

4.3.4. Manufacturing and process industry (Industry, agriculture SMEs)

4.3.4.1. Operation of ETS

Objectives and description

Hungary, as an Annex I Party to the Kyoto Protocol, in accordance with Directive 2003/87/EC of the European Parliament, has been operating the Emission Trading Scheme (ETS) since 2005. The legal background for the ETS is provided by Act LX of 2007 on the implementation framework for the United Nations Framework Convention on Climate Change and its Kyoto Protocol, whereas the organisation and operation of the ETS is regulated by the Act CCXVII of 2012 on the participation in the European Union emission trading system and in the implementation of effort sharing decision. The ETS is the key instrument in compelling the large energy consumers of the economy to make efforts to mitigate their GHG emissions.

Type of policy instrument: Regulatory/Economic.

Status of implementation: Implemented.

Monitoring indicators:

- Verified GHG emissions
- Industrial GDP

Effects and impacts

The second ETS trading period coupled awareness-raising with directs economic interest, as the quantity of allowances was below the actual emission at most companies. Further strong incentives are provided in the third trading period by the more strict emission limits and mandatory auctioning.

Positive changes have already occurred within the industry. The following chart shows the changes of GDP and the industrial GHG emissions. It is apparent that emissions had a general declining trend, despite the fact that GDP increased. This is more ostensibly shown by the trend of specific emission normalised to the GDP generated by the industry.

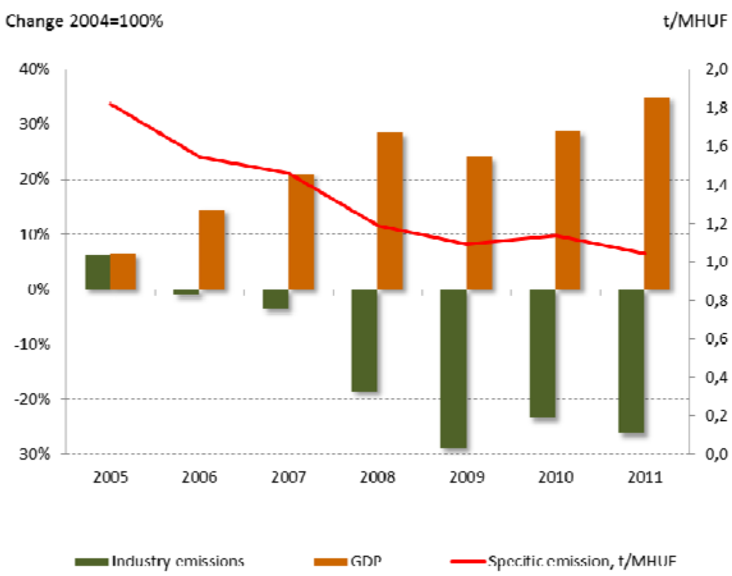


Figure 4.5. Industrial GHG emissions

Here again, the emission trends are determined by several factors, from fuel and energy prices to market conditions of the industrial products, therefore it is not possible to attribute the changes in emissions to a single policy, such as ETS, however important role it may have played. Therefore, although the detailed modelling provides projections for the industry emissions, it cannot be broken down to this individual policy, so no projections for the effects are provided here.

4.3.4.2. District heating efficiency sub-program

Policies for the modernisation of district heating systems have been in place for a long time, because this is a very important sector of the Hungarian energy system, not only for its sheer size but also due to its political importance: more than 2 million people of the nearly 10-million populace are affected. There are approximately 640.000 district heated homes and a large number of public institutions in 92 cities and towns where district heating schemes are in operation.

The 2nd NEEAP states that the efficiency is of primary concern, and will involve the modernisation of heat supply pipe systems and primary heat reception and heat substations and the establishment of modern measurement, data acquisition and control systems processes for the sake of energy efficiency. In line with the 2nd NEEAP a support scheme is in place to help improving DH systems (KEOP-2012-5.4.0).

The declared primary objectives of the policy are to save energy and thus both locally and on national level to reduce GHG emissions via the improvement of heat generation and distribution systems.

With a total budget of 4 billion HUF for 2012-13, the policy provides grant money to finance energy saving or energy efficiency improvement projects of DH companies in the range between HUF 10 and 1000 million, which shall correspond to 10-50% of the total project cost. The following project types are eligible for the support.

- Waste heat recovery in the DH system
- Replacement/thermal insulation of primary supply pipe lines. Replacing overland pipes to underground pipelines.
- Modernisation of DH substations, splitting large substations.
- Conversion to variable mass-flow rate control.
- Switching heat transfer medium (from steam to hot water)
- Replacement of electric chillers with district heat operated chillers (district cooling)
- Recruiting new customers (only if that improves utilisation factor, system efficiency).
- CHP but only if the total generated power is used within the DH system, heat storage systems, trigeneration.
- Conversion to renewable energy

Type of policy instrument: Economic.

Status of implementation: Implemented.

Monitoring indicators: Calculated energy saving achieved.

Effects and impacts

The forecasted GHG emission savings are the following:

Table 4.22. Forecasted GHG emission savings

	2015	2020	2025	2030
Cummulative emission reduction k t_{CO2}/year	135,08	242,05	312,75	347,18
Change in energy saving PJ/year	0,305	0,232	0,141	0,050
Cummulative energy saving PJ/year	1,695	3,037	3,925	4,357
Change in emission reduction k t_{CO2}/year	24,29	18,49	11,24	3,98

4.3.4.3. Reducing the energy use of enterprises

The objective of the policy is twofold:

- reduction of GHG emissions and
- improving the competitiveness of the Hungarian production sector.

Energy efficiency improvement, the mitigation of the energy use of enterprises, the minimisation of energy losses are recognized to serve both objectives. The policy is implemented through the following measures.

4.3.4.4. Modernisation of process technology at SMEs (heat recovery, efficient motors) by support from the New Széchenyi Plan [KEOP], preferential loans

Support in the form of investment subsidies is made available for the technological modernisation of SMEs. The concrete projects can include waste heat recovery, improvement of electric engine efficiency (replacement of motors), reduction of the losses of industrial furnaces, other industrial heat utilising equipment, fans, pumps, materials handling. Heat recovery from exhaust gas, flash steam, condensate also have special attention.

Enterprises can also implement developments for the energy performance of buildings combined with traditional and renewable energy sources via the New Széchenyi Plan and KEOP schemes.

Some of the operative programs aimed at modernising the technology are:

- Complex technology development for micro, small and medium enterprises. (GOP-2011-2.1.1/KHG, GOP-2012-2.1.1/B)
- Development of micro enterprises (GOP-2011-2.1.1/M, KMOP-2011-1.2.1/M)
- Some of the operative programs referred to in the chapter about the promotion of renewables

Energy efficient reconstruction of industrial, agricultural and other (commercial, services) buildings

All measures affecting the energy performance of buildings (such as more strict requirements, energy certification) described in other chapters of this report are also valid for the industrial, agricultural and commercial buildings. Subsidies for their energy efficient reconstruction of such buildings, however, are not yet available, although planned according to the 2^{nd} NEEAP. The foreseen support mechanism will be similar to those in the residential and public sector.

Large energy consumers: Compulsory employment of energy managers and energy reporting

At large energy consumers, improvement of the standard of energy management has been proven to result in significant energy savings. However, employing an energy expert having the necessary qualifications is an essential requirement. Since the deregulation of the former legislation that made the employment of energy managers compulsory, most likely due to budgetary considerations, very few organisations employ energy managers today. It is planned to make the employment of such experts compulsory again. The policy is primarily targeted for the non-ETS companies and municipalities of larger than 5000 population. In order to ensure proper level of expertise, parallel to the regulatory change, proper training of energy managers is planned to be ensured.

Besides proper energy management it is also important that large consumers would closely track their energy consumption. Most companies with high energy consumption already prepare a mandatory report on their energy use (energy balance of the industrial sector) for statistical purposes on a yearly basis within the framework of the National Statistical Data Collection Programme run by the Central Statistical Office (KSH) regulated by Gov. Decree No 257/2010 (XI.9.). Efforts are planned for the correction and expansion of information relating to energy savings and energy efficiency during the development of the data collection system.

Voluntary agreements in industry (energy audits, efficiency improvements)
According to the programmes of the New Széchenyi Plan the monitoring system must be established with the conclusion of voluntarily undertaken agreements and audits periodically monitoring implementation processes in order to achieve energy-saving targets. The objectives are:

- to make industrial energy efficiency measurable,
- to standardise the audit and monitoring systems which are aimed at the more efficient use of energy by industrial participants,
- to establish a motivating regulatory framework and acknowledgement system and
- to conclude agreements aimed at long-term voluntary commitments guided by international examples.

Type of policy instrument: Economic, Voluntary/ negotiated agreement, regulatory.

Status of implementation: Implemented, planned.

Monitoring indicators:

- Contracted energy saving
- Calculated GHG emission reduction
- Overall GHG inventory data of the industrial sector

Effects and impacts
The forecasted GHG emission savings are the following:

Table 4.23. Forecasted GHG emission savings

	2015	2020	2025	2030
Cummulative emission reduction ktCO_2/year	655.9	1477.6	2182.0	2737.5
Change in energy saving PJ/year	1.7	1.5	1.4	1.0
Cummulative energy saving PJ/year	6.8	14.8	21.8	27.7
Change in emission reduction k tCO_2/year	166.7	149.1	134.6	95.4

4.3.5. Horizontal measures

The general objectives of these measures are the same as of the sector specific policies: improvement of energy efficiency and through that, mitigate GJHG emissions. These measures cover several sectors, with impact on residential, industrial public and often transport-related energy consumption. The individual measures of this category are the following:

4.3.5.1. Information exchange, information platform
The creation of an open database under the industrial energy efficiency programme, from which energy-consultants, investors, local governments, SMEs, large companies, etc. can obtain structured and thematic information on the planning, organisation and economic– financial relations of energy saving projects as well as the experience of realised projects (“good practices”)

4.3.5.2.Strengthening and coordination of sustainable energy-related R&D activities
The harmonisation of EU or state-funded R&D and basic and applied research tenders in order to strengthen the R&D activity of domestic research institutes, higher education institutions and SMEs.

4.3.5.3.Cooperation with energy companies to enhance their DSM activities
Energy service providers must dispose of several means to facilitate the mitigation of final energy consumption. One of these means is the operation of consumer consultancy offices, where energy consumers can receive practical advice on the possibilities to reduce their energy use. Other means include the presentation and publicity of energy saving products and technologies, etc. The requirements for concluding a service contract with energy consumers must be set in a way that they encourage consumers to achieve energy savings and the mitigation of used power.

Type of policy instrument: Regulatory, information, research, voluntary/ negotiated agreement.

Status of implementation: Implemented, planned.

Monitoring indicators:
- Calculated energy saving from public tender database data
- Calculated energy and emission saving from representative sampling surveys.

Effects and impacts
The forecasted GHG emission savings are the following:

Table 4.24. Forecasted emission savings

	2015	2020	2025	2030
Cummulative emission reduction k t_{CO2}/year	126.3	336.7	547.2	757.7
Change in energy saving PJ/year	0.5	0.5	0.5	0.5
Cummulative energy saving PJ/year	1.50	4.00	6.50	9.00
Change in emission reduction k t_{CO2}/year	42.1	42.1	42.1	42.1

4.3.6. Transport Sector

4.3.6.1. Reducing the energy demand of cargo and passenger transport

Objectives and description
The overall objective is to reduce GHG emissions by mitigation of energy consumption through alteration of transport habits. The individual measures of the policy are listed below:

Development of the cycling route networks (KÖZOP subsidies)
The promotion of regional development and the improvement of the living standards of the regions' and settlements' population are among the key objectives of the Transport Operational Programme 2007–2013. A means of this development is the development of bicycle-travel facilities, which would also enhance transport safety and would allow for the spread of bicycle use for commuting. The aim of the tender scheme entitled "Development of the cycle lane network" is to construct interurban cycle lanes, lanes for commuting and other bicycle-travel facilities, and to establish and extend the regional cycle transport infrastructure, to ensure connection with national and international cycle lane networks as well as to organise existing elements into a network.

- *Operative programme KÖZOP-3.2.0/C-08-11* (currently suspended) provides co-financing for cycling road projects. The following can be supported:
  - Design (feasibility studies, licensing, tendering procedure)
  - Site preparation (surveys, supervisor engineering services)
  - Construction and commissioning
  - Public procurement procedure

  - Communication
- Regional *operative projects* (ÉMOP-5.1.3-11, ÉAOP-3.1.3/A-11, DAOP-3.1.2/A-11, DDOP-5.1.1-11, KDOP-4.2.2-11. *NYDOP*-4.3.1/B-11) also support the development of cycling infrastructure, but only complex development projects, i.e. projects that address an entire town or an independent part of a city, or that connect two towns directly.

Creating low-traffic zones
The establishment of such zones is to give rise to an environmentally friendly and energy-aware behaviour in which “Green aspects” would be preferred. Highly air pollutant heavy vehicles will be gradually banned from zones that ensure liveable surroundings. The tools for implementing this measure include the reduction of speed limits (30 or 40 km/h), ban of freight traffic (of vehicles above 7.5 t).

Toll system for heavy vehicles
A toll system for all commercial vehicles above 12 tons weight on the majority of the national road network has been in place in Hungary since 2007. As a part of the measure the extension of the toll system for other lower priority roads is planned.

Currently the toll was paid in the form of a sticker to be bought, on lump-sum basis. This has already generated some positive effects, although in the beginning lot of problems were caused by the traffic shifted form the toll roads to lesser roads through towns. Therefore a more correct electronic toll system will be introduced, in line with the European directives 2004/52/EC and 2006/38/EC. According to most recent information, the new electronic toll system of heavy vehicles will be operating from the summer of 2013, and for all vehicles from 2020.

With the change of the tariff system the State will grant less support from general tax revenues to the operation and maintenance of the road infrastructure compared to current rates, and users will make an (increasingly) larger contribution proportional to their road use. A future objective is for road infrastructure maintenance to be financed completely from the tariffs collected directly from road users. Consultations are still being held within the EU on the subject of turning externalities into tariffs, and the future application of this system – if it is extended to congestions – may result in significant energy efficiency improvement.

Environment friendly transport campaigns
Events designed to strengthen the environmental awareness of society that strive to draw the attention of residents and the city managements to environmental, accident and city planning problems caused by increased car traffic, encourage a responsible choice of means of transport; demonstrate the advantages of sustainable, environmentally friendly and philanthropist city transportation and highlight the necessity to develop public, cycle and pedestrian transport. One of the long-term objectives of the campaigns is to persuade citizens usually travelling to work, school or to spend free-time activities by car to use alternative, sustainable means of transport for travelling, thereby contributing to the gradual reduction of air pollutant emissions. The events include European Mobility Week, European; Car Free Day, Bam! - Cycle To Work! campaigns and others.

Type of policy instrument: Fiscal, economic, regulatory, information

Status of implementation: Implemented, planned

Monitoring indicators:
- Tolls collected
- Statistical data of transport sector (passenger kilometres, ton-kilometre)
- Calculated energy and emission saving from representative sampling surveys

Effects and impacts
The forecasted GHG emission savings are the following:

Table 4.25. Forecasted emissions savings

	2015	2020	2025	2030
Cummulative emission reduction k t_{CO2}/year	38.71	98.16	111.78	122.36
Change in energy saving PJ/year	0.178	0.128	0.033	0.033
Cummulative energy saving PJ/year	0.604	1.5315	1.744	1.909
Change in emission reduction k t_{CO2}/year	11.4089	8.2041	2.1151	2.1151

4.3.6.2. Reducing the energy demand of cargo and passenger transport by directing transport to railways

The objective is the mitigation of energy consumption and related GHG emissions of transport by diverting cargo and passenger transport from roads to the railway. The policy employs the following measures:

Electrification and modernization of railway lines (KÖZOP subsidies)
According to the Transport Operational Programme 2007–2013, approx. 500 km of railway line could be modernised (including suburban lines) as a result of EU developments together with the relevant information technology, security and management tools. It is expected that the competitiveness and market position of railway transport, whose energy efficiency is higher than that of road transport, will improve as a result of such developments. The other aim is to achieve further energy savings based on the fact that railway infrastructures with a higher axle load allow for the transport of larger units of cargo. Currently two projects are planned that relate to energy savings directly: Budapest– Esztergom line and the Győr – Pápa – Celldömölk line.

Procurement of new, energy efficient railway engines
Within the framework of the Transport Operational Programme and Green public procurement the plan is to purchase mainly electric energy-efficient and energy-saving locomotives, which will replace polluting diesel locomotives and energy-wasting electric locomotives.

Campaigns to promote railway transport
In order to popularise and utilise energy-efficient (environmentally friendly and reliable) electric locomotives, publicity campaigns and programmes will be organised to achieve that people prefer railway transport to passenger cars and trucks (e.g. the organisation of car free days in passenger transport).

Type of policy instrument:
Economic, information

Status of implementation:
Implemented, planned

Monitoring indicators:

- Length of modernized lines
- Number of procured locomotives
- Statistical data of transport sector (passenger kilometres, ton-kilometre)

Effects and impacts
The forecasted GHG emission savings are the following:

Table 4.26. Forecasted emissions savings

	2015	2020	2025	2030
Cummulative emission reduction k t_{CO2}/year	51.276	80.576	89.733	89.733
Change in energy saving PJ/year	0.1	0.07	0.00	0.00
Cummulative energy saving PJ/year	0.8	1.257143	1.4	1.4
Change in emission reduction k t_{CO2}/year	6.4095	4.5782	0.0000	0.0000

4.3.6.3. Reducing the energy demand of passenger transport by directing transport to public transport and developing public transport

The objective is to reduce transport energy consumption and the related GHG emissions, by diverting short-distance travel to public transport. The major tool is to make public transport attractive and easy-to-use by awareness raising, technical modernisation. The major measures of the policy are the following.

P+R systems
Safe car parks and parking lots will be established near the public transport system hubs at the boundary points of the inner city at the major cities of the country. The parking facilities can be used free of charge or at a significant discount if the driver utilises them in a P+R system. In order to monitor this, an integrated electronic ticket and pass system should be introduced, which can be used to check whether the driver indeed uses public transportation after parking.

Bus fleet modernisation / replacement
Budapest bus replacement programme: Budapest Transport Company (BKK) has started to purchase approx. 1000 new buses, and also plans to modernise its IK412 and IK415 buses within the framework of the Domestic Bus Reconstruction Programme. This decision would influence annual emissions significantly, because engines falling under the Euro 5 norm would be built in these buses under the programme.

Volán bus replacement programme
Compared to 15–20-year-old buses, bus types commissioned in the past 6 to 8 years have approx. 10% to 20% lower consumption levels depending on the category based on the fuel consumption data of buses operated by Volán companies. Around HUF 2 billion in energy savings could be achieved annually with the replacement of approx. 1700 buses above the age of 15, which have the highest consumption levels.

Campaigns to promote public transport
In order to popularise and utilise energy-efficient (environmentally friendly and reliable) means of transport, publicity campaigns and programmes will be organised to achieve that people prefer public transport to passenger cars (e.g. the organisation of car free days in passenger transport).

Type of policy instrument: Economic, information

Status of implementation: Implemented, planned

Monitoring indicators:
- Length of modernized lines
- Number of procured locomotives
- Statistical data of transport sector (passenger kilometres, ton-kilometre)

Effects and impacts
The forecasted GHG emission savings are the following:

Table 4.27. Forecasted emission savings

	2015	**2020**	**2025**	**2030**
Cummulative emission reduction k t_{CO2}/year	19.6	52.4	84.7	106.5
Change in energy saving PJ/year	0.0763	0.109	0.089	0.055
Cummulative energy saving PJ/year	0.31	0.82	1.32	1.66
Change in emission reduction k t_{CO2}/year	4.8904	6.9863	5.6764	3.4932

4.3.6.4. Reducing the fuel demand of cars, increasing the share of renewables in car fuel

The objective of the policy is mitigation of the fuel use of road vehicles and the improvement of the efficiency thereof, the increase of the share of biofuels in fuel use. Car manufacture industry is rather strong in the country, with most of the car manufacturers present in Hungary the Government signed strategic cooperation agreements. Therefore one tool of the policy is the development of car plants, "product development incentive" (without state aid) by improving the competitive position of manufacturers and suppliers of cars if they apply changes in their car design, technology or manufacturing process that help to increase the share of renewable fuel, achieve other environmental benefits, or create jobs.

In achieving these goals other horizontal measures already described, such as "green" public procurement; information exchange, platform on good practices in energy saving; strengthening and harmonisation of R&D activities relating to sustainable energy management can also have serious positive impact. Other measures, stemming from the NREAP, already discussed in this report elsewhere, or in the previous Biennial Report in detail, such as support for planting energy crops and forests; promotion of renewable (bio) fuels also largely contribute to achieving the goals of this policy.

Type of policy instrument: Regulatory, research, fiscal

Status of implementation: Implemented, planned

Monitoring indicators:
- Biofuel use
- Statistical data of transport sector (passenger kilometres, ton-kilometre)

Effects and impacts
The forecasted GHG emission savings, calculated on the basis of the transport related target figures of the NREAP are the following:

Table 4.28. Forecasted emissions savings

	2015	2020	2025	2030
Cummulative emission reduction k t_{CO2}/year	713.82	1435.68	2454.83	3499.58
Cummulative energy saving PJ/year	11.14	22.40	38.30	54.60

4.3.7. Agriculture, land use change and forestry

Agriculture and forestry used to be one of the key branches of the Hungarian economy for a long time. Hungary's natural endowments, the climate, the quality of the soils and the long-time tradition and expertise can provide for excellent production results both in terms of quality and quantity. Arable land represents the biggest sector in terms of area, while forests the second one.

Out of the total 9.3 million hectares of the total area of Hungary, in 2012 5.3 million hectares (46%) were agricultural land – which is uncommonly high in Europe. Of this, 4323.6 thousand ha (tha) was arable land,

758.9 tha was grassland, 81.3 tha was kitchen gardens, 92.6 tha was orchards and 81.6 tha was vineyards. The total area of forests was 1 922 tha in the same year.
The ownership structure of forests is as follows (2011):

- State-owned: 56.41%
- Community-owned: 1.09%
- Privately-owned: 42.50%

Afforestation in Hungary was in 2010 5096 ha/year and in 2011 2803 ha/year (NÉBIH EI 2012).

Based on the trends of the recent years and the reconfirmed intention of the Government to accelerate the afforestation, it is safe to state that the desired 27% target can be reached until 2050, i.e. within the 25–50 year time span defined in the National Afforestation Programme. Due to the changed EU supporting conditions, the scope of afforestation is lessening, thus the need to find another solution to increase the level of afforestation (for example: support the spontaneous forestation).

4.3.7.1. National Agri-Environmental Programme (NAEP)

The NAEP, a sub-programme of the National Environmental Programme, approved by the Government Decision No 2253/1999 (X.7.), includes several horizontal and zonal targets. One of them is to increase the territorial proportion of semi-natural forest management. NAEP also looks at afforestation as a tool of implementing some of its measures, such a forest plantation on flood areas in order to protect wetland habitat. The NAEP objectives were integrated into the agri-environmental measures of the National Rural Development Plan (NRDP) in 2004.

Type of policy instrument: Economic

Status of implementation: Adopted

Monitoring indicators:

- Number of projects supported
- Number of events
- Fund spent on projects

Effects and impacts
Increasing forest areas.

4.3.7.2. New Nitrate Action Programme

Objectives and description
The earlier Government Decision No. 49/2001. (IV. 3.) on protection against the nitrate contamination of waters from agricultural sources (Nitrate Decree for short) referred to in the previous report was replaced and partly superseded by Government Decree 27/2006. (II. 7.), amended by Government Decree 81/2007. (IV. 25.). The new decree also identifies the nitrate sensitive areas, contains an extended list of settlements in these areas (67 settlements were deleted from the list, 320 added), states the general rules of protection against nitrate pollution and prescribes an overall, coherent, nation-wide action plan. The annex of the earlier decree on the rules of Good Farming Practice in manuring remained in effect, until this new action programme, conform with Directive 2003/35/EC, is ready. The new decree also extends some of the earlier deadlines such that for the isolation of manure storages. In order to fund the Action Programme, a project was launched, including a detailed study published in September, 2006.

Type of policy instrument: Economic

Status of implementation: Adopted

Monitoring indicators:
- Number of projects supported
- Number of events
- Fund spent on projects

Effects and impacts
The aim of the project was to establish the conditions for developing environmentally conscious and competitive agricultural practice and technology for protecting groundwater against nitrate pollution. Vulnerable zones will be reconsidered taking into account the opportunities of developing environmentally sound agricultural practice without reducing agricultural competitiveness. The project was to develop a GIS to be tested in pilot areas. At the level of agricultural producers the aim of the project was to ensure the availability of information at local level, to improve opportunities for obtaining subsidies, the technological-financial elaboration of environmentally sound agricultural / animal husbandry / plant growing models by investigations in pilot areas, the development of the complex professional consultancy system, and the elaboration of project preparation manuals.

4.3.7.3. New Hungary Rural Development Strategic Plan (2007–2013)

The Plan is the sequel of ARDOP (Agricultural and Rural Development Operatio-nal Programme). Its actions are grouped into three different sets: Set 1: Competitiveness of agriculture, forestry and food industry Set 2: Improvement of the condition of the environment. Set 3: Quality of life in rural areas. The three sets are supplemented by a Technical Assistance package. GHG mitigation efforts are mainly in Set 2. The most important objectives are in line with the following Community priorities: biodiversity, traditional landscapes, water management and climate change. The national priorities, stemming from the above are:
- Protection of Natura 2000 areas and other natural values
- Less Favoured Areas
- High Quality Water Management
- Increasing the forestry resources and their sustainable management
- Utilisation of biomass for energy generation
- Protection of soils

Type of policy instrument: Economic.

Status of implementation: Implemented.

Monitoring indicators:
- Number of projects supported
- Number of events
- Fund spent on projects

Effects and impacts
Quantitative targets of the GHG related actions of the New Hungary Rural Development Strategic Plan are:
1. Increase of energy crop production: +4%
2. Renewable energy production from agriculture and forestry 800 ktoe
3. Agricultural area for biomass production 300 th ha
4. Area of energy forests 60 th ha
5. Energy intensity of agriculture -2.5 TJ/billion HUF
6. Integrated farming area 600 th ha

4.3.7.4. National Forest Programme 2006–2015

The National Forest Programme 2006–2015 sets the following strategy objectives: maintaining the current level of forestation but preferably increasing it. Neither the quantity nor the quality and value of the forests must not deteriorate. Use of wood in the society, as an environmentally friendly resource should be encouraged. Forest management has to ensure that the increased demands for wood would be met, without endangering sustainability. Knowledge and information on forests shall be increased in the society. The key elements of implementing the strategic goals are the followings:

1. Protection of forests, of natural processes in the forests. Perseverance of biological and genetic values. Natural forest management.
2. Utilisation of forests. The competitiveness of forestry products shall be increased. Utilisation areas may be widened, with respect to industrial and energy-purpose utilisation of wood.
3. Development. Increase of forests with respect, however, to biodiversity, landscape, and erosion protection.

Type of policy instrument: Economic

Status of implementation: Implemented

Monitoring indicators:

- Increase of afforested area
- type of forests (CO_2 sequestration capability)

Effects and impacts

The mentioned elements are to be implemented through the following specialised targeted programs / support schemes: 1. Development of state owned forests, 2. Development of private forests, 3. Rural development, forestation, forest restructuring, 4. Nature conservation in the forests, 5. Modern forest protection, 6. Rational utilisation of wood, 7. Forestry management, 8. Research, education, product development, 9. Communication about the forests in order to improve the forest-human relationship.

4.3.7.5. Forestry management and forest protection

This Act provides a comprehensive frame for forestry management and forest protection. In Section I, general rules regarding forests and forest management are set out. Forests must be divided into planning districts. These are the units with regard to planning and monitoring of sustainable forest managing activities. Forests are registered in the National Forest Database. Forest manager (the proprietor or the user) are also registered. The Act foresees also the establishment of the National Forest Council that is an opinion and proposal making body. Section II deals with the destination and operational mode of forests. Forests are to be classified with regard to their primary destination: protection, public welfare and economic use. Section III regulates forest planning and the reporting-authorization system of forestry activity. Section IV regards forestation. Section V provides rules for the restoration, bringing-up and restructuring of forests. Prevention and protection against harms (caused by pests, wildlife, harmful activities, fire) to forests and the soil are rules in Section VI. Section VII regards profitable activities in forests, such as timber extraction, collection of propagating material, collection of galipot. In Section IX on the use of forests for transporting and on the visiting of forest, contains an important title regarding the certification of origin of timber. Section X provides rules on professional governance of forestry works, forest workers and on the forest guarding service. Forest administration is provided for in Section XI. Penalties are set forth in Section XII.

Type of policy instrument: Economic.

Status of implementation: Implemented.

Effects and impacts
The impact of the Act is, through the regulation of the relation between forests and the society, and, in particular, through the determination of sustainable requirements of forest management, to assure the maintenance, the protection, the growth, and the increase of its positive effects on the environment, the society and the economy.

4.3.7.6. Mitigation of agricultural emissions with partial change of nitrogen fertilizer utilization and cultivations change

The objective of this policy is to achieve 4–9 tons of CO_2e or GHG emission reduction per hectare using modern soil management and fertilization practices. Farmers should use practises which allow for the reduction of fossil N-fertiliser with 50 kg/ha. Nutrient holding capacity of the soil can be significantly improved compared to the past, and the loss of soil carbon per hectare can be reduced to 2 tons/ha/year amount.

Type of policy instrument: Economic.

Status of implementation: Implemented.

Monitoring indicators:

- CO2e savings per hectare (CO2e/ha)

Effects and impacts
Application of adequate soil tillage methods has not only favourable effect on soil physical properties but it could also reduce soil respiration. Soil organic matter content can be preserved and amount of CO_2 getting into the air can be reduced. With this action 4–9 tons of CO_2e or GHG emission reduction per hectare using modern soil preparation and fertilization practices can be achieved. Furthermore 200,000 t CO_2e saving can be reached per year with this practise and the applied nitrogen agent during the agricultural practise can be reduced.

4.3.7.7. Support for perennial, herbaceous energy plantation by the European Agricultural Fund.

Objectives and description
Decree 71/2007. (VII. 27.) FVM (Ministry of Agriculture and Regional Development) provides subsidy for farmers. The purpose of the grant is supporting perennial, herbaceous energy plantation and it is necessary to maintain this practise for at least five years. With this measure the law-maker wants to stabilize the food product chains and improve the living standards of the rural population, improving soil structures. Dissemination of renewable energy sources is also a priority.

Type of policy instrument: Economic

Status of implementation: Implemented

Monitoring indicators:

- Number of projects supported
- Number of events
- Fund spent on projects

Effects and impacts
With this action the government supports the local industry and businesses and encourage new investment in rural communities. Energy plants make a substantial, positive impact on local and regional economies by generating well-paying jobs inconstruction and operation of the plant and collection and transportation of biomass material. This support is non-refundable. Increasing planted areas can be reached.

4.3.7.8. Terms of complementary financing to support the plantation of energy crops by the European Agricultural Fund

Decree 33/2007. (IV. 26.) provides complementary subsidy for farmers. Those farmers have opportunity to take additional support, who comply with the conditions of SAPS (Single Area Payment Scheme), and grow energy plants for energetic use. A farmer can get 45 euro per hectare support.

Type of policy instrument: Economic

Status of implementation: Implemented

Monitoring indicators:

- Number of projects supported
- Number of events
- Fund spent on projects

Effects and impacts

Effects are the same like the above mentioned. Farmer can get complementary support. Increasing planted areas can be reached.

4.3.7.9. Ignác Darányi Plan

Objectives and description

The objective of the Plan is to remove obstacles that hinder farmers and producers through the amendment of legislation and regulations. The first pillar aims at removing obstacles that hinder farmers and producers through the amendment of legislation and regulations. The second plans to reduce bureaucracy through the setting up of customer-friendly offices and by reducing administrative requirements. The third pillar focuses on changing people's way of thinking and on providing training courses. The fourth pillar will support rural areas in Hungary by launching jointly financed European Union and Hungarian tenders for rural development projects. The fifth and final pillar includes the preparation, launching and running of national programmes, including for example the Farmstead Programme and the Demographic Land Programme.

Type of policy instrument: Economic.

Status of implementation: Implemented.

Monitoring indicators:

- Number of projects supported
- Number of events
- Fund spent on projects

Effects and impacts

Decisive change in rural life in Hungary by working on five areas of action resting on five basic pillars.

4.3.7.10. Climate protection by efficient manure management and biogas

The project activity will replace the old manure management system with its deep open lagoons and avoid the fugitive methane (CH_4) emissions. Manure will instead be transported from the barns to the gastight digesters of the biogas plant, where the emitted methane is captured, stored and finally destroyed in the CHP (Combined Heat and Power) system. The heat produced from the CHP facilities will replace fossil fuels in the existing heating systems of the barns and thus reduce carbon dioxide (CO_2) emissions. The digestate (manure and other substrates after the biogas treatment) will be used as a fertilizer in a similar way manure is used today. But because of the added co-substrates nitrogen (and nutrient) content in the digestate will be higher than in the manure alone.

Type of policy instrument: Economic.

Status of implementation: Implemented.

Monitoring indicators: Emission reduction tCO_2e/year.

Effects and impacts
Nowadays manure of the animals is stored in deep open lagoons or earth basins. Methane escapes unobstructed to the atmosphere where it works as a greenhouse gas and contributes to global warming. Instead of storing manure in the lagoons, manure will be digested in the biogas plant to produce CO_2 neutral energy. The product of the biogas process, the digestate, is a very good natural fertilizer and can be used instead of artificially produced fertilizers. 200,000 t CO_2e saving can be reached per year with this practise.

4.3.8. Some major policies affecting the forestry sector

4.3.8.1. Afforestation of agricultural lands

Objective of measures – the main objectives of the measure are: to increase the size of the afforested area, to improve the state of the environment, to strengthen the environmental, economic, social-public welfare role of woodlands, to increase the size of the afforested area of the country. Through all these the aim is to widen rural employment and the opportunities for getting income.

Quantitative estimate of effects – see Figure 2.15 and Table 2.22.

4.3.8.2. Forest-environmental payments

Objective of measures – the objective of the measure is to create and ensure the ecological basis of sustainable forest management, contributing to the maintenance and increase of biodiversity, as well as to the protection of waters and soil. The aim is the use of forest management practice most adapting to the land conditions in order to enforce the multi-purpose functions of the forests simultaneously, the propagation of the environmentally aware forest management practice. Beside these the aim is to promote the establishment of rural workplaces and employment, to introduce forest management methods ensuring the balance of the ecological-economic conditions of sustainability.

Type of measures – Economic; regulatory
Status of measures – Implemented
Quantitative estimate of effects – see Figure 2.15 and Table 2.22.

4.3.8.3. Restoring forestry potential and introducing preventive actions

The objective of the measure is to mitigate and eliminate the factors endangering the satisfaction of the public welfare, free time and environmental demands of the society; to eliminate and prevent the abiotic and biotic damage, so to maintain and increase the variety of species through this. It is a further aim to reduce the risks of forest management, to prevent and eliminate the damage endangering the ecological, public welfare services of the forests.

Type of measures – Economic; regulatory

Status of measures – Implemented

Quantitative estimate of effects – see Table 4.19

4.3.9. Waste

The basis of Hungary's waste management policy is – in the focused period adopted – the Act on Waste (Act No. CLXXXV in 2012) and the implementing regulations. This Act implements the Waste Framework Directive (2008/98/EC) of the European Union and it entered into force on January 1st, 2013.
The Act goals the following – partly in the National Environmental Protection Program 2009-2014 already declared – targets:

- reduction of biodegradable residual wastes landfilled under a maximum 820 thousand tons by 2016
- preparing for reuse and recycling of 50% of papers, glass, metals and plastic by 2020
- preparing for reuse and recycling of 70% of construction and demolition wastes by 2020.

To achieve these goals, the following measurements were taken:

- introduction of landfill tax, yearly decreasing till 2016 (as shown in Table 4.26.)
- compulsory door to door separate household waste collection for household paper, plastics and metal wastes by January 1st, 2015
- prescription of National Waste Prevention Plan
- furthermore the Act declares principles of waste treatment:
    - waste should be through operations recovered providing the best overall environmental outcome in respect of the waste to be recovered
    - waste incinerators or co-incinerators shall be permitted where they are related to produce electricity, heat energy, cement, brick, or construction tile or ceramics
    - in waste incinerators or co-incinerators only non-recyclable wastes should be incinerated or co-incinerated
    - hazardous waste can be burned only in hazardous waste incinerators.

Table 4.29. Waste types

Type of waste	landfill tax HUF/t			
	2013	2014	2015	2016
1. residual waste	3000	6000	9000	12 000
2. construction and demolition waste	3000	6000	9000	12 000
3. hazardous wastes	3000	6000	9000	12 000
4. residual sewage sludge	3000	6000	9000	12 000
5. still recoverable hazardous and non-hazardous wastes after recovery	1500	3000	4500	6 000

On the operative way of implementing EU-waste management – especially recycling – targets, basic steps have been the EU Cohesion Fund co-financed establishment of regional waste management systems. These projects contain elements of the following instructions:

- separate collection of household biowastes, packaging wastes and paper – partly door to door;
- establishment of waste yards for hazardous household wastes, biowastes, waste electric and electronic equipments, household construction wastes and separate collected packaging waste
- household composting
- transfer stations for residual waste
- facilities for sorting, separation and press to balls
- recycling/composting separate collected waste
- mechanical-biological treatment of household wastes
- refuse-derived fuel production, co-incineration in cement factories
- post-collection waste separation for recycling
- closing and recultivation of former used unmanaged waste dumps
- building new, fully managed and isolated landfills
- landfill gas collection and energy recovery.

Through the diversion of household biowastes, packaging wastes and paper from landfilling and the increased optimization of transport demands, these projects have been the main influence for greenhouse gas emissions changes coming from waste management in the focused period. In this time and the years before there was ca. 10% yearly decrease in the landfilled household waste compared to the previous period. Only the setting up of door to door separate collection for household paper, plastic and metal wastes in Budapest diverts ca. 50 thousand tons of waste per year in a longer period – with a biodegradable part of about 30%.

There are 22 running regional projects in diverse periods of realization. The projects complete and continue former similar investigations co-financed by ISPA and later Cohesion Fund.

5 Projections of greenhouse gas emissions

5.1. Projections

Based on the sectoral methodologies and the impacts of policies and measures sectoral projections for the With Existing Measures (WEM) and With Additional Measures (WAM) scenarios were developed. Results are shown in Tables 5.1. and 5.2. in Gg CO_2 equivalent.

Table 5.1. Sectoral emissions in the WEM scenario (Gg CO_2 equiv.)

	2008	2010	2015	2020	2025
Energy sector	19400,93	16680,11	14007,58	11856,53	11161,08
Manufacturing Industries and Construction	4936,099	3902,621	3295,542	2940,1	2944,091
Transport	12987,91	11823,53	12839,97	12901,74	13587,3
Commercial/Institutional Sector	3524,671	4129,531	3861,624	3372,638	2927,046
Households	9095,855	9062,113	8497,028	8139,549	7617,296
Heat generation in Agriculture/Forestry/Fisheries	1199,861	1075,749	1029,586	900,9982	831,0679
Fugitive Emissions from Fuels	1816,271	1844,052	1792,339	1682,018	1667,313
Industrial Processes	6808,146	6432,464	6266,012	5898,629	5695,083
Solvent and Other Product Use	294,7703	267,5943	354,3561	352,4813	350,6066
Agriculture	8886,84	8680,833	9195,436	9860,251	9860,251
Waste	3551,75	3651,345	2286,09	1874,074	1888,35
Land Use, Land-Use Change and Forestry	-4889,35	-3881,83	-2795,49	-1793,7	-2206,86

Table 5.2 Sectoral emissions in the WAM scenario (Gg CO_2 equiv.)

	2008	2010	2015	2020	2025
Energy sector	19400,93	16680,11	13861,66	11595,04	11013,41
Manufacturing Industries and Construction	4936,099	3902,621	3206,082	2788,971	2884,953
Transport	12987,91	11823,53	12565,5	12733,06	13319,86
Commercial/Institutional	3524,671	4129,531	3712,13	2999,098	2357,618
Residential	9095,855	9062,113	8104,697	7578,401	7029,511
Heat generation in Agriculture/Forestry/Fisheries	1199,861	1075,749	1022,12	891,4249	823,0155
Fugitive Emissions from Fuels	1816,271	1844,052	1778,906	1553,793	1543,955
Industrial Processes	6808,146	6432,464	5915,256	5415,048	5289,356
Solvent and Other Product Use	294,7703	267,5943	354,3561	352,4813	350,6066
Agriculture	8886,84	8680,833	8982,209	9273,876	9273,876
Waste	3551,75	3651,345	1962,19	1531,775	1445,582
Land Use, Land-Use Change and Forestry	-4889,35	-3881,83	-2795,49	-1793,7	-2206,86

The trends of greenhouse emissions by gases is depicted in Figures 5.1 and 5.2 respectively for the With Existing Measures (WEM) and With Additional Measures (WAM) scenarios.

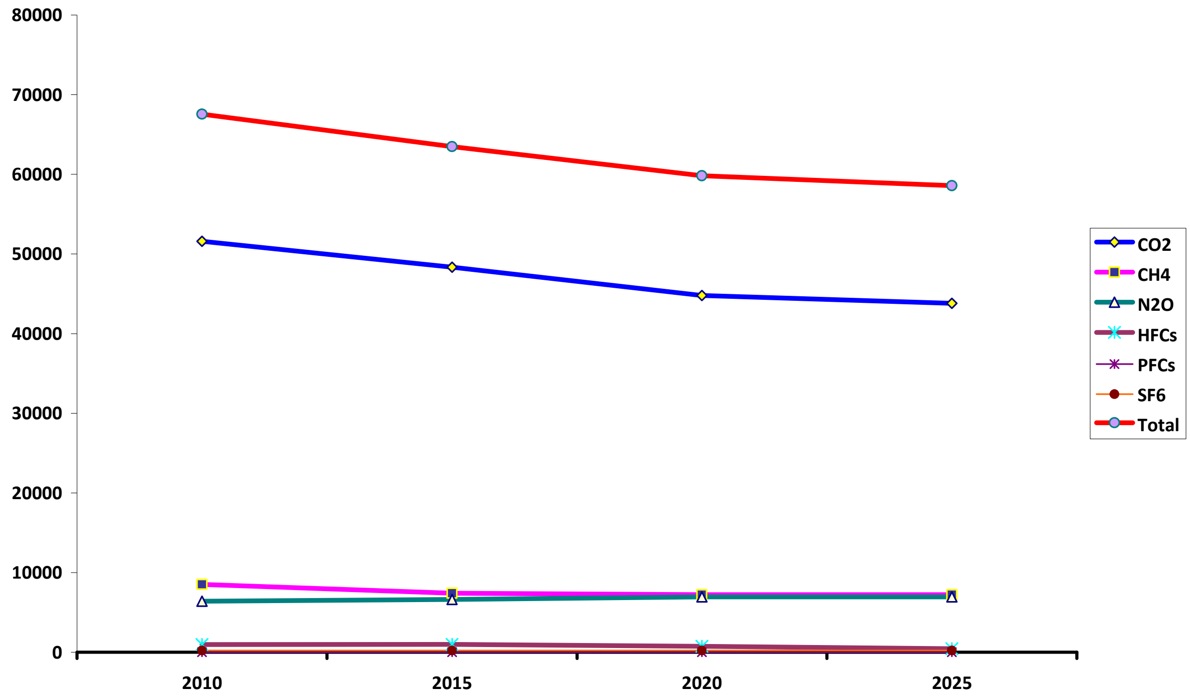


Figure 5.1. Emissions by gases in the With Existing Measures (WEM) scenario

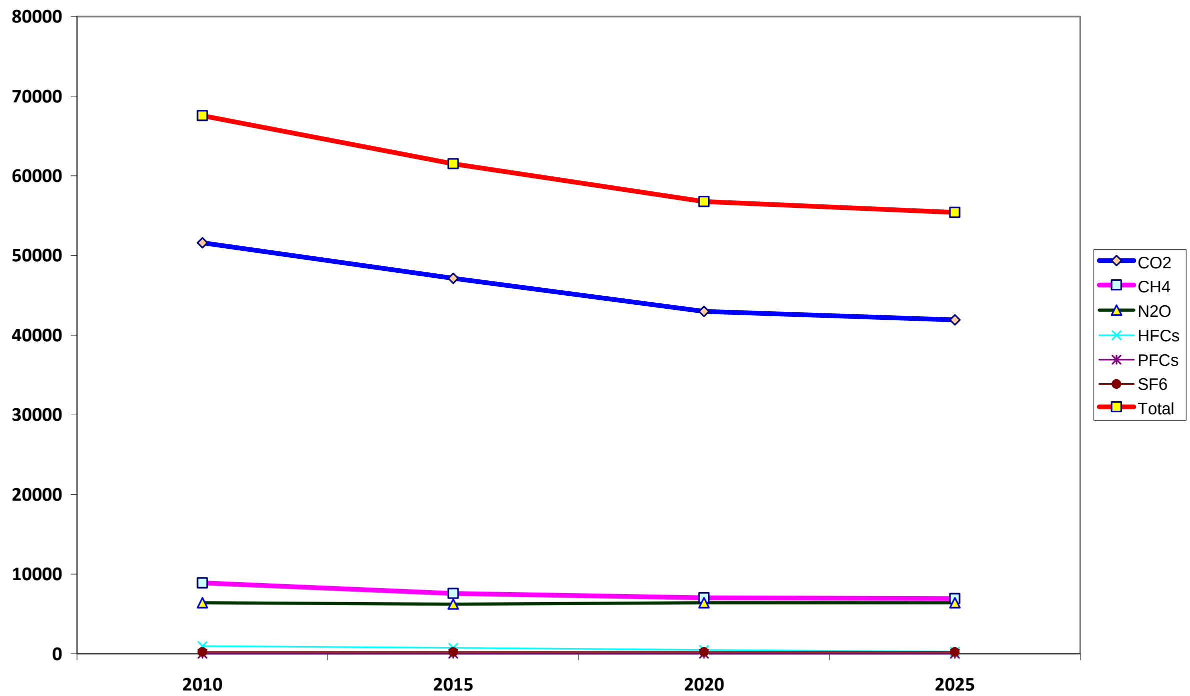


Figure 5.2. Emissions by gases in the With Additional Measures (WAM) scenario

The overal total trend of emissions is shown on Figure 5.3. for the WEM and WAM scenarios.

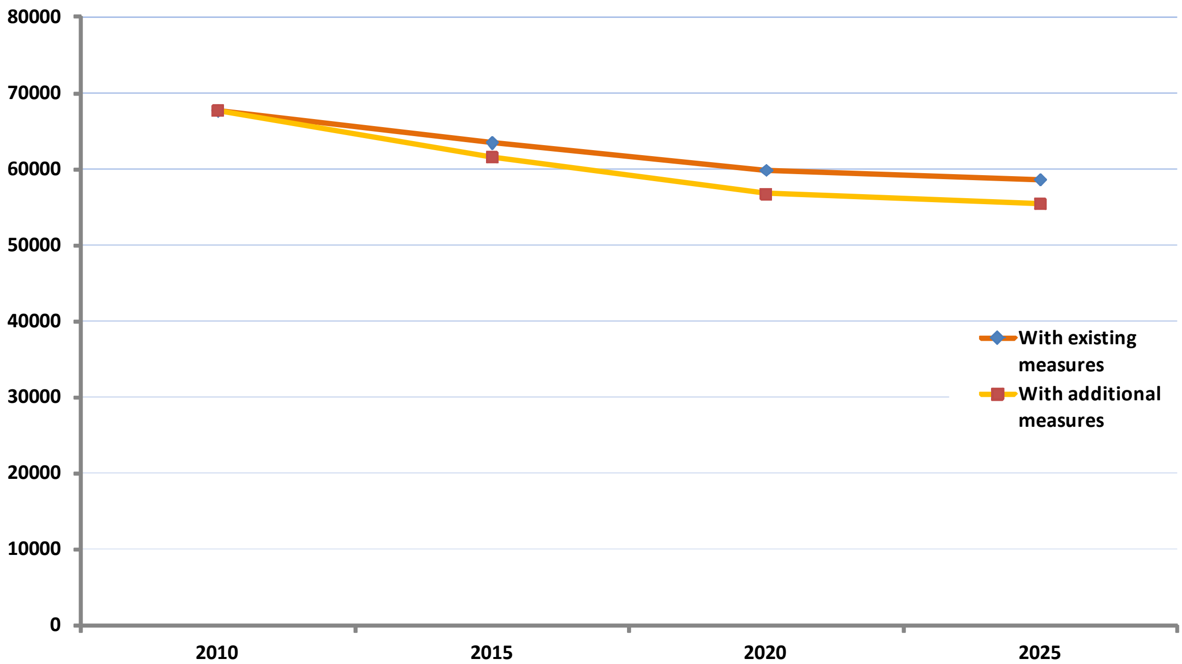


Figure 5.3. Total emissions in the WEM and WAM scenarios

Table 5.3. summarises total emissions for the two scenarios (with and without LULUCF) compared with the Without Measures Scenario.

Table 5.3. Total emissions in the WEM and WAM scenarios (Gg. CO_2 equiv.)

	2010	2015	2020	2025
Without measures scenario	67 679,05	63568,7	65945,7	69473,6
WOM including LULUCF	*63 694,31*	*66193,0*	*68731,3*	*69473,6*
With existing measures	67 679,05	63 475,56	59 840,24	58 598,03
WEM including LULUCF	63 694,31	60 680,07	58 046,54	56 391,17
With additional measures	67 679,05	61 515,11	56 774,2	55 400,29
WAM including LULUCF	63 694,31	58 719,62	54 980,5	53 193,42

It can be seen that the two scenarios do not differ significantly at the end of the forecasting period. This indicates that the WEM scenario already exploits a large share of the potential abatement measures and mitigation options.

5.2. Assessment of aggregate effects of policies and measures

Table 5.4. gives an overview of the aggregate mitigation impacts of the respective policies and measures considered in the forecasts.

Table 5.4 The aggregate impact of policies and measures (kt CO_2-eq./yr)

	Policy name	Status	WAM/ WEM	2015	2020	2025	2030
1	Promotion of renewables	implemented	WEM	5 600,25	8 821,2	11 299,1	13 061,0
2	Nuclear power	adopted	WEM	2 762,66	5 172,8	7 875,8	10 593,8
3	"Liveable panel buildings" sub-program	implemented	WEM	509,7	953,5	1 374,1	1 592,7
4	"Our home" reconstruction sub-program	implemented	WEM	402,9	844,4	1 324,6	1 861,8
5	"Power saving households" program	implemented	WEM	535,4	1 117,1	1 439,7	1 573,6
6	Renewable Public Institutions Sub-Program	implemented	WEM	366,6	722,1	1 058,1	1 360,4
7	Reduction of power demand of public institutions	implemented	WEM	495,3	972,8	1 451,6	1 866,4
8	District heating efficiency sub-program	implemented	WEM	135,1	242,0	312,7	347,2
9	Reducing the energy use of enterprises	implemented	WEM	655,9	1 477,6	2 182,0	2 737,5
10	Horizontal measures	implemented	WEM	126,3	336,7	547,2	757,7
11	Reducing the energy demand of cargo and passenger transport	implemented	WEM	38,7	98,2	111,8	122,4
12	Directing transport to railways	planned	WEM	51,3	80,6	89,7	89,7
13	Directing transport to public transport and eveloping public transport	planned	WEM	19,6	52,4	84,7	106,5
14	Reducing road transport emissions	adopted	WEM	727,5	1 549,7	2 578,0	3 622,7
15	Environmental awareness in agriculture	adopted	WEM	na	Na		
16	Less nitrate get into water and N-cycle	implemented	WEM	na	Na		
17	Draw attention to decrease GHG emission in agriculture	implemented	WEM	na	Na		
18	National Forest Programme for increasing forest area	implemented	WEM	500,00	700	1 000,00	1 300,00
19	Frame for forestry management and forest protection	implemented	WEM	na	Na		
20	Mitigation of agricultural emissions with change of nitrogen fertilizer utilization and cultivations	implemented	WEM	200,00	Na		
21	Support for perennial herbaceous energy plantation by the European Agricultural Fund	implemented	WEM	na	Na		
22	Complementary financing to support the plantation of energy crops by the European Agricultural Fund	implemented	WEM	na	Na		
23	Rural development for sustainable and modern agriculture	implemented	WEM	na	Na		
24	Climate protection by efficient manure management and biogas	implemented	WEM	135,00	Na		
25	New waste management instruments	adopted	WEM	2,14	4,62	12,70	16,96
26	Setting up regional waste management projects	implemented	WEM	17,14	20,77	34,29	51,83
27	Packaging waste governmental regulation	adopted	WEM	6,43	23,08	39,37	58,43
28	Budapest municipal door to door separate waste collection	adopted	WEM	12,86	20,77	31,75	45,24
29	Landfill recultivation, remediation	adopted	WEM	2,14	4,62	11,43	16,02
30	Prevention	adopted	WAM only	0,00	9,23	25,40	29,22
31	Waste landfilling tax	implemented	WEM	4,29	13,85	31,75	39,58

Table 5.5 gives an overview of the mitigation impact of the above analysed measures, by GHG gas.

Table 5.5. The impact of policies and measures, by GHG gas

Policy name	Objective	CO_2	CH_4	N_2O	HFC	PFC	SF_6
Promotion of renewables	Increase the share of renewables within total energy consumption	X					
Nuclear power	Increase the share of nuclear energy within the energy mix, saftey of supply	X					
"Liveable panel buildings" sub-program	reduction of district heating demand in pre-fab (panel) buildings	X					
"Our home" reconstruction sub-program	Reduction of heat demand in residential buildings (individual or central-heated family homes and multi-home residential buildings)	X					
"Power saving households" program	Reduction of power demand in households	X					
Renewable Public Institutions Sub-Program	Reduction of heat demand in buildings through complex energy-efficiency reconstruction	X					
Reduction of power demand of public institutions	Reduction of power demand of public institutions	X					
District heating efficiency sub-program	Improvement of efficiency of heat transport and distribution	X					
Reducing the energy use of enterprises	Minimisation of energy losses, improvement of energy efficiency and competitiveness	X					
Horizontal measures	Reduce the energy demand of municipalities, public inctitutions	X					
Reducing the energy demand of cargo and passenger transport	Reducing the energy demand of cargo and passenger transport	X					
Directing transport to railways	Reducing the energy demand of cargo and passenger transport	X					
Directing transport to public transport and eveloping public transport	Reducing the energy demand of passanger transport	X					
Reducing road transport emissions	Reducing the fuel demand of cars, increasing the share of renewables in car fuel	X					
Environmental awareness in agriculture	Support of agricultural production methods that are environmentally friendly	X	x	X			
Less nitrate get into water and N-cycle	Protection of waters against pollution caused by nitrates from agricultural sources.			X			
Draw attention to decrease GHG emission in agriculture	Competitiveness of agriculture, forestry and food industry; Improvement of the condition of the environment; Quality of life in rural areas	X					
National Forest Programme for increasing forest area	Increasing forest area	X					
Frame for forestry management and forest protection	To assure the maintenance, the protection, the growth, and the increase of its positive effects on the environment, the society and the economy.	X					
Mitigation of agricultural emissions with partial change of nitrogen fertilizer utilization and cultivations change	Achieve 4-9 tons of CO_2e or GHG emission reduction per hectare using modern soil preparation and fertilization practices.	X		X			
Support for perennial herbaceous energy plantation by the European Agricultural Fund	The objective of the measure is to support perennial, herbaceous energy plantation. With this measure the law-maker wants to stabilize the food product chains, improve the living standards of the rural population, improving soil structures. Dissemination of renewable energy sources is also priority.	X					
Complementary financing to support the plantation of energy crops by the European Agricultural Fund	The objective of the measure is to give additional support for those farmers who grows perennial herbaceous energy plantats.	X					
Rural development for sustainable and modern agriculture	Removing obstacles that hinder farmers and producers through the amendment of legislation and regulations.	X					
Climate protection by efficient manure management and biogas	Replace the old manure management system with its deep open lagoons and avoid the methane (CH4) emissions caused by	X	x				

	them.						
New waste management instruments	Waste reduction, increased recycling, decreased amount of waste to landfill.	X					
Setting up regional waste management projects	Selective waste collection, increases recycling and composting		x				
Packaging waste governmental regulation	Set the minimal recycling targets	X					
Budapest municipal door to door separate waste collection	It increases the amount of separate collected municipal paper, plastic and aluminum waste	X					
Landfill recultivation, remediation	Proper closure of filled landfills		x				
Prevention	Prevention of waste generation		x				
Waste landfilling tax	Levy on landfilling		x				

The total effects of policies and measures are summarised in Table 5.6.

Table 5.6. Total effect of policies and measures until 2030.

Gg CO_2-equivalent per year	**2015**	**2020**	**2025**	**2030**
Estimated emission savings from PAMs	13 307,19	23 237,98	32 915,95	41 250,61

5.3. Supplementarity relating to mechanisms under Article 6, 12 and 17, of the Kyoto Protocol

By comparing the figures of the Hungarian GHG inventory and the company levels figures of the ETS inventory between 2006 and 2009, the share of the ETS for all the sectors and gases can be calculated. The result – which is the basis of our forecast – is shown in the following table.

The shares of 2006-2009 have not been updated due to the unavailability of updated information on the share of energy and process related emissions in the NACE sectors where both types of emissions apply.

Table 5.7. The average share of the ETS coverage in the various sectors and GHG gases between 2006 and 2009

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
Public Electricity and Heat production	98%	0%	0%	0%	0%	0%
Petroleum Refining	100%	0%	0%	0%	0%	0%
Solid fuel production and other energy industries	90%	0%	0%	0%	0%	0%
Manufacturing Industries and Construction	95%	0%	0%	0%	0%	0%
Transport	0%	0%	0%	0%	0%	0%
Other combustion sectors	11%	0%	0%	0%	0%	0%
Fugitive emissions form fuels	0%	0%	0%	0%	0%	0%
Industrial processes w/o chemical industry and other	90%	0%	0%	0%	0%	0%
Chemical industry	90%	0%	100%*	0%	0%	0%
Industrial Processes - other	0%	0%	0%	0%	0%	0%
Solvents and other product use	0%	0%	0%	0%	0%	0%
Agriculture	0%	0%	0%	0%	0%	0%
LULUCF	0%	0%	0%	0%	0%	0%
Waste	0%	0%	0%	0%	0%	0%

** Only in the WEM and WAM scenario*

Source: Hungarian GHG Inventory and CITL

5.4. Modeling methodology and assumptions used for the scenarios

This chapter covers GHG emissions from energy sector fuel combustion. The first part discusses heat energy consumption and the related emissions, whereas the second part deals with emissions from electricity and heat generation.

5.4.1 Heat consumption

Heat is produced and consumed in the industry, households, tertiary sectors and agriculture. Approximately 41% of the total energy is consumed in the form of heat, as the following figure shows.

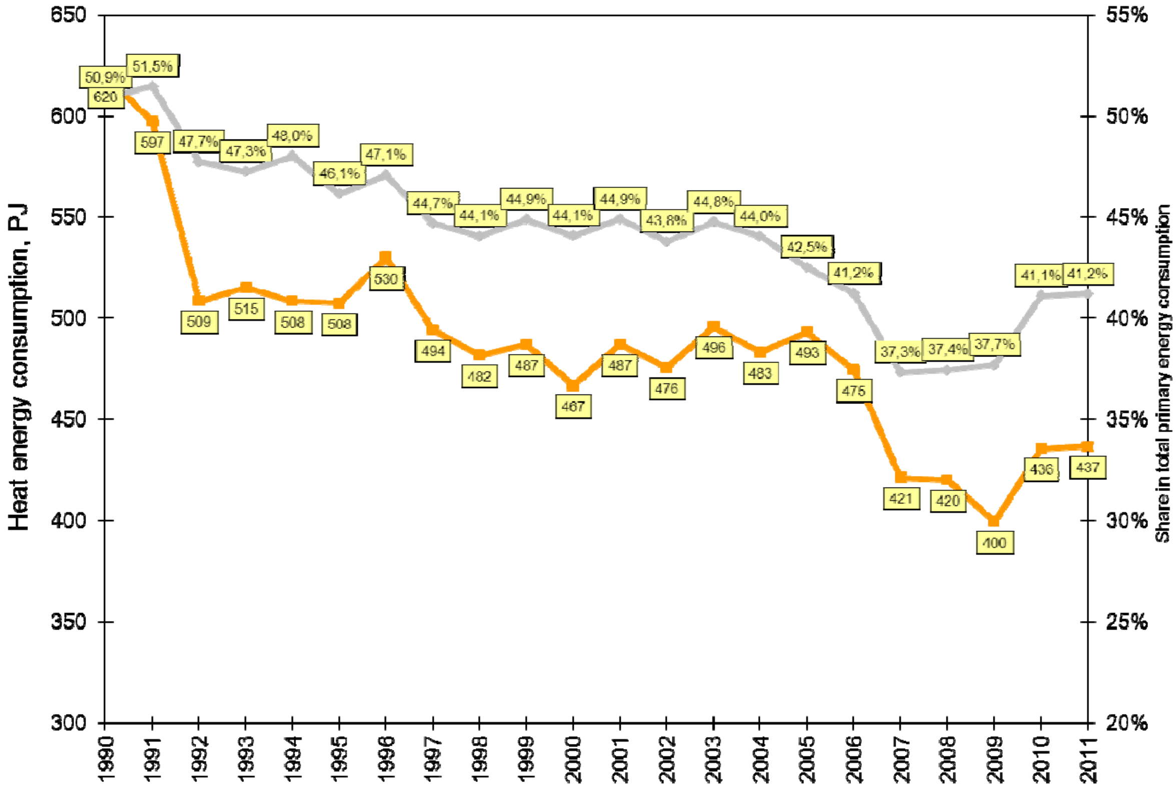


Figure 5.4. Heat energy consumption (PJ) and its share in total primary energy consumption (%), 1990-2011

Source: Eurostat

The contribution of the various sectors is depicted in the following figure. The most important sectors are households and service sector (68%) within the total consumption.

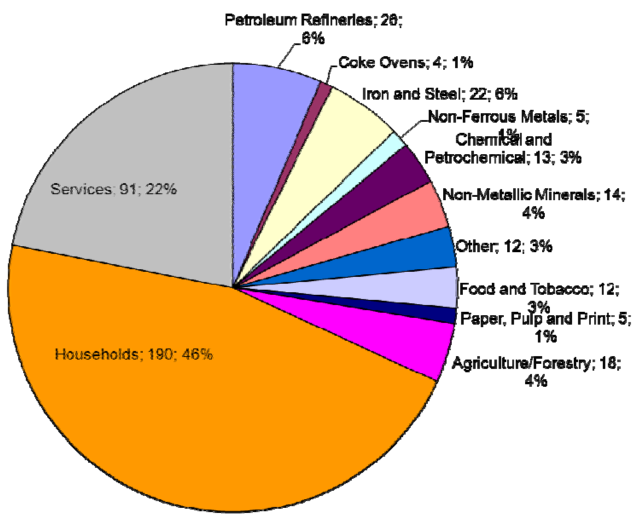


Figure 5.5. Distribution of the heat energy consumption in 2011, PJ and %

Source: Eurostat

The methodology used for emissions forecast is as follows (see Figure 5.6). First, the heat energy consumption of all sub-sectors are forecasted (TJ) and in parallel the aggregate RES share in the heat energy consumption (%) is determined. By multiplying aggregate consumption and RES share, the total RES consumption (TJ) is derived. This is distributed among the various sub-sectors taking into account the distribution of RES consumption in the last three years, while the share of other fuels is calculated on the basis of the historical distribution. Finally, GHG emissions of the various sub-sectors are calculated by using the respective emission factors.

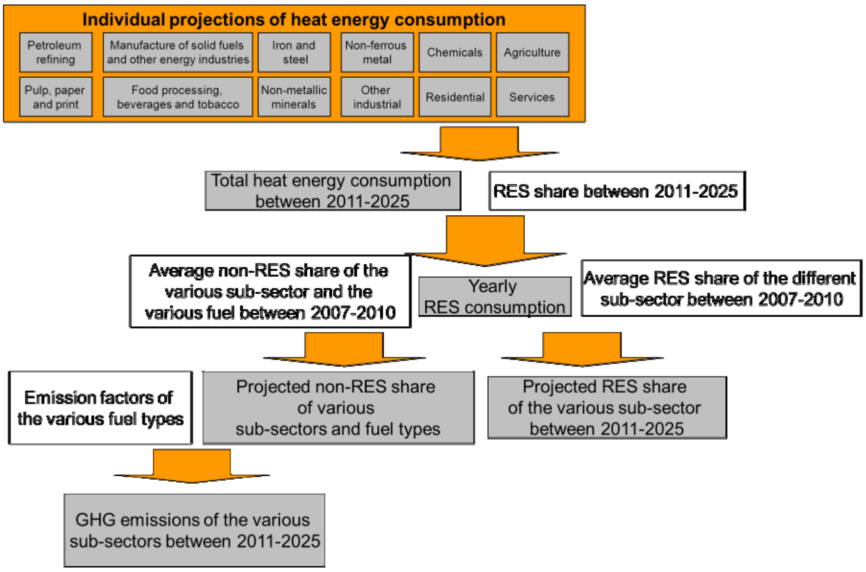


Figure 5.6. GHG emissions calculation methodology

5.4.1.1. RES share

An important input of emissions calculation is the share of renewables in the heat energy consumption. The WAM scenario uses the heat RES target defined by the National Renewable Energy Action Plan (NREAP), i.e. 18.9 % by 2020. In the WEM scenario the RES share in 2020 is lower, i.e. the level defined by the Renewable Directive. The following figure shows the assumed RES shares in the various scenarios. WOM refers to the hypothetical "with zero measures" scenario, where none of the measures would be introduced.

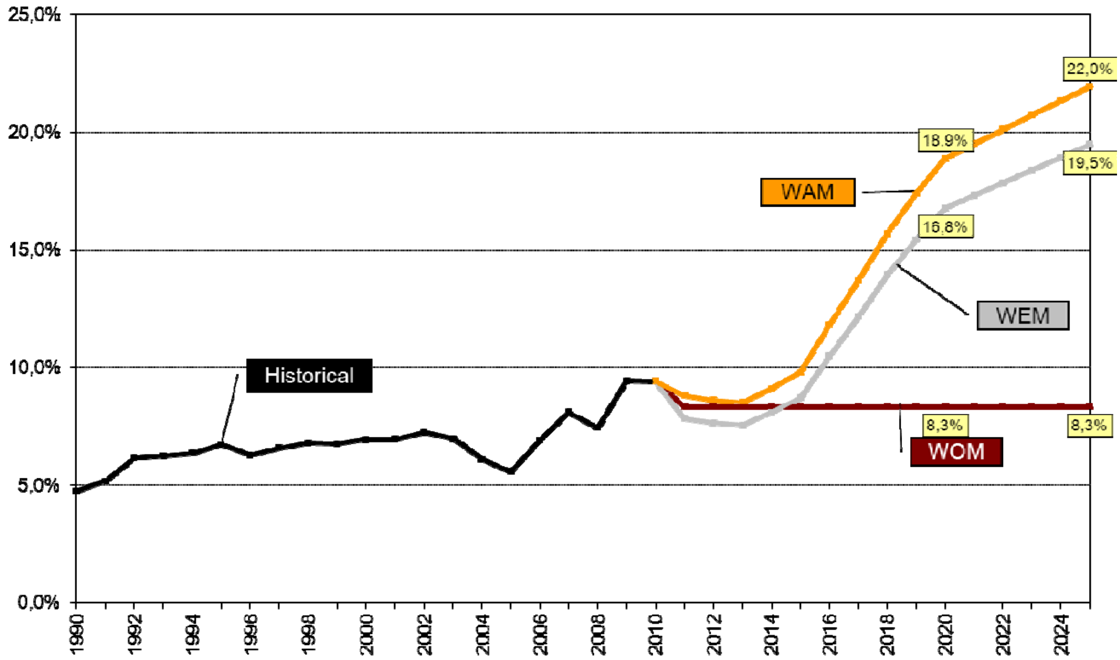


Figure 5.7. Historical and forecasted RES share in heat energy consumption in the three scenarios

Source: Eurostat, NREAP

5.4.1.2. Industry

Independent forecasting models have been developed for the following industrial sectors: petroleum refining, chemical industry, production of coke, iron and steel production, non-ferrous metals production, non-metallic minerals production, paper and pulp production. Forecasting is based on the time-series regression models. Our explanatory variables fall into two categories. One is the group of variables that are forecast by independent sources (e.g.: EU Commission, National Statistical Office, IEA) for example: GDP, population, crude oil price.

Besides these exogenous variables, in order to improve fitting, in some of the sectors additional explanatory variables were used with no available forecast values: value added of total manufacturing and value added by subsectors. In such cases our models are two-tier. First we explain observed variations of the value added by the subsector and estimate its future values (parameter estimation model). Secondly, we use the estimated parameter along with other independent variables to forecast the energy use of each industrial subsector (energy use forecast model).

This approach allows us to improve the explanatory power of our models without adding too much independent variables: one cannot use more than 2-4 independent variables per model because the relatively short length of the observed time series (1995-2012) limits the statistical degree of freedom.

In the following sections we summarize all the relevant data of our parameter estimation models and the energy use forecast models by subsectors. Then we aggregate our industrial energy use estimate through 2025.

Petroleum refining

Value added of the refining sector shows a substantial decline between 1995-2002 and flats out almost perfectly afterwards. This phenomenon could not be econometrically modeled so parameter estimation of sectoral production is substituted by an assumption of constant value added.

The energy use forecast model was developed with three independent variables: sectoral value added, crude oil price and the lag of energy use (energy in the previous year). The model is an autoregressive time series estimation because it explicitly explores the linear dependence of refinery energy use on the sector's energy use in the previous year.

Table 5.8. Petroleum refining energy use estimation model

Model type:	Autoregressive	
R-square:	91%	
Durbin-Watson statistic:	2.3	
Independent variables	Coefficient	p-value
Constant	-94594.061	
Value added by sector	79.121	.000
Energy use in previous year	.353	.007
Population	9.519	.006
GDP	-60.394	.040

The following graph shows the fit of the estimated energy use by the refining sector to the observed variations.

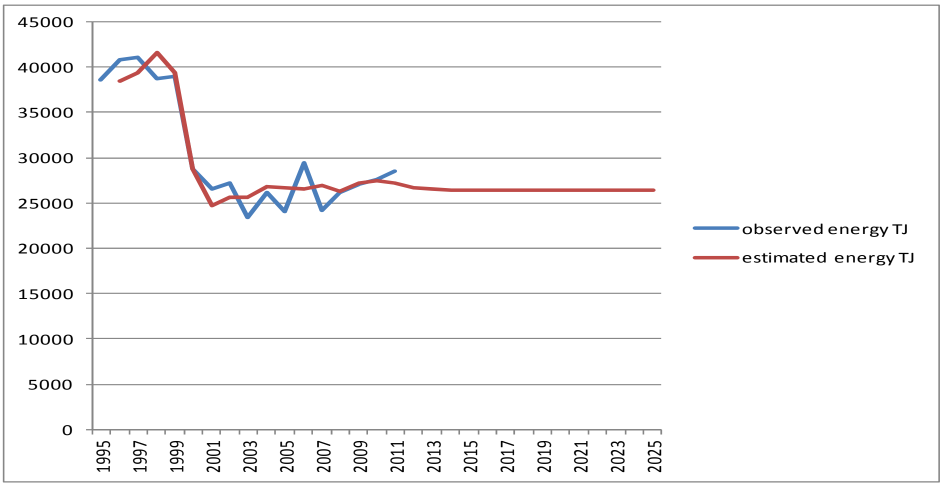


Figure 5.8. Observed and estimated energy use by the petroleum refining sector, TJ

Chemicals production

Although we estimated the sector's value added and constructed energy use estimation models with value added among the explanatory variables, eventually we did not use it in the final energy use forecast model. Energy use by chemicals production is estimated by a simple autoregressive model with a lag variable for energy use and gross domestic product as independent variables. The model is specified in the following table.

Table 5.9. Chemicals production energy use estimation model

Model type:	Autoregressive	
R-square:	84%	
Durbin-Watson statistic:	1.91	
Independent variables	Coefficient	p-value
Constant	12377.647	
Energy use in previous year	.636	.041
GDP	-49.026	.012

Fit of estimated energy use by the chemical industry is shown in the following figure.

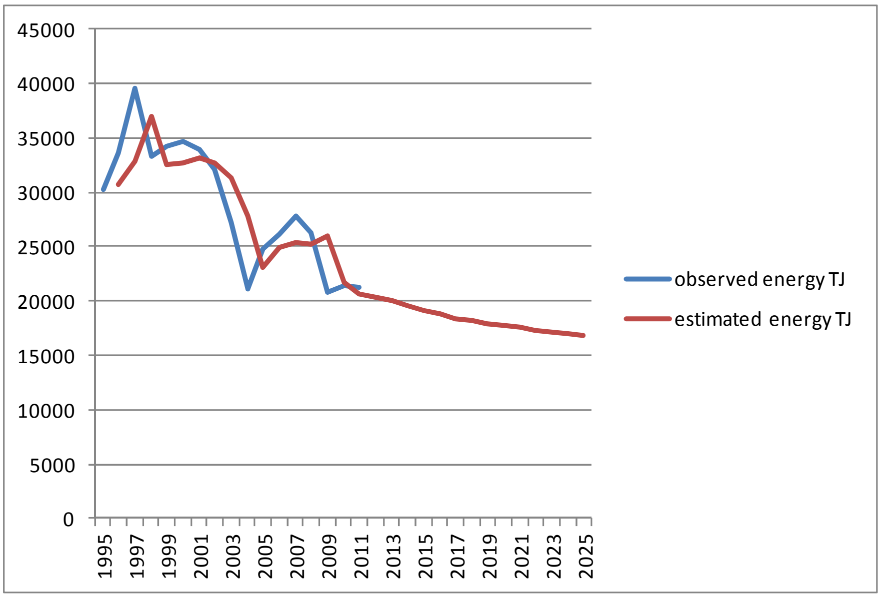


Figure 5.9. Observed and estimated energy use by the chemical industry, TJ

Coke production

In case of the coke sector, the sector's own value added has proved to be insignificant when included among the explanatory variables to estimate the energy use of coke production. Instead, value added of total manufacturing is used with not very high statistical significance either. The energy use estimation model is not very powerful, much of the observed variations remain unexplained. (R^2=0.6) Nevertheless, it is a fair autoregressive model with total manufacturing, energy lag and crude price as the best combination of independent variables. The estimated coefficients are presented in the next table. Note that crude oil price displays a positive coefficient indicating the unusual experience that an increase in crude oil price triggers an increase in energy use by the coke sector.

Table 5.10. Coke production energy use estimation model

Model type:	Autoregressive	
R-square:	60%	
Durbin-Watson statistic:	1.91	
Independent variables	Coefficient	p-value
Constant	-3527.890	
Value added by total manufacturing	-26.006	.196
Energy use in previous year	.417	.124
Crude oil price	26.876	.089

See following chart for a graphic representation of the fit of coke industry energy estimation.

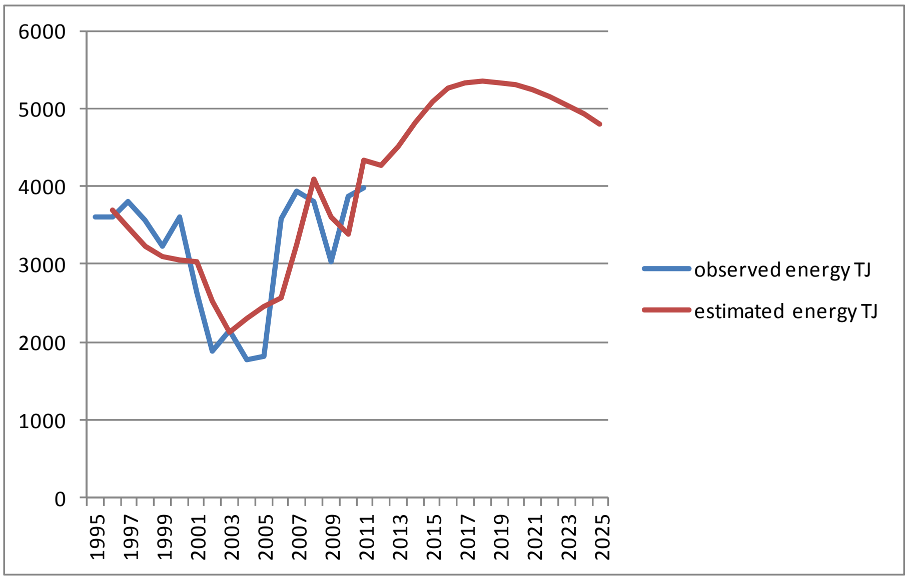


Figure 5.10 Observed and estimated energy use by the coke industry, TJ

Iron and steel production

Iron and steel production was the hardest of industrial sectors to develop an energy use estimate model for. The sector's value added has been steadily increasing along a slowly but surely decreasing energy use. This notable decoupling trend was hard to econometrically model. The best explanatory power was achieved by a simple autoregression of energy use by a lagged variable and, interestingly, population, which seems to be a proxy for declining energy intensity of the sector.

Table 5.11. Iron and steel production energy use estimation model

Model type:	Autoregressive	
R-square:	63%	
Durbin-Watson statistic:	2.1	
Independent variables	Coefficient	p-value
Constant	-114572.123	
Energy use in previous year	.418	.060
Population	12.883	.100

Goodness of model fit is depicted by the following chart of observed and estimated energy use of iron and steel production.

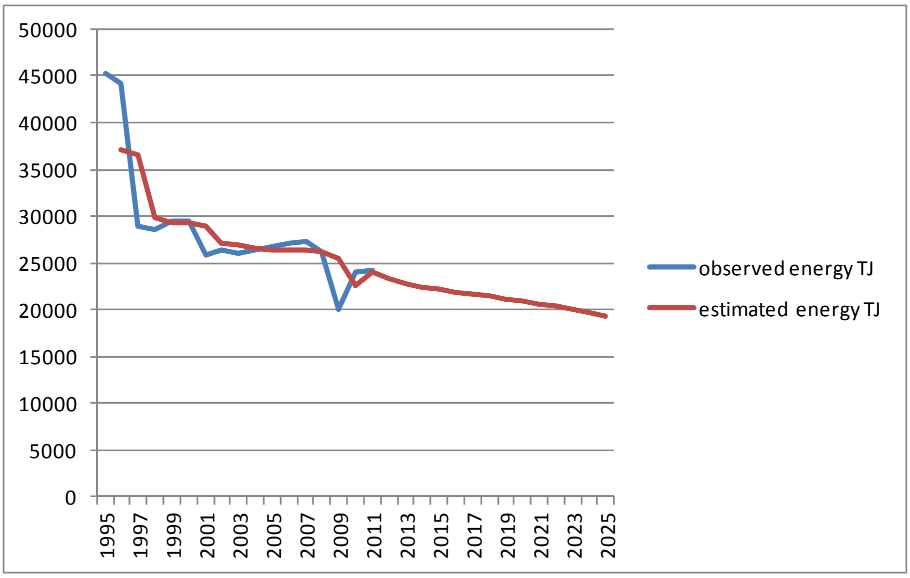


Figure 5.11. Observed and estimated energy use by iron and steel manufacturing, TJ

Non-ferrous metals production

The sector's energy use could not be estimated by the sector's value added: it failed to show statistical significance in any combination of the independent variables. Eventually, it was replaced by the value added of the total manufacturing sector and complemented by the crude oil price index. The model is specified in the next table. Note, that in terms of econometrics, this is not an autoregressive model because there is no lagged variable among the independents. Therefore, the coefficients shall not be directly interpreted.

Table 5.12. Non-ferrous metals production energy use estimation model

Model type:	Linear regression	
R-square:	62%	
Durbin-Watson statistic:	2.3	
Independent variables	Coefficient	p-value
Constant	4123.452	
Value added by total manufacturing	79.933	.000
Crude oil price	-89.689	.025

Fit of estimated to observed energy use by the non-ferrous metals industry is presented by the next figure.

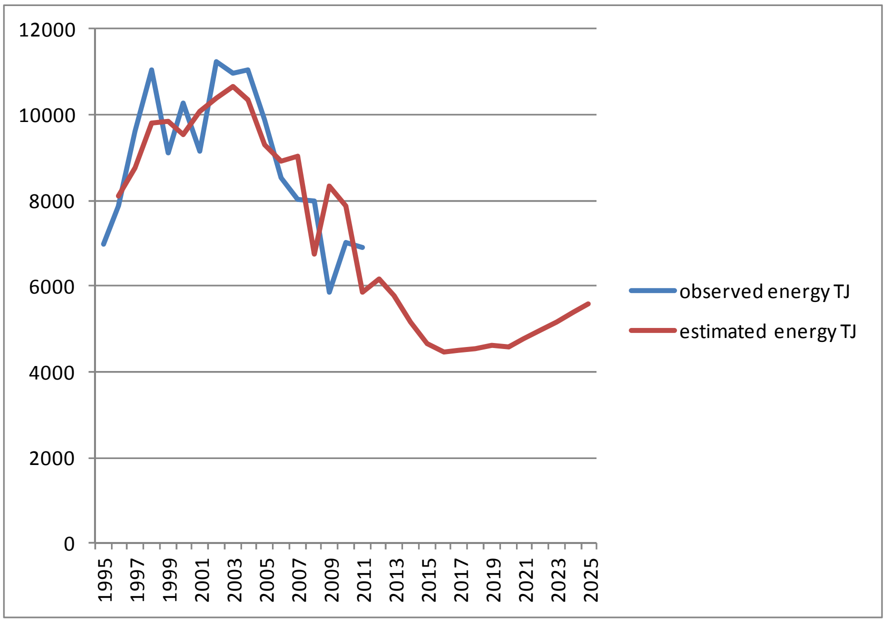


Figure 5.12. Observed and estimated energy use by the non-ferrous metals industries, TJ

Non-metallic minerals production

Non-metallic minerals production is a very heterogeneous sector. It contains manufacturing of cement, lime, ceramics and glass products. As a result, only a limited share of the observed variation could be explained in econometric terms (0.58). The best model uses the sector's own value added among the independent variables, which had had to be predicted by an independent time series regression model beforehand. That model uses the Cochrane – Orcutt algorithm to adjust the linear model for serial correlation by a lag in the error term. The value added prediction model is specified as follows:

Table 5.13. Non-metallic minerals production value added estimation model

Model type:	Cochrane-Orcutt	
R-square:	58%	
Durbin-Watson statistic:	1.6	
Rho:	0.447	
Independent variables	Coefficient	p-value
Constant	-64.074	
GDP	1.545	

Having obtained a reliable prediction for the future values of the sector's value added, next we developed an estimation model for the sector's energy use. Value added proves to be statistically very significant, only the crude oil price index adding similar explanatory power to the model. Population, though not statistically significant, adds to the estimation power of the model. Time serial correlation is adjusted by a lagged energy variable. Model details are presented in the following table.

Table 5.14. Non-metallic minerals production energy use estimation model

Model type:	Autoregressive	
R-square:	79%	
Durbin-Watson statistic:	1.84	
Independent variables	Coefficient	p-value
Constant	-73013.429	
Value added by sector	146.372	.007
Energy use in previous year	.342	.182
Crude oil price	-110.177	.063
Population	7.750	.462

The following figure shows the observed variations and the estimated values of energy use by the non-metal minerals production industries.

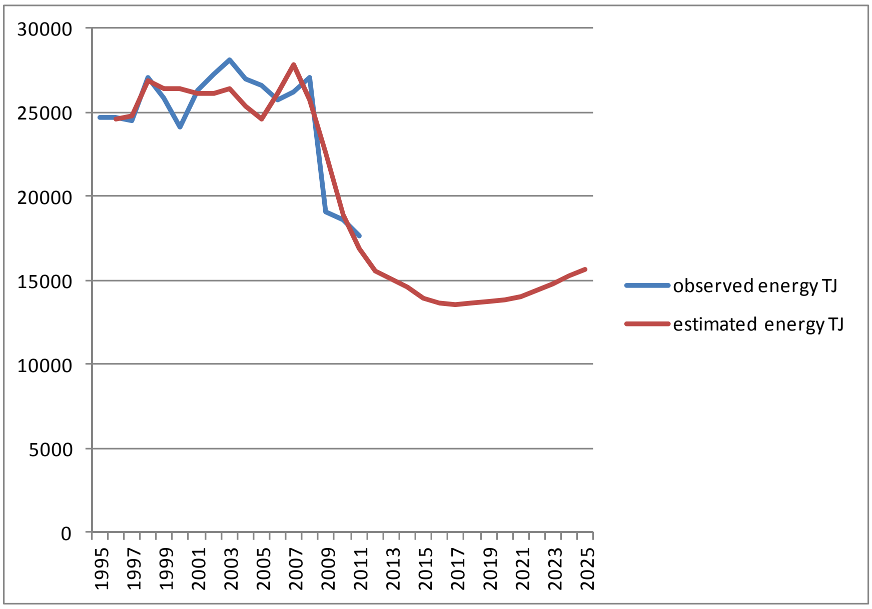


Figure 5.13 Observed and estimated energy use by the non-metallic minerals production industries, TJ

Paper and pulp production

The value added was estimated for the paper and pulp industry from gross domestic product by a time series model. Serial correlation is adjusted by the Cochrane – Orcutt algorithm of the lagged residual. See next table for model specification.

Table 5.15. Paper and pulp production value added estimation model

Model type:	Cochrane-Orcutt	
R-square:	87%	
Durbin-Watson statistic:	1.44	
Rho:	0.299	
Independent variables	Coefficient	p-value
Constant	-49.723	
GDP	1.512	

A relatively strong predictive model was built for the paper and pulp sector's energy use with value added in combination with population and GDP. A very significant explanatory power is attributed to all included independent variables. Note that having both GDP and the sector's own value added together in the model improves the estimation compared to omitting any of them. Time serial correlation is adjusted by the lagged energy use variable. We summarize the energy use estimation model details for the paper and pulp industry in the following table.

Table 5.16. Paper and pulp production energy use estimation model

Model type:	Autoregressive	
R-square:	83%	
Durbin-Watson statistic:	2.01	
Independent variables	Coefficient	p-value
Constant	-94594.061	
Value added by sector	79.121	.000
Energy use in previous year	.353	.007
Population	9.519	.006
GDP	-60.394	.040

See next figure for the graphic presentation of how estimated energy use fits the actually observed values in the paper and pulp industry.

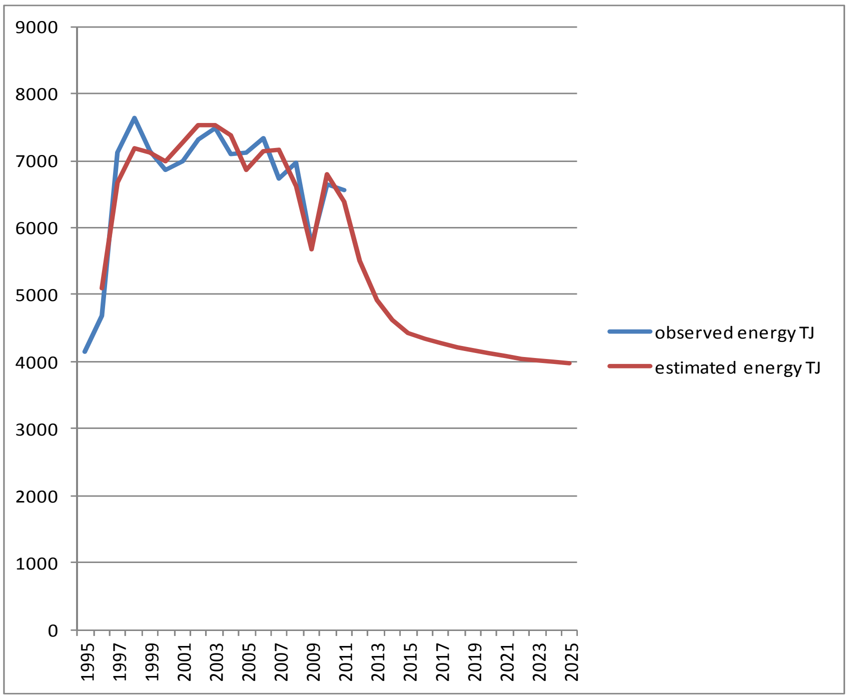


Figure 5.14. Observed and estimated energy use by the paper and pulp industry, TJ

Food processing, beverages and tobacco

The first half of the 1990s brought about a sharp decrease in the heat energy consumption of food processing, beverages and tobacco sector. Then it was stable until the early 2000s when it started to decline. It is assumed that the heat energy consumption of this sector will be characterized by a slow increasing trend until 2015, when it will reach the average energy consumption level of 2004-2008. No significant change is expected in the heat energy consumption of this sector.

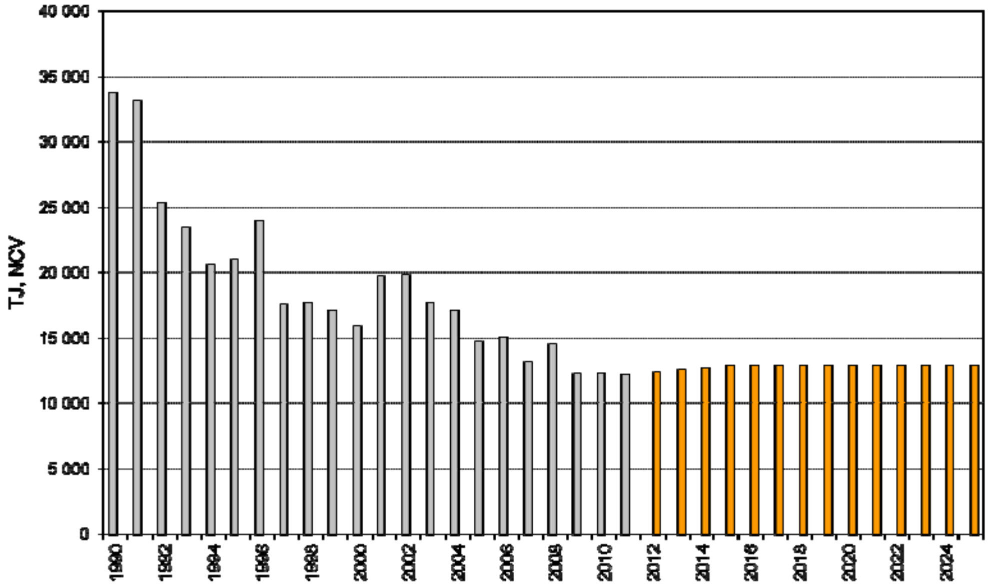


Figure 5.15. Historic (1990-2011) and forecast (2012-2025) heat energy consumption of the food processing, beverages and tobacco sector, TJ, NCV

Source: Eurostat

Other industrial sectors

Other industrial segments consist of the following sub-segments: mining and quarrying, textile and leather, transport equipment, machinery, wood and wood products, construction and other non-specifies industrial sub-segment. The following figure demonstrates the heat energy consumption of these sectors in the last ten years and the projected figure till 2025.

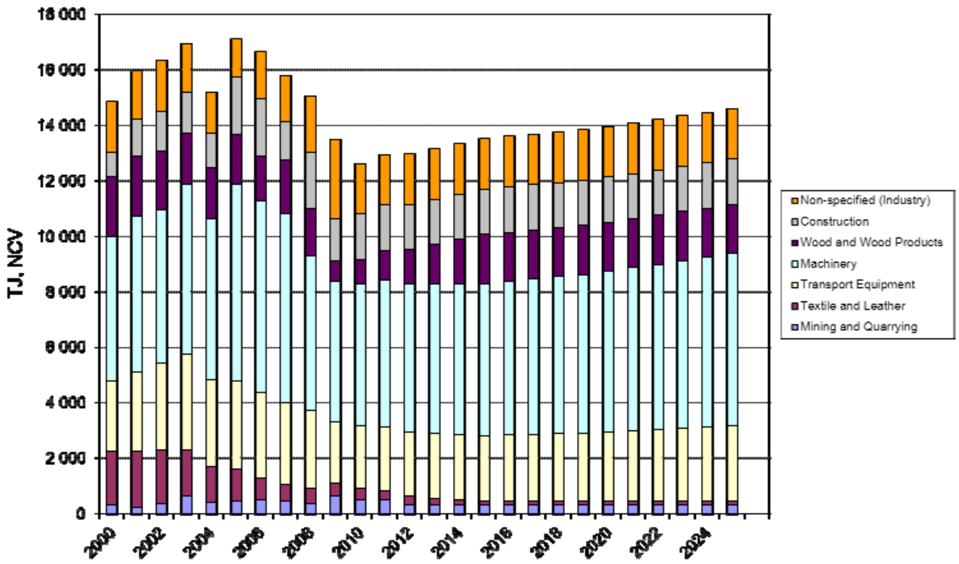


Figure 5.16. Historic (2000-2011) and forecast (2012-2025) heat energy consumption of other industrial sub-sector, TJ, NCV

Source: Eurostat

5.4.1.3. Agriculture

Heat energy consumption of the agriculture sector has been decreasing since 1990 from over 40 PJ to 17.7 PJ in 2011. It is assumed that this trend will continue till 2025 but at a smaller rate.

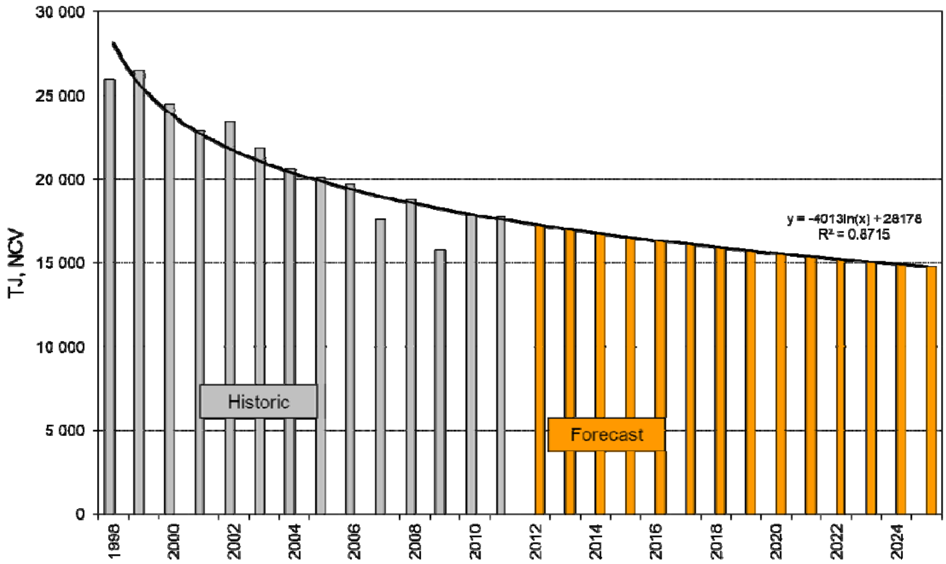


Figure 5.17. Historic (1998-2011) and forecast (2012-2025) heat energy consumption of the agriculture sector, TJ, NCV

Source: Eurostat

5.4.1.4. Residential sector

Electricity and heat consumption of the residential sector accounts for a significant share (34% in 2011) of total energy consumption.[1] The domestic energy balance (published by Energy Center) and international statistical data (Eurostat) quote around 231 PJ in 2011. Figure 5.18. indicates the historical trends of energy consumption.

[1] Source: Eurostat

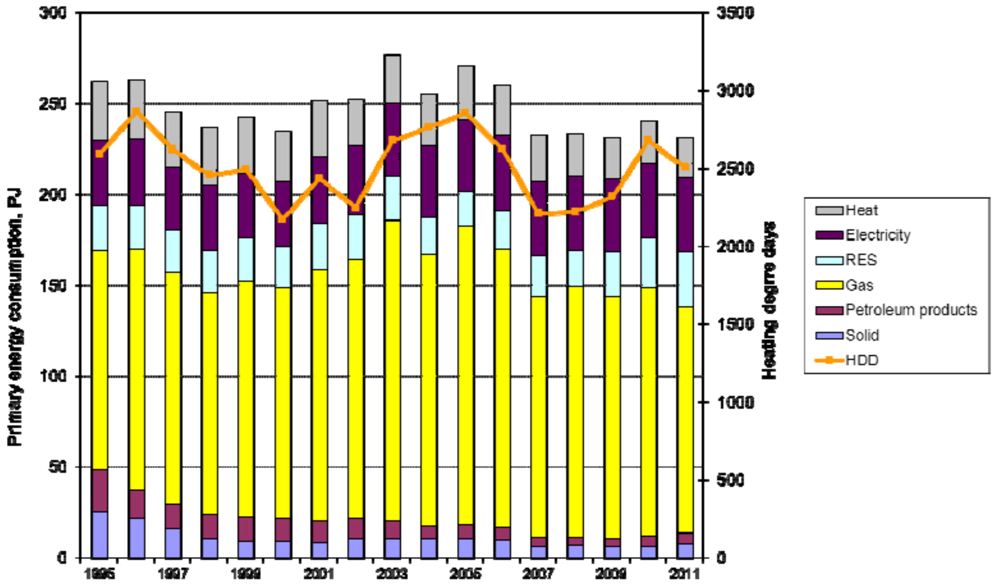


Figure 5.18. Primary energy consumption of the residential sector (PJ), and the value of heating-degree days (HDD), 1995-2011

Source: Eurostat

The consumption trend (increasing up to 2003-2005 then decreasing) hides several changes in the background variables. On one hand, the number of flats has increased from 4 to 4.2 million in the last decade, in parallel with an increase in the average floorspace (from 74 to 78 m^2). Simultaneously, there was a 95% increase in energy prices (measured in real gas price level in 2005€), having a significant effect on the households' energy bills.[2] Temperature fluctuations in winter have significant impact on residential energy consumption resulting in a +/- 15% fluctuation. The subsequent projections assume the average temperature of the last 10 years.

Primary energy use and GHG emissions scenarios for the residential buildings

Future primary energy demand and the consequent GHG emissions of the residential building stock are projected on the basis of an open ended building stock model that enables the alteration of various input parameters. GHG projections are done according to the following steps:

1. building stock modelling (autonomous annual stock change)
2. application of retrofit assumption (rate for each type, deepness, fuel change)
3. determination of GHG emissions of the derived building stock (Figure 5.19.).

[2] Energy expenses grew from 11% to 14.5% in proportion of households' income (Hungarian Statistical Office (KSH): Energy Consumption of Households 2008; in Hungarian)

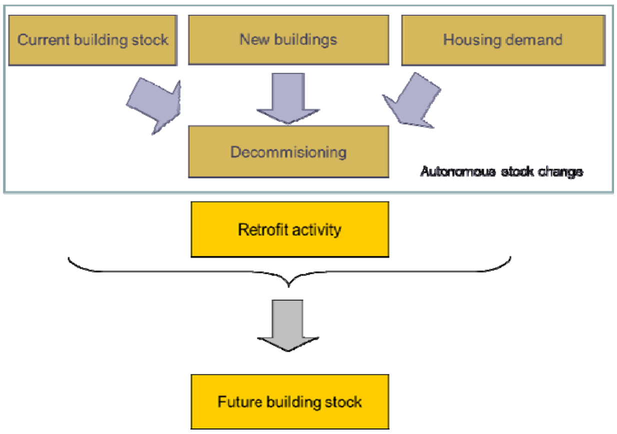


Figure 5.19. Modelling steps (residential building stock)

Current residential building stock

The stock description consists of 15 types of buildings that are most characteristic in Hungary, plus 4 building types that is envisaged to be characteristic in the future (Table 5.17). The typology is based on various features such as size (small/big), vintage, wall material and- in case of multiflat blocks – the number of flat contained in the building.

Table 5.17. Building typology

	Type	Vintage
1	detached house_small	-1944
2	detached house_big	-1944
3	detached house_small	1945-1979
4	detached house_big	1945-1979
5	detached house	1980-1989
6	detached house	1990-2001
7	semi-detached	2001-
8	block house (4-9 flats)	-2001
9	block house (4-9 flats)	2001-
10	block house (10+ flats)	-1944
11	block house (10+ flats)	1945-2001
12	block house (10+ flats; concrete)	1944-2011
13	industrial block house (10+ flats)	-1979
14	industrial block house (10+ flats)	1980-2001
15	block house (10+ flats)	2011-
16	new detached house (1-3 flats)	2013-2020
17	new detached house (1-3 flats)	2021-
18	new detached house (4+ flats)	2013-2020
19	new detached house (4+ flats)	2021-

The projection of the typology to the national building stock is executed on the basis of official statistical data (Hungarian Central Statistical Office, 2012). The primary energy calculated includes the energy used for heating and cooling (where applicable), hot water use and the auxiliary electricity used for the operation of heating/cooling/hot water devices and expressed in kWh/m^2 per annum.

The primary energy uses calculated according to the engineering method prescribed by the Hungarian regulation (pursuant to the EPBD) refers to the original condition of the buildings, meaning that – in order to approximate the real energy use of these buildings – it must be corrected with the already executed energy saving retrofit activities. Based on past studies, we have assumed that 25% of the current building stock has undergone refurbishment and does not comply with the energy performance standards in force (Negajoule, 2010; ÉMI, 2012).

Further correction factors include the ratio of abandoned flats, the rate of blocks that are adjacent to each other (typology calculations assume detached blocks whereas in reality in urban areas a significant share of these building are detached to each other resulting in lower energy demand) are the non-heated areas of inhabited flats and indoor temperature.

Autonomous stock change
The model updates the building stock annually where the demand for housing area, the existing housing area and the newly built area are the three input variables. The size of decommissioned housing areas is derived from the previous 3 variables. The logic of stock change is depicted by the following formula:

$$DEC_t = D_t - S_{t-1} + N_t$$

where

DEC_t: decommissioned housing floor area (m_2) in year t
D_t: demand for housing floor area (m_2) in year t
S_{t-1}: housing floor area in year t-1
N_t: newly built floor area (m_2) in year t

Newly built flats are characterised by the rate of building activity (% per annum), the type (detached/block) and the average floor area (m2). The model distinguishes 4 types of new flats according to size and vintage periods (Type 16-19 in Table 5.17). The rate of building activity and the average floor area are input parameters that take different values in the different scenarios (Table 5.18).

The per capita living floor area assumptions are based on international comparisons. The average m2 per capita increase with quite similar dynamic in all the countries examined but the absolute numbers are higher in Austria and Germany (Figure 5.20).

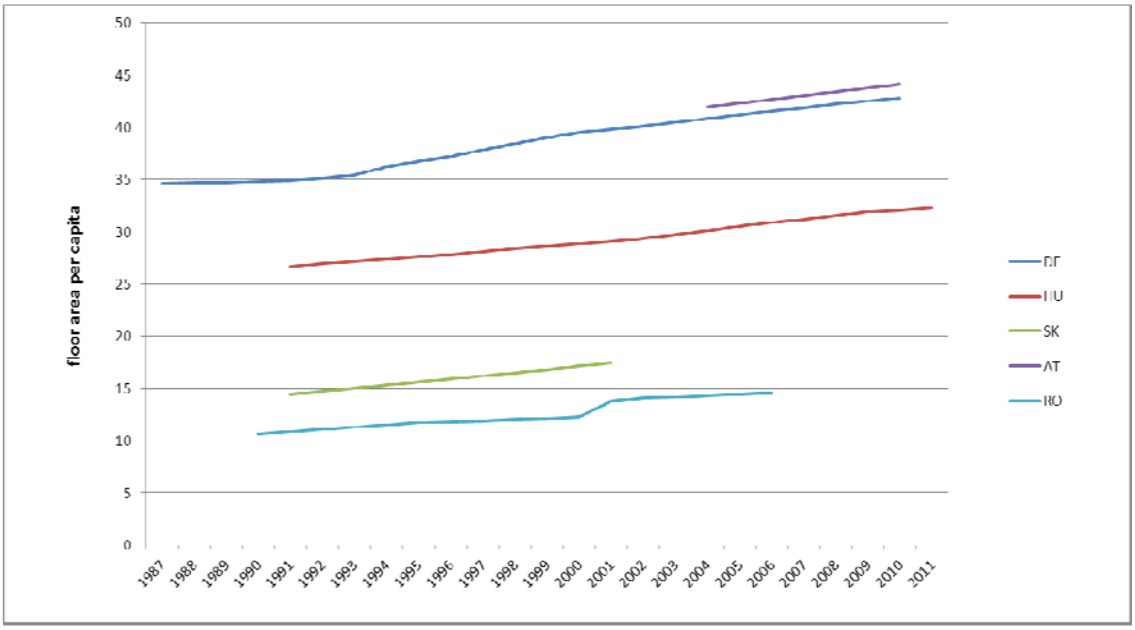


Figure 5.20. Per capita living floor area in various European countries (m^2/capita)

Source: REKK compilation

The aggregate floor area decommissioned each year is an output parameter of the model that need is distributed among the 15 building types on the basis of their relative share in the building stock (except for building built after 2001 where we assume no decommissioning).

The retrofit levels

The model uses two distinct retrofit levels. The 'current standard' level assumes that the building – after the refurbishment – complies with the current national regulation regarding building energy standards (TNM).[3] A second – more deeper – refurbishment level is the one resulting in the so called 'nearly zero building'(NZB). The different scenarios use the different input assumptions regarding the new building activity rate, the per capita floor space changes and the rate of refurbishment to both levels (TNM and NZB).

Table 5.18. Input assumptions of the WOM, WEM and WAM scenarios

	WOM	WEM	WAM
new building activity rate (% of total stock)	linear increase to reach 1% by 2025	linear increase to reach 1% by 2020	linear increase to reach 1.5% by 2020
average floor space of new flats (m2/capita)	current HU rate of increase	current HU rate of increase	levelling the projected DE value by 2050
rate of TNM level refurbishment (% of total stock)	0.5%	1.5%	3%
rate of NZB level refurbishment (% of total stock)	0.2%	1%	1.5%

Based on these assumptions were the WOM, WEM and WAM primary energy use scenarios constructed until 2025 (Figure 5.21) and the adjacent CO_2 emissions scenarios (Figure 5.22.). We have to note that these values

[3] 7/2006 TNM Order (Order of the Minister without Portfolio)

include total heat consumption of the residential sector (individual and district heating as well) and also the auxiliary electricity used for the operation of heating/cooling/hot water devices. Once excluding district heating and electricity the modelled primary energy use in 2011 is 165.4 PJ and CO_2 emissions are 8.2 million tonnes Figure 5.20 and Figure 5.21). The model results fit well to the historical value for 2011 (168 PJ) and the CO_2 emission reported in the NIR (8.2 mt).

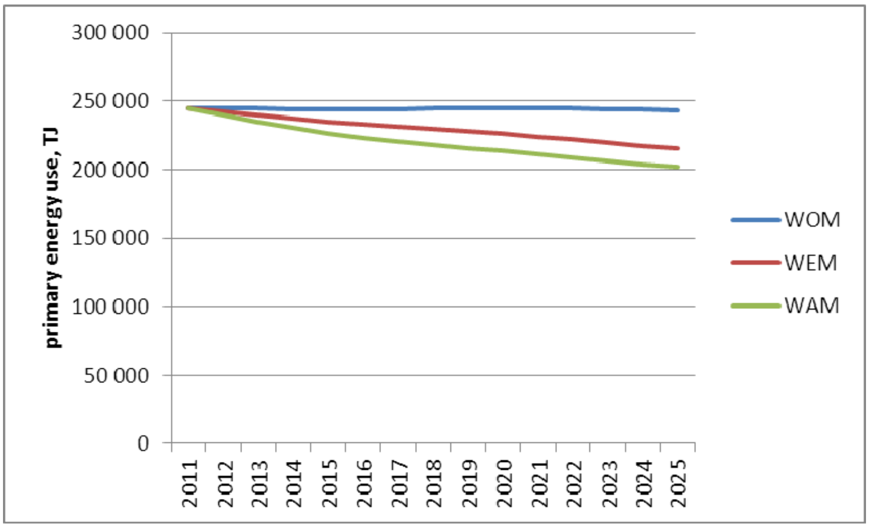


Figure 5.21. Primary energy use of residential buildings in the various scenarios (WOM, WEM and WAM) until 2025

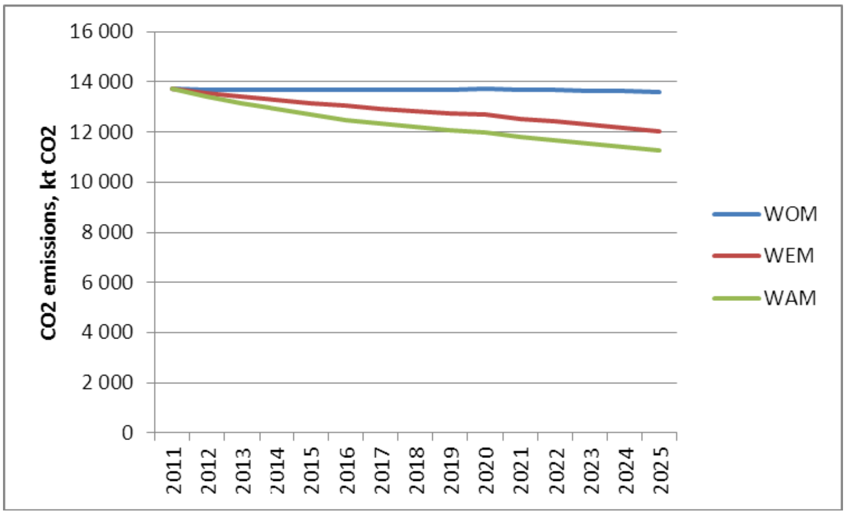


Figure 5.22. CO_2 emissions of residential buildings in the various scenarios (WOM, WEM and WAM) until 2025

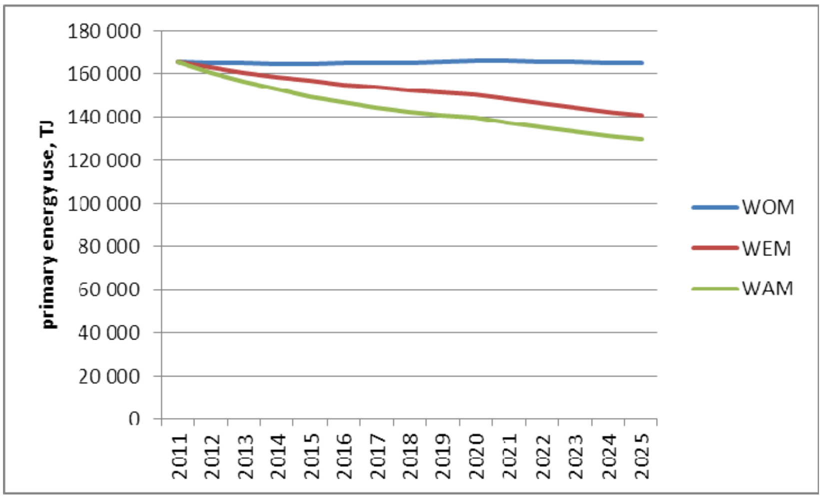


Figure 5.23. Primary energy use (excluding district heating and electricity) of residential buildings in the various scenarios (WOM, WEM and WAM) until 2025

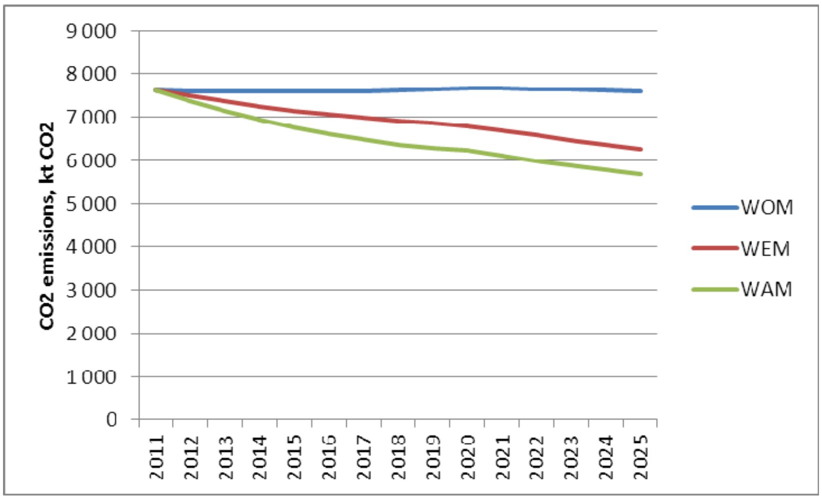


Figure 5.24. CO_2 emissions (excluding district heating and electricity) of residential buildings in the various scenarios (WOM, WEM and WAM) until 2025

We can conclude from the figures (both in case of all inclusive emissions and the individual heating only case) that the doubling the refurbishment rate and increasing the new building activity rate by 50% from the WEM to the WAM scenario is – to a great extent – counterbalanced by the envisaged strong increase of per capita space, notably by levelling the 2025 projected German values by 2050.

5.4.1.5. Tertiary sector

The tertiary sector means the aggregate of public buildings (both belonging to the central government and to municipalities) and the service sector buildings (privately owned offices, hotels, and retail facilities). Figure 5.26 indicates the historical trends of energy consumption.

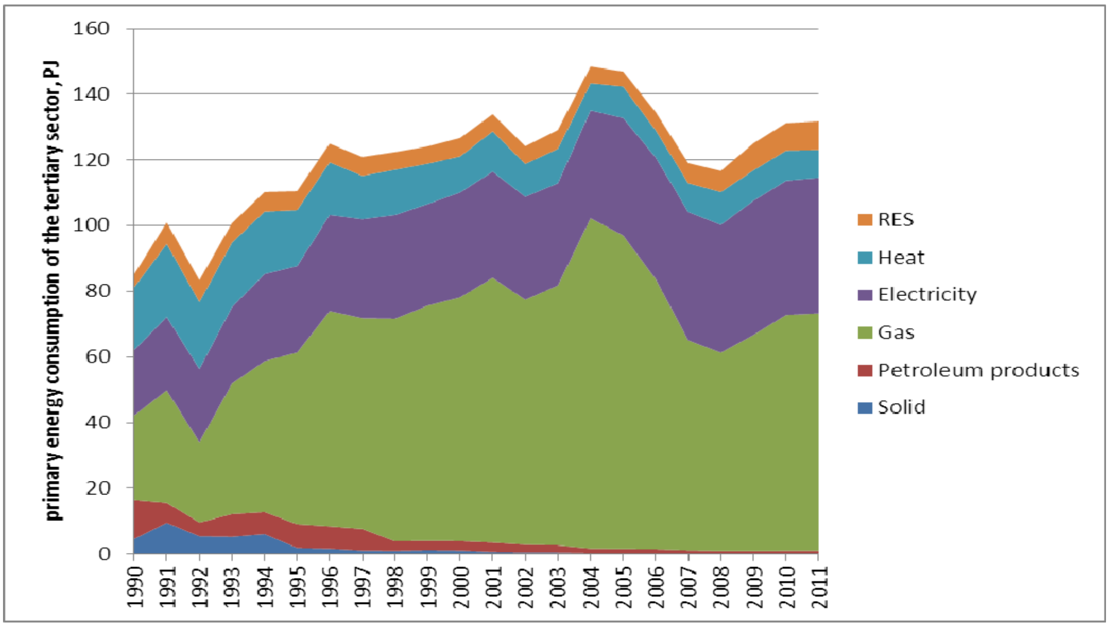


Figure 5.25. Primary energy consumption of the tertiary sector (PJ), 1990-2011

Source: Eurostat

The overall primary use of the sector in 2011 was 131 PJ which is the result of a tendency change in 2008 when the contracting energy use started to increase again. This is due to the increarsing gas consumption from 2008.

Primary energy use and GHG emissions scenarios for the buildings of the tertiary sector

Future primary energy demand and the consequent GHG emissions of the tertiary building stock are projected on the basis of an open ended building stock model that enables the alteration of various input parameters. GHG projections are done according to the following steps:

1. building stock modelling (autonomous annual stock change)
2. application of retrofit assumption (rate for each type, deepness, fuel change)
3. determination of GHG emissions of the derived building stock (Figure 5.26.).

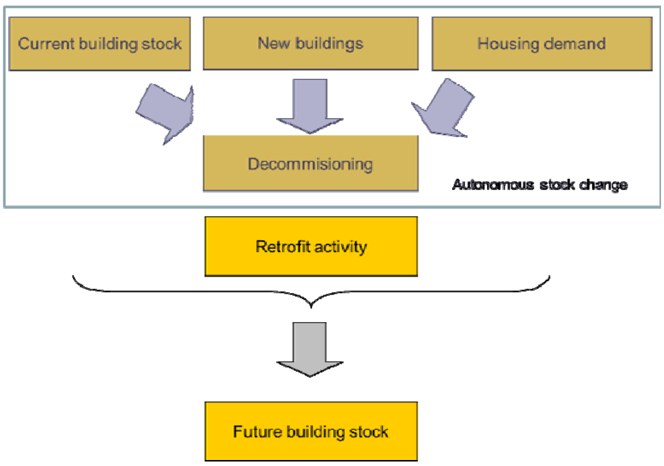


Figure 5.26. Modelling steps (buildings of the tertiary sector)

Current tertiary building stock

The public building stock consists of 42 types of buildings belonging to 5 functional categories and several vintage periods. The service sector stock covers 2 retail, 2 office and 3 hotel building categories that are differentiated according to the current energy performance (as a proxy to vintage as we have no statistics on these buildings) (Table 5.19).

Table 5.19. Building typology

		Type	Function	Vintage/current energy performance
public buildings	1	EÜ_1900_1	healthcare	-1900
	2	EÜ_1900_2	healthcare	-1900
	3	EÜ_1901-1945_1	healthcare	1901-1945
	4	EÜ_1901-1945_2	healthcare	1901-1946
	5	EÜ_1946-1979_1	healthcare	1946-1979
	6	EÜ_1946-1979_2	healthcare	1946-1980
	7	EÜ_1980-1989_1	healthcare	1980-1989
	8	EÜ_1980-1989_2	healthcare	1980-1990
	9	EÜ_1990_1	healthcare	1990-
	10	EÜ_1990_2	healthcare	1990-
	11	I_1900_1	office	-1900
	12	I_1900_2	office	-1900
	13	I_1901-1945_1	office	1901-1945
	14	I_1901-1945_2	office	1901-1946
	15	I_1946-1979_1	office	1946-1979
	16	I_1946-1979_2	office	1946-1980
	17	I_1980-1989_1	office	1980-1989
	18	I_1980-1989_2	office	1980-1990
	19	I_1990_1	office	1990-
	20	I_1990_2	office	1990-
	21	KER_1979_1	commerce	-1979
	22	KER_1979_2	commerce	-1979
	23	KER_1980_1	commerce	1980-
	24	KER_1980_2	commerce	1980-
	25	KUL_1945_1	cultural	-1945
	26	KUL_1945_2	cultural	-1945
	27	KUL_1946-1979_1	cultural	1946-79
	28	KUL_1946-1979_2	cultural	1946-79
	29	KUL_1980-1989_1	cultural	1980-1989
	30	KUL_1980-1989_2	cultural	1980-1989
	31	KUL_1990_1	cultural	1990-
	32	KUL_1990_2	cultural	1990-
	33	OKT_1900_1	educational	-1900
	34	OKT_1900_2	educational	-1900
	35	OKT_1901-1945_1	educational	1901-1945
	36	OKT_1901-1945_2	educational	1901-1946
	37	OKT_1946-1979_1	educational	1946-1979
	38	OKT_1946-1979_2	educational	1946-1980
	39	OKT_1980-1989_1	educational	1980-1989
	40	OKT_1980-1989_2	educational	1980-1990
	41	OKT_1990_1	educational	1990-
	42	OKT_1990_2	educational	1990-
Service sector buildings	43	retail_TNM	commerce	TNM
	44	hotel_current	hotel	sub TNM
	45	office_TNM	office	TNM
	46	retail_NZ	commerce	NZ
	47	hotel_TNM	hotel	TNM
	48	office_NZ	office	NZ
	49	hotel_NZ	hotel	NZ

The projection of the typology to the national building stock (aggregate m^2) is executed on the basis of official statistical data in the case of public buildings (Hungarian Statistical Office). Service sector floor area data are REKK estimations (due to the lack of primary data) derived from various sources.[4]

The primary energy calculated includes the energy used for heating and cooling (where applicable), hot water use and the auxiliary electricity used for the operation of heating/cooling/hot water devices and expressed in kWh/m^2 per annum.

The primary energy uses calculated according to the engineering method prescribed by the Hungarian regulation (pursuant to the EPBD) refers to the original condition of the buildings, meaning that – in order to approximate the real energy use of these buildings – it must be corrected with the already executed energy saving retrofit activities. Based on past studies, we have assumed that 25% of the current building stock has undergone refurbishment and does not comply with the energy performance standards in force.

Autonomous stock change

The model updates the building stock annually where the demand for floor area in each functional category (healthcare, educational etc.), the existing floor area and the newly built area are the three input variables. Demand for floor area in each functional building stock is driven by population change (healthcare, cultural and educational) or GDP (office and commerce).The size of decommissioned housing areas is derived from the previous 3 variables. The logic of stock change in educational buildings (as an example) is depicted by the following formula:

$$DEC_t=D_t-S_{t-1}+N_t$$

where

DEC_t: decommissioned floor area (m_2) in educational buildings in year t

D_t: demand for floor area (m_2) in educational buildings in year t

S_{t-1}: floor area in educational buildings in year t-1

N_t: newly built floor area (m_2) in educational buildings in year t

The model distinguishes 13 types of new buildings according to function and energy performance (Table 5.20.).

[4] Hotel building area data are from the Hungarian Statistical Office (2011 Report on the state of tourism), retail floor area data are from the Minstry of National Development, and office floor data are from private sector market sources (Colliers, 2012 and OTP, 2013).

Table 5.20. New building types used in the tertiary sector model

	Type	Function	Energy performance
1	EÜ_új	healthcare	TNM
2	I_új	office	TNM
3	KER_új	commerce	TNM
4	KUL_új	cultural	TNM
5	OKT_új	educational	TNM
6	EÜ_új	healthcare	NZ
7	I_új	office	NZ
8	KER_új	commerce	NZ
9	KUL_új	cultural	NZ
10	OKT_új	educational	NZ
11	hotel	hotel	NZ
12	retail	retail	NZ
13	office	office	NZ

The model uses two distinct retrofit levels, similar to the residential model. The 'current standard' level assumes that the building – after the refurbishment – complies with the current national regulation regarding building energy standards (TNM).[5] A second – more deeper – refurbishment level is the one resulting in the so called 'nearly zero building'(NZ).

The input assumptions of the three scenarios is summarised in Table 5.14. In case of service sector buildings, the total floor area is assumed to be constant over the whole period. The rate of new buildings (1.5% of total stock per annum) and the decommissioning rate equals meaning that new buildings simply substitute the same amount of old floor area. We only assume retrofit activity in case of hotels as retail facilities and offices have been built in the last decade and hence are not likely to be retrofitted.

In case of public buildings, the WOM, WEM and WAM scenarios assume different retrofit activity rates. The 2.5% of the WEM scenario is a proxy for the 3% retrofit requirement of the Energy Efficiency Directive. The 3% is downscaled due to the limited coverage of the Directive requirement: only central governmental buildings and only above a certain floor area. The new building rates are derived from observed new floor area in each functional category in the last vintage period and the total floor area of the same functional category.

[5] 7/2006 TNM Order (Order of the Minister without Portfolio)

Table 5.21. Input assumptions of the WOM, WEM and WAM scenarios

			WOM	WEM	WAM
Service sector buildings		total floor area change (m2)	constant		
		retrofit rate of hotels, from current state to TNM	1%		
		new building activity rate, %	0,5%		
		decommissioning rate, %	0,5%		
public sector buildings	retrofit rate, %	from current state to TNM	0,2%	2,5%	0,0%
		from current state to NZ	0,0%	0,0%	2,5%
		from TNM to NZ	0,0%	0,0%	0,0%
	new building acticity rate, %	healthcare	0,7%		
		office	0,5%		
		commerce	1,5%		
		cultural	0,7%		
		educational	0,4%		
	Total floor area (m2) change	healthcare	population driven		
		office	GDP driven		
		commerce	GDP driven		
		cultural	population driven		
		educational	population driven		

Based on these assumptions, we have constructed the WOM, WEM and WAM primary energy use scenarios up to 2025 (Figure 5.27.) and the adjacent CO_2 emissions scenarios (Figure 5.25). We have to note that these values exclude district heating and electricity, in conformity with the GHG reporting scheme. The model result fit well to the historical value for 2011 (82 PJ) and the CO_2 emission reported in the NIR (4104 kt).

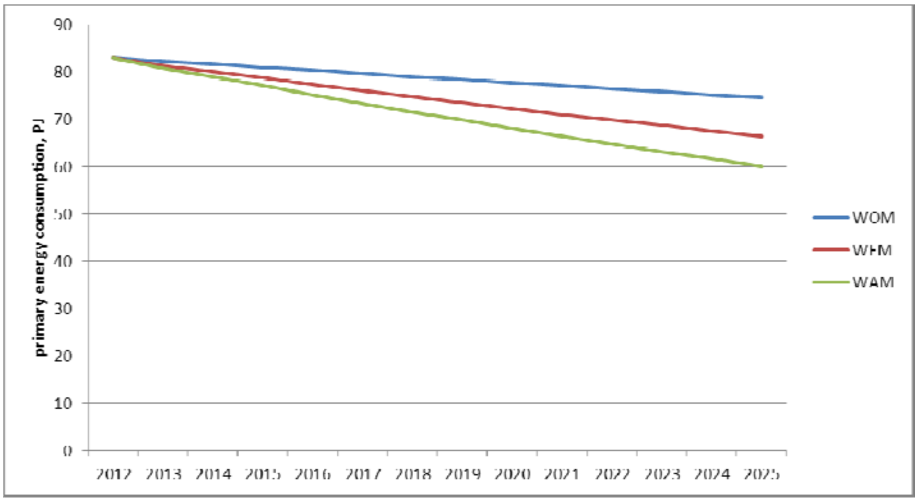


Figure 5.27. Primary energy use of tertiary sector in the various scenarios (WOM, WEM and WAM) until 2025

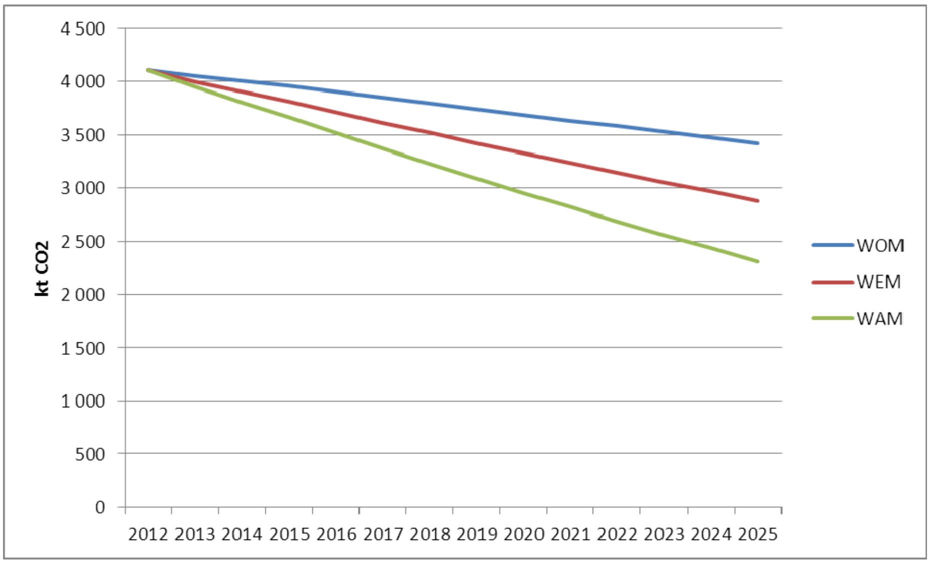


Figure 5.28. CO_2 emissions of tertiary sector in the various scenarios (WOM, WEM and WAM) until 2025

5.4.2. Electricity sector

This section gives a detailed analysis of the GHG emissions forecast in the electricity sector. Only GHG emissions related to electricity generation are included i.e. emission from heat production (as well as the GHG emission from the heat production part of the cogeneration plants) are not analysed.

First, the key parameters of the three emissions scenarios - WOM, WEM and WAM - are defined, followed by the introduction of the European Electricity Market Model (EEMM) developed by REKK, which computes the emissions of the scenarios. Finally, the results are presented.

5.4.2.1. Definition of various scenarios

The three scenarios differ in three aspects: allowance (AAU) price, in share of renewable sources and projected electricity consumption in Hungary.

Assumptions on allowance prices

Three different CO_2 price paths are used. The WOM scenario assumes the present price (~4€/t) to remain until 2025. The price assumptions of the WEM and WAM scenarios are based on “Impact assessment to the roadmap for moving to a competitive low carbon economy in 2050” document (Figure 5.27).

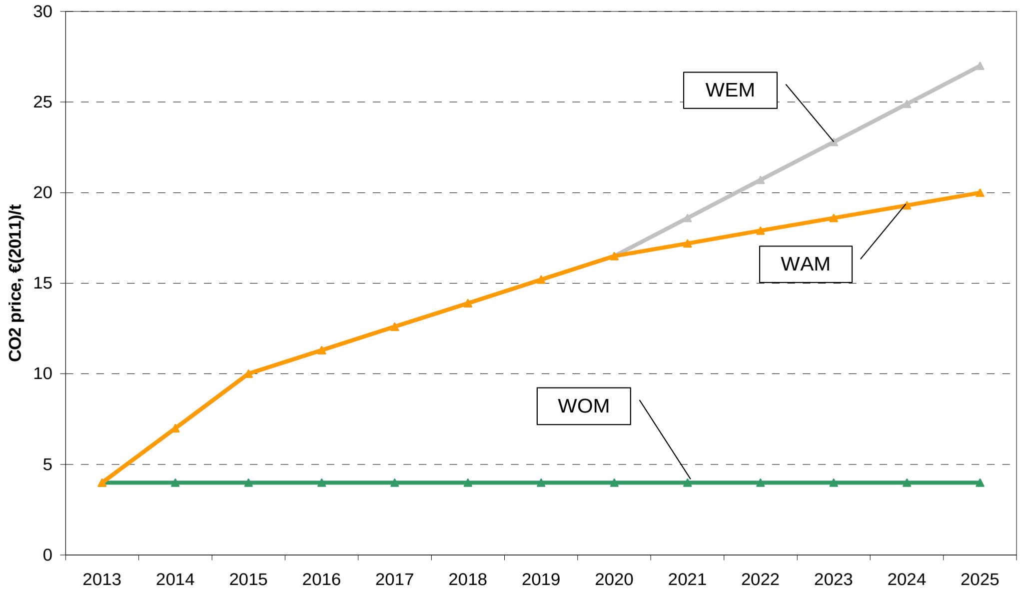


Figure 5.29. EUA price in different scenarios

Source: DG Climate

Future electricity consumption in the modelled scenarios

The annual electricity consumption is estimated by a regression calculation based on historical data of electricity consumption changes and GDP changes. The historic GDP values are taken from the Hungarian Central Statistical Office (KSH), while the forecasts equal with the recommended value (0.9 %/year between 2010-2015; 1.0%/year between 2016-2020 and 1.7 % between 2021-2025). We have to note that these value are much smaller compared that were announced in the last GHG report, which result in a significantly smaller gross electricity consumption and it is also smaller than stated in the National Energy Strategy 2030.

Figure 5.30. shows the real electricity consumption in Hungary between 1991 and 2012, the fitted consumption curve and the forecast electricity consumption until 2025 in the WOM scenario.

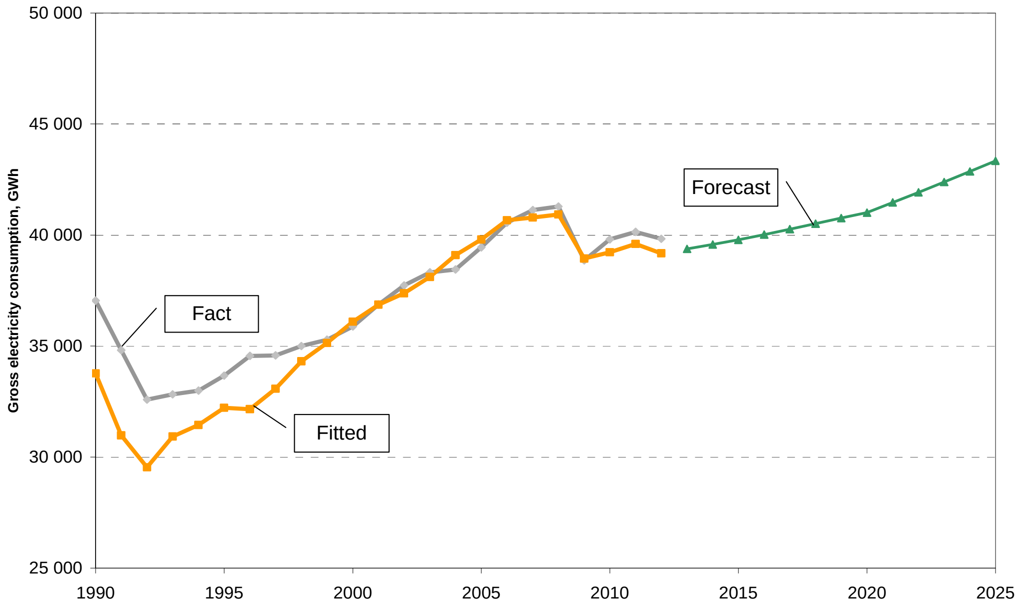


Figure 5.30. Historical, adjusted and forecasted gross electricity consumption in the WOM scenario, 1991-2025, GWh

Source: Hungarian Energy Office (MEH), REKK estimation

When forecasting electricity consumption, our assumptions were based on the relationship between the historical GDP and the electricity consumption figures and thereby assumed that energy efficiency measures will be realised to the same extent as in the base period of the estimation, between 1999 and 2012. However, it is important to examine the impact of the expected considerable additional energy efficiency investments on the future electricity consumption. Other important factors that could have significant impact on the future are electricity consumption of heat pumps and electricity consumption of electrical cars. While energy efficiency investments decrease the electricity consumption, heat pumps and electrical cars increase it. In the following these factors are examined and the final forecast electricity consumption in the three scenarios is determined. We assume that these factors (or the forecasted value of them) have not changed significantly since the last GHG Report; it means these assumptions are also applied in the projections of the GHG emissions of the electricity sectors.

Energy efficiency measures in the WEM and WAM scenarios

As a starting point, the results of a comprehensive international study prepared for the EU Commission[6] was chosen that determined - comparing the current energy consumption methods and the state-of-the-art technologies - what savings can be achieved in the given sectors based on various assumptions. The study examined three scenarios:

- Low policy intensity potential (LPI): The assumption of this scenario was that only those energy efficiency measures are realised that are profitable under regular market conditions.
- High policy intensity potential (HPI): The assumption of this scenario was that administrative barriers significantly decrease, furthermore, all the investments are realised that are profitable at an aggregated level i.e. not at consumer level.
- Technological potentials: This scenario ignores the costs of energy efficiency measures and observes the best available but rationally considerable cases.

[6] Fraunhofer ISI et.al., Study on the Energy Savings Potentials in EU Member States, Candidate Countries and EEA Countries (2009). The database established as a result of the study is available on the website http://www.eepotential.eu/.

The study includes the analysis of energy efficiency measures with regard to electricity consumption in three sectors: industrial, household and tertiary. All the three sectors turned out to have significant energy savings potentials that are profitable even on a market basis at a magnitude of 5.4 TWh by 2020.

Although details of the methods applied in the quoted study are not known and consequently, hence its findings cannot be debated, these figures are still considered unrealistically high.

For example, energy savings accounting for 5.4 TWh exceed 11% of the projected BAU electricity consumption in 2020. As a comparison, Hungary in its preliminary National Action Plan laying down the foundation for the implementation of the Europe 2020 Strategy, aims at 10% *total* energy savings, which, in the general opinion of the sector, can be fulfilled primarily by the large-scale reduction of energy consumption for heating purposes.

Accordingly, it is deemed justified to downscale this figure or assume that its realisation takes longer than 10-20 years. The argument behind these figures are the same as in the heat energy sector: in the WAM scenario the final electricity price will be higher compared to WEM scenario, which will result in a lower electricity consumption or more energy efficiency investments will be realized. In the WOM scenario zero additional energy savings from energy efficiency investments are assumed (Figure 5.31).

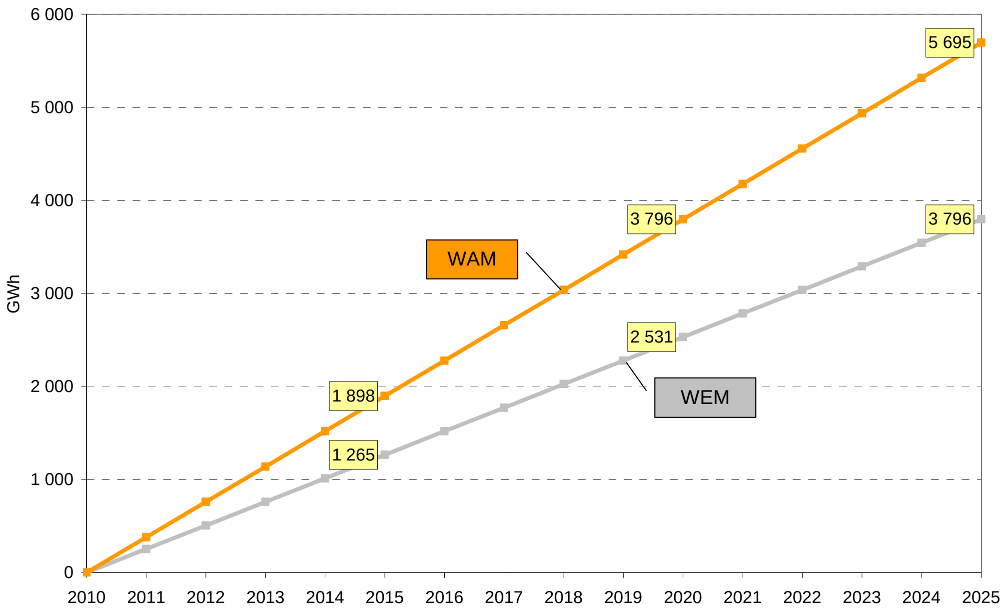


Figure 5.31. Energy savings in the electricity sectors in WEM and WAM scenarios, 2010-2025, GWh

It is important to emphasise that in the European electricity market modelling it was assumed that in both scenarios energy efficiency improvement is realised in all modelled countries.

Heat pumps

Widespread use of heat pumps increases electricity consumption significantly. According to the Hungarian NREAP by 2020 heat pumps will generate 6 PJ heat. To produce one Joule heat energy from heat pumps, it needs 0.25 Joule electricity. If the target set in the NREAP is reached, then electricity consumption will increase by 417 GWh. In the WEM scenario it is assumed that half of the energy from heat pumps will be realized, so the electricity growth is only 208 GWh by 2020. In the WOM scenario no significant heat production from heat pumps are assumed. The following table demonstrates the electricity growth due to heat pumps.

Table 5.22. Electricity consumption of heat pumps in different scenarios, GWh

	WOM	WEM	WAM
2015	0	104	208
2020	0	208	417
2025	0	255	509

Electrification in the transport sector

The rate of vehicle electrification mainly depends on European-wide policies and market development), much less on the Hungarian PAMs. Until 2020 zero electricity consumption is assumed due to the electric cars. Between 2020 and 2030 the optimistic PRIMES figures are accepted: 9% of the fuel consumption in the transportation sector is based on electricity (full electrical cars or plug-in hybrid cars). According to this figure the consumption growth could reach 5.5 TWh by 2030. This constitutes our WAM scenario. In the WEM and WOM scenarios it is assumed that the whole electrification will be delayed by five years, which means no electricity consumption growth is assumed because of the electrification in the transport sector during the period (2013-2025).

Electricity consumption

Based on the previous analyses, the forecast gross electricity consumption in Hungary in the different scenarios is shown in the following figure.

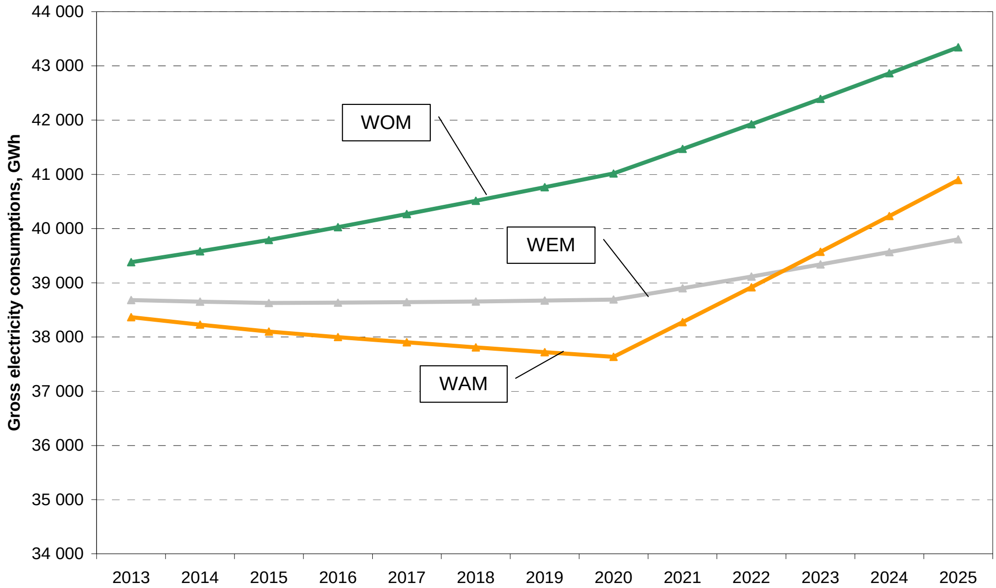


Figure 5.32. Gross electricity consumption in different scenarios, TWh, 2010-2025

The 2020 trend breakpoint in the WOM scenario is due to higher GDP growth assumption from 2020. In the other two scenarios, this is coupled with the additional sources of electricity demand: from 2022 the WAM scenario exceeds the WEM scenario, due to the higher electrification rate in transport and the faster spread of heat pumps.

Renewable-based electricity production in the various scenarios

As the whole region is modelled, and not only Hungary – in order to capture the trade effects as well -, it is assumed that the development of RES-E production in other EU Member States is similar to Hungary. In the

WOM scenario, the renewable share of 2012 is assumed to be constant in the analysed period, whereas the WEM and WAM scenarios assume that the renewable production will be in line with the NREAPs.

Summary of scenarios

Based on the above sections, Table 5.23. summarises the assumptions of the parameters (EUA price, electricity consumption, spread of renewable sources) for all the three scenarios.

Table 5.23. Assumptions for the various scenarios

		WOM	WEM	WAM
EUA price, $€_{2010}$/t	2015	4.0	10.0	10.0
	2020	4.0	16.5	16.5
	2025	4.0	27.0	20.0
Gross electricity consumption, TWh	2010	39.2	38.6	38.6
	2015	39.8	38.6	38.1
	2020	41.0	38.7	37.6
	2025	43.3	39.8	40.9
RES-E	2010-2025	No new RES-E investments in the modelled region	RES-E investments are in line with NREAPs	

5.4.2.2. European Electricity Market Model (EEMM)

The European Electricity Market Model (EEMM) is a simulation model of the European electricity wholesale market that works on a perfect competition assumptions (see later for details) stylized manner. The model is developed by the Regional Centre for Energy Policy Research (REKK). This section describes the economic principles that govern the simulation.

Geographical and technological details of the model

EEMM covers 36 countries with rich bottom-up representation, where all the EU 25 (Malta and Cyprus not included in the model) countries are modelled in full details, while those neighbouring countries that are important participants in the EU electricity markets are also modelled. The two groups are shown in the figure below: in those countries, which are indicated with an orange background, prices are derived from the demand-supply balance. In the other group of countries indicated with a light blue background, the prices are given, we assume exogenous prices.

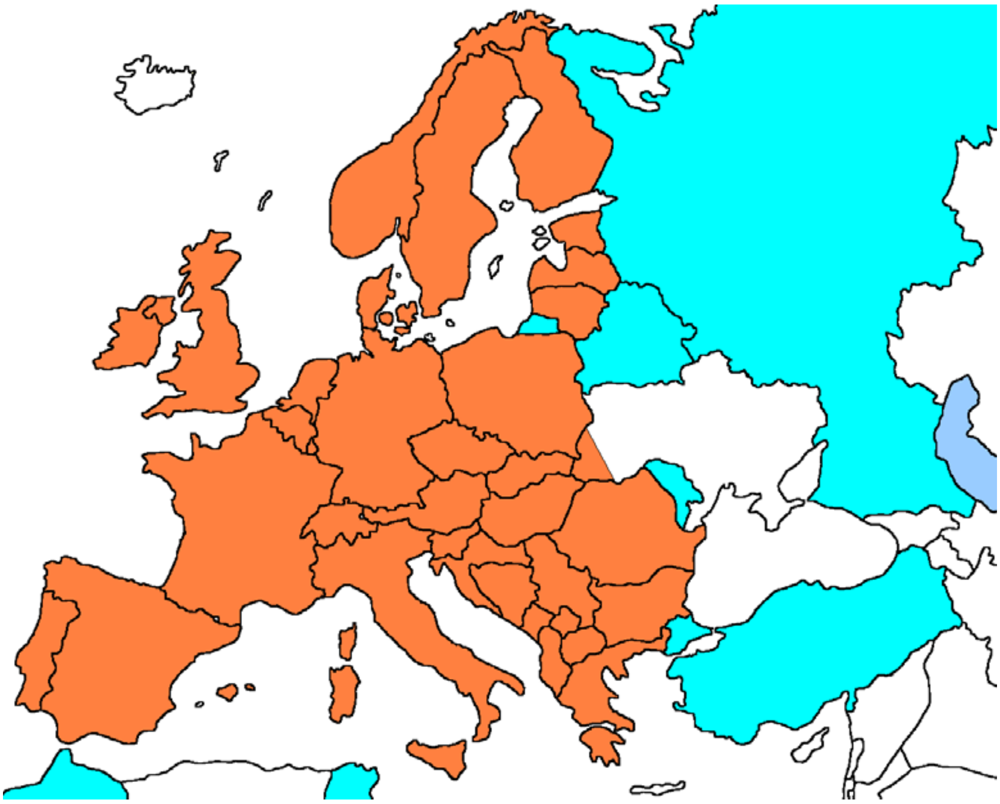


Figure 5.33. Countries analysed

In the electricity production sector we have differentiated 12 technologies by fuel type: biomass, coal, lignite, geothermal, heavy fuel oil, light fuel oil, hydro, wind, PV, nuclear, natural gas and tide and wave. In addition the transmission network is also modelled, however at a more aggregated level: we assume one country as one node. In other words, we assume one interconnector per pair of countries, which arrives to modelling 85 transmission lines. EEMM models the production side at unit level, which means that at a greater European level almost 5000 number of units are included in the model runs. Reaching equilibrium (in prices and quantities) takes place simultaneously in the producer and transmission segment. These units are characterized by various technological factors, allowing the construction of the merit order for the particular time period. In each year we have 90 reference hours to represent the load curve with sufficient details for each European country.

Market participants

There are three types of market participants in the model: producers, consumers, and traders. All of them behave in a price-taking manner: they take the prevailing market price as given, and assume that whatever action they decide upon has a negligible effect on this price.

Producers are the owners and operators of power plants. Each plant has a specific marginal cost of production, which is constant at the unit level. In addition, generation is capacity constrained at the level of available capacity.

The model only takes into account short term variable costs with the following three main components: fuel costs, variable OPEX, and CO_2 costs (where applicable). As a result, the approach is best viewed as a simulation of short term (e.g. day-ahead) market competition.

Price-taking producer behaviour implies that whenever the market price is above the marginal generation cost of a unit, the unit is operated at full available capacity. If the price is below the marginal cost, there is no production at all, and if the marginal cost and the market price coincide, then the level of production is determined by the market clearing condition (supply must equal demand).

Consumers are represented in the model in an aggregated way by price-sensitive demand curves. In each demand period, there is an inverse relationship between the market price and the quantity consumed: the higher the price, the lower the consumption. This relationship is approximated by a downward sloping linear function.

Finally, traders connect the production and consumption sides of a market, export electricity to more expensive countries and import it from cheaper ones. Cross-border trade takes place on capacity constrained interconnectors between neighbouring countries. Electricity exchanges always occur from a less expensive country to a more expensive one, until one of two things happen: either (1) prices, net of direct transmission costs or export tariffs, equalize across the two markets, or (2) the transmission capacity of the interconnector is reached. In the second case, a considerable price difference may remain between the two markets.

Trading with countries outside the modelled region
The model only simulates the supply-demand characteristics of the European region. However, trade still takes place at the region's borders, e.g. with Turkey or Moldova. Our assumptions regarding the cross-border trade with countries outside the modelled region is that prices in these countries are exogenously given and not influenced by the amount, or direction of the cross-border transactions.

Equilibrium
The model calculates the simultaneous equilibrium allocation in all markets with the following properties:

- Producers maximize their short term profits given the prevailing market prices.
- Total domestic consumption is given by the aggregate electricity demand function in each country.
- Electricity transactions (export and import) occur between neighbouring countries until market prices are equalized or transmission capacity is exhausted.
- Energy produced and imported is in balance with energy consumed and exported.

Given our assumptions about demand and supply, market equilibrium always exists and is unique in the model.

Electricity product prices
The calculated market equilibrium is a static one: it only describes situations with the same demand, supply, and transmission characteristics. However, these market features are constantly in motion. As a result, short run equilibrium prices are changing as well.
To simulate the price development of more complex electricity products, such as those for base load or a peak load delivery, we perform several model runs with typical market parameters and take the weighted average of the resulting short term prices.

5.4.2.3. Key results
This section gives a detailed analysis on the effects of the various scenarios on the electricity market including particularly on the electricity mix and carbon dioxide emissions.

Expected changes in the electricity mix

Total electricity consumption differs in the WOM, WEM and WAM scenarios, as it has been already demonstrated in the previous sections. The following figure shows, that nuclear units will produce 15.8 TWh electricity in all cases. Coal-fired power generation will decrease until 2025. The amount of renewable-based energy production is not the output but the input of the model. Natural gas-fired power production is the highest in the WOM scenario. Net import will be quite significant, e.g. in 2025 in the WOM scenario the net import will be 7.2 TWh, which will satisfy nearly 20% of the total yearly electricity consumption.

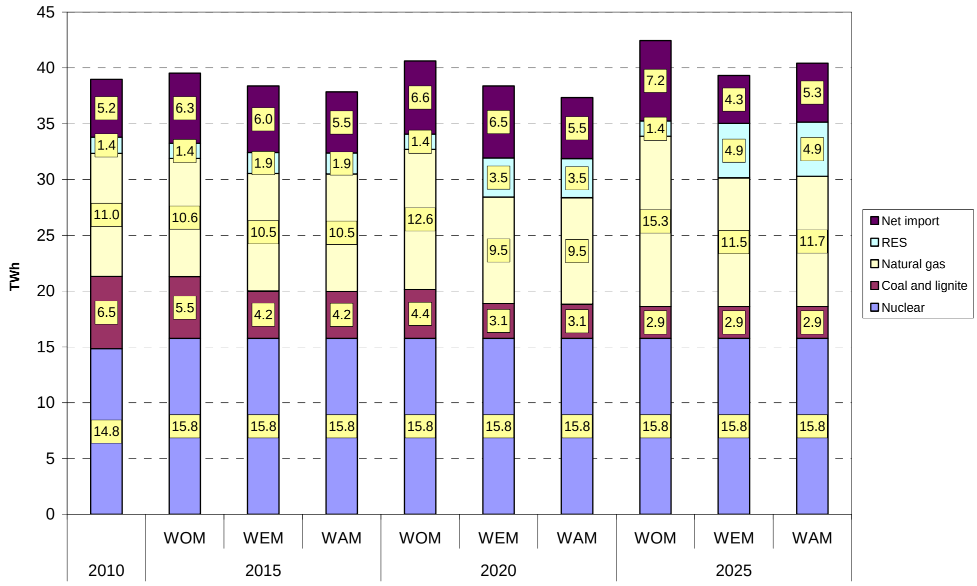


Figure 5.34. Electricity mix in 2015, 2020 and 2025 for various scenarios, TWh

Source: ENTSO-E and REKK forecast

Carbon dioxide emissions

Carbon dioxide emissions vary between 7.4 and 11.4 million tonnes in the various scenarios (Figure 5.35). The emission is essentially determined by the production of gas-fired power plants and the total domestic consumption: the less the consumption and the natural gas-based electricity production are, the less the carbon dioxide emission is.

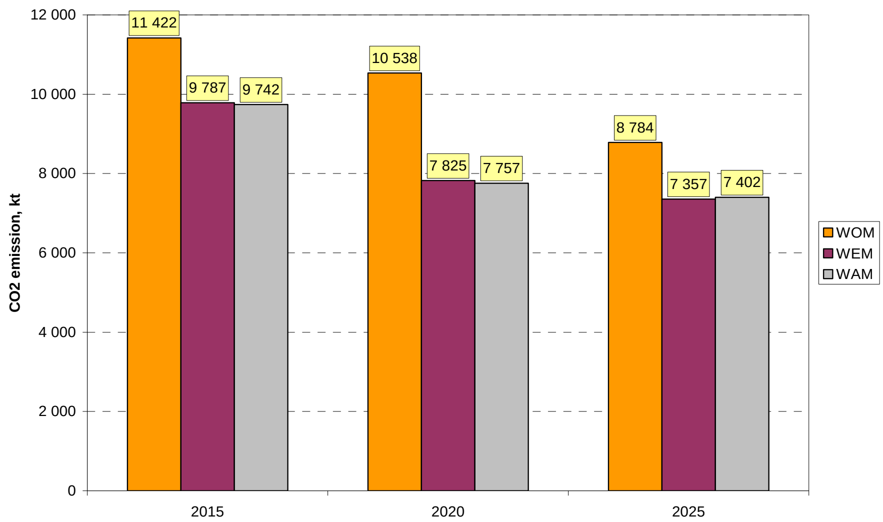


Figure 5.35. Emissions of electricity producers in 2015, 2020 and 2025 for various scenarios, thousand tonnes

5.4.3. Transport sector

The transport sector accounted for 18% of total GHG emissions measured in Hungary in 2011[7], and 19% including aviation emissions, measured in tonnes of carbon dioxide equivalent. Figure 5.36 shows that transport emissions (including CH_4 and N_2O) increased significantly in the period of 1985-2011, from 7929.91 to 12561.43 kt or Gg CO_2 equivalents (including aviation), with two breaks in the upward trend. Transportation activity and consequently emissions declined for some years in the period of transition (from 1990 to about 1995), and later as a result of the recent recession from 2009.

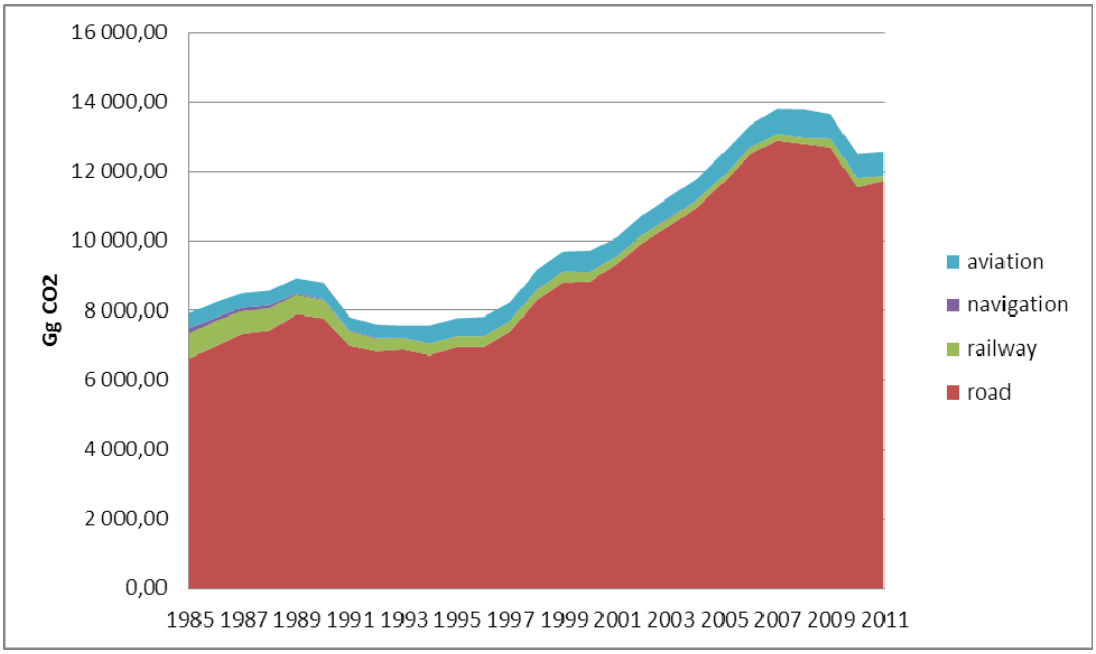


Figure 5.36. GHG emissions of the transport sector, 1985-2011

Source: NIRs, 2013–1985 to 2013-2011

It is apparent from the graph that road transport contributes to the majority of emissions, followed by an increasing amount coming from aviation, and a decreasing amount emitted by railways. The share of navigation in Hungary has decreased continuously in spite of policy objectives to increase its importance. In line with the calculations in the national inventory reports, we based our GHG emission projections on forecasting future fuel consumption of the different transportation modes. The next sections describe the estimation methods used for the road, rail, navigation and aviation sectors separately.

5.4.3.1. Road transport

Road transport accounts for 99 % of transport emissions. Measuring the future contribution of the sector based on earlier trends in transport volumes is quite difficult, given the significant role of personal cars in passenger transport, for which passenger kilometer data are hardly available. The number of cars registered, as well as the accessible statistics on freight and passenger transport (only available for public transportation) did not show statistically significant relationship with the energy used.

Figure 5.37. depicts the historical values of these measures.

[7] without LULUCF

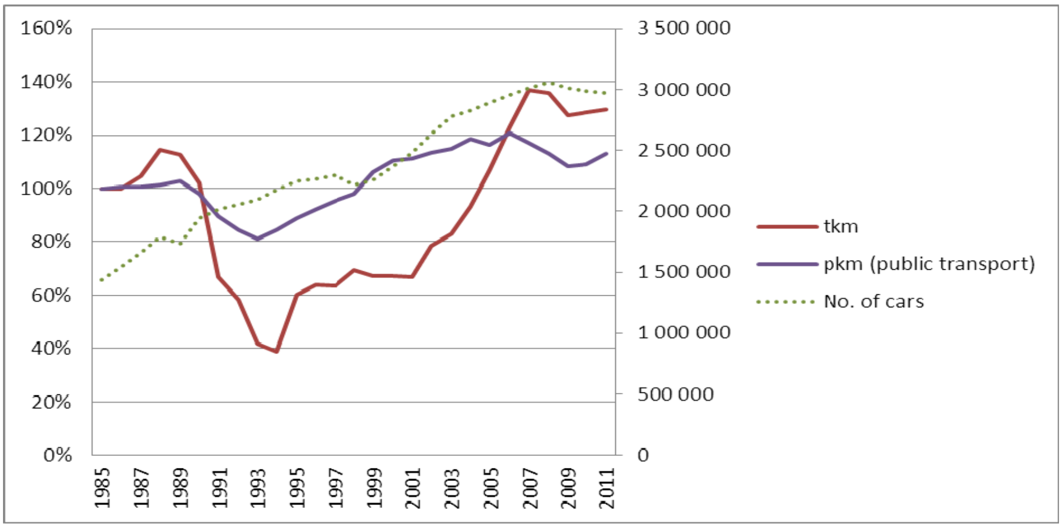


Figure 5.37. Volume of freight and passenger transport and the number of cars in Hungary, 1985-2011

Source: HCSO, 2013

Therefore energy use was estimated in one step, using data for which past values and forecasts are available, and are usually included in top-down road transport projections: population, oil prices, GDP and road network. Population and road network did not explain variations in road energy use, therefore GDP and fuel prices served as the main explanatory variables. The Cochrane-Orcutt model estimates were used to forecast total road transport energy and diesel fuel consumption, to correct for serial correlation. As Table 5.24. Table 5.24.shows, total road transport energy use is explained with the weighted average of gasoline and diesel fuel prices and GDP, using observations from 1996 to 2011, because no reliable fuel price statistics are available for earlier years. Data on energy use were obtained from the NIRs, while the source of fuel price and GDP data is the Hungarian Statistical Office.

Table 5.24. Model for estimating the total energy used in road transport sector

Cochrane-Orcutt, using observations 1997-2011 (T = 15) Dependent variable: roadEuseTJ				
	Coefficient	Std. Error	t-ratio	p-value
const	108 912.00	57 995.60	1.88	0.085
GDPindex_2000	1 192.64	431.92	2.76	0.017
w_ave_fuelprice	-188.57	53.51	-3.52	0.004
Statistics based on the rho-differenced data:				
R-squared	0.975		Adjusted R-squared	0.971
F(2, 12)	7.336		P-value(F)	0.008
rho	0.247		Durbin-Watson	1.496

The model for diesel consumption in road transportation also relies on the GDP and on the diesel prices for the same period. Table 5.25. summarizes the model estimates and statistics.

Table 5.25. Model for estimating diesel fuel consumption in road transport

Cochrane-Orcutt, using observations 1997-2011 (T = 15) Dependent variable: dieselTJ					
	Coefficient	Std. Error		t-ratio	p-value
Const	43 124.80	39 795.80		1.08	0.30
diesel_price	-82.44	34.47		-2.39	0.03
GDPindex_2000	764.46	262.04		2.92	0.01
Statistics based on the rho-differenced data:					
R-squared	0.98		Adjusted R-squared		0.98
F(2, 12)	5.01		P-value(F)		0.03
Rho	0.20		Durbin-Watson		1.57

Crude oil projection data was used to estimate future diesel and gasoline prices, assuming constant fuel tax and exchange rates, while the GDP forecast data used for the estimations are the same included in GHG emission projections for the manufacturing sectors.

Besides diesel oil and gasoline, LPG, gaseous-, and biofuels are considered in the NIR as contributors to GHG emissions in road transport. The LPG and gaseous fuel levels were determined based on a 2011 JRC study, which projects that the average EU level of these fuels will be around 1,5 and 1,6% of all fuel use respectively in 2020, and non of their shares will exceed the 2% level in the longer term either.[8] Because our projections are based on a period reaching into 2011, we consider the results to be WEM estimates. The WEM estimates related to biofuel use reach the 10% renewable energy target[9] linearly by 2020, and then stay at a constant level until 2025. Adding these fuel levels to the values of diesel consumption, and subtracting them from total energy use, we received our gasoline consumption estimates. The results are shown in Figure 5.38. which depicts the projections for diesel, gasoline and total energy use. Our results anticipate a slightly increasing trend in total and diesel consumption, while the role of gasoline is predicted to shrink further.

[8] EU renewable energy targets in 2020: Analysis of scenarios for transport JEC Biofuels Programme, JRC 2012, http://iet.jrc.ec.europa.eu/sites/about-jec/files/documents/JECBiofuels_Report_2011_PRINT.pdf

[9] as mandated by Directive 2009/28/EC

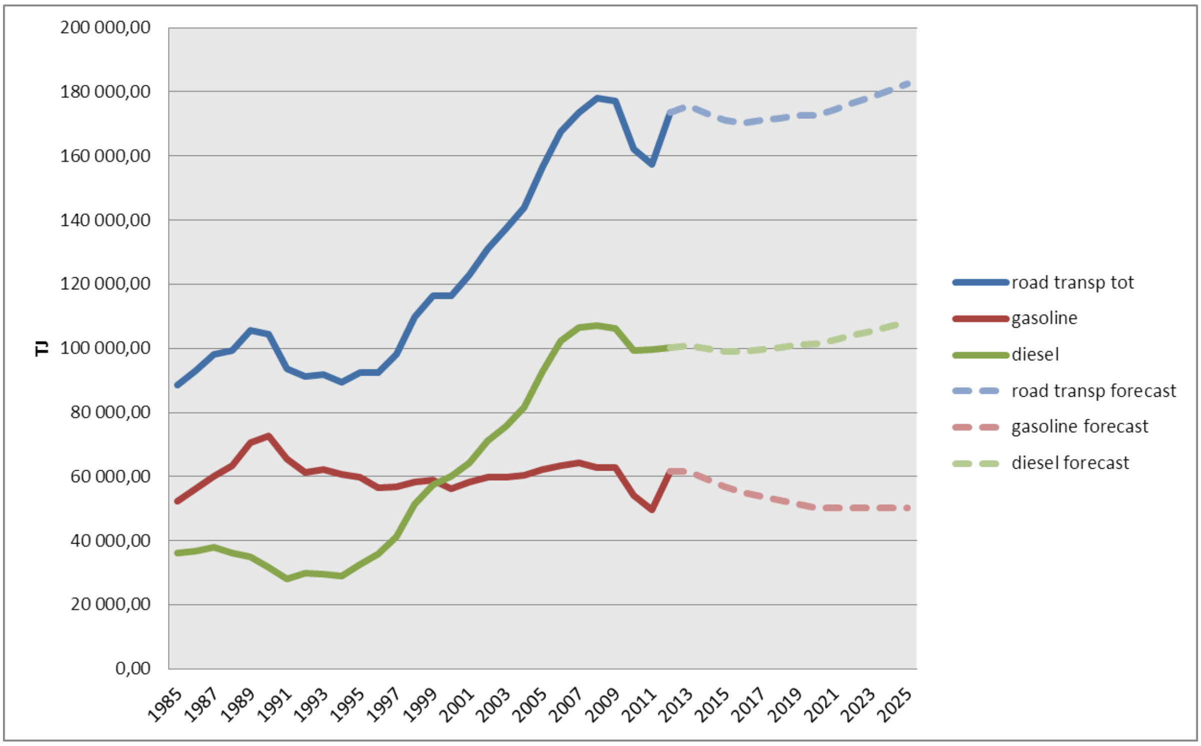


Figure 5.38. Forecast of diesel and gasoline fuel and total energy consumption of road transport

GHG emission forecasts were calculated using the emission factors of NIR 2011.

5.4.3.2. Railways

Although according to the modal split of Hungarian transportation rail accounts for 12% of passenger and 20 of freight transport volumes[10], its share in GHG emissions is 1,1%, and is falling continuously, mainly due to the gradual electrification of rail lines. Because fossil fuel use of the railways is expected to decrease further, we assume that energy use declines following a logarithmic trendline shown in Figure 5.39.

[10] Eurostat

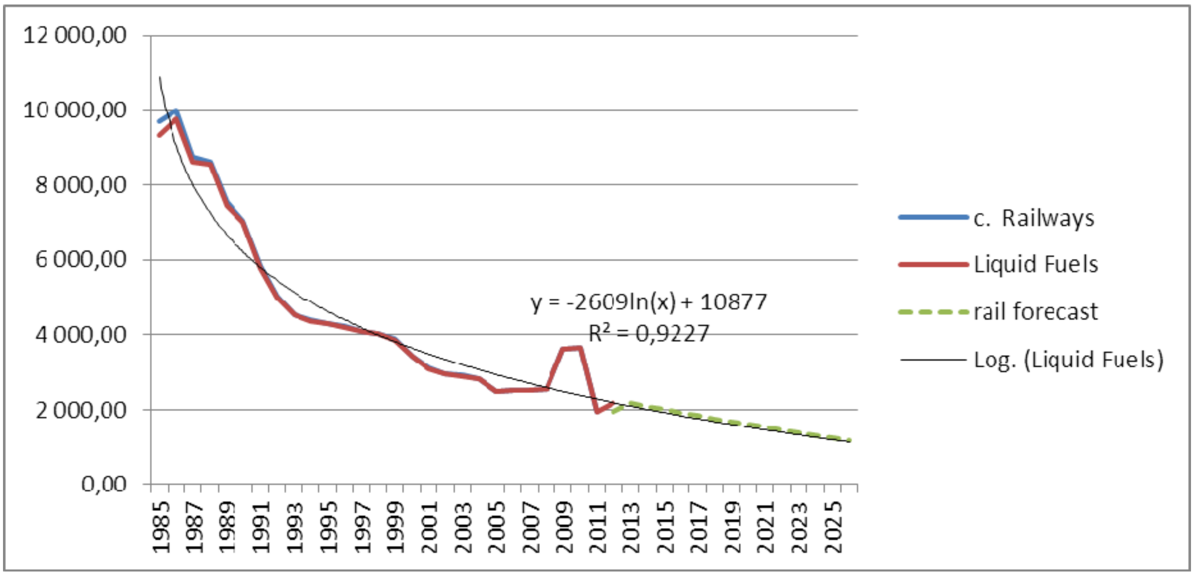


Figure 5.39. Estimation of energy use in rail transport (TJ)

5.4.3.3. Navigation

Energy use of navigation has dropped sharply since 1985, from its initial value of 1898 TJ until 2007, when it flattened out at the level of 42 TJ. Since then it has not changed at all, therefore our projection is that its value will remain at the same level during the forecast time horizon in case no additional measures are introduced to increase its share in the modal split.

5.4.3.4. Aviation

Given that inland aviation is negligible in Hungary, aviation related GHG emissions are considered to be related exclusively to international aviation in the Hungarian NIR, reported under international bunkers and multinational operations. Emissions are calculated from the aviation related fuel sold in Hungary, therefore we can expect fuel consumption to be related to the number of flights arriving and departing from the international airport of Budapest. The turnover of flights has increased steadily since 1985, roughly exponentially[11], while the use of energy ascends at a more moderate rate. Figure 5.40 shows that with a logarithmic transformation the two lines can be modelled and forecasted quite easily. After placing a linear trend on the line of the natural logarithm of the number of planes arriving and departing from the airport, we can use the forecasts to estimate the energy consumption as well as the emissions of aviation transport.

[11] The source of data on airplanes is the Hungarian Statistical Office.

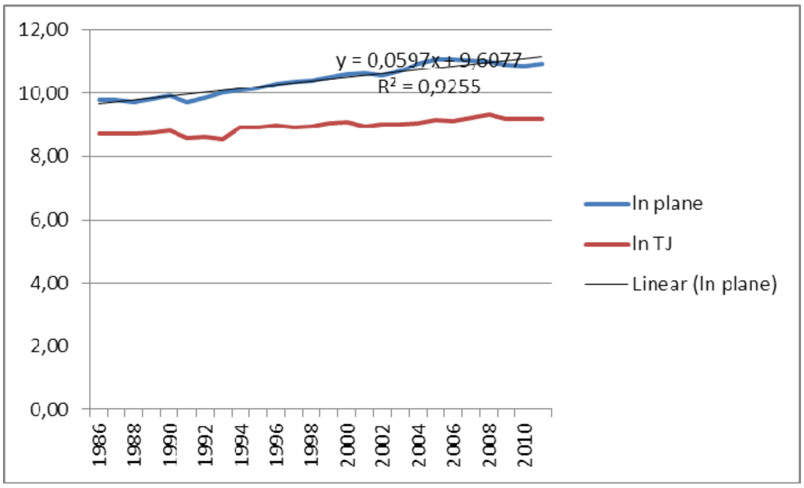


Figure 5.40. Estimation of the trend in the number of airplanes at the Liszt Ferenc Airport

The summary of model estimates is included in Table 5.26, the coefficients of which are used for the future prediction of energy use.

Table 5.26. Estimation of the energy use of aviation

Model 4: Cochrane-Orcutt, using observations 1987-2011 (T = 25)				
Dependent variable: ln(TJ)				
rho = 0,254101				
	Coefficient	Std. Error	t-ratio	p-value
const	4.56345	0.52388	8.7108	<0.00001
ln(No_of_planes)	0.420886	0.05006	8.4069	<0.00001
Statistics based on the rho-differenced data:				
R-squared	0.845625		Adjusted R-squared	0.838913
F(1, 23)	70.67649		P-value(F)	1.81E-08
rho	0.01283		Durbin-Watson	1.973294

On Figure 5.41 the number of flights is measured on the right, while TJ of historic and forecast energy data is measured on the left hand side axis.

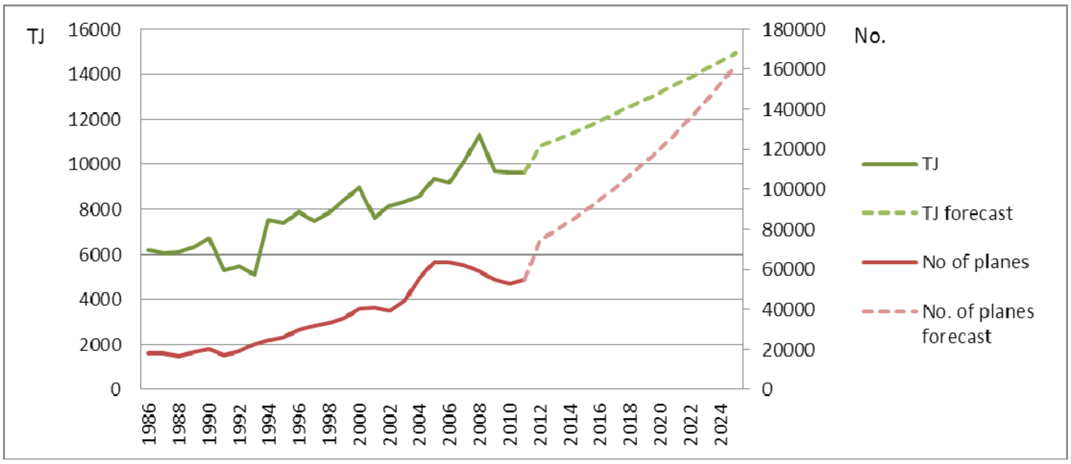


Figure 5.41. Forecast of energy use of aviation

Energy use of the sector is predicted to increase steadily, although at a smaller rate than the number of flights, indicating that the propagation of more fuel efficient aircrafts will probably lead to lower emission levels. However, the decrease due to increased fuel efficiency will most probably not be enough to level off the rise due to increased airplane turnover.

5.4.3.5. Effect of WAM scenarios

Because projections refer to the situation with existing measures, we set up a WAM scenario incorporating the effects of the additional measures provided by the Ministry of National Development, as well as the effects of a possible increase in electric car use, and a growing rate of biofuel share in energy consumption after 2020.

The additional policy measures and their effects determined by the MND are described in the Policies and Measures section. The two other additional abatement possibilities are described below.

It was assumed in the electricity model that the electricity consumption of electric cars in a WAM scenario will grow from 548 GWh in 2021 to 182,566 GWh in 2025. Taking into account the estimated average km run by a car in a year in Hungary[12], as well as the average estimated kWh/km consumption of electric cars (11-20 kWh/km)[13] we determined the number of kilometers run by using this amount of electricity, and the amount of fossil fuels that could be eliminated by running this distance by electric rather than conventional cars. We assumed in our calculations that about 50% of diesel and 50% of gasoline use would be replaced by electricity. Calculating GHG emissions attributable to this amount of fossil fuel we received the abatement amounts indicated in Table 5.27. Emissions from the electricity production used for fuelling the electric cars is already accounted for in the electricity model.

[12] 10000-15000 km/y according to expert estimates

[13] http://www.technologicvehicles.com/en/actualite-mobilite-verte/1961/consommation-des-voitures-electriques-le-top

Table 5.27. Assumed electricity consumption by electric cars and the corresponding GHG abatement

	2021	2022	2023	2024	2025
Assumed EV/PHEV consumption GWh	548	1 095	1 643	2 191	2 739
Mileage from this amount of GWh (000 km)	36 513,3	73 026,6	109 540	146 053,3	182 566,6
Diesel fuel substituted (l)	2 008 233	4 016 467	6 024 700	8 032 933	10 041 167
Gasoline fuel substituted (l)	2 373 367	4 746 733	7 120 100	9 493 467	11 866 833
TJ diesel saved	86,76	173,51	260,27	347,02	433,78
TJ gasoline saved	102,53	205,06	307,59	410,12	512,65
Average TJ saved	94,64	189,29	283,93	378,57	473,21
Decrease in transport emission (kt CO_2 eq)	6,97	13,94	20,90	27,87	34,84

Concerning additional savings from assuming a positive growth rate in biofuel share after reaching the 10% target in 2020, we assumed that the share of biofuels will reach 12,66% gradually by 2025. Emission savings are obtained by decreasing the gasoline consumption by the same amount of TJ, given that in our model we receive gasoline consumption as the residual value after subtracting the use of all fuels from the total forecast road energy consumption. Possible abatement values are 2,4; 4,86; 7,37; 9,94 and 12,57 kt CO2 eq in years 2021-2025.

The difference in the road transport emissions under WEM and WAM scenarios is represented by the difference between the curves depicted in Figure 5.42, suggesting that additional measures improve GHG savings only to a slight extent compared to the WAM scenario.

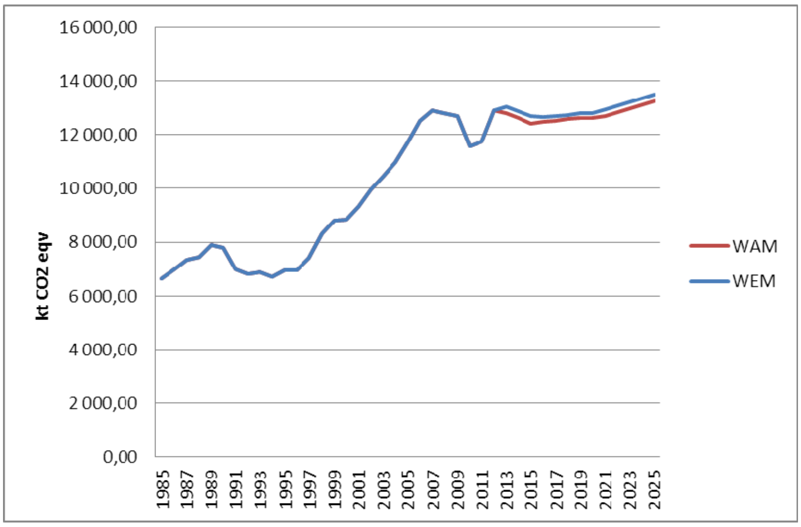


Figure 5.42. Emissions under the WEM and WAM scenarios (kt CO_2 eq.)

5.4.4. *Fugitive emissions from fuels*

This category includes fugitive methane and carbon dioxide emissions released during coal mining and handling, and from oil and natural gas activities, mainly at exploration, production and transmission.

5.4.4.1. Solid fuels

According to the NIR (2013) surface mining emission factor is zero, while underground coal mines varies between 0.62-0.69 kg CH_4/t depending on the quality of coal. In 2011 the released methane emission from coal mining was 0.46 kt CH_4. The major source of this emission was the mine in Márkushegy which will be closed in 2014, from that point only recultivation will be carried out till 2018. Due to this, fugitive emissions from coal mining will be assumed to be zero after 2014.

5.4.4.2. Oil

Methane emissions are emitted during oil production, transportation, refining, venting and flaring, oil production being the main source of emissions. Oil extraction was 68 PJ in 1995, 44 PJ in 2001, which decreased to 31 PJ by 2010. It is assumed that the production will further reduce to 26 PJ by 2025 followed with similar reducing trend in methane emissions (see Figure 5.43.).

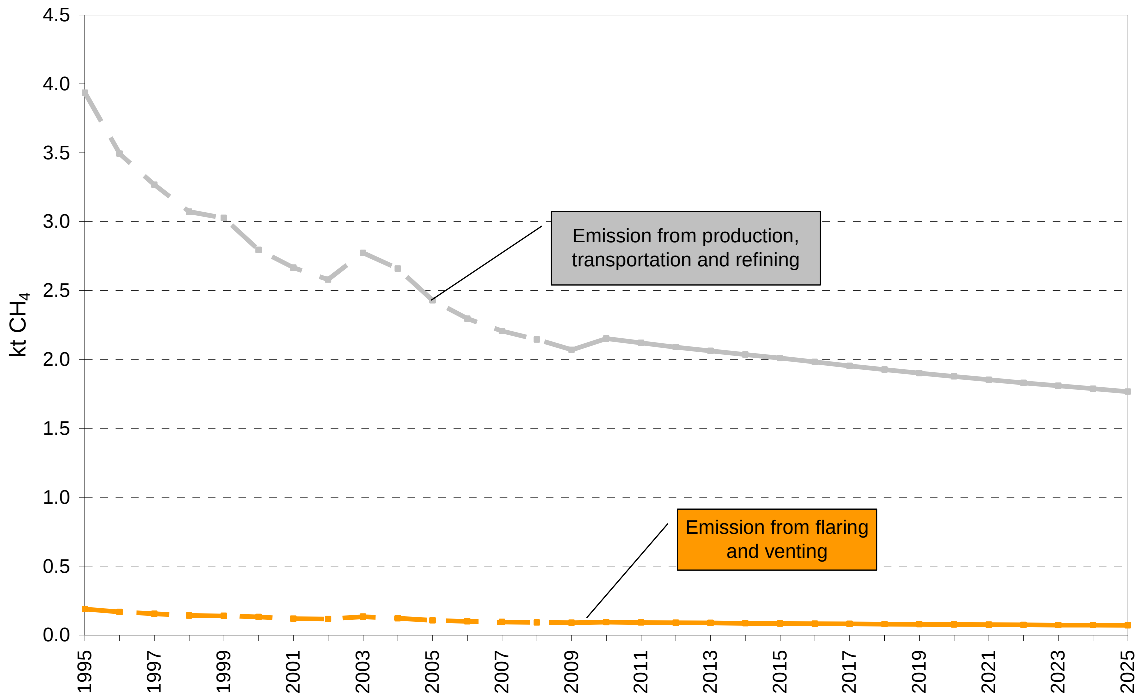


Figure 5.43. Methane emissions from production, transportation and refining, and from flaring and venting between 1995 and 2025, kt CH_4

Flaring releases carbon dioxide, too. As CO_2 emission is also linked to oil production, its trend is very similar to that of methane, as the following figure shows. Emission from oil flaring is assumed to be the same in the various (WEM and WAM) scenarios.

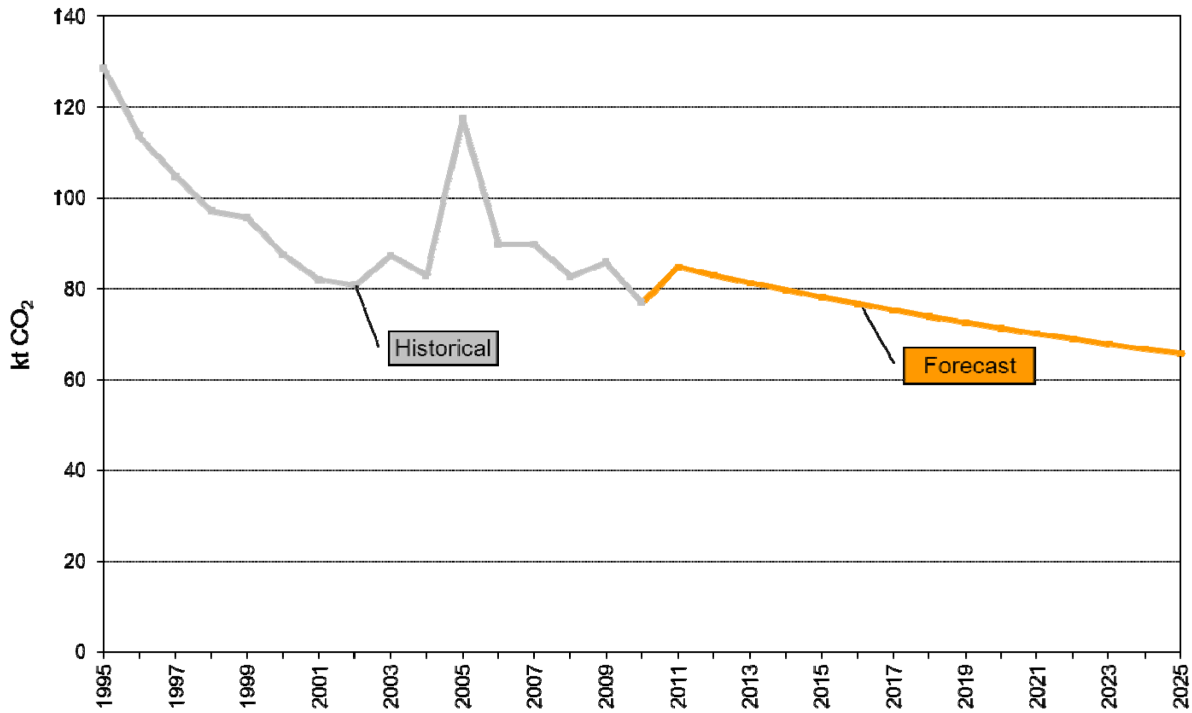


Figure 5.44. Carbon dioxide emission from oil flaring between 1995 and 2025, kt CO_2

5.4.4.3. Natural gas

Methane is emitted during natural gas production/exploration, transmission, distribution, storage activities, venting and flaring, while carbon dioxide emission is released during flaring. Methane emission from fugitive emissions related to natural gas is demonstrated in the following figure.

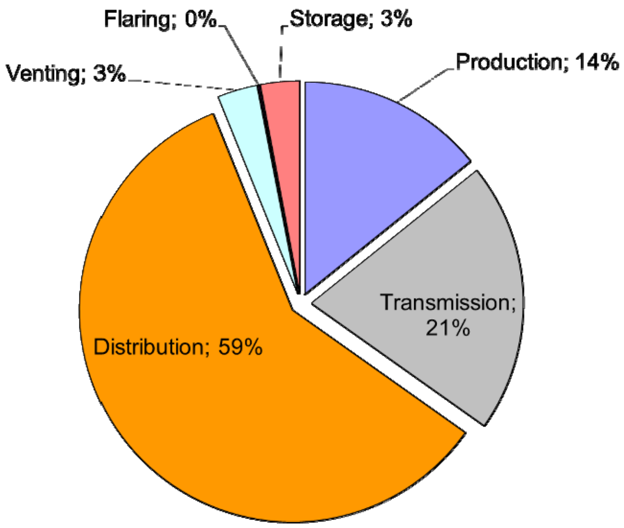


Figure 5.45. Methane emissions by sources, 2010

Distributing natural gas causes methane emission. The emission can be predicted on the basis of the forecasted length of the gas distribution network: the longer the distribution system, the higher the methane emission.

The natural gas production forecast of REKK (2011) is used to project methane emission from gas production. According to its projection, gas production will be around 80 PJ until 2017-2018, and gradually decrease to 25 by 2020 and further during the 2020s. It is assumed that natural gas storage activity level will not change significantly, i.e. methane emission from storage will not change till 2025.

The last component of this category is natural gas transmission activity that can be estimated by the yearly natural gas consumption, i.e. larger the natural gas consumption, higher the methane emission. The three scenarios employ different annual consumption levels that are derived from annual electricity production based on natural gas and the heat energy consumption.

Fugitive methane emissions from natural gas in the various scenarios are shown in the following figure.[14] A very sharp drop can be seen in 2018 caused by the dropping domestic natural gas production.

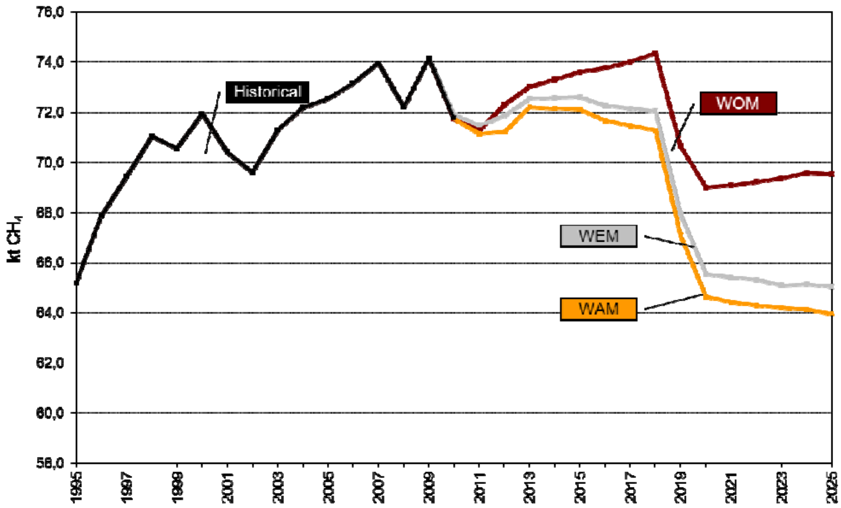


Figure 5.46. Fugitive methane emissions from natural gas, kt CH_4

The pattern of methane and carbon dioxide emissions from venting is very similar, shown in the following figure, where the drop in emissions is due to the drop in projected natural gas production.

[14] excluding venting and flaring

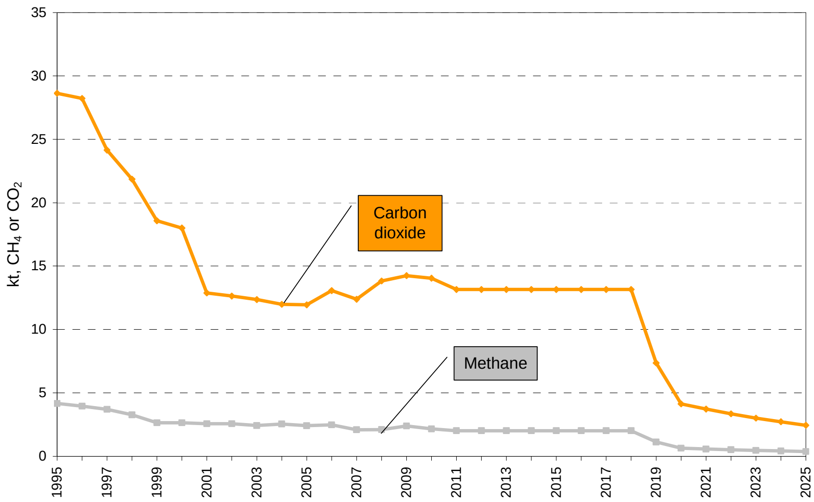


Figure 5.47. Methane and carbon dioxide emissions from natural gas venting and flaring, kt

5.4.5. *Industrial processes*

5.4.5.1. *Overview of industrial emissions*

Industrial sector emissions are created by non-firing processes related to industrial production, i.e. combustion borne emissions are reported under the combustion category. The industrial processes category consists of the mineral products, chemical industry, metal production, consumption of halocarbons and emissions from feedstocks. In 2010, GHG emissions from industrial processes accounted for 7.7% of the total Hungarian GHG emissions (excluding LULUCF and HFCs) as shown in the following figure.

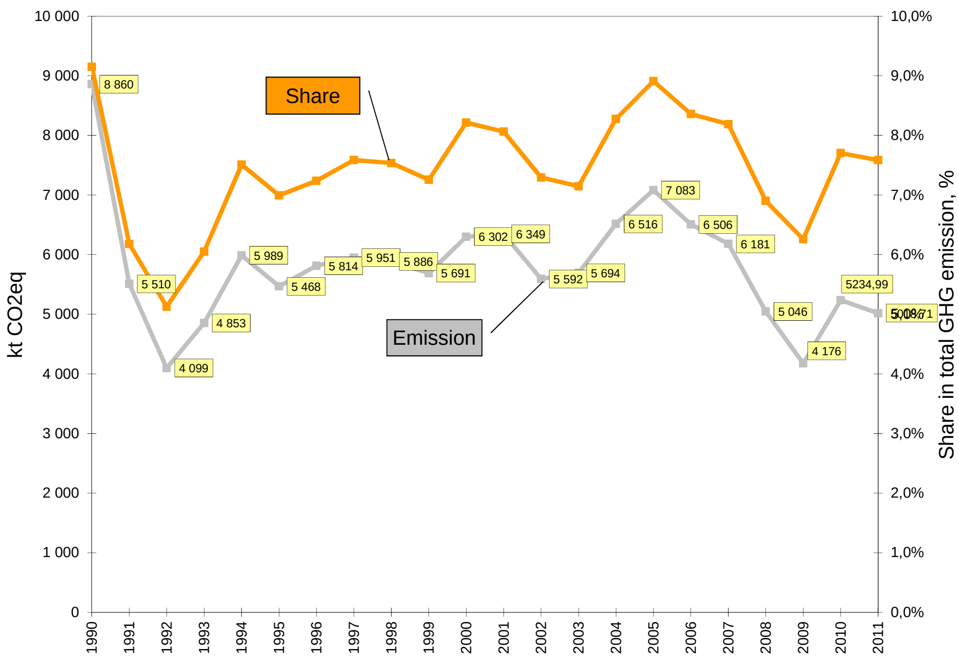


Figure 5.48. GHG emissions from industrial processes and its share in total emissions, (*kt CO_{2eq} and %*)

Source: Hungarian GHG inventory 2013

Since 2005 emissions have decreased significantly, from 7 Mt in 2005 to 5.0 Mt by 2011. In 2009 almost 80% of the emitted GHG from industrial processes was carbon dioxide, 16% are HFCs. Other GHGs are not significant as it can be seen in the following figure.

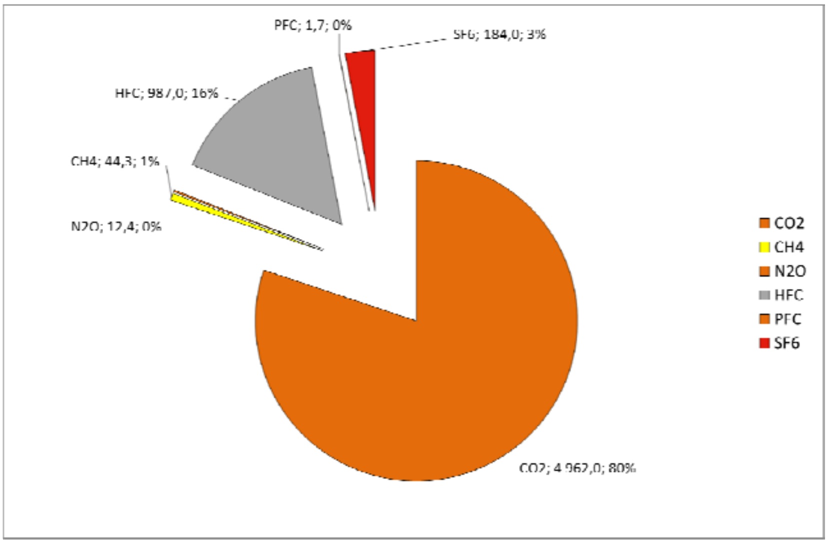


Figure 5.49. Distribution of the different GHGs from industrial processes in 2011

Source: Hungarian GHG inventory 2013

The largest sub-sector – from an emissions point of view - in 2011 was metal production emitting 2.2 Mt CO_{2eq}, followed by the mineral products sector with 1.2 Mt CO_{2eq}. Consumption of halocarbons/SF_6 and feedstocks gave 15-15% of the total GHG emissions of the industrial processes, while chemical industry and metal production GHG emissions were slightly higher than 0.5 Mt CO_{2eq}.

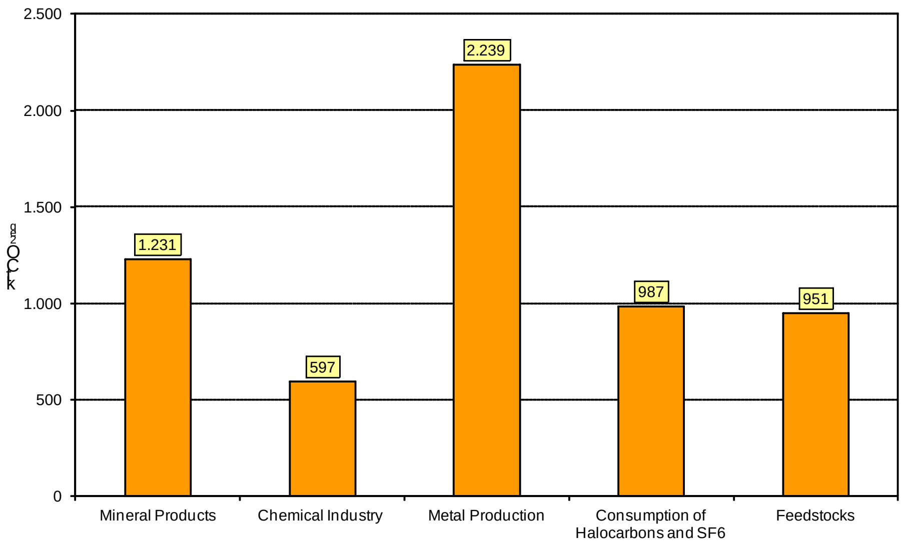


Figure 5.50. GHG emissions of the sub-sectors in the industrial processes in 2011

Source: Hungarian GHG inventory 2013

5.4.5.2. Analysis and projections

Mineral products

GHG emissions in mineral products consist of emissions from cement production, lime production, limestone and dolomite use, glass production and bricks/ceramics production. The figure below shows the carbon dioxide emission of these processes.[15] The figure illustrates the significant impact of the economic crisis on this sector, which resulted in a sharp decrease of its activities and consequently reduced CO_2 emissions as well.

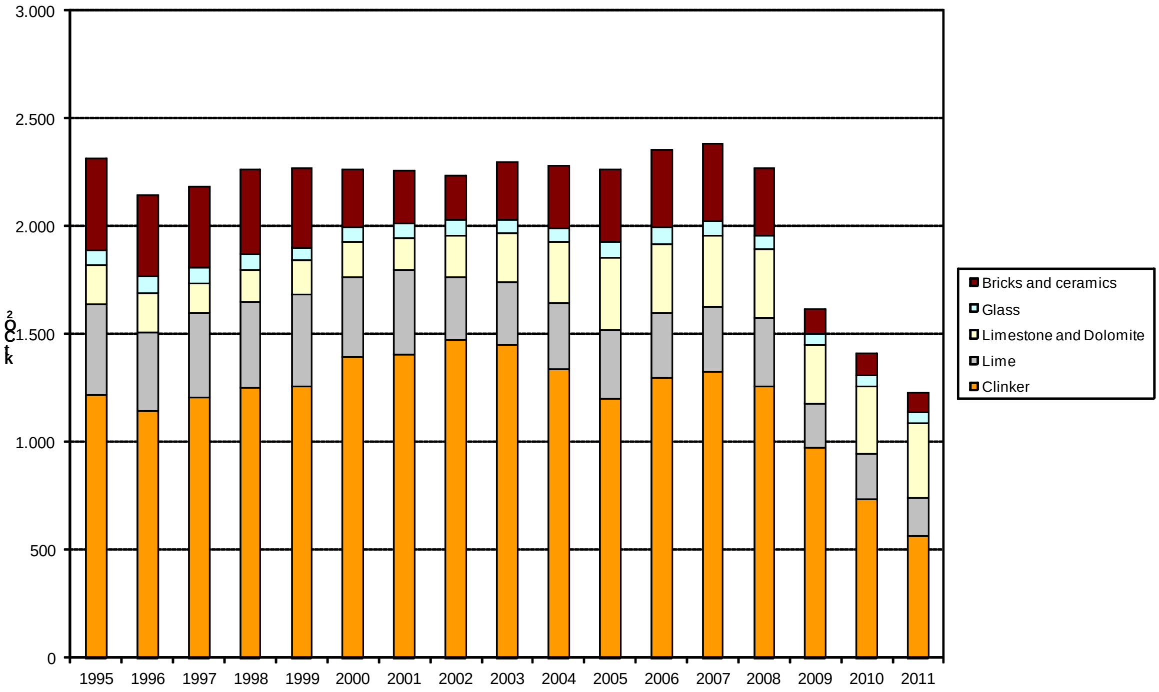


Figure 5.49. Carbon dioxide emission of mineral products, 1995-2009, kt CO_2

Source: Hungarian GHG Inventory, 2013

Clinker, lime production, limestone and dolomite production

In the non-metallic mineral sector the energy consumption was estimated using an econometric model (see section 0). As energy consumption is closely related to the activity level of the sectors, its projected trend is applied to the five subsectors process emissions as well.

According to the Hungarian GHG inventory one ton of clinker production caused 0.52 ton of CO_2 emission in 2010. The emission factor of lime is assumed to be 0.79 t/tCO_2, while the limestone and dolomite emission factor is 0.44 t/tCO_2. These emission factors are assumed to remain constant till 2025.

Glass

As there is no clear emissions trend in glass production (see the following figure), it is assumed that the volume of glass production will remain constant for the next one and a half decade at the level of the 1995-2010 average.

[15] Other GHGs are not emitted in these processes.

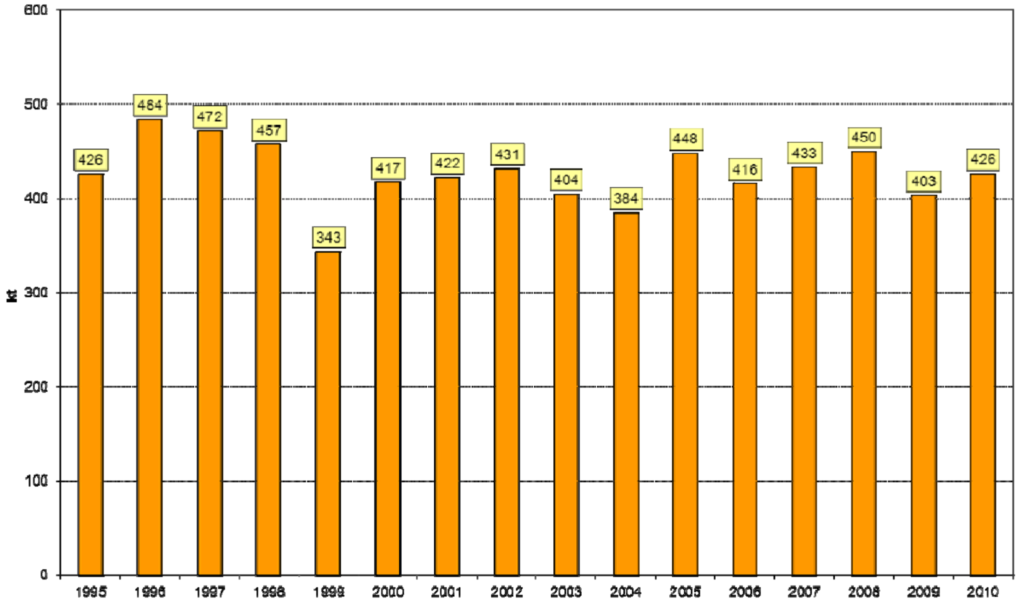


Figure 5.50. Carbon dioxide emissions from glass production, 1995-2001, kt CO_2

Source: Hungarian GHG inventory

According to the Hungarian GHG inventory one ton of glass production caused 0.13 ton of CO_2 emission in 2009. It is assumed that this emission factor will not change until 2025. The emissions of the WOM scenario are constant (as described above). In the WEM and WAM scenarios different levels of technical GHG reductions are assumed, i.e. the use of cullet. According to the HUNMIT model, the maximum reduction potential is 22.2 kt CO_2 (WAM), all of these investments are profitable below zero or around zero EUA price level. The following figure shows the CO_2 emission of glass production under the various scenarios.

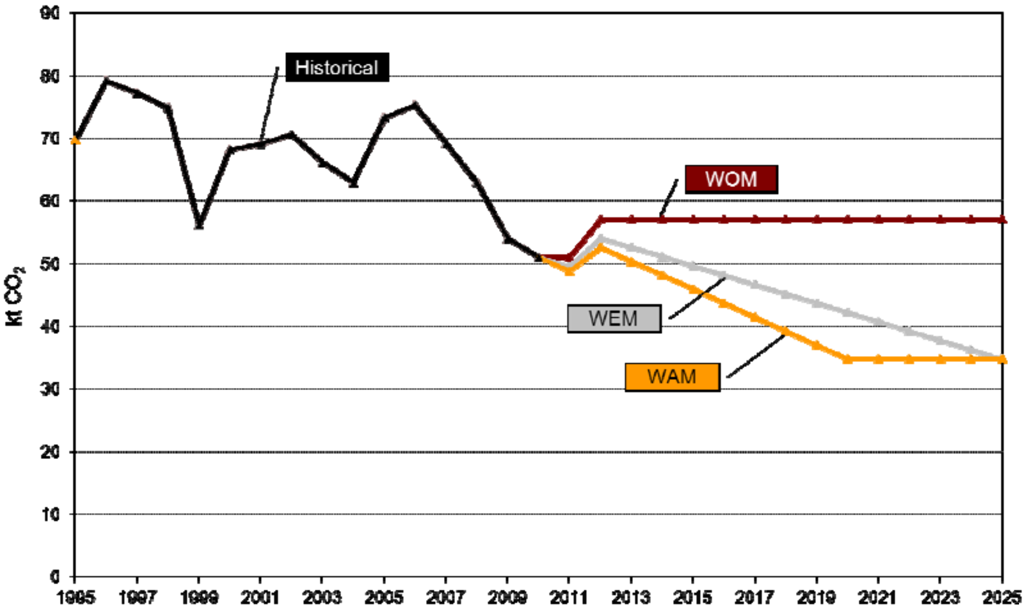


Figure 5.51 CO_2 emissions from glass production in the three scenarios, kt CO_2

Bricks and ceramics

In the bricks and ceramics production dropped dramatically from 2008 to 2009 followed by signs of partial recovery in 2010-2013. Due to these significant changes in this case an exogenous assumption is applied.

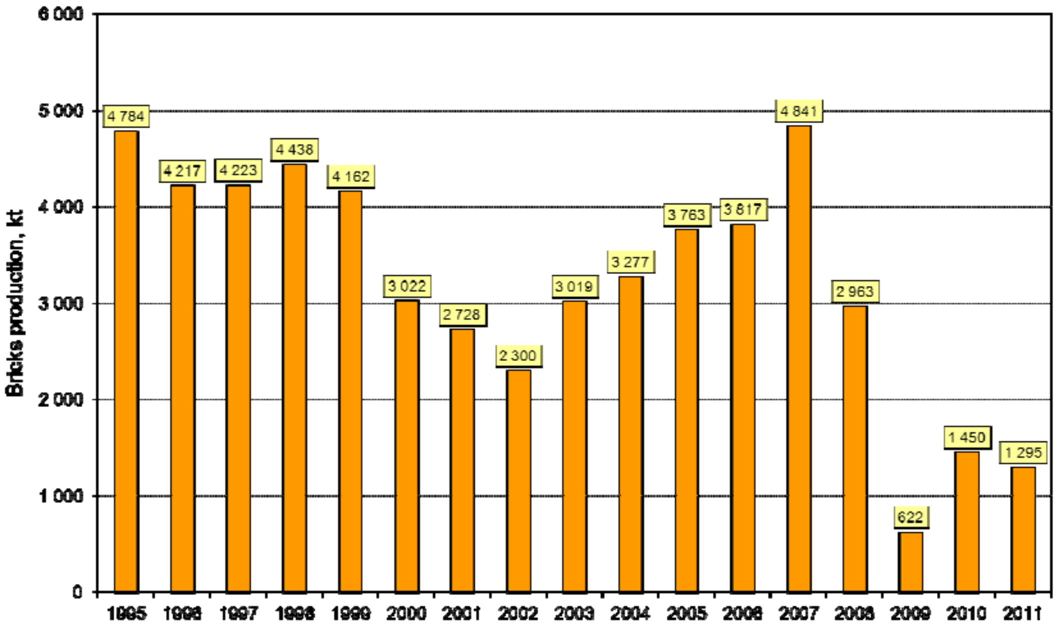


Figure 5.52. CO_2 emissions from bricks and ceramics production, kt CO_2

Source: Hungarian GHG inventory

Bricks and ceramics sector are expected to recover by 2015 to the pre-crises production level and by 2020 it will reach the average production of 2005-2010. After 2020 a production growth pattern similar to the 2015-2020 path. With this growth, brick production will still be under the level of 2006-7.

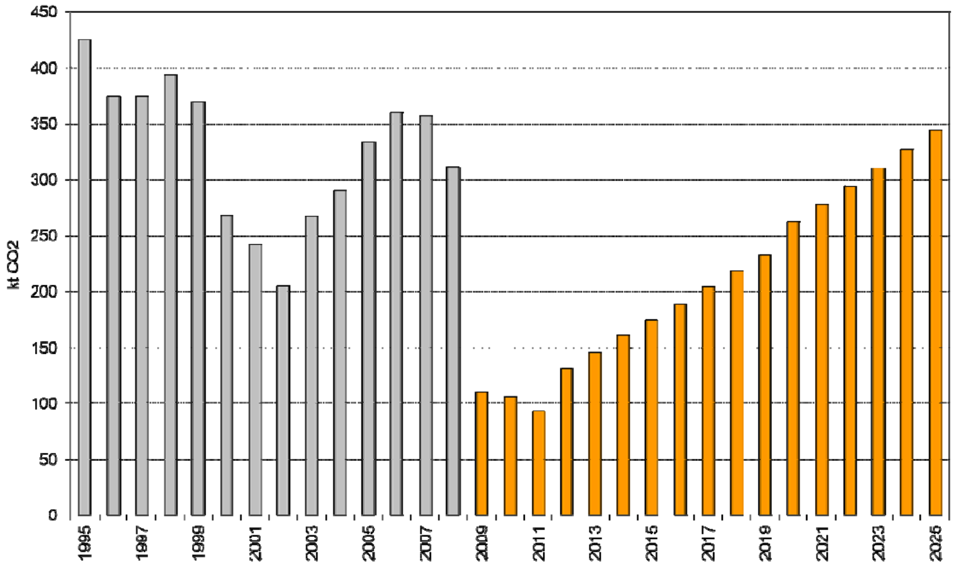


Figure 5.53 Carbon dioxide emissions from bricks and ceramics production, kt CO2

Source: Hungarian GHG inventory

Chemical Industry

In the chemical industry carbon dioxide is emitted from ammonia production, N_2O from nitric acid production and a small amount of methane from carbon black and ethylene production. Natural gas is used in ammonia production as a raw material (not for combustion). The natural gas consumption reveals no clear tendencies, except the sharp decrease of the last two years due to the financial crises.

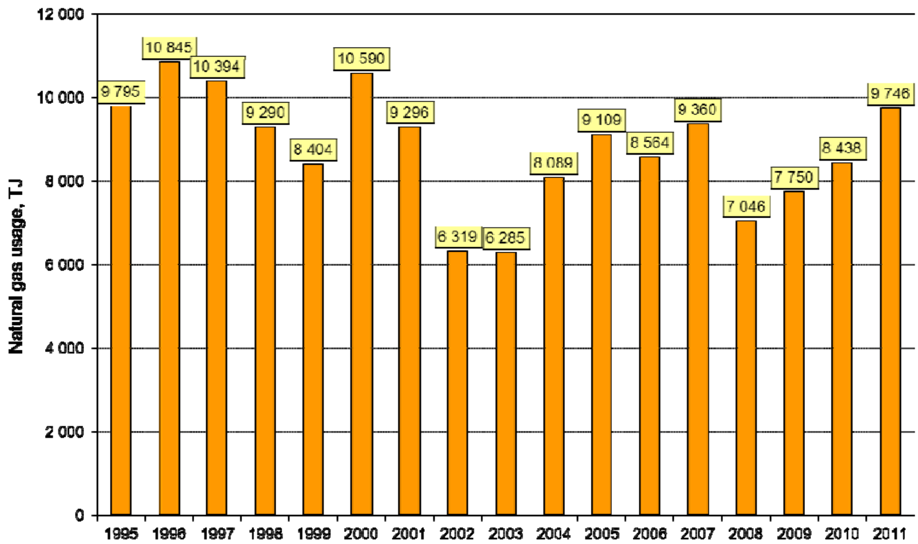


Figure 5.54. Non-energy consumption of natural gas in ammonia production, TJ

Source: Hungarian GHG inventory, Eurostat 2013

In the WEM scenario the process emissions are assumed to follow the trend of the econometrically estimated model for the chemical sector. In the WAM scenario technical GHG emission reductions are assumed. The four reduction options included in the HUNMIT model can altogether reduce the carbon dioxide emission by 129.1 kt.

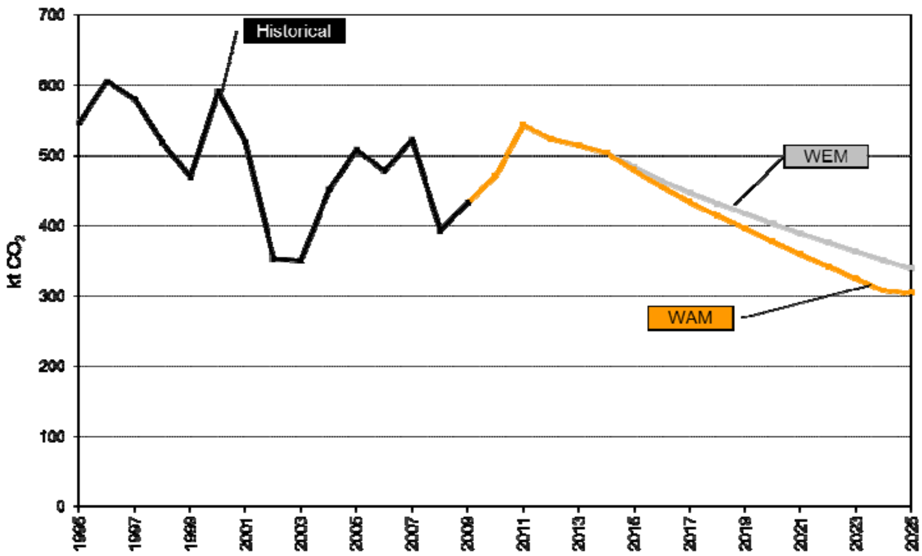


Figure 5.55. Carbon dioxide emissions from ammonia production, kt CO_2

In Hungary nitric acid is only produced by Nitrogénművek. Due to a major JI investment between 2006 and 2008 N_2O emission went down to almost zero from 1.5-1.9 Mt CO_{2eq}.[16] It is assumed that the average emission of 2008-2010 (around 10 kt CO_{2eq}) remains stable till 2025 in all scenarios.

In 2010 the emission from carbon black and ethylene production was around 30 kt CO_{2eq}, which is quite a typical value within the last decade. Consequently, it is assumed that the amount of methane emission from these processes will not change till 2025 in all scenarios.

Metallurgy
Carbon dioxide process related emissions in the metallurgy sector are assumed to follow similar trend as the energy consumption of the sector i.e. the same econometrically estimated model trend is applied for the process emissions. In this case also the HUNMIT model carbon reduction values were applied to arrive to the WAM scenario results.

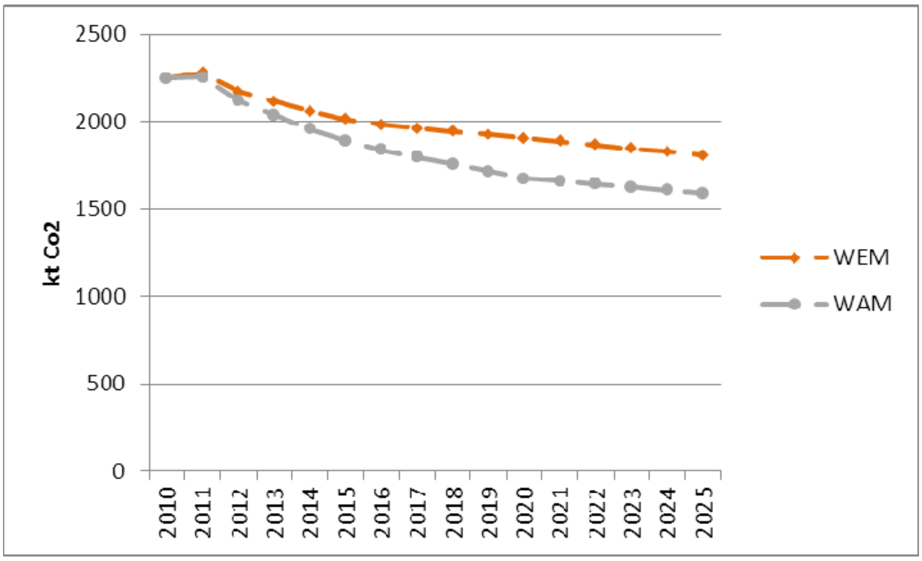


Figure 5.56 Carbon dioxide emissions in the metallurgy sector, kt CO_2

Consumption of halocarbons and SF_6
The main source of halocarbons emissions are refrigeration and air conditioning equipments covering 95% of the total emissions in this segment. The rest is emitted in foam blowing, fire extinguishers and aerosols/metered dose inhalers. Most of these emissions are HFCs, and only a small part of the emissions are PFCs.

Halocarbons emissions from refrigeration and air conditioning equipments have shown stable growth since 1995, in average of 60.6 kt CO_{2eq} per year. Unfortunately, no clear marginal abatement costs are known regarding to halocarbons, but according to expert forecasts in the WOM scenario the increasing trend will continue until 2015 when a strong decrease trend will start. In the WEM and WAM scenarios emissions from halocarbons will not increase in the next five years, and after 2015 a similar trend will be seen as in the WOM scenario.

[16] Nitrogénművek Annual Report 2008

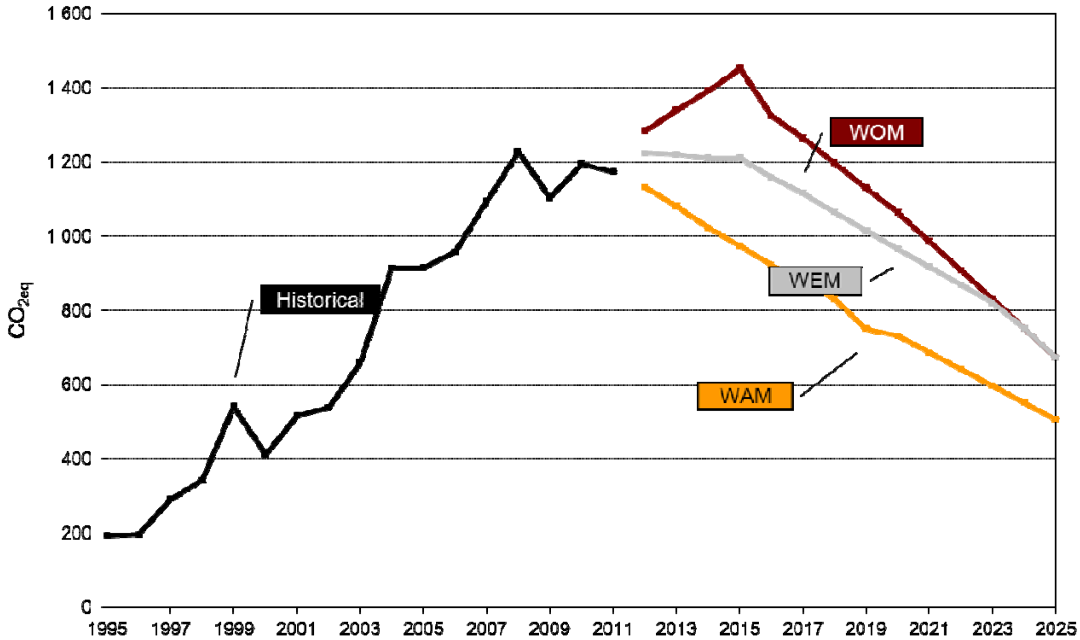


Figure 5.57. Historical halocarbon emissions between 1995-2011 and forecasted emissions, CO_{2eq}

Feedstocks

This category was created for calculating carbon dioxide emissions from fuels used as feedstock or other non-energy purposes. The use of fossil fuels as feedstock or for other non-energy purposes is reported in an aggregated manner by Energy Statistics under "Non-Energy Use" for each individual fuel. It is an aggregated category because the real consumers of these fuels are unknown (NIR, 2013), and significant changes in accounting took place in the NIR system since 2010. The following figure shows the actual emission between 1995 and 2009 and the forecast value. The projection assumes that future emission will equal the average of the last five years.

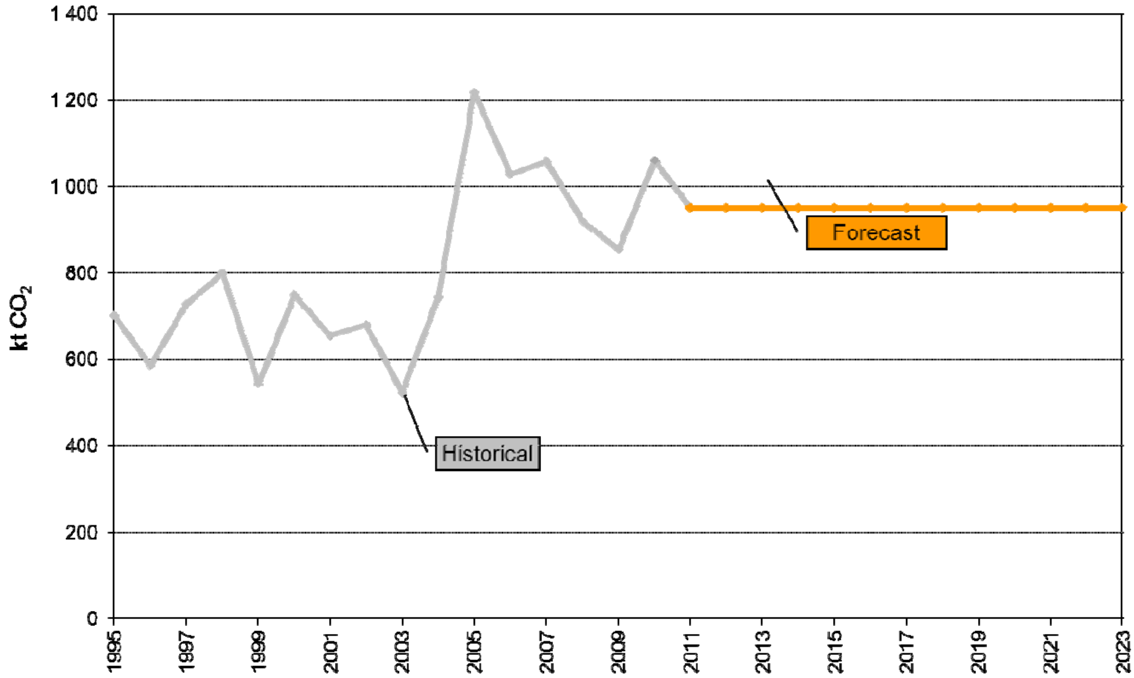


Figure 5.58 Historical carbon dioxide emission of feedstocks between 1995-2011 and the forecasted value, kt CO_2

Source: Hungarian GHG inventory

5.4.6 Solvents and other products

There are four main sources of GHG emissions within the solvents and other product uses category: paint application, degreasing and dry cleaning, use of N_2O for anesthesia and use of N_2O for whipped cream. While in the first two processes carbon dioxide is emitted, in the other two N_2O is used.

Emissions from degreasing and dry cleaning, and whipped cream are not significant: altogether their emissions are below 5 kt CO_{2eq} in 2009, and the emissions from these processes are assumed to decrease and by 2025 go down to nearly zero. Assumed carbon dioxide emission from paint application will be constant in the future at a level of 68 kt CO_2, which is the average of the last ten years. Finally, GHG emissions from anesthesia will also not change in the future; N_2O use will equal 0.94 kt N_2O, which is equal with the average of the last five years.

5.4.7. Agriculture and LULUCF

For the purpose of modelling greenhouse gas (GHG) emissions till 2025 there are three separate models developed: one is dealing with GHG emissions from agriculture and contains all driving factors and input data necessary for the calculations. The second model calculates land use and land use change related to GHG emissions. The third model focuses exclusively on forestry and estimates carbon flux due to both land use related and management related changes.

5.4.7.1. Agriculture

First the agricultural model will be described. GHG emissions in the agricultural model consist of the following emissions:

- CH_4 emissions from enteric fermentation
- CH_4 and N_2O emissions from manure management
- CH_4 emissions from rice production
- Direct and indirect N_2O emissions from soil.

In case of enteric fermentation the statistical data on livestock was considered as the main input. Methane emissions characteristic of certain species were taken from the previous National Inventory Report 1985-2010 (NIR 2010). These are the CH_4 emission factors (EF, kg CH_4/head/yr) summarised in Table Table 5.28.

Table 5.28. Species and their CH_4 emission factors

Dairy cow	120,98
Non-dairy cattle	54,45
Bulls	82,05
Young cattle	82,05
Buffalo	55
Sheep	8
Goats	5
Horses	18
Donkey and mules	10
Saw	1,5
Boars	1,5
Piglets	1,5
Poultry	0,015
Rabbits	0,08

Source: NIR,2013

In case of emission from manure management the following manure management systems were considered:

- Liquid slurry
- Sold storage
- Pasture, range, paddock
- Other
- Pit storage < one month
- Pit storage > one month

The amount of manure managed in these systems was estimated for each year in the period of 2010-2025. This constitutes the second most important input data in this calculation.

In the next step the emission factors characteristic of the different livestock were calculated, which was based on the data form NIR too. The country and livestock specific emission factors multiplied by the number of livestock in the actual year and given in Gg mean the CH_4 emissions from enteric fermentation. The equation 4.17 from IPCC-GPG[17] was applied.

The calculation of N_2O emission was also based on livestock numbers and share of manure managed in each manure management system. However, manure from grazing was separately calculated.

[17] IPCC „Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories" (abbreviation: IPCC-GPG)

The main determining factors were the N_2O-N emissions of the manure management systems (EF_3), and species with specific N excretion (N_{ex}).

Emission from rice cultivation was based on the area of cultivation in the country, type of cultivation and the given emission factors in IPCC-GPG using equation 4.42. The specific emission for the country was 20 g CH_4/m^2, which was multiplied by the cultivated area and transformed to a Gg/year format.

Emissions from soil were split to direct and indirect emission as given in the IPCC-GPG. Direct soil emissions consist of nitrogen synthetic fertilisers applied to soil use (F_{SN}), manure N applied to soil (F_{AM}), nitrogen fixed by N-fixing crops (F_{BN}), and amount of N in crop residues returned to soil (F_{CR}). Emission from synthetic fertiliser use was calculated by equation 4.22 in IPCC-GPG. Here the amount of applied N fertiliser was multiplied by the volatilisation factor ($Frac_{GASF}$), which defines the share of ammonia and nitrogen volatilised from the applied fertiliser. The volatilisation factor was set to 0.1 according to NIR. Emissions form manure applications to the soil (equation IPCC-GPG 4.24 in IPCC-GPG) were calculated by multiplying excreted manure N with the volatilisation factor ($Frac_{GASM}$). This was set to 0.2 based on NIR. Manure from grazing was considered here too. Generally, it was assumed that finally all manure produced in the country sooner or later will be applied to soil, since there is no manure burning in the country.

N_2O emissions from N-fixing crops were estimated by calculating the amount of annual crops multiplied by the volatilisation factor $Frac_{NCBRF}$ (equation 4.26 IPCC-GPG). Emissions from crop residues were concerned according to their share of N-content left on site (equation 4.28 IPCC-GPG). The direct soil emission was estimated by summing up the N input to the environment from the above sources and multiplying this amount by the share of N forming N_2O. This factor (EF_1) was taken from NIR and set to 1.25%.

Indirect N_2O emissions were calculated from mineral fertiliser use and manure from grazing leached and deposited to the soil. In case of deposition the factor of N_2O emissions from fertiliser and manure was determined by EF_4=0.01 (equation 4.31 IPCC-GPG). Emissions from leaching were determined by the amount of N excreted and the emission factors $Frac_{LEACH}$ = 0.3 and EF_5 = 0.025 were taken from NIR.

5.4.7.2. Land use and land use change

Emissions from this part are also calculated by the IPCC-GPG. Here the following land use categories were taken into consideration:

- Forest
- Cropland
- Grassland
- Wetland
- Settlement
- Other

Emissions from land use emerge only on managed land that is extended by the emissions stemming from land use change. That is why a complete land use change matrix is needed. The matrix used in our calculations is given below.

Table 5.29. Land use change matrix

	Forest Land	Cropland	SA-Cropland	Grassland	SA-Grassland	Wetland	Settlements	Other Land
Forest Land								
Cropland								
SA-Cropland								
Grassland								
SA-Grassland								
Wetland								
Settlements								
Other Land								

Red cells in the table indicate conversions that are considered in our calculations, forest flux is calculated in forestry. Emissions from different sinks were calculated in a 20-year horizon. Carbon storages in case of different land uses and biomass coverage are taken from average values based on NIR 2012. These changes are summarised in Table 5.30.

Table 5.30. Carbon storage changes in biomass and soil

Biomass changes	**tC/ha**
Grassland converted to cropland	1,88
Cropland converted to grassland	-1,87
Cropland converted to settlement	-5,00
Grassland converted to settlement	-3,13
Soil carbon storage changes	
Cropland - *changing over time*	in 2007
Cropland remaining cropland	0,55
Set aside cropland converted to cropland	-8,91
Cropland converted to set aside cropland	9,57
Grassland converted to cropland	-17,97
Grassland	
Grassland remaining grassland	-2,88
Grassland converted to set aside grassland	-1,97
Cropland converted to grassland	15,65
Settlements	
Cropland converted to settlement	-10,40
Grassland converted to settlement	-14,44

Additionally, perennials – vineyards and orchards – also have to be considered. An accumulation rate (vineyard 0.3 tC/ha and orchards 0.16 tC/ha) in case of an increase in the area of perennials and a biomass carbon loss (vineyard 8.86 tC/ha and orchards 4.7 tC/ha) in case of area losses of perennials are important factors here. These together with the values in Table 5.30 are then multiplied by the changes in land use giving the net changes of total carbon stored in biomass and soil. These calculations only consider CO_2 emissions, since other pollutants are accounted in the sphere of agriculture and because on-site burning is prohibited in Hungary. Emissions from management changes, however, were not considered in our model.

5.4.7.3. Forestry

In our calculations, emissions and removals were modelled using methods that are compatible with those applied in the greenhouse gas inventory of the country (http://unfccc.int/files/national_reports/annex_i_ghg_inventories/national_inventories_submissions/application/zip/hun-2013-nir-15apr.zip). For the projection of the net emissions in the forest land remaining forest land category, we only considered the biomass pools by assuming two scenarios for the amount of wood harvested. For the projection, we assumed in the first step that harvest rates will not increase and thus net emissions can be extrapolated using a linear regression line. Then, in the second step, we added the emissions from the increased harvest scenarios to the extrapolated values.

For developing projections for the afforestation scenarios, the above mentioned methods are all incorporated in our country-specific model called CASMOFOR (http://www.scientia.hu/casmofor). This model is able to directly estimate carbon stock changes in all six pools described in the IPCC 2006 Guidelines, however, we only considered the biomass pools.

5.4.7.4. Driving factors

In this section the main input data used for the calculation models will be introduced and based on these the relevant scenarios are defined.

Driving factors in agriculture

Since the last forecast made in 2011 for agriculture and LULUCF the most important measures were the national agricultural strategies like the National Rural Strategy (NRS), the Darányi Plan, which is a short-term version of the NRS, and the proposed modifications of the CAP in the period of 2014-2020.

Concerning the intended modifications in the CAP, the most important changes are the transformation of area based payment schemes (SPS, SAPS) towards environmental performance based payments (Törőné 2012; Potori et al. 2012). The first pillar subsidies will be introduced in a unified structure, where the base subsidy (minimum 40%) will require at least three greenhouse gas neutral and environmentally good practices in agriculture as a prerequisite. This is extended by the green component (minimum 30%) aiming at the diversification of plant production, maintenance of pastures and realisation of further ecological performances (Törőné 2012, p51). However, these subsidy schemes will not change the financial position of Hungary considerably, but the money will be given no longer on area basis but on environmental performance basis. Thus, more environmental friendly practices are enforced.

The structure of the second pillar subsidies will be modified considerably along with the strategy of 2020. The maintenance and rehabilitation of agricultural and forestry ecosystems, and supporting resource-effective and low-carbon agriculture and forestry will be prioritised (Törőné 2012, p54). Based on these changes in the finances of the sector GHG neutral practices are expected to rise. However, to express the effects of these practices in GHG emission is not possible, because the calculation methodology of IPCC considers these changes only in TIER 2 factors and not in activity data.

Among the Hungarian measures the National Rural Strategy and its short term version, the Darányi Ignác Plan, and the Swine Strategy (Governmental Decree 1323/2012) are the most important. The NRS intends to favour the middle and small holder agricultural production structure over the huge agricultural concerns. Beside this fact the strategy supports the ecological performances of agricultural production and the spread of ecological agriculture.

In animal husbandry the Swine Strategy set the goal to increase the number of pigs in the country from the current ca. 3 Million to 6 Million. In the poultry sector inland consumption of meat and egg should be covered by national production. The grazing livestock, cattle and sheep should be maintained based on the grassland potential of the country. Among these sectoral strategies only the Swine Strategy has governmental money, so in our calculations we only accounted with the increase of swine numbers.

With the above trends contrasting results anticipates the study of the Agricultural Research Institute (AKI) (Popp-Potori 2009), where the possible effects of the CAP reform were modelled (Potori et al. 2012). This study states that the national husbandry sector is less competitive, its market access is narrowed and the related environmental measures are going to be stricter. According to their results turkey, pig fattening and sow husbandry is expected to shrink by 3-5%, while dairy, other poultry will be stable, additionally calve fattening and sheep production can increase with 1-5% till 2020 (Potori et al. 2012, p42).

Based on the above policy measures and models two scenarios are constructed:

WEM (with existing measures) – considers measures till December 2012, WAM (with additional measures) – considers measures and written proposals and their analysis till April.

According to these scenarios the effects of the NRS and the Swine Strategy are considered in the WEM scenario and the possible additional effects of the new CAP regimes are incorporated into the WAM scenario. The anticipated changes in the activity data are summarised in Table 5.31.

Table 5.31. Summary of expected changes in the input activity data

Activity data	WEM	WAM
Dairy cow	moderate decrease	AKI projections
Fattening cow	increase	AKI projections
Sheep	moderate decrease adjusted to real data in 2011 – decreasing with 5000 head/yr till 2020 then stagnation	AKI projections
Swine	Doubling due to Swine Strategy	Moderate increase due to moulding Swine Strategy and effects of CAP reform - AKI projections
Poultry	moderate decrease adjusted to real data in 2011 – decreasing with 200000 head/yr till 2020 then stagnation	AKI projections
Area of cereals	AKI projections + in case of corn and barley 10% increase due to increase of swine production	AKI projections + in case of corn and barley 5% increase due to increase of swine production
Industrial crops	AKI projections	AKI projections
Crop production	Steady state, but moderate increase in fodder production	Steady state
Fertilisers	7% increased based on 2011	Steady state based on 2011

Driving factors in land use change

In the land use change calculations the most important factors are the changes of the different land uses over time with regard to the sources of the conversions too. Here land use change was adjusted to the anticipated afforestation activities in the country.

According to this in WEM a moderate conversion of cropland and grassland will happen: 3000 ha cropland and 2000 ha grassland will be converted to forest land annually. In WAM these numbers are doubled: 6000 ha cropland and 4000 ha grassland is converted to forest land annually. The relevant conversion matrices are given below.

Table 5.32. Conversion matrix of the WEM scenario

Mean	Forest Land	Cropland	SA-Cropland	Grassland	SA-Grassland	Wetland	Settlements	Other Land
Forest Land		0	0	0	0	0	0	0
Cropland	3 000	0	0	0	0	0	0	0
SA-Cropland	0	0	0	0	0	0	0	0
Grassland	2 000	0	0	0	0	0	0	0
SA-Grassland	0	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0	0
Settlements	0	0	0	0	0	0	0	0
Other Land	0	0	0	0	0	0	0	0

Table 5.33 Conversion matrix of the WAM scenario

Mean	Forest Land	Cropland	SA-Cropland	Grassland	SA-Grassland	Wetland	Settlements	Other Land
Forest Land		0	0	0	0	0	0	0
Cropland	6 000	0	0	0	0	0	0	0
SA-Cropland	0	0	0	0	0	0	0	0
Grassland	4 000	0	0	0	0	0	0	0
SA-Grassland	0	0	0	0	0	0	0	0
Wetland	0	0	0	0	0	0	0	0
Settlements	0	0	0	0	0	0	0	0
Other Land	0	0	0	0	0	0	0	0

Other important conversions are not anticipated in this forecasting period.

The renewable rate of vineyards and orchards (3%) has been prolonged till 2025, but the area of these land use types were kept from the previous forecast. Additionally, the trend of soil friendly cultivation based on data of Hungarian Central Statistical Office, such as direct sowing and reduced tillage, was prolonged till 2025.

Driving factors in forestry

In the forestry sector, emissions and removals are mainly affected by the following factors: (1) the area of forests that remain forests, which also reflects the area of deforested land, (2) the amount of harvests in this land, (3) the area of afforestation, (4) the site where afforestation are done, and (5) the species composition of the afforestation. Considering the nature of these factors and the additional special characteristics of the sector, the relevant provisions change less frequently than in other sectors, therefore, the general approach of deriving different scenarios that is used in other sectors does not directly apply, therefore, we use an analysis of the above factors to derive scenarios.

Of all the above factors, the area of forests remaining forests has not really decreased as the deforestation rate is very low, only a few hundred ha each year. We expect that, even without any additional legislation, this will remain so, thus, no different scenarios were constructed to estimate the effect of this factor.

The amount of harvests has increased more intensively for the last few years than we projected in the previous NC. This increase is partly driven by the soaring energy prices, but also partly by the need to reduce net greenhouse gas emissions in the country. Therefore, we had to change our projection for the harvest rates (thinning and final cuttings taken together) upwards for all scenarios. For the WEM scenario, we now assume an intensive increase from around 8 million m^3/year to 10 million m3/year by 2020, and then remaining the same until 2025. This rate is sustainable, given that the amount of increment amounts to 13-14 million m3/year, however, given that forests have multiple services that limit the amount of the allowable cut, we project for the WAM scenario now a smaller rate of harvest, which is still higher than assumed earlier, growing from around 8 million m^3/year currently to 9 million m3/year by 2020 and then remaining the same until 2025.

We also had to change the projection of the area of afforestation that we used in our last NC. Based on previous experience, we assumed earlier that, due to the multiple benefits of afforestation including carbon sequestration, and due to the traditions, the rate of afforestation will be minimum 10 thousand ha annually. However, afforestation is long-term investments and the assumed rate could not be maintained mainly because of the financial and economic crisis of the recent years. Therefore, we now assume that afforestation rates will be lower than expected earlier. In the WEM, we assume that afforestation will occur on poor soil, with predominantly slow growing species, and at a rate of 5 thousand ha each year until 2025. In the WAM scenario, we assume that the area can be increased to 10 thousand ha by 2025 (with a slow but steady increase each year), and also that afforestation will be done using predominantly fast growing species on better sites. This scenario thus presents a more optimistic assumption which, however, still assumes less afforestation than assumed earlier.

Note that all data were taken from the official statistics of the Forestry Directorate of the Central Agricultural Office.

5.4.7.5. Results

The reasons for modifications in the results compared in the earlier forecast are threefold:

- The earlier forecast data were replaced with actual NIR data;
- There has been a major revision of factors in husbandry methane emission factors and also in LULUC biomass emission factors, where country specific TIER 2 factors were introduced;
- The anticipated effects of policies has been changed as well, and new rather production inducing effects are expected.

The GHG emissions from agriculture are higher in the WEM scenario reaching 10,000 Gg in 2020 (Figure 5.59). The WAM scenario has, due to the more ambitious environmental activities, less emission. These numbers stay below 9500 Gg during the whole period. However, both scenarios depict an upward trend expecting 15% and 8% growth by the end of the period respectively.

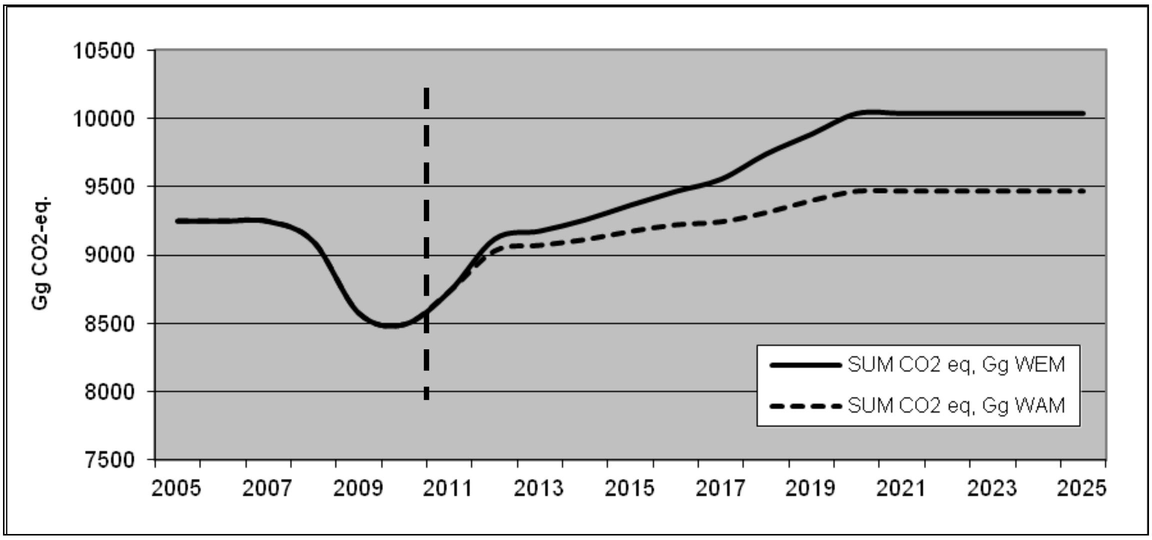


Figure 5.59. GHG emissions from agriculture

Figure 5.59. summarises the emissions from LULUC. Here a moderate increase of sequestration is expected; meanwhile there is not much difference between the two scenarios. This is due to the long-term effect of more soil friendly cultivation with less tillage to increase soil organic carbon content, to the cease of carbon emitting land use conversions. Soil emissions/accumulation is much higher than biomass based GHG effects that are negligible in comparison to soil based effects. However, soil based GHG sequestration tends to decrease due to diminishing effects of earlier soil friendly cultivation.

Since there is a difference between WEM and WAM only in cropland-grassland-forest conversion, the overall difference in the two scenarios is minor.

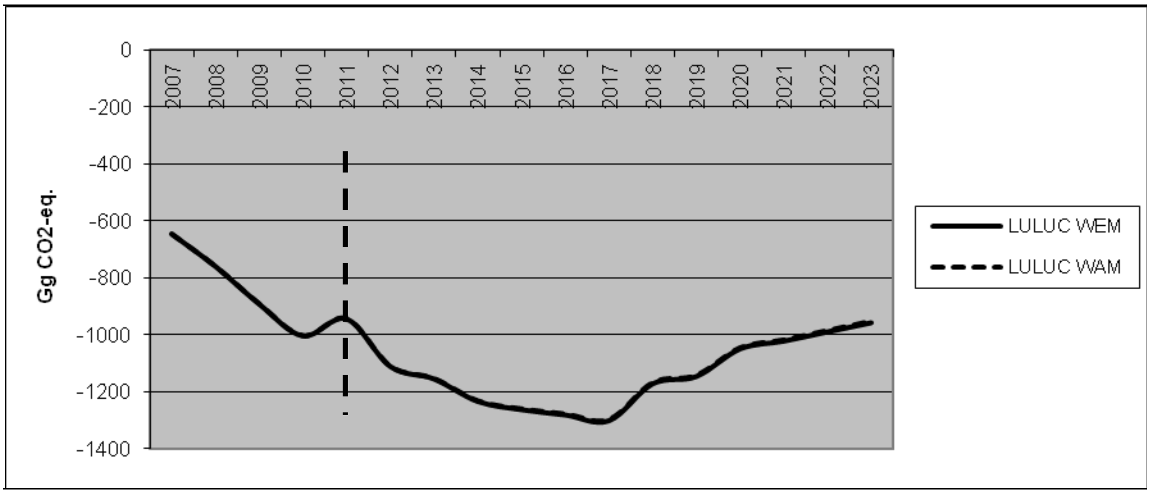


Figure 5.60. Emissions from LULUC

In the forests remaining forests category, the net removals would slowly decrease even if the rate of harvests were not increased. This is due to the current age class structure and the distribution of the current forests over site fertility. Future harvests will change this structure and distribution over time, which affects the total net woody increment. This change cannot be projected as no reliable estimation exists about which forests will be harvested, and when. However, the total amount of harvests will have a much more profound effect on the net removals of forests. With the WEM scenario, net removals will be almost reduced to zero (Figure 5.61.). With the WAM scenario, it is assumed that less wood will need to be cut, and this will result in a slower decrease of the net removals, but even then they will amount to half of what we have now. Concerning afforestation, on aggregate, they shall fix a large amount of carbon, however, this amount is much less than predicted earlier, and will accumulate only some time after the new stands will be established. Nevertheless, the amount fixed by the new forests will probably be more than that of the currently existing forests. The removals in the WAM scenario are projected to be twice as much as those in the WEM scenario; therefore, the WAM scenario is preferable from a carbon management point of view.

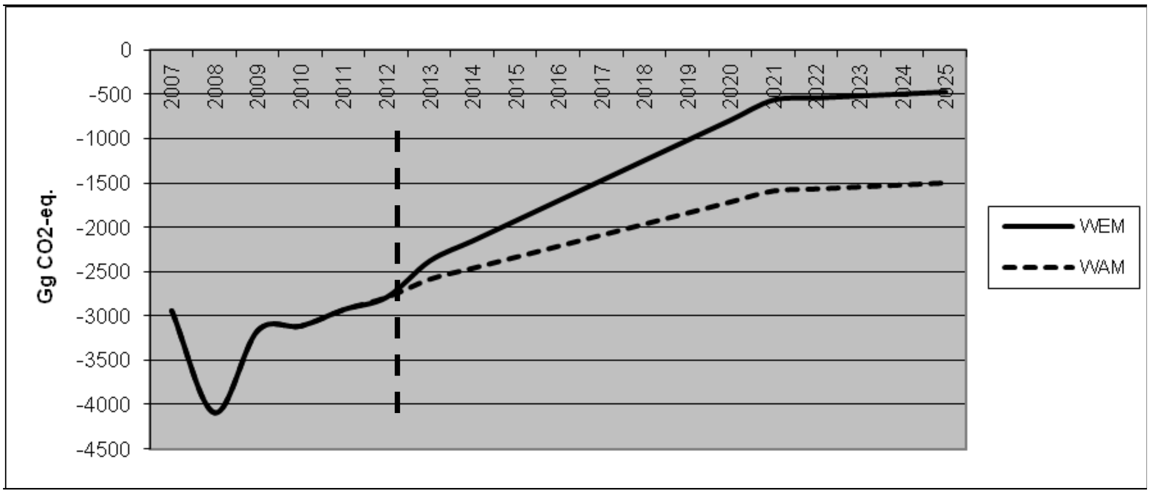


Figure 5.61. CO_2sequestration in forestry

5.4.8. Waste

5.4.8.1. Solid waste

This section is to present an estimation of greenhouse gas emissions of the Hungarian solid waste management sector. Carbon dioxide and methane are produced in the course of the treatment of waste, and their share from the total global emission is not significant but cannot be neglected.

Waste management policies defining greenhouse gas emission

The quantity of the waste production and the proportions of different waste management methods (landfill, incineration, recycling and prevention) may be influenced fundamentally by the following policies until 2030:

- Prevention will be a more stressed priority. Hungary's waste management policy influenced by the new EU waste framework directive tries to emphasize the importance of this device.
- Recycling will be growing in several areas – also because of higher landfill costs due to landfill tax and due to different new incentives.
- From the point of view of GHG emissions it is important to increase recycling (composting) of biodegradable waste.
- EU accession has resulted in a quick closing process of old landfill sites without state-of-the-art environmental technologies. Modern regional landfills equipped with leachate control and biogas utilisation technologies took their place.

Waste management data and trends: Non-hazardous waste from production

The relevance of the production (non-municipal) waste from the point of view of GHG emissions is the incineration. The typical manner of treatment of these wastes is disposal (with a proportion of 60%). Recycling (rate is at 29%), incineration (1-2%) and other treatments (9-10%) have a minor role.

Decrease in the amount of non-hazardous waste from production is a European and domestic tendency. The source of this trend in Hungary is the political and economic transition, and that the most waste intensive sectors like mining and metallurgy have lost their economic weight. 40% decrease was caused by closing up of old firms born in the centrally planned economy. Additional modernisation of the production technologies would be a driving force in the next decades.

The Domestic Material Consumption (DMC) of Hungary decreased significantly between 2005 and 2009, and in 2009 was below the level of 2000. The Resource Productivity Index clearly increased from 0.59 €/kg in 2000 to 0.80 €/kg in 2009. Because of the EU-27 average is 1.55 €/kg, there is a large potential to further development.

Industrial non-hazardous waste was 27.5 million tonnes in 2000, and only 20 million tonnes in 2008. A considerable part of this quantity is mining waste, slag from power generation and metallurgical technologies, and mud of sewage treatment.

Forecast until 2025: The production of non-hazardous solid waste will decrease in the future, but at a slower rate than in the period of 1990-2010.

In waste management incineration and co-incineration will stay between 400 and 500 thousand tons level (with a slowly increasing tendency), landfilling could decrease slightly, and recycling has to come nearer to the EU average level.

Forecast until 2025: The quantity of hazardous waste will decrease moderately. No essential change is expected in the treatment structure.

Because of the low share of incineration, and because of a strong opposition to any new installation by the people, we calculate a stable level of incineration, and no action, and additional measures from the Government. In Hungary the marginal cost of incineration significantly higher than the marginal cost of landfilling, there is no force on waste producers to switch from landfilling to incineration. Of course, in the case of some types of waste (e.g. medical waste), where the land disposal is not applicable because of environmental protection reason, the incineration remains the appropriate management method. On the other hand the increase of recycling is targeted by a numbers of Governmental measures, and the Government has no further additional resources to implement incentives in favour of incineration.

Therefore we don’t able to see any difference between WOM, WEM, and WAM scenarios regarding incinerated amount of waste for the period of 2015-2025. We are expected a slight increased amount of incinerated amount of waste due to the more effective use of existing capacities, a slight increase of co-incineration, and utilisation of RDF.

Municipal solid waste (MSW)

The quantity of the MSW fluctuated greatly in the past two decades, stagnated or decreased at the end of the 90’s, and from 2000 it grew mildly. The amount of generated MSW is very sensitive to the price level and to the income of households. Because of the European economic crisis and the debt crisis of Hungarian households and the recession of the Hungarian economy the consumption of the households is falling in the recent years and the near future, which results a decrease of the amount of MSW. It is important to note that in Hungary the generation of MSW per capita is smaller than the average of the EU15 or even the EU27.

Table 5.34. Forecast for the treated MSW with the measures listed in Chapter 4. until 2025, kt

	2011	2013	2015	2020	2025
Waste generated	3 820	3 756	3 800	4 005	4 284
Deposited	2 570	2320	2139	1785	1473
Recycling	660	741	815	1230	1495
Incineration	410	450	546	630	905
Composting	180	245	300	360	411

Forecast until 2025: The quantity of municipal solid wastes may increase slowly in the future. After the crisis the increasing income and increasing consumption will cause this. In the WEM scenario we calculate that a significant and strong waste management policy in favour of recycling can handle the effect of this increase. In the WAM scenario we expect a growing relevance of resource scarcity (with higher consumer price level) and stronger importance of prevention, therefore a decreasing volume of MSW after 2020.

5.4.8.2. Waste management scenarios

The following table shows the main assumptions in the various scenarios.

Table 5.35. Main assumptions in the different scenarios

<table>
<tr><th></th><th>Waste production</th><th>Proportion of landfill and incineration</th><th>Tendencies of recycling</th></tr>
<tr><td>WOM</td><td rowspan="2">Production: mild decrease according to the trend of the past decade;
MSW: mild increase following the increase of household’s income</td><td>Disposal: a decisive share, burning capacity does not expand</td><td>Is growing mildly, with small late compared to the EU regulations</td></tr>
<tr><td>WEM</td><td rowspan="2">Disposal decreases significantly, in favour of recycling, burning capacity does not expand</td><td rowspan="2">Accomplishes the EU regulations fully;
Recycling is growing fast;
Because of the many significant existing measures, no additional measures are taken into account</td></tr>
<tr><td>WAM</td><td>Additional prevention actions, the amount of MSW will be stable</td></tr>
</table>

The highlighted data for waste are the following in the WOM, WEM and WAM scenarios.

Table 5.36 Incinerated amount of non-municipal waste in Gg, 2008-2025

	2010	2015	2020	2025
Without measures	84,5	87,7	91,4	95,2
With existing measures				
With additional measures				

Table 5.37. Generated MSW in Gg, 2008-2025

	2010	2015	2020	2025
Without measures	4033	3800	4005	4250
With existing measures	4033	3800	4005	4250
With additional measures	4033	3800	4005	4003

Table 5.38. Landfilled MSW in Gg, 2008-2025

	2010	2015	2020	2025
Without measures	2838	2246	2083	2040
With existing measures	2838	2139	1785	1473
With additional measures	2838	2139	1785	1401

The GHG emission data based on the above-mentioned waste management scenarios are the following.

CO_2 from incineration

Because of the energy utilisation of the burning process, GHG emissions from the Municipal Waste Incinerator of Budapest (this is the one and only municipal solid waste incinerator in Hungary) and from some hazardous waste incinerators are calculated by the Hungarian Inventory of GHG emissions in the section of „Energy" instead of chapter „Waste". Here only the emissions of some non-municipal hazardous waste incinerator plans were accounted for.

Table 5.39. Carbon dioxide emission from solid waste incineration in Gg, 2008-2025

	2008	**2010**	**2015**	**2020**	**2025**
WOM/ WEM/ WAM	64,12	84,31	87,47	91,20	94,92

CH_4 from landfills

The table below shows the methane emission from landfills till 2025.

Table 5.40. Methane emission from landfills in Gg, 2008-2025

	2008	2010	2015	2020	2025
Without measures	143,9	139,8	88,5	73,0	73,4
With existing measures	143,9	139,8	78,9	59,0	59,4
With additional measures	143,9	139,8	78,9	59,0	56,5

5.4.8.3. Wastewater

WEM scenario

The most critical update relates to the ratio of households connected to the sewer. This data was updated for all the years between 2008 and 2025, driven by several factors.

Past data for 2008-2011 has been revised based on the officially published data by the Hungarian Statistical Office. The new figures indicate a somewhat slower implementation of the National Sewage Program than previously foreseen. A 76% connection rate had been foreseen for 2011, while according to the officially released figures it was only 72.8%.

There are two new pieces of regulations, however, which are likely to speed up future implementation. At the end of 2010 the ratio of households that were not connected to an accessible sewer (a sewer directly in front of the house) stood at 7.5% of all households in Hungary. Water utilities and municipalities struggled to get households to connect. Two regulations have been adopted to ease this process:

- Paragraph 55 of Act 2009 of 2011 requires households along a sewer to actually connect, and the notary of the municipality now has the power to enforce the connection.
- Households that are not connected to an accessible sewer, and the wastewater of which is collected in a septic tank are subject to the payment of a soil load fee (Act 89 of 2003) after each cubic meter of sewage that is not collected by a licensed sewage collector truck, proven by proper documents, including an invoice. As of 1 Febuary 2012 the level of this fee was raised from 120 HUF/m3 to 1,200 HUF/m3, providing a strong incentive for households to connect to the sewer.

The National Sewage Program foresees a sewage connection rate of 89.2% by 2015. Previously, 89% was applied for the WEM. Thus a minor adjustment is carried out. It is believed that slower than foreseen implementation of the National Sewage Program can be counterbalanced by the newly introduced strong incentives to connect to the sewer, therefore the 89.2% connection rate is used for 2015, noting that there is a risk that this target may be reached with a two year delay.

Another important amendment is related to the treatment of municipal wastewater. The ratio of collected wastewater that is treated mechanically or not treated at all had been foreseen to gradually decline from 30% in 2008 to 0% by 2015. This process, however, is happening much more abruptly. Thanks mainly to the 2010 launch of the Budapest Central Wastewater Treatment Plant, the ratio of untreated or mechanically treated wastewater in Hungary is already below 2%. This development is also incorporated in the forecasted emissions.

The protein consumption of the population, effecting N_2O emissions from human waste, has not been changed. It is believed that the projected decline of the population (from 10.0 million in 2010 to 9.8 million by 2025) will be counterbalanced by an improvement of livings standards (GDP is predicted to increase in each 5-year period until 2025), and overall protein consumption will therefore not decrease from current levels.

Emission forecasts from industrial wastewater, i.e. 60% of 2008 emissions by 2015, were not changed, only the original 2008-2011 values were replaced with actual reported values.

Changes to the WAM scenario

Under the With Additional Measures (WAM) scenario it is assumed that additional measures are taken only if the price of carbon credits justifies it. Two years ago possible, not yet utilised, GHG reducing interventions were compiled into a marginal abatement cost curve of GHG emissions within the wastewater sector. The same marginal cost curve is used today, but with updated carbon credit prices.

Sources of wastewater related GHG emissions

According to the sectoral classification of the UNFCCC, wastewater collection and treatment – together with solid waste management - belongs to the waste sector. Within wastewater management there are three main sources of GHG emissions:

- CH_4 emissions from household sewage and industrial wastewater released into public sewers. The volume of methane is determined primarily by the pollution load of the wastewater as measured by its biological oxygen demand (BOD) and the technology of wastewater collection and treatment, especially its aerobic / anaerobic attributes. The volume of methane that actually gets emitted is determined by the methane conversion factor (MCF) specific to each technology, and the share of collected and utilized (combusted) methane, which is to be subtracted.
- N_2O may be released during nitrification and denitrification, to a small extent from the wastewater treatment technology, and to a larger extent after wastewater is discharged into recipient water bodies.
- Methane may also be released from industrial wastewater discharged directly into water bodies. Emissions can be computed based on the chemical oxygen demand (COD) of the wastewater. The key polluting industries are those the discharged wastewater of which has high organic content, such as the food industry and pulp and paper production.

Secondary (or more advanced) treatment of wastewater will result in residual sewage sludge, which – without proper treatment – will release methane into the atmosphere. This emission is to be calculated with an MCF of 0.8 to 1, implying that this is the most potent source of sewage related GHG emission. Since wastewater sludge is generally taken over by the solid waste sector and the agricultural sector, most of the methane emissions from untreated sludge are emitted there. If the sludge is anaerobically treated within the wastewater sector and the generated methane is combusted to produce energy then the methane emissions from the wastewater sector will not be impacted, while emissions from sludge disposal in other sectors should decrease. Moreover, the biogas based energy will replace some fossil fuel based generation therefore the GHG emissions of the energy sector should also decline.[18]

Baseline emissions in Hungary in 2008

According to the National Inventory Report, the following baseline GHG emissions were registered in the wastewater sector in 2008:

- 431.09 $GgCO_2eq$ CH_4, of which 402.55 $GgCO_2eq$ originates with households (sewage released to the sewer and sewage treated on site in latrines and septic tanks) and 28.54 $GgCO_2eq$ of emissions are of industrial sources;
- 288.29 $GgCO_2e$ of N_2O emissions.

An additional 140 $GgCO_2eq$ of methane was flared or combusted to generate energy. The source of this gas is sludge based biogas utilization.

According to the UNFCCC methodology the GHG emissions originating from household wastewater and industrial wastewater released to public sewers are driven primarily by the following factors:

- Number of inhabitants (more inhabitants mean more pollution, since a uniform BOD content of 60 g/day/person is used for Hungary based on UNFCCC documentation);
- Ratio of households on the sewer (higher ratio means lower pollution as on-site treatment has a higher MCF – in fact, an increase in sewer penetration is the most effective method of GHG abatement in the wastewater sector);
- Wastewater treatment technology (untreated or mechanically treated wastewater has an MCF of 0 while advanced treatment – a mix of aerobic and anaerobic technologies in Hungary - was given an MCF of 0.15 within the NIR);

[18] Unless the methane is simply flared without energy generation, which is not uncommon at wastewater facilities, especially during the summer when the energy need of the facilities is below their sludge based energy producing capacity (electricity sales to the grid are characterized by water utility managers as difficult).

- Collection of methane from the wastewater treatment technology (while anaerobic treatment has a higher MCF, the resulting methane is more likely to be collected as the technology is in a closed system, and methane poses a danger of explosion);
- Sludge treatment technology and sludge disposal (use of sludge for biogas generation will offset GHG emissions elsewhere, while sludge disposed in other sectors will generate GHG emissions).

Hungarian estimates for N_2O emissions from wastewater have traditionally been driven by the protein consumption of the population with little impact from changes in the wastewater treatment technologies.

Key attributes of GHG emission scenarios until 2025

Using the detailed Hungarian implementation plans of the Water Framework Directive (WFD) of the EU, the forecasts of the National Sewage Program, statistics on the progress of sewer developments, recent regulatory requirements for households to connect to accessible sewers, and the estimated GHG emission abatement costs within the wastewater sector three scenarios have been created: WOM, WEM and WAM.

Under WOM it is assumed that the development of the wastewater collection and treatment infrastructure takes place in accordance with pre-2001 plans, corresponding to - on balance - higher GHG emissions than in the other two scenarios. No targeted GHG reduction measures are implemented.[19]

Under WEM the National Sewage Program is smoothly implemented, resulting in lower GHG levels than under WOM. Emission reductions are achieved due to large infrastructural changes driven by the implementation of the EU water directives, without consideration of GHG impacts. Therefore the associated costs of the large scale investments are not accounted for as GHG abatement costs - GHG abatement is a side-impact of implementing the water regulations.

Under WAM, on top of WEM all GHG abatement measures with a cost below projected carbon credit prices are implemented. This is the only scenario in which targeted emissions reductions take place, and consequently, this is the only scenario in which GHG abatement costs are estimated. Indeed, currently there are not any plans that would trigger if a specific carbon price is detected, therefore WAM is more like an estimate of an economically achievable emission reduction potential that could be turned into a program of measures, than a planned program.

Table 5.41. below provides a summary of the key attributes of the three scenarios. Baseline is the starting point of the projections, representing year 2008 conditions. The figures for WOM, WEM and WAM represent year 2015 conditions. It is presumed that the key attributes of large water infrastructure (as described by items 1 through 5 in the table) do not further change between 2015 and 2025.

The targeted GHG abatement measures (item 6) are assumed to be gradually implemented between 2016 and 2025.

Table 5.41. Key assumptions of the scenarios

Feature	Baseline (2008)	WOM (2015)	WEM (2015)	WAM (2015)
1. Household BOD emissions	60 g/person/day	60 g/person/day	60 g/person/day	60 g/person/day
2. Ratio of households connected to the sewer	70%	84%	89.2%	89.2%
3. Ratio of collected sewage that is not	30%	0%	0%	0%

[19] Measures the sole purpose of which GHG is abatement.

treated or treated only mechanically before released to water bodies				
4. N effluents from municipal wastewater treatment plants (thousand tons/year)	24	34.6	24	24
5. COD content of industrial effluents (percent of 2008 level)	100	100	60	60
6. Targeted GHG abatement measures implemented	none	none	none	all with a cost below projected carbon credit prices

Targeted GHG abatement within the wastewater sector (WAM)

As already discussed, the infrastructural investments prompted by water policy result in large scale changes in sectoral GHG emissions. These changes are out of the scope of climate policy and their costs are not assessed. There is, nevertheless, also room for active GHG abatement within the wastewater sector. These opportunities are discussed in two sections:

- Measures related to wastewater treatment
- Measures related to sewage sludge management.

Measures related to wastewater treatment

In addition to large scale infrastructural development, there are multiple site-specific methods to reduce wastewater related GHG emissions. While these options are discussed in international literature, related cost estimates are vague or missing, and Hungary specific information is virtually non-existent. Therefore the Hungarian estimate for the abatement opportunities and costs is based on foreign studies and is inherently uncertain. It is therefore presumed that the assessment below is updated in the future, including detailed appraisal of abatement opportunities at large and medium sized domestic wastewater infrastructure.

The following measures are worth considering:

- Septic tanks are used to collect sewage in settlements without a sewer and are a major source of methane emissions within the wastewater sector. Replacement of obsolete septic tanks with modern septic tanks is mentioned in literature as a possibility to reduce GHG emissions, but without quantifying the mitigation potential and costs.
- Upgrade and optimization of existing wastewater treatment plants. These technical changes can target either methane emissions from the wastewater treatment process (aeration, more dynamic anaerobic processes) or the composition of the effluent, which in turn impacts N_2O emissions from recipient water bodies. According to Criqui (2002) at European wastewater treatment plants up to 40% of N_2O emissions could, in theory, be abated, but a 20% target is more practical.
- Methane from closed circuit, anaerobic sewage treatment technologies is usually collected for safety reasons. In facilities where such methane is not collected but simply released into air, or the collection of methane is not efficient (much leakage) methane emissions can be abated at a relatively low cost by upgrading the methane collection system, and then flaring or combusting the gas.

In order to get a reliable picture of the abatement potential, a detailed, site-specific assessment is required and such an exercise may cost tens of millions forints, setting a lower boundary for unit abatement costs[20] –this figure is assumed to be 5 EUR/tCO_2eq. Such an analysis may even make it necessary to revise existing GHG emission figures from the wastewater sector. Based on international experience up to about 20% of CH_4 and

[20] Assuming that the cost of the assessment is part of the cost of abatement – but since emission reductions require such an analysis, we cannot disregard the associated costs.

N_2O emissions could be terminated with no-regret and low cost (below 10 EUR/tCO_2eq) abatement options, and a further 20% with a unit cost falling between 10 and 40 EUR/tCO_2eq. The remaining 60% of GHG emissions could be reduced only at even higher and steeply rising marginal costs. The resulting abatement cost curve is illustrated in 5.62. below.

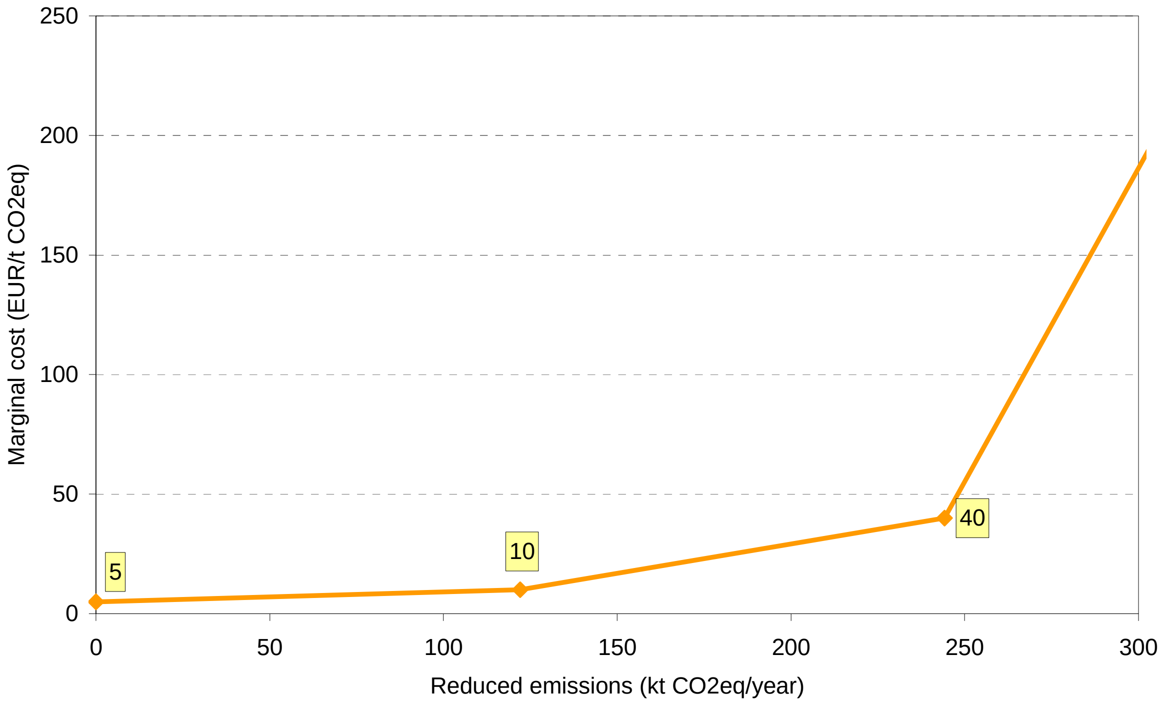


Figure 5.62. Marginal abatement cost curve of GHG emissions from the wastewater sector

Sewage sludge management

In 2011 a selection of Hungarian wastewater treatment plants were surveyed to investigate the net cost of sewage sludge management. Inquiry was made about the costs of fermentation and combustion, the value of the generated energy and the cost savings due to reduced need for disposal of sludge. A lot of the sewage sludge management facilities were established as part of larger infrastructural development projects (such as building or upgrading a wastewater treatment plant) without separate cost-benefit analysis of sludge treatment. Thus the information obtained should be regarded as a rough estimate only.

In a separate survey the potential for additional sludge based biogas generation at all wastewater treatment plants with capacity above 15,000 m^3/day was reviewed.

Finally, sectoral experts from the agricultural and the solid waste management sectors – where sewage sludge is commonly disposed of – were consulted regarding the GHG emissions of sludge disposal. In case of biogas based utilization of sludge these other sectoral emissions would be avoided. The GHG emissions of replaced energy were also considered, since energy generated and used (or, less commonly, fed into the grid) at wastewater facilities does not have to be produced elsewhere. What was not accounted for as avoided emission is the methane that is actually combusted during sludge management, since this methane was generated explicitly for energy purposes and would otherwise not have been produced and emitted.

At the end of the exercise it was concluded that if all currently non-used sludge were utilized for biogas generation at all wastewater treatment plants with capacity above 15,000 m^3/day, then annually about 15

$ktCO_2e$ of GHG could be saved at a cost falling between 14 and 220 EUR/tCO_2eq. At large facilities the unit cost would be closer to the low end of the range, at small facilities it would be higher.

Compared to GHG emissions reduction from wastewater management, sludge based abatement is much more expensive, while its potential volume is much lower. Therefore it was decided not to include this option among the GHG abatement of the WAM scenario.

GHG emission pathways

The GHG emissions of the scenarios have been estimated based on i) key sectoral changes, and ii) targeted GHG emission abatement options. Changes in emissions under WOM and WEM come at no abatement cost, while the size and cost of GHG abatement opportunities entailed by WAM are detailed in the previous section. The estimated emissions by source and gas are provided in Table 5.42 and Table 5.43. The reduced emissions of the WAM scenario have been allocated to sources and gases in proportion to the distribution of emissions among sources and gases under WEM.

Table5.42. CH_4 emission estimates by gas for key years, $ktCO_2eq$

	Source of wastewater	2010	2015	2020	2025
Without measures	1. Industrial	29.53	28.54	28.54	28.54
	2. Domestic and Commercial	324.69	290.26	290.26	290.26
	3. Other	0	0	0	0
With existing measure	1. Industrial	29.53	17.12	17.12	17.12
	2. Domestic and Commercial	324.69	233.39	233.39	233.39
	3. Other	0	0	0	0
With additional measures	1. Industrial	29.53	17.12	14.01	10.90
	2. Domestic and Commercial	324.69	233.39	190.97	148.54
	3. Other	0	0	0	0

Table 5.43. N_2O emission estimates by gas for key years, $ktCO_2eq$

	Source of wastewater	2010	2015	2020	2025
Without measures	1. Industrial	0	0	0	0
	2. Domestic and Commercial	272.93	415.61	415.61	415.61
	3. Other	0	0	0	0
With existing measure	1. Industrial	0	0	0	0
	2. Domestic and Commercial	272.93	288.29	288.29	288.29
	3. Other	0	0	0	0
With additional measures	1. Industrial	0	0	0	0
	2. Domestic and Commercial	272.93	288.29	235.88	183.48
	3. Other	0	0	0	0

6. Vulnerability assessment, climate change impacts and adaptation measures

6.1. Expected impacts of climate change

On the basis of about 20 years of international research in the frame of the Intergovernmental Panel on Climate Change (IPCC), there is no doubt that due to anthropogenic activity the Earth is facing global warming (IPCC 2007). Global climate models (GCMs) are widely used to estimate the future climate change, however, for the regional scale analysis their coarse resolution (typically 150–200 km) limits their applicability in the assessment of the regional consequences of global warming. Regional climate models nested in GCMs (Giorgi 1990) may lead to better estimations of future climate conditions in the European subregions as well as in other parts of the world since the horizontal resolution of these RCMs is much finer (around 10–25 km) than the GCMs' (IPCC 2007).

6.1.1. Modeling background for impact assessment

The Carpathian Basin is located in the target regions of several recent EU-projects (e.g. PRUDENCE (http://prudence.dmi.dk, Christensen – Christensen 2007), ENSEMBLES (www.ensembles-eu.org , van der Linden – Mitchell 2009), CECILIA (www.cecilia-eu.org, Halenka 2007), CLAVIER (www.clavier-eu.org , Jacob et al. 2008)) that focused on the regional climate change in the 21st century using high-resolution climate model simulations, as well as on the environmental impacts of the projected climate change. In the frame of international cooperative projects, four regional climate models have been successfully adapted and tested for the region, two of them at the Eötvös Loránd University, Budapest: PRECIS (**P**roviding **Re**gional **C**limates for **I**mpact **S**tudies), and RegCM (**Reg**ional **C**limate **M**odel) (Bartholy et al. 2009a). By now, after completing several RCM experiments for the Carpathian Basin and its vicinity, it is possible to estimate the future changes in the climatic means and extremes in this region for the 21st century (Torma et al. 2008, Bartholy et al. 2009a,b,c, Pieczka et al. 2010, Krüzselyi et al. 2011). These projections are especially important for planning at the low-elevation limits of the retreating closed forest zone, such as in Hungary (Mátyás 2010).

In the next section the model PRECIS is used to analyze the simulated temperature and precipitation change by 2071–2100 for Hungary (compared to 1961–1990, as a reference period). Besides the evaluation of the mean climate changes, extreme conditions are also discussed. Finally, the main conclusions are summarized.

For the future (2071–2100) three experiments were completed, namely, for the A2, A1B, and B2 global emission scenarios (Nakicenovic – Swart 2000). The estimated global mean CO_2 concentration level for the end of the century is 856 ppm, 717 ppm, and 621 ppm, respectively. Thus, A2 can be considered the most pessimistic, and B2 the most optimistic among these scenarios. The projected change of temperature and precipitation (compared to 1961–1990) are discussed in the next two sections.

6.1.2. Simulated temperature change by 2071–2100

For 2071–2100 A2, A1B, and B2 scenario runs have been completed using the model PRECIS. A2 scenario implies the highest temperature values in the Carpathian Basin (due to the highest estimated CO_2 concentration level). The projected annual mean temperature change for Hungary is between 4.0 °C and 5.4 °C. The projected seasonal mean changes are summarized in *Table 6.1*. It can be clearly seen that the largest warming is likely to occur in the summer (the spatial average of the simulated change is 6.0–8.0 °C). The smallest warming is projected for spring and winter. The simulated change is significant at the 5% level for each season and grid point (Pieczka et al. 2010).

Table 6.1. Projected seasonal mean temperature change (°C) for Hungary by 2071-2100 (ref. period 1961-1990)

	Winter	Spring	Summer	Autumn
B2 scenario	3.2	3.1	6.0	3.9
A1B scenario	4.1	3.7	6.7	5.0
A2 scenario	4.2	4.2	8.0	5.2

The year-to-year variation of the seasonal mean temperature for Hungary is presented in *Figure 6.1*. All the time series highlight the significant warming for each season and for all scenarios. The largest seasonal warming is projected for the summer. The mean temperature in autumn is likely to increase more than in spring, thus autumn may become warmer than spring due to the robust warming in late summer/early autumn (Bartholy et al. 2009c). The year-to-year variation in the transition seasons is also likely to increase to up to 1.5–2 times of their current value in case of the A2 and B2 scenarios, however, such a change is not projected for A1B. Standard deviation of the winter mean temperature is projected to slightly decrease for all scenarios. According to the simulations, the presently quite large standard deviation in summer is likely to slightly decrease for B2, and slightly increase for A1B and A2 scenarios, but no robust change is projected. On the continuous 140-years simulation of A1B the warming trend is obvious for each season, with the highest rate in the summer. To visualize this tendency, the fitted linear trends using the least squaresmethod are shown for the entire 1961–2100 period.

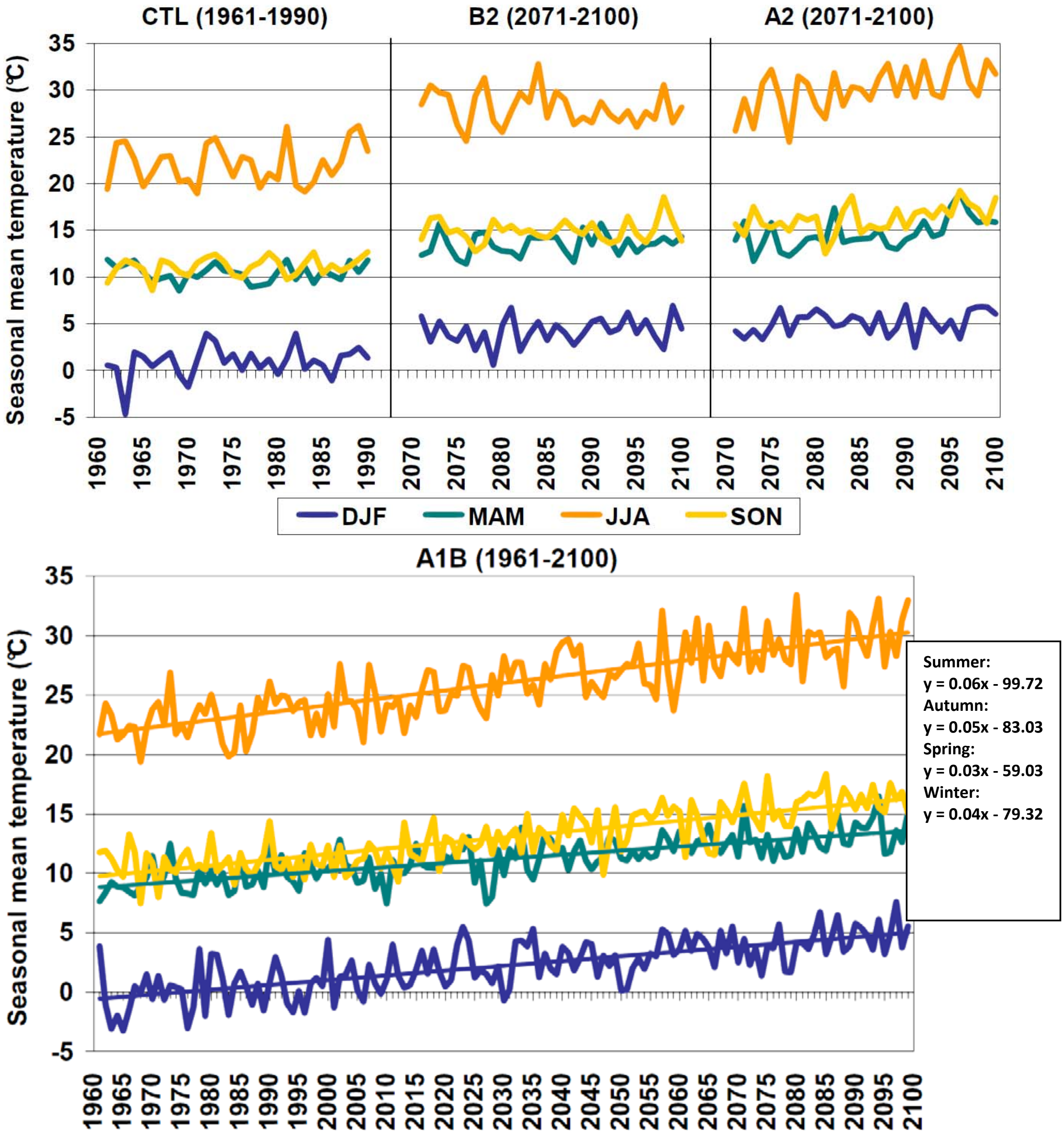


Figure 6.1. Year-to-year variation of seasonal mean temperature (°C) for Hungary. For the A1B simulation the fitted linear trends are also shown for 1961–2100. Source: Pieczka et al.

In *Figure 6.2* Box-Whisker plot diagrams calculated from the simulated values of the monthly temperature anomalies for 2071–2100 (relative to the 1961–1990 monthly mean values) in all the gridpoints located within Hungary are shown for all scenarios. The small rectangles represent the lower and the upper quartiles, and the vertical lines indicate the minimum and the maximum of the sample (the size of the entire sample is 6,870). The lower quartile values are always positive (and in most of the summer and autumn months the minimum values are also above 0 °C), which highlights the projected warming trend. The middle 50% of the sample is represented by the boxes: the larger the size, the larger the variance of the sample. In case of the different scenarios, the total ranges of the middle-half of the monthly anomalies are similar (around 2–5 °C), the largest ranges are projected in the summer months. Negative anomalies compared to the mean of 1961–1990 are likely to occur by 2071–2100 only in a few cases and locations, mainly in the winter months (especially in December and in February).

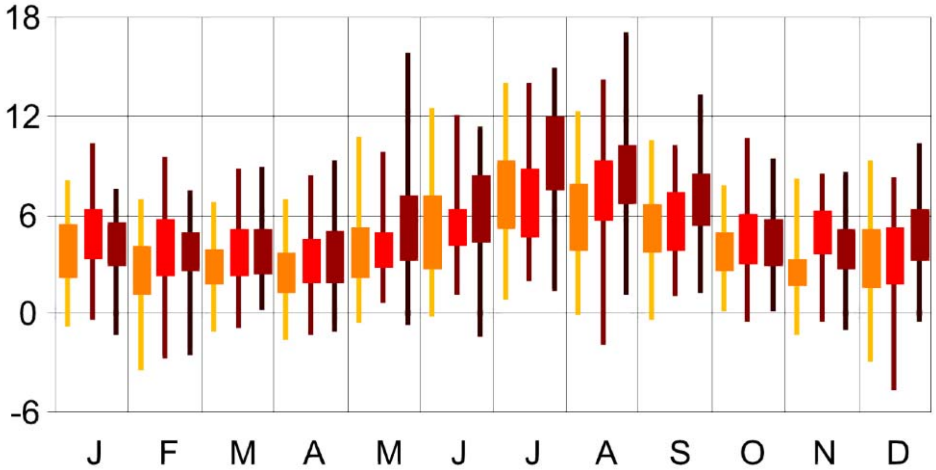


Figure 6.2. Monthly temperature change in 2071-2100 (compared to 1961-1990)

Source: Pieczka et al.

The distribution change of the simulated daily mean temperature is also analyzed. The results for January and July (being the coldest and the warmest months, respectively) can be seen in Figure 6.3.

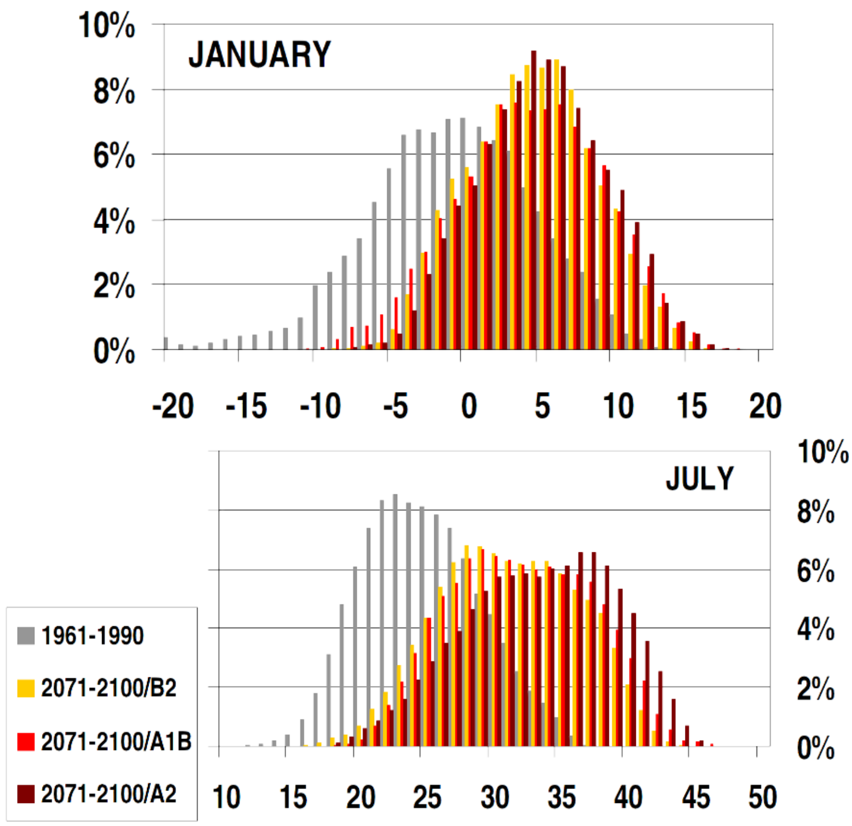


Figure 6.3. Distribution change of simulated daily mean temperature in January (left panel) and July (right panel),

Source: Pieczka et al.

In January the distribution is projected to shift towards the larger temperature values (the projected monthly mean change is about +5.2 °C, +5.0 °C, and +5.7 °C in case of B2, A1B and A2 scenario, respectively), which implies less cold and more warm and record warm periods in winter. In July (shown in the lower panel) not only a shift, but also a change in the shape of the empirical distribution is visible. The relative frequency values of different temperature intervals are likely to change remarkably (the projected monthly mean temperature increase isabout +6.3 °C, +7.1 °C, and +8.4 °C in case of B2, A1B, and A2 scenario, respectively). The projected distribution changes for these three scenarios are very similar in the winter months (January is shown in this paper as an example), but differ more in case of the summer months (especially in July and August, from which July is shown in Figure 6.3). Thus, for the summer the simulations imply less cold and more hot periods, and larger record hot conditions than in the reference period. This frequency shift is larger in case of A2 scenario than A1B or B2 scenario.

In order to evaluate the projected distribution change from a spatial aspect, a special method has been developed. The main aim of this method is to quantify the empirical probability of temperature or precipitation anomalies exceeding given thresholds based on the model simulations, and then to compare to the occurrence determined from observational datasets (such as the E-OBS gridded data (Haylock et al. 2008)). The comparison enables the provision of a clear message to the impact modelers on the distribution shift for instance.

Among the various threshold values used during the analysis Figure 6.4 shows the empirical probability of the temperature anomaly exceeding 4 °C in winter and summer for the reference period (1961–1990) and the target period (2071–2100) for the three scenarios (PRECIS experiments project at least 4 °C annual warming for Hungary.) For the end users these maps may provide useful spatial information about the probability of threshold exceedance. In the past climatic conditions, monthly temperature anomaly exceeding 4 °C occurred in about 5–10% of all the winter months, and it hardly ever happened in the other seasons (only summer and winter are shown). According to the PRECIS simulations, this is very likely to change in the future: by the end of the 21st century the monthly temperature anomaly (e.g., the difference from the mean of 1961–1990) exceeding 4 °C will become quite frequent (B2: 35–45% in the winter, 70–80% in the summer; A1B: 50–60% in the winter, 80–85% in the summer, A2: 50–60% in the winter, 85–95% in the summer). The largest probability values can be seen in the summer. The spatial structure of the empirical probability fields is similar, but the values differ, namely, probability values for A2 are larger than for A1B and B2. In summer azonal structure can be recognized, with the largest probability values in the eastern/southern part of Hungary.

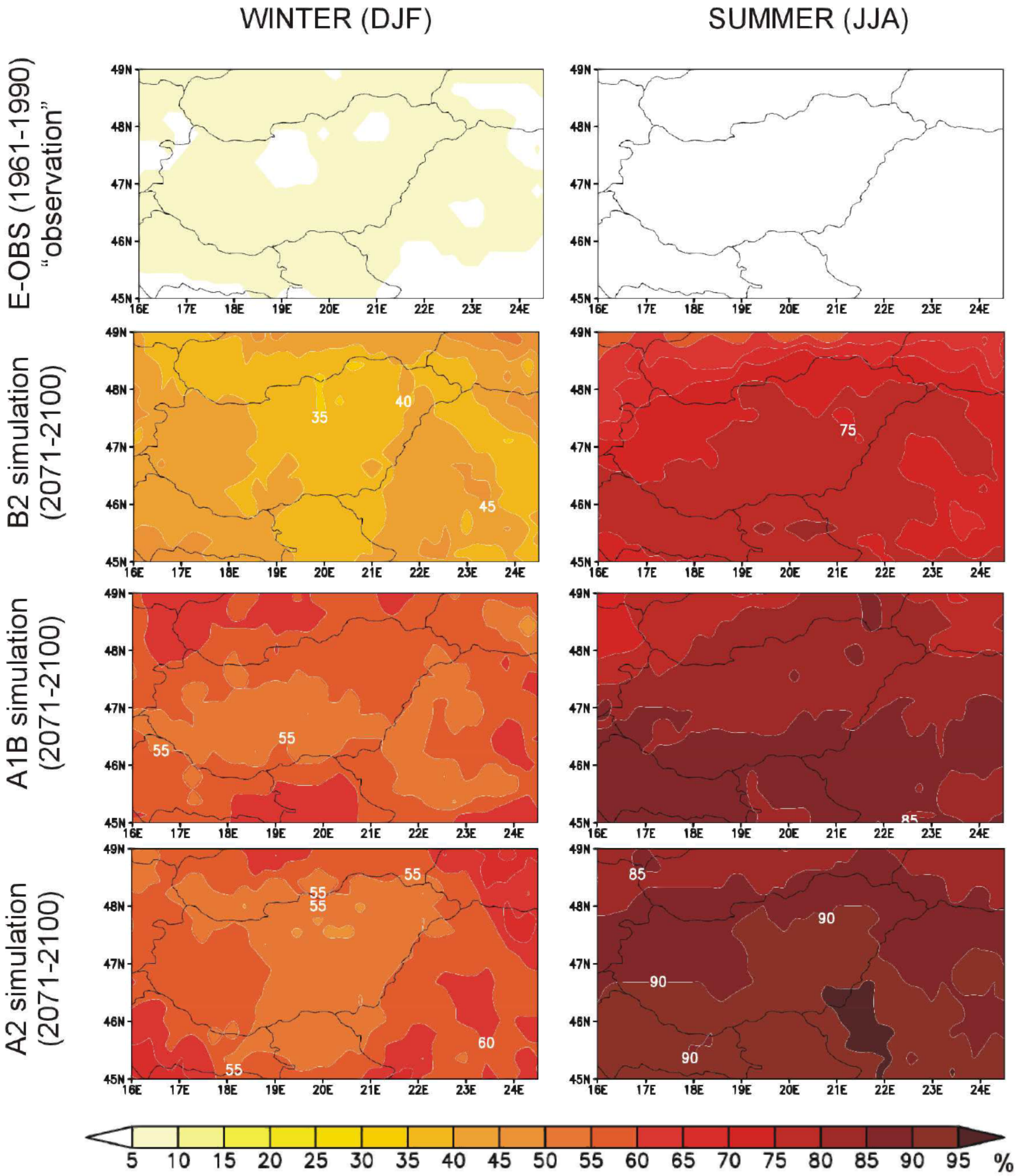


Figure 6.4. Seasonal empirical probability of monthly temperature anomaly exceeding 4 (relative to the 1961–1990 monthly mean values).

Source: Pieczka et al

6.1.3 Simulated precipitation change by 2071–2100

Model prediction shows about 20% annual precipitation decrease on average for Hungary by the end of the 21st century in case of A2 and B2 scenarios, but gives practically no change in the annual precipitation in case of A1B. However, if seasonal or monthly simulated changes are evaluated, the largest change is projected for the summer. Namely, significant drying is likely according to the simulations for the whole country (the simulated precipitation decrease is 34%, 43%, and 58% using spatial averages in case of A1B, B2,and A2, respectively). Also, for spring and autumn the projected trend is negative (except for A1B in spring, when it is slightly positive), but it is much smaller than in the summer and not significant at 5% level. The direction of the simulated precipitation change in the transition seasons involves large uncertainties. In the winter a slight increase is projected (in spatial average about 14%), which is significant in case of A2 in the Transdanubium, where the simulated winter precipitation change may exceed 30–40% (Pieczka et al. 2010). The A1B experiment projects a larger, significant precipitation increase (34% in spatial average) for the entire country.

Precipitation is highly variable both in space and time. According to the PRECIS simulations, the year-to-year variation in Hungary will remarkably change in the future (Figure 6.5 and Figure 6.6). The results suggest a major annual redistribution of precipitation, a significant decrease in summer precipitation, as well as in interannual variation of summer precipitation, and increase of the interannual variation in spring and winter. In the summer, both the seasonal sum and the temporal standard deviation is likely to decrease dramatically, by about 50% in case of A2 and B2 scenarios. The largest decrease of the standard deviation is expected in June, July and September, in the rest of the year the simulated changes are less pronounced. However, the simulated year-to-year variation increase of the monthly precipitation in spring is quite large, especially in May in case of A2 scenario. The results from the A1B experiment suggest that by the middle of the century the sum and variation of the precipitation in the summer and winter will be almost equal, and by the end of the century most of the precipitation will fall during the winter – but in some years the opposite may happen (*see Figure 6.5*). Trends in the spring and autumn precipitation change are small and not significant.

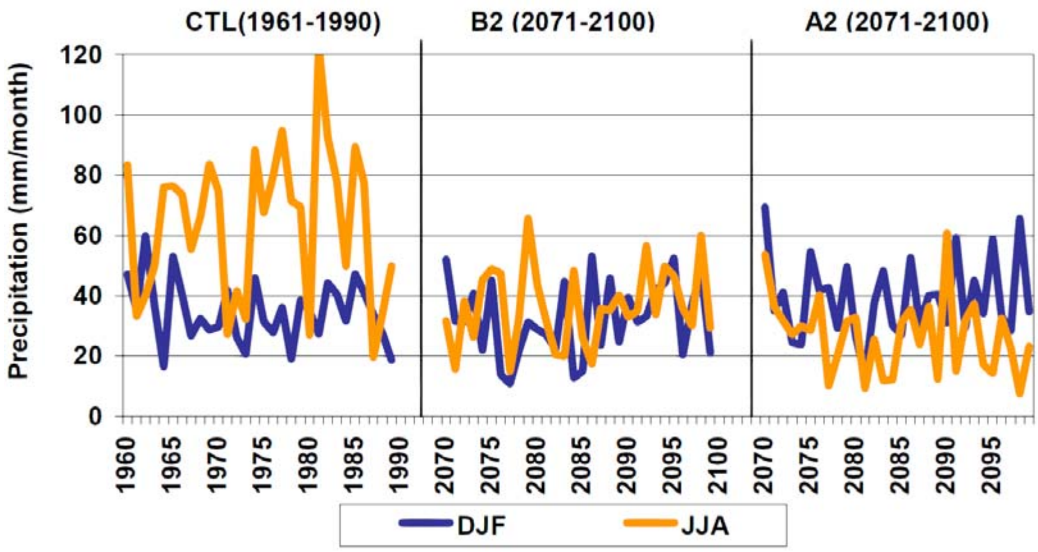


Figure 6.5a. Year-to-year variation of seasonal mean precipitation (mm/month) for Hungary in winter and summer.

Source: Pieczka et al

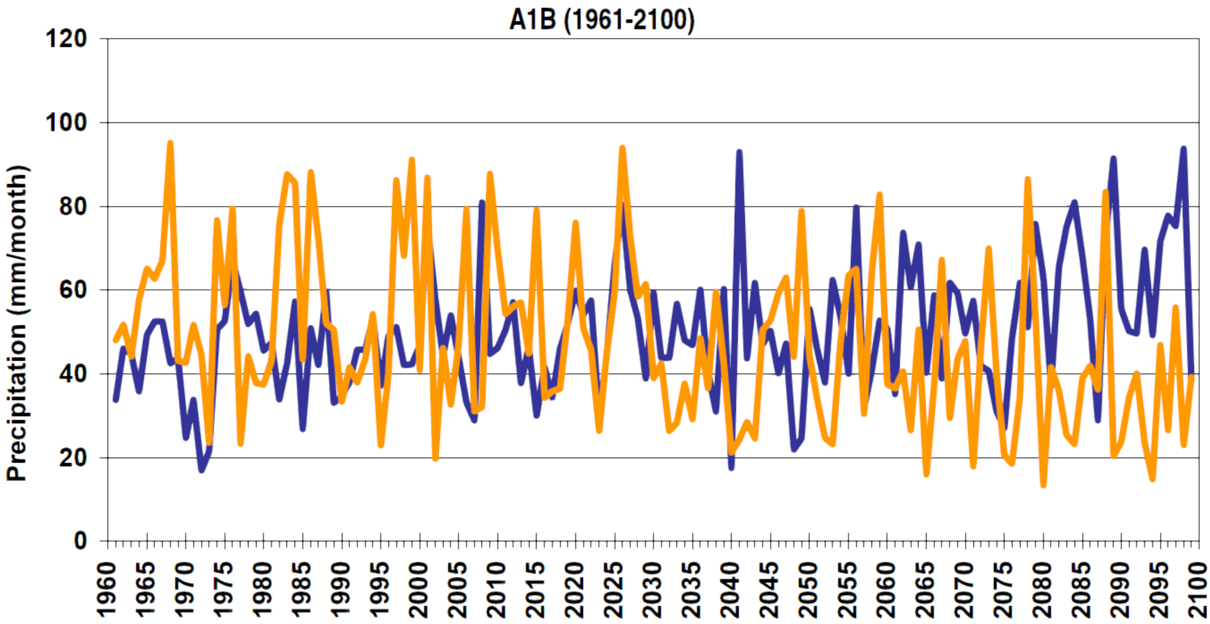


Figure 6.5b. Year-to-year variation of seasonal mean precipitation (mm/month) for Hungary in winter and summer.

Source: Pieczka et al.

The projected change in the annual distribution of simulated monthly mean precipitation is shown in *Figure 6.7.* In the present climate (1961–1990), the wettest months in Hungary are in late spring, early summer (May, June), when the monthly mean precipitation sum exceeds 60 mm. The driest months are January and February with about 30–35 mm total precipitation on average. The PRECIS simulations suggest that in case of all three scenarios, the annual distribution of monthly precipitation is very likely to be restructured in the future. The driest months are projected no longer to occur during winter, but in July and August instead (in case of A2 with less than 20 mm, in case of A1B around 20–25 mm, and in case of B2 with about 25–30 mm on average by 2071–2100). The wettest month of the A2 scenario run is projected to be April with about 65–70 mm precipitation on average, while in case of the B2 and A1B simulations the wettest months are April, May and June with about 60 mm (B2) / over 60 mm (A1B) total precipitation on average.

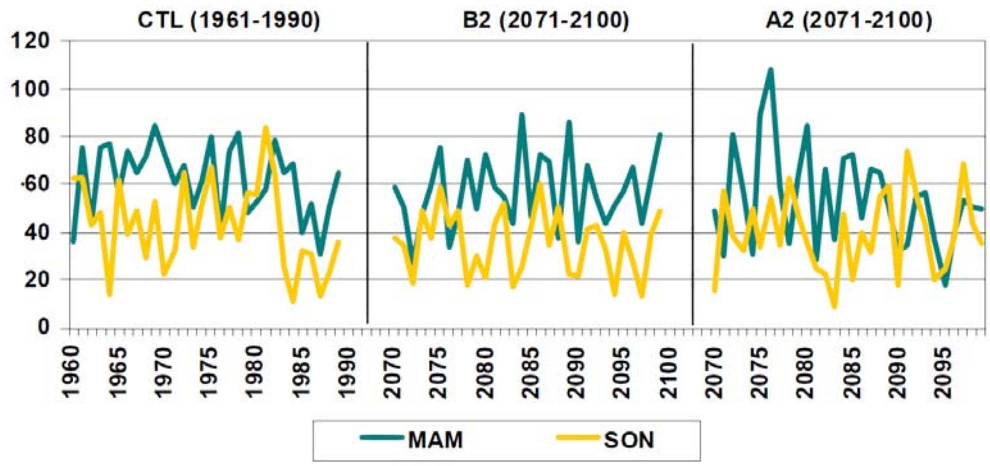


Figure 6.6a. Year-to-year variation of seasonal mean precipitation (mm/month) for Hungary in spring and autumn

Source: Pieczka et al

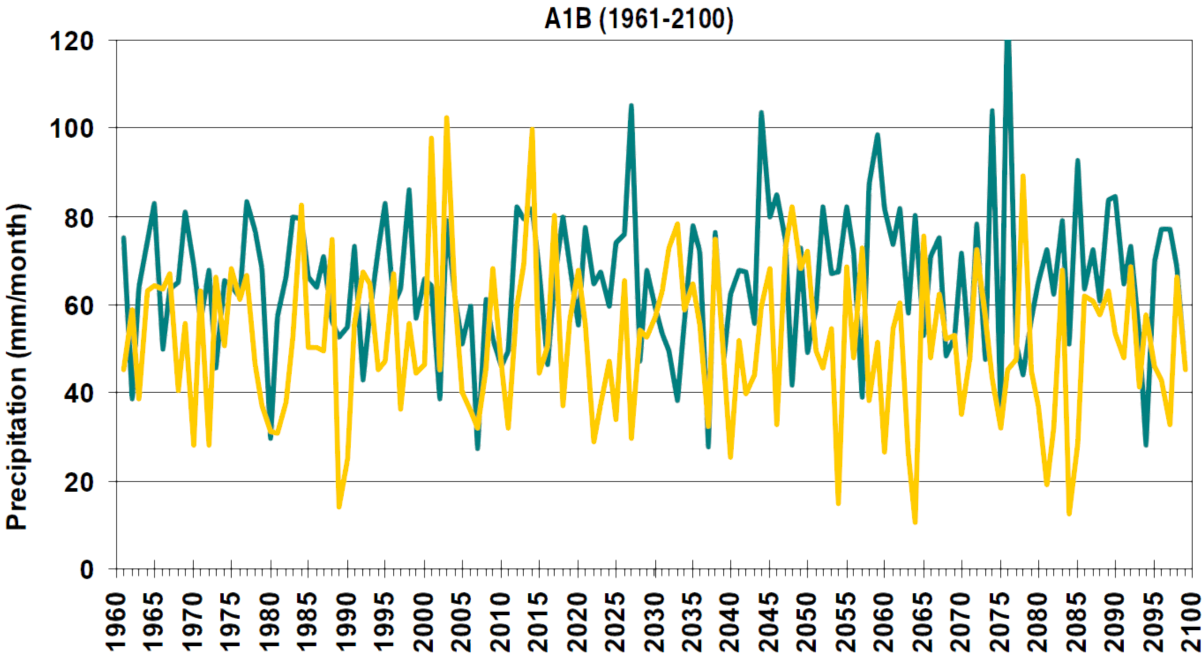


Figure 6.6b. Year-to-year variation of seasonal mean precipitation (mm/month) for Hungary in spring and autumn.

Source: Pieczka et al.

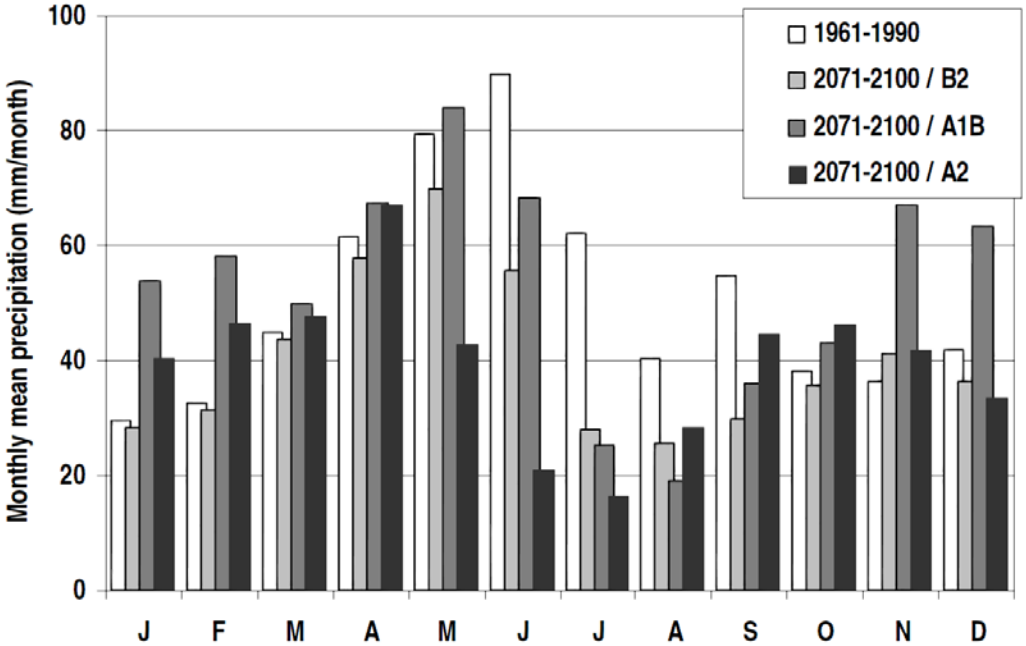


Figure 6.7. Annual distribution of simulated monthly mean precipitation (mm/month) in the reference period (1961–1990) and in the target period (2071–2100).

Source: Pieczka et al

Overall, the model PRECIS predicts a drier climate in the Carpathian Basin. The more pronounced changes will probably happen during the winter and summer months. In case of the empirical probability analysis, threshold values –20% and +20% were selected since two of the presented experiments suggest 20% annual precipitation decrease for Hungary. The empirical probability of the negative precipitation anomaly exceeding –20% in past (1961–1990) climatic conditions occurred in about 40–55% of all the autumn months, and 30–40% of all the months in the other three seasons. According to the PRECIS simulations, a drying tendency is projected by the end of the 21st century, especially, in the summer months (the occurrence of the monthly precipitation anomaly exceeding –20% increases significantly to 70–80% in case of B2 and A1B, and 80–90% in case of A2 scenarios). In the winter a less pronounced frequency increase is expected (B2: to 40–60%, A2: to 30–50%), and in case of A1B even a slight decrease can be seen (to 20–30%).

The empirical probability of positive precipitation anomaly exceeding 20% in the past climatic conditions occurred about 25–35% of all the months throughout the year. A major decrease is projected for the summer months: the probability of wet conditions decreases to 0-20% in case of B2, to 5–15% in case of A1B, and to 0–10% in case of A2. It can be clearly seen that in case of the A2 scenario the amplitude of the summer changes are likely to be larger than in case of B2 or A1B. For winter the changes are less pronounced for B2, but for A2 a major increase is projected in the Transdanubium (from 25–35% to 45–55%) and for A1B scenario for the entire country (to 45–60%), as we mentioned earlier. In winter, in case of A2 the wetter periods are likely to become more frequent in the whole country, while the dry periods will become less frequent mainly in the area of Transdanubium. This finding is even more pronounced in case of A1B scenario, however, valid not only for parts of the country but for the entire area.

6.1.4. Uncertainties of forecast

PRECIS is only one of the four RCMs adapted and used for assessing the regionalclimate change in Hungary. Obviously, these experiments differ in many aspects, e.g., in model formulation, physical parameterization, spatial resolution, driving boundary conditions and forcings. Due to these differences besides the robust future changes suggested by the different RCM results, the uncertainties associated to the estimated changes for the Carpathian Basin can be also assessed. Moreover, previous RCM results based on PRUDENCE outputs (Batholy et al. 2008) and ENSEMBLES outputs (Bartholy et al. 2011) also enable us to evaluate the PRECIS simulations. Compared to these other RCM experiments, PRECIS results for Hungary project somewhat warmer conditions than the mean temperature change of all the available simulation results. The largest seasonal warming projected for summer by PRECIS simulations are consistent with other results (Bartholy et al.2008, 2011). In the case of precipitation projections, the uncertainty is much larger than in the case of temperature. The RCM results often disagree in the sign of the projected seasonal and annual changes, which are often non-significant. However, the summer drying is estimated by most of the RCM experiments, as well, as PRECIS runs presented in this paper. Slightly wetter winter conditions are also likely to occur in the future compared to the reference period 1961–1990. From this sense PRECIS simulations are consistent with the available RCM results.

6.1.5. Summary of climate change impacts on Hungary

The forecast for the climate conditions of the 2071–2100 periods shows that the projected temperature and precipitation changes for the Carpathian Basin can be significant. The main conclusions are as follows.

- The sign of the simulated temperature change is the same for all of the three scenarios, the projected annual temperature increase is in the range of 4.0–5.4 °C. The amplitude of the projected warming is the largest in case of A2, according to which the highest CO_2 concentration level is estimated.
- In all the four seasons significant warming is projected at 5% level in all simulations, the largest warming is likely to occur in the summer (for Hungary the spatial average warming by the end of the 21st century is likely to reach 6–8 °C).

- Not only the mean climatic conditions will change, but also the distribution of the daily (and monthly) mean temperature, implying more frequent warm and hot periods and greater record hot conditions than in the 1961–1990 reference period.
- By the end of the century the annual precipitation in the Carpathian Basin is likely to decrease by about 20% for both A2 and B2 scenarios. The A1B scenario does not project such annual changes.
- Significant drying is projected in the region, especially in the summer (the seasonal precipitation amounts as well, as the probability of occurrence of wetter periods are likely to decrease in Hungary) while in winter the precipitation is projected to increase. The direction of precipitation change in the transition seasons is uncertain, the simulations do not estimate significant changes.
- According to the PRECIS simulations, the annual distribution of monthly mean precipitation is also expected to change. In the 1961–1990 reference period the wettest months in Hungary occurred in May and June, and the driest months were January and February. In the 2071–2100 future period, the driest months are projected to be July and August, while the wettest April, May and June.

6.2. Vulnerability assessment

6.2.1. Agriculture

Agriculture in Hungary is one of the most vulnerable sector. Climate change impacts can have adverse effects depending on land use, agrotechnical and natural characteristics. Besides warming and draught, meteorological extremes can cause significant damage in plantations, livestock and food-, and water supply. Climate change related risks include floods, inland water, draught, heavy rainstorms, sleet, fog, early and late frost, blizzard, hailstorms, heat waves, increase of UV-B irradiation, forest fires, appeareance of new parasites. Figure 6.8 shows the distribution of damages by meteorological source in agriculture in Hungary. It is well visible that draught is the single most harmful impact, the second is hail.

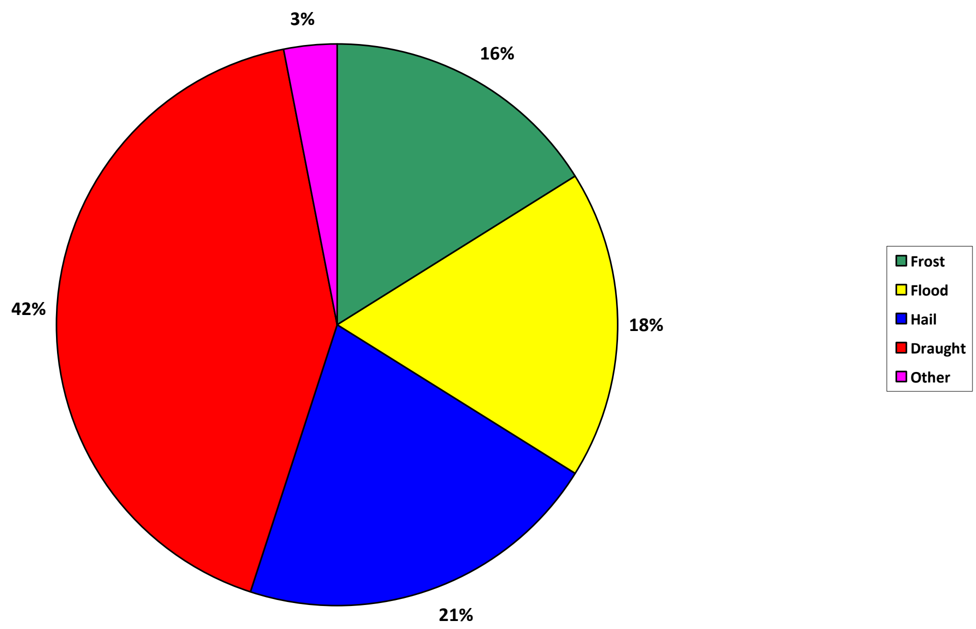


Figure 6.8. Agricultural damages by meteorological events

Source: Association of Hungarian Insurance Companies,

The fundamental conditions for agricultural production are soil and water, adaptation strategy has to be based on the changing ecological parameters. For the Carpathian basin, water and natural precipitation has to be kept in the soil and circulated. Facilitatation of water reserve development and replenishment of the missing surface water supply is vital both becauses it yields safety in production and because it provides an efficient tool to tackle water related anomalies (drought, floods). Land use has to be revised and the structure of agricultural production adjusted to host more sustainable and efficient acitivities, technical-technological modernisation of cultivation is also recommended.

An important element of the adaptation to the extreme lack of water is the selection of the best cultivation method regarding the actual state and conditions of the area. In areas inflicted by drought the competition for water is expected to sharpen.

Area inflicted by inland waters is enormous, reaches 4.4 million hectares of which 2.7 million is intensively cultivated. This roughly amounts to 41% of the total area cultivated. Since 1940 only three years can be accounted as periods without defense against inland water. It has to be emphasised that water storage in soil, efforts agains flood and inland waters, as well as reformation of the soil cultivation can also prevent formation of floods. Low height areas with inland water have to be removed from cultivation, subsidisation has to be adjusted to support multicriteria optimised land use.

Hailstorms are yet another important threat, their share is 21% in total damages inflicted by nature in agriculture. Areas with largest risks are Tolna-Baranya counties (approximately the middle of Hungary) and the Duna-Tisza interim region. Risks were slightly reduced in the historical wine producing regions and orchards by applying several methods of defense, e.g. iceweb, ice cannon, paraffin-canister frost defense, antifrost irrigation, and foilcovers.

Adaptation of agriculture can be significantly improved by increasing water supply reserves. The creation of water reservoirs, enlargement of managed lakes, utilisation of flood water reserves for irrigation, enhancement of biodiversity by integrating nature protection and agricultural goals through utilising flooded areas and areas protected by summer dykes professionally. Irrigation has to be implemented with the restoration of earlier systems and installation of new systems primarily in the areas with good soil quality, valuable plantations, foil and greenhouse productions, vegetable plantations and at certain technological phases (levaning). Irrigation is considered to be feasible only as a local solution for production branches with high added value. In most of the domestic landscapes the harmonisation and planning of water requirements, concise land organisation and management targeting water infiltration and plantations with low water needs. Additionally conventional methods of household irrigation have to be re-discovered (collection of rainwater with various utensils).

Similarly to human health problems, parasites, pests and weeds can spread easily. This can be accompanied by the gradual crowding out and extinction of indigenous species. The best approach might be to understand natural processes better and apply near nature methods (succession, grazing of invasive weeds, enhancement of biodiversity, aiding self defense of indigenous bioms).

Animal husbandry reacts according to the livestock and method of husbandry involved, intensive animal farming is the most vulnerable, as these livestocks are very sensitive and can react to shocks with immediate decrease of yield. Certain traditional livestocks (grey cattle, mangalitsa (swine), ratska sheep, churlish chicken) have better genetical characteristics and better adaptation skills due to extensive farming. Another factor to be considered is the probable increased need of livestock for shade and water. When subliming new types adaptation to climate change, related issues have to be considered besides other quantitative and qualitative factors. On the other hand, farming methods have to be reshaped towards more appropriate methods.

Hungary is characterised by drought, the last century has seen 28 years with drought. It is frequent that in the same year flood, inland waters and frost are present. Climate change raises the question of food supply security very sharply. In critical periods this can lead to increased import dependence, while demand also increases in countries poorly endowed with resources for food production, leading to a surge in the expected price of imported food. Risks in food supply can be reduced by enhancing domestic plantations abilities to adapt.

6.2.2. Housing and Inhabitation

The largest threat to the built environment and settlement infrastructure is posed by heat waves, torrential rains, accompanying storms and increased wind speed. Human population working and inhabiting buildings are threatend by the increased strength and higher frequency of heat waves. Impacts of climate change are significantly influenced by the characteristics of building stock and settlement structure. With proper policies and conscious urban planning, negative impacts can be reduced.

Building stock

As shown by several analyses, the frequency and strength of heat waves will increase. This means that periods of higher temperature will be more frequent and last longer. This does not directly affect building stock but means a high risk for public health. Defense against heat actively (air conditioning, ventillation) and passively (orientation, shading) are the cornerstones of adaptation and to be considered by the regulatory authorities in the future when deciding and authorising new constructions. Air conditioning transfers the heat to the outskirts of the buildings, leading to the formation of heat islands in densely built areas. Cooling equipment on the facades increase the heat load of the neigbouring buildings, leading to a chain reaction of installation of similar equipment resulting in increasing GHG emissions and energy consumption (and a higher peak load as a burden on the power grid). Air conditioning has to be therefore installed with proper care and in the smallest possible extent preferably on the top of the buildings.

Increase in maximal wind speed and higher frequency of storms pose a direct physical threat on building stock, mostly for facade and roof structures. Besides apertures and insulation elements, elements protruding outwards (antannea, electric wires) are vulnerable. Urban infrastructure and street plantation (trees) can also cause serious damage in a strong tempest.

The increasing weather extremes make sudden large rainfalls more likely. The harmful impact is influenced by the geomorphological characteristics, vegetation cover, condition and transmissivity of water drainage systems, settlement structure and location. In the hilly areas sudden floods, in plains inland waters can be expected, some areas can suffer landslides and soil deformations leading to damages in building stock. The most important is to develop a drainwater treatment method and revise and strengthen the construction regulations.

Special attention has to be paid to monuments and historical buildings which due to their high age are more sensitive to precipitation, extreme wind and parasites attacking their organic components.

Some geological perils can also be intensified by climate change impacts, especially loessial walls and river walls have to be fortified.

6.2.3. Transportation

Vehicles, commuters, traffic and transportation infrastructure are all negatively effected by climate chage. Heat waves put extreme load on drivers as temperature inside the vehicles can be multiple centigrades higher than outside. Heat in tunnels and heat equalisation between surface and under-surface cause severe problems for vehicles moving underneath the surface.

This makes the improvement of cooling and ventilation in vehicles imperative. In personal traffic high temperature causes traffic safety problems, therefore attention has to be paid to informing drivers on the road.

Summer months can bring increased damages in the asphaltous road cover, trails can develop in heavy truck wheelbases negatively influencing traffic and leading in some cases to road closure. The overheated road cover can further increase the temperature of urban areas. Rails are also likely to deform and warp in hot temperature. In road and railway design the increasing temperature and more frequent heat waves have to be considered. It is advisable to make pavements and roads more heat resistent and wherever it is possible replace asphaltous cover with less heat containing materials (concrete, pavestones, etc).

In the winter months slippery roads and fog can impair road conditions and visibility. Temperature oscillating around frost point can heavily damage road surfaces as melting and refreezing humidity leads to an increased density of potholes. Snow cover can also form road obstacles if snowfall is extremely high.

Traffic is endangered by increasing floods and storms, riverside or flood area roads can come under watercover and underground traffic is also endangered by floods. Roads and sidewalks can be under water for longer periods or be completely washed away by highland waters flooding downwards. A further problem can stem from sudden rainfalls undercutting road and railway embankments leading to occasional landslides. Enduring drought can on the other hand lead to sinking of these architectures. Severe storms can also harm traffic lighting and safety equipment, lightning in summer can endanger railway safety equipment.

During heatwaves the smog is more likely to occur under heavy solar irradiation and traffic emissions (NO_x, CH, CO) and low wind speeds. To prevent this, it is of fundamental importance to cut emissions from road traffic. An efficient method is promotion of communal transportation and reduction of individual traffic needs.

6.2.4. Waste management

Waste management is one of the less involved sectors in climate change impacts. The greatest challenge is the safe operation of the existing waste disposal sites as changing precipitation patterns influence operation of waste disposal sites and wastewater-treatment sites. Increasing health and epidemic risks also have to be mentioned, and a special area is the waste containment areas, landfills, slurry and sludge reservoirs which store a significant amount of waste and can be a starting point for ecological catastrophes.

Insulation of waste disposal sites was undertaken with the consideration of contemporary conditions in mind. However, climate change can cause an escalating erosion, groundwater level change can lead to changes in soil mechanics and movements causing stability and insulation problems in the disposal areas. Wind change can harmfully intensify dust disposal and spillage in the surrounding locations. Solutions include risk assessment and individual measures like improvement of physical defenses and development of monitoring systems.

6.2.5. Energy infrastructure

When considering vulnerability of energy sector it can not be ignored that energy supply is the cornerstone of our modern societies and a basic ingredient of our economy. Thus the propagation of smaller impacts can have a large aggregate impact on the economy as a whole.
The primary challenge for power plants is change in demand. Due to milder winters, the heat needs (primary natural gas consumption) are expected to lessen, while in the summer the surge of power demand (for cooling purposes) is foreseen. Estimations show 100MW increase in power demand per every centigrade increase of temperature.

Coolant demand of power plants also changes. Available coolant temperature has significant technological impact, a gas turbine based power plant can loose 15% of its output for an increase of 5 °C ambient temperature under certain operational conditions. Changing yield of rivers might also influence power plants by reducing e.g. the available amount of coolant and can in extreme cases lead to a halt of turbines. Road and rail transportation of solid fuels (lignite, firewood, hay) can be affected by climate change inferring safety-of-supply problems.

Climate change will influence renewable energy availability but there is a high level of uncertainty in the direction and magnitude of variance. Solar energy can be influenced by global irradiation and cloud cover changes. Applicability of hydro power will be determined by river flows, wind energy by wind changes. Renewables based on agricultural wastes are subject to uncertainty as their yield (especially those based on the production of corn, hay, rape, firewood and woodchips) and price might be affected to a yet unknown extent by climate change.

Systems of energy transfer and public infrastructure are also subject to increasing risks. Storms with strong wind gusts threaten aerial lines, transformers, increased precipitation might underwash supporting structures. Winter frost, wet snow cover and sleet can cause increased load on aerial lines, more frequent forest fires. Floods on endangered locations can all add to increased vulnerability of power grid elements. More frequent summer temperature extremes with higher values in urbanised areas increase power system peak load leading to power surges and power cuts together with decreasing transmission capacity of the power lines (increasing resistance with increasing heat).

6.2.6. Tourism

Tourism plays an important role in the domestic economy. Climate and weather can be considered as the primary resources of tourism as they fundamentally define the attractivity of an area or region. Beneficial or poor climatic conditions set the range of touristic activities and influence supply side of tourism. Change of climate can reduce the activity level of a given branch of tourism or can lead to complete oblivion of a given acitivity or on the contrary, can create new opportunities. Climate conditions primarily effect outdoor activities (e.g tourism, skiing, etc.), climate however has a significant impact on traveling patterns. Tourism is a dynamic open system integrated in the socio-economical environment and the interaction is mutual.

- Direct interaction is through weather changes which simultaneously influences demand and supply. Extreme weather and shifting seasons change potential prospects of tourism industry leading to new preferences and decisions. Market restructuring, change of products, services and destination is expected. Direct impacts are also notable through GHG emissions from tourism as related services significantly add to the global emissions.
- Indirect mechanisms are through changing natural resources like biodiversity, water base, landscape which can influence certain types of tourism. Public health risks have to be emphasised as modification of mean and extreme temperature, drought or floods increase the probability of epidemics and diseases.
- Impacts can be perceived by decision makers on economical social and political relationships. Policymakers can start to constrain tourism in some cases. The promotion of tourism to aid economical development can also lead to severe political problems once turnover from tourism plunges. Indirectly it can promote other global problems as poverty or terrorism which in turn can impair tourism in a region further.

It is important that tourism is not solely effected by climate (heat waves, weather variance, frequency of storms) but by natural impacts caused by climate change (biodegradation, invasive species and socio-economical impact (epidemics, energy and drinking water availability and pricing). Climate friendly tourism conciously prepares for adverse effects from climate change and weather change while striving to reduce GHG emissions. In those regions where tourism is a major source of income diversification of economic activities can be one of the most important adaptation measures.

6.2.7. Public security

Threats from climate change makes it a central element in public security concerns. In Hungary the following tendencies and adverse impacts can be expected.

- *Safety of infrastructure and public utilities*. Variability in surface water levels increases erosion in dams, dykes and defense lines, inland waters, floods threaten settlements, traffic and critical infrastructural elements. Winter months can bring blizzards paralysing the traffic in complete regions, while low precipitation can endanger water supply. Extreme weather events (e.g. storms) endanger telecommunication infrastructure and control systems, impairing data transmission and Internet availability.
- *Industrial security*. Certain resource intensive industries are negatively effected by lack of water, increased cooling needs, increased CO_2 abatement costs and changing consumption patterns. Sudden flood like rainstorms (flash-floods) can endanger hazardous waste disposal containers and reservoirs and cause contamination.
- *Ecological safety*. Shifting of climatic belts, appeareance of Mediterrenaen and subtropical conditions adversely effect biodiversity. Species of water habitats, grasslands and forests are endangered.
- *Human health and food security*. Increased length and intensity of heat waves and drought cause appeareance of diseases, contagion and epidemics endangering national security. Drought in addition infringes on food supply and food security together with extreme variance of precipitation affecting irrigation and soil erosion. Plant cultivation, animal husbandry, game management and fishery are all subject to increasing risks. New parasites and pests and food related diseases appear.
- *National security*. Indirect impact is the migration from countries effected by severe climate change risks. Climate change can make Hungary a global migration target.

6.3. Adaptation measures

Elements of adaptation to climate change are laid down in several strategical documents of the Hungarian Government, notably the National Water Strategy, the National Rural Development and the National Health Strategy.

6.3.1. Human health

New risks from climate change make adaptation in our life expedient. Based on the recently drafted adaptation strategy of Hungary, human health related adaptation measures are as follows.

Short-term measures

- Institutions with higher headcount should compose an action plan and a set of criteria. Workplaces with external activities should introduce safety rules and health precautions in reponse to heat anomalies.
- Pest and disease penetration has to be controlled as new epidemics already appeared in Hungary (vectors carrying Lyme-disease, West-Nile fever, Dengue-fever, Dirofilaria immitis are already present in the region). If necessary, locations have to be monitored and pests have to exterminated.
- The extension of the already operating, capital city based Climate Health Network to the country level in order to monitor environmental health and patients with high risk illnesses. Preparations have to be made for emergency situations and fast response has to be practiced. Standardised forewarning

systems have to be developed and emergency health care conditions have to be improved with regards to catastrophes.

- Awareness raising, education and information dissemination among social and healthcare personnel about climate change and health related problems in educational institutions. Awareness of the population has to be raised by the mass media and preparation of educational leaflets and booklets. Possible and potential threats have to be regularly communicated (campaigns organised) with the involvement of NGOs, churches and municipalities.
- Best practices have to be shared, research results, data, information, technologies and tools related to climate change have to be put in the commons. Public healthcare has to be provisioned with information, tools, advices using WHO leaflets and educational materials and domestic experience.

Middle-term targets

- Food security measures have to be extended in order to tackle indirect impacts of climate change. Environmentally and socio-economically sustainable food production and distribution has to be ensured with food safety as focus. For this, legislation has to be revised and strictly monitored using an appropriate institutional background. Protection of water base and improved water quality control in extreme weather conditions put increased burden on the system of water supply.
- Healthcare systems have to be strengthened to prepare for climate change impacts, especially to extreme weather conditions. Internal organisation and operational system has to be revised to integrate climate change adaptation criteria. For succesful adaptation healthcare institutions have to be modernised, insulation and cooling are of primary concern.
- In defence prevention has to be emphasised over intervention (ambulance, treatment, rehabilitation). Additional vaccination has to be introduced and vaccination practice has to be revised. Development of vaccines has to focus on new molecular genetical methods.
- A complete inventory of human illnesses and diseases from climate change impacts has to be composed. The stakeholders have to be reached with preventive measures. Disease vectors (species as vehicles of illnesses) have to be enlisted and methods have to be developed to slow spreading and to thin the numbers of carriers and localise epidemics.

Long-term guidelines

- With the consideration of its actual extent climate change has to be fully integrated into human resource management and social policies.

6.3.2. Water management

Climate change is a challenge for water management as uncertainty is high concerning its speed and extent. Past records don't provide sufficient guidance and other complex interactions exist which are yet not fully understood. Climate change as an increasing risk has to be dealt with even if probabilities of severe incidents seem to be low. As the short run changes from climate change are not decisive, there is time to take the relevant adaptation measures. Preparation can not be delayed however as impacts are already present and can be significant if an adverse climate scenario is realised. Consultation and public debate is also a time consuming process followed by legislation and ratification necessary for concrete actions to take place.
The short term adaptation concepts for water management are as follows.

Short-term measures

- The improvement of the Vásárhelyi Project has to be implemented. In all areas the shallow water floodplain management has to be supported. Farmers have to be aided with consultation, awareness raising and education to promote sustainable landscape use.

- Regular implementation of tasks from the Water Directive has to be ensured to make the quality and quantity of our waters acceptable. Regular revision and adjustment to changing climatic conditions have to be undertaken for water reserve management plans.
- Water drainage has to be replaced with water recycling systems. Regional, natural protection, agricultural and water management planning have to be integrated to initiate sustainable land use practice and pilot projects as soon as possible.
- Land use has to be revised and adjusted to the changing ecological and climatic conditions. Floodplains and areas inflicted by inland water have to be moved out from cultivation or utilised according to their characteristics (land use change, subsidisation). A natural way of water replenishment has to be developed, small region rehabilitation, forest and water habitats role in water conservation has to be further examined.
- Floodplains pilot projects on landscape management have to be developed in appropriate areas.
- Water saving technologies in irrigation have to be disseminated in agriculture. Growing irrigation needs will require the maintenance and development of present water supplying infrastructure. Conveyance losses have to be reduced.
- Risk of water quality variation from flash floods has to be reduced, small-scale nature friendly wastewater decontamination systems have to be installed in areas where large wastewater management facilities are unnecessary.
- Water friendly technologies have to be developed for all areas of use. The economical and legal framework supporting balanced water use has to be framed.
- More detailed analysis is necessary to assess the expected impact of climate change in waterstreams and hydrological characteristics and possible interactions.
- Extreme flood events and their increasing frequency has to be understood. Past trends and flood levels have to be explored, risks have to be mapped. Possible locations for hydrological reservoirs have to assessed in hilly areas. Hydro reservoirs impact on floods have to be examined (flood mitigation, smoothing).
- Municipal water management has to be examined from climate change vulnerability aspects, excess water reserves have to be found, settlement level flood risks have to be identified. Increased wastewater treatment demand has to be explored.
- Possible alternatives to adaptation measures have to be revealed for all possible climate change scenarios. Costs and feasibility have to be assessed to see what the drawbacks of delayed action or inaction can be. Measures with potential benefits aiding adaptation (win-win) have to be identified (water demand control, environmental protection).
- A system of indicators and monitoring has to be developed to track climate change impacts on water quality, water management and water flows in order to provide decision makers with a better founded and more realistic approach to the problem.
- Additional adaptation procedures have to be enlisted, best practices demonstrated. Adaptation measures serving double or multiple benefits have to be identified which can be useful even if climate change does not occur in the expected way or extent.

Middle-term targets

- Water restraining management has to be introduced, hydrological cycles in small regions have to be restored.
- Floodplains pilot projects for land management has to be extended to deep flood areas reactivation.
- Watercourses have to be examined. The Danubian watercourse has to be maintained under international treaties but this does not always adhere to criteria of sustainability. Watercourses are supported by many economical and environmental considerations, as well as there are many arguments maintaining waterstreams natural conditions.
- Forecasting of growing water demand, adjustment of demand side mangement to growing needs – shrinking reserves to ensure long term sustainability.

- Monitoring has to be developed to track water quality, water management and water flows. The complex hydrological consequences of climate change has to be explored in the region with special regards to international cooperation on Danube and Tisza rivers.
- Establishment of proper quantity and good quality of waterstreams until 2027. Full scale integration of natural, agricultural and water management planning to develop a sustainable land use pattern.

Long-term objectives

- With the consideration of its actual extent, climate change has to be fully integrated into water management policies and international arbitration and policy considering negotiation of water resource sharing on the long run.

6.3.3. Agriculture

Adaptation of agriculture is aided by sustainable and profitable land management practices complying with location characteristics. These do not burden natural resources and the environment, save water and economise on energy, build on location specific knowledge, traditions, reduce GHG emissions and prevent erosion. Development and dissemination of such practices is thus one of the capstones of adaptation.

Mitigation of climate change related damages in agriculture

- *water restraining management of waterstreams, landscape and irrigation*
- *improvement of biodiversity*
- *domestication of versatile, resilient quasi-natural plantations (orchards, agro-forestation systems, extensive plantations)*
- *development and use of species resistent to extreme weather events*
- *using methods requiring less soil mechanics, e.g. mulching,*
- *forest belts, biotopes, forestation, increase of green cover*
- *greenhouse and foil plantations*
- *insulation and cooling of stables and other livestock housing, shade creation*
- *preparation of pest control and animal healthcare*
- *incresed efforts in relevant research areas, support of farmers with consulting and knowledge transfer*

When examining adaptation responses the starting point is the change of paradigm in agriculture. Mitigation of harmful impacts of globalisation, substitution of industrial methods endangering the fundaments of rural existence, repopulation of decaying rural regions are important objectives besides adaptation to climate change impacts.

Sustainable land management methods complying with locational endowments will economise on natural resources, will not put an excessive burden on environment, will be conserving water and other inputs, will rely on knowledge and provide economically feasible solutions on the long run. In addition such methods would reduce GHG emissions, slow erosion, save energy thus their development and dissemination is a key element of adaptation. Development of such systems would require the in-depth transformation of economic and social processes of rural life. The framework which includes adaptation tasks is set in the National Rural Strategy. The following actions can be considered along these guidelines.

Short-term actions

- The appropriate land and landscape use has to be emphasised, by adjusting production to changing climate and ecological conditions. Landscape use has to be adjusted to increasing weather extremes to locally mitigate those.
- Growing need for water has to be considered in agricultural adaptation. Doubtlessly fresh water (for irrigation and for drinking) is available in limited amounts globally and its value will rise sharply. Survival of the populace depends on potable water which rivals with irrigation needs – this has to be resolved. The domestic and regional water needs have to be carefully assessed, planned and regulated.
- It is imperative to aid utilisation of precipitation by promoting its admittance to and sustainance in the soil. On lowlands measures can be taken to loosen soil structure, on lands regularly covered with inland waters plowing has to be stopped. These latter can be utilised as water inhabitats or be afforested supported by a subsidy scheme to be developed.
- In areas threatened by drought, nature friendly hydrological solutions (storing of excess supply from floods, floodplains land management) have to be found besides developing plant species resilient to weather extremes. Areas with the most severe expected impact (the middle and southern regions) should apply water restraining measures and restore water habitats. Plantations with high water requirements should be replaced with other less water intensive cultures.
- For irrigation only high added value agricultural purposes should be considered as the price and availability of water will force us to abandon inefficient solutions. This implies that only a fraction of our arable lands can be irrigated on the long run. Existing irrigation systems will have to be revised and new ones installed where deemed economically necessary. In such locations new environmentally sustainable water efficient irrigation systems can supply households, industries and the ecological needs either.
- Groundwater level should not be raised over critical levels especially where diluted organic compounds are over 500 mg/l to avoid soil salinisation. Proper water management practices, soil cultivation and indigenous plant cultures can aid this goal.
- Areas prone to acidification should be aided by selecting appropriate plantation species and management. Adaptive soil cultivation and fertilisation shold be used to prevent further deterioration.
- Modern technological skills and techniques coupled with the revival of the traditional knowledge of the landscape can improve adaptation in all fields of land management.
- Strategical steps in adaption are connected to technical-technological steps: reduction of the number of technical phases of operation by merging or omitting some. Application of energy and material efficient equipment and machinery using precision agrotechnologies and intelligent machinery. Damages from extreme weather can be mitigated by certain defense measures like the improvement of production flexibility and inclusion of new activity profiles. This also aids adjustment to changing market demand, providing a more balanced income structure resulting in more profit.
- Biological research has to be further pursued in order to create new species which are more resilient to draught and weather extremes. Indigenous species have to be involved in research and production using existing gene banks.
- A decision support system based on the national geoinformatical system on adaptation (NATER) has to be developed supplying drought related information. Meteorological information, alerts and forecasts have to be communicated to farmers and land managing entities.
- A prognosis of soil quality development has to be undertaken in the framework of NATER on the local level based on geographical, meteorological, geomorphological and pedological information. The necessary soil defense measures have to be identified to promote adaptation to climate change impacts.
- Professional consultants and advisors have to be trained to deliver the institutional background of the adaptation strategy. These experts have an important role in education, practices and demonstration

by repetitively returning to locations and dealing with accute problems and questions. The training of these experts is the first task in equipping them with the knowledge about prevention, preparation, defense and mitigation measures.

Mid-term targets

- Backup sources of water supply have to be developed by e.g. creating multipurpose water reservoirs, enlarging lake farms, using emergency flood reservoirs for landscape management. In addition using bogs, marshes, polders in a concise manner by extending grass and forest management and restricting tillage.
- Agricultural products simultaneously play a strategic role with biomass under adaptation. A goal is the fullest possible utilisation of organic materials produced with a minimalisation of waste and recycling them in the organic cycle of the soil. Another goal is the minimisation of GHG emissions and other pollutatns. Renewable energy production should be increased primarily in the form of biogas production with localisation which can result in 70-80% of costs saved.
- Capital scarcity in farming and management and ignorance of landscape characteristics in production structure (supported partially by the present subsidy system) might put excessive burden on farmers and insurance companies and the state in the case of agricultural damage and disaster. Probability of damage occurrance will increase as weather extremes become more frequent. The adaptation strategies therefore consider insurance policies as a vital element. Insurance should be multiparty and preventive and should aim at self-care. The agricultural insurance system should be put on a new basis and should be harmonised with subsidy based economic signals.
- Adaptation could be aided by installation of precision farming technologies which help reduce expenditures and environmental harm by applying GPS guidance.
- When breeding livestock, resilience to long term climate change impacts should be an important parameter besides qualitative and quantitative parameters.

Long-term objectives

- The extension of the integration of systems of local production, local production local consumption.
- Actual impacts of climate change as a constraining condition should be integrated fully into rural development and agriculture.
- A long term goal is sustainable agricultural production in the territory of Hungary. In this perspective farmers would disturb natural cycles only minimally targetting reproduction. Only those interventions (chemicals, fertilisers, medication, irrigation) would be used which don’t endanger such cycles and satisfy food demand at a favourable cost-benefit rate.

6.3.4. Forestry

Adaptation tasks and measures concerning natural protecion are conceived in the National Natural Protection Plan, in natural protection management plans. Forest management related tasks are in the National Forest Programme and its executive frameworks. Based on these the following are the short term adaptation measures.

- Revision of the National Forest Programme according to the climate change objectives. Increasing of forest cover should be accomplished according to the National Afforestation Programme considering changing climate conditions. Indigenous species should be used or species indicatively assigned as appropriate by dedicated research.
- Reduction of forest incendiary risks, preventive measures against forest fires. Restricting most flammable plantations from areas under highest risk of fire.
- Sustainable forest management through utilisation of technologies which improve forest resiliance and stability against climate change impacts including fires, pest and storms.

- A comprehensive green infrastructure should be created which consists of natural and restored ecosystems providing sufficient biodiversity and transmigration.
- Restoration of water habitats hydrological restraining capabilities and elaboration of possible water replacement schemes.
- Development of a pilot project of ecosystem based adaptation. Amphibous areas should be reactivated by draining water and formulating a compliant land use. Increased consideration of ecological aspects in reservoir and foreshore operations.
- Assessment of climate change impacts on forest habitats, forest micro-climate. A geospatial model should be developed for forests which presents possible scenarios for forest cover zone changes, soil impacts and expected migration of typical species.
- Explorative analyses should be prepared for climate change and anthropogenic impacts on the biosphere, measures reducing vulnerability and improving adattation should be identified and assessed from cost-benefit aspects. These should be integrated into natural protection plans.
- Vulnerability assessment should be prepared in the framework of the national afforestation programme (NATER) for the most important habitats and their key species. Indicators should be quantified on expected impact and adaptation abilities.
- Improvement of monitoring activities in natural protection areas to improve assignment of protected status.
- Information dissemination and awareness raising should focus on ecological impacts of climate change and services from ecosystems. This should appear in public education and public awareness acitivities.

Mid-term actions

- Development of models for forest managers which consider the long lifetime of forests and the compliance with sustainable economic development.
- Elaboration of defense concepts and initial recommendations for uncultivated areas (hedges, tree lines, bounds) in order to maintain and improve their natural condition.
- The revision and replanting of vulnerable forest areas with new types, the revision of the central 10 year forest plan, and the restoration of areas struck by natural disasters.
- Maintenance or revival of conventional landscape management (grazing, reaping) methods, revitalisation of small streams and their shores. Increasing subsidisation of these activities.
- Preservation of local gene sources and selection of those genetical assets which are the most adaptable to future growth conditions. This includes use of new species or variants.

Long-term guidelines

Actual impacts of climate change as a constraining condition should be integrated fully into forest protecion and natural protection policies.

- Pursuing a forest management practice which results in a continous forest cover and considers natural forest dynamics.
- Preservation of game stock at a level which does not hinder natural restoration in the long run.
- Low density groove forests in forest steppes.
- Preservation of heterogenity, diversity and of several development phases.

6.3.5. Urban planning

Urban areas and buildings and settlement structures are mostly endangered by extreme weather (storms, precipitation, wind). Impact of heat waves are mostly public health related, yet the design of new buildings, the organisation of settlement structure can significantly decrease these threats. Elements on adaptation and detailed tasks should be included in the National Reorganisation Plan, the National Traffic Strategy, and the National Waste Management Plan according to the following directions and measures.

Short-term actions

- Revision of the regulation of construction design and area use from the aspect of climate change, their strict and consequent enforcement.
- Detailed list of adaptation measures effecting built environment and settlement development. Development of recommendations on waste management and traffic infrastructure.
- Survey of landslide endangered areas and revision of relevant reoganisation plans, construction regulations. Prohibition of construction activities on such areas and recommendations for aleady built in areas with the danger of landslides.
- Survey of endangered museal values and monuments, identification of intervention points, action plan on reconstruction of historic monuments to make them resistant to climate change.
- Harmonised development and reorganisation plans for settlement-ensembles (agglomerations, agglomerating regions, farm regions) most vulnerable to climate change.
- Incentivisation for alternative environment friendly modalities of individual transport.
- Enlargement of urban green areas and networks, reduction of paved surfaces.
- Program for tree seating on roads and in parks to provide heat shields for traffic infrastructure and reduce urban heat islands.
- Reduction of motorised traffic needs and servicing demand with more efficient and sustainable means.
- Comprehensive vulnerability assessment for building stock, road network and public utilities.
- Revision of existing and potential waste disposal sites to comprehensively assess possible risks of climate change.
- Continous information of construction industry on climate friendly materials and design.

Mid-term targets

- Elaboration of a proper regulation to promote use of more heat resistant road pavement materials.
- Integration of adaptation and sustainability in settlement development planning and construction industry standards and documentation.
- Establishemnt of a system of green areas which help ecological migration and aid ventillation of settlements and reduction of heat island formation.
- Preparation of communal transportation to extreme weather events (heat waves, floods, storms), identification of areas of intervention and development of an action plan.
- Adaptation by new construction methods and solutions in the construction sector as a response to climate change issues (heat waves, extreme weather, storms, floods, etc.). Preparation of existing stock for extreme events and water supply problems.

Long-term objectives

- Actual impacts of climate change as a constraining condition should be integrated fully into settlement planning and urban development policies.
- A well articulated and compact urban structure should be promoted which considers adaptation needs by green surfaces and areas aiding ventillation.
- The proportion of built-in area should be reconsidered in agglomeration and weekend house zones and merger of settlements should be blocked, multicentrality should be supported.

6.3.6. Energy infrastucture

Climate change directly influences energy production and utilisation methods and demand for energy. Adaptation goals should be defined considering the following steps.

Short-term actions

- Climate change risks should be integrated in power system planning. Vulnerability should be considered in horizontal (interactions with other sectors) and in vertical (a given supply chain, consumption effects) terms.
- Information acquirement and impact assessment on production and distribution safety. Identification of actual impact chains and their systematic evaluation.
- Revision of infrastructure by extending available methodologies (auditing, qualifications) with climate change related criteria.
- Revision of weather dependent renewables (primarily solar, wind and biomass) from the aspect of availability, stock and sustainable utilisation considering expected climate change impacts.
- Awareness raising, knowledge sharing and best practices dissemination.

Mid-term targets

- Revision of measures considering actual impacts of climate change, further modification of legislative criteria.

Long-term objectives

- Electrification of transportation and traffic with intelligent (smart) urban public utilities, full scale integration of climate change as a constraining condition in energy policy.

Urban planning
Urban structure significantly influences climate conditions of settlements. The proportion of building cover, pavements, location of parks and greenery, morphological characteristics and physical organisation of towns together with the horizontal and vertical structure. The area with covers and natural ventillation of roads and streets are also important factors in the microclimate of a city and have a deterministic role in adaptation to climate change. The adjustment and transformation of settlement structure can reduce the negative impacts from climate change on the population, building stock and infrastructure. With urban policies and measures efficient adaptation can be achieved.

It is vital to secure cross ventillation pathways where suburban fresh air can flow to the downtown cleaning and cooling urban air. Attention should be paid to building density of agglomeration settlements and to the preservation of forests and agriculutral areas on the city perimeters.

Securing cover is another important measure against heat, with proper shielding and shadowing (e.g. alleys, plantation, definition of building height and position, etc.) heat waves can be significantly mitigated. Increasing the proportion of green cover and reducing pavement area is yet another step towards this with the simultaneous benefit of reducing heat islands formation and thus improving settlement water balances.
Some additional areas effected by urban planning are typical distances in city traffic, energy need for heating and air conditioning and vulnerability of city environment.
Largest vulnerability is expected in towns and farm regions. Towns are mostly sensitive to heat and weak ventilation, while farm regions lack healthcare and social infrastructure and lower income of inhabitants prevent or delay adaptation.

6.3.7. Tourism

We can consider tourism as an area where climate is a direct resource. The following adaptation measures are foreseen.

Short-term actions

- Elaboration of climate friendly tourism strategy based on relevant domestic findings and sustainability and adaptation indicators.

- Practical applications of adaptation studies made for domestic tourist regions. Further evaluation and assessment of stakeholders' adaptation potential.
- Strengthening of awareness raising activities. By informing stakeholders their participation rate and motivation can be improved. A climate friendly trademark has to be introduced. Guidances have to be prepared for adaptation requirements in supplied tourist services.

Mid-term targets

- Methodology of risk assessment and analysis has to be elaborated and applied in destination management.

6.3.8. Public safety

According to many sources, climate change can be a dominant threat in the next 100 years in national security. Public safety and national defense as an institutional background provide emergency services. The new challenge of climate change requires additional actions as follows.

Short-term actions

- Early forecasting and tracking ability has to be improved.
- Scientific and professional organisations have to be involved to improve understanding.
- Information dissemination has to be started, defense has to be organised, preparations have to be made.
- Strengthening of capabilities and assets of public defense, internal security and national defense to ensure ability to deal with environmental risks and provide appropriate adaptation responses.
- Operative framework of public health, internal safety, police and regulatory forces to deal with epi demics and diseases.
- Integrated and operative civil defense has to be organised to handle massive road accidents, road congestations, energy supply problems in extreme weather events.
- Climate safe reconstruction or refurbishment of buildings and institutions of high national security classification. Enhancement of water and energy supply safety.

Mid-term targets

- Elaboration of a complex (infrastructure, transportation, rural development, internal safety) defense framework of settlements, critical infrastructure, agricultural and fores management.
- Preparation for global climate-migration. Migrants leaving their domiciles migrating en masse towards developed countries will need a complex set of actions from governmental, diplomatical, internal safety institutions.
- Demographical consequences of climate change on the Carpathian-basin have to be assessed to map internal migration.

Long term objectives

- Climate change as a constraint on our development has to be considered and integrated fully to our national security policy.
- Preparation and organisation of defense has to be initiated to be able to repell a full scale direct military conflict or indirect economical and political attack to gain control of arable land and freshwater reserves.

6.4. Available measures for the execution of the National Adaptation Strategy

The following table summarises the available measures for stakeholders in adaptation tasks.

Table 6.2. Available adaptation measures by stakeholders

Stakeholders	Measures
Governmental organisations	• Appropriate legal framework • Applications and program structure • Institutional background • Empowerment of regulatory and monitoring organisations (authorities, offices)
Local and regional governments	• Local ordinances and financial incentives (e.g. taxes) • Climate friendly settlement organisation and area development • Climate conscious management of municipal companies • Municipal associations
NGOs and churches	• Organisation of local community respecting traditions and local values • Information dissemination, awareness raising • Demonstration of best practices
Households	• Formulation of conscious consumption patterns, purchase of local, sustainable products • Economising with resources • Preparation for expected impacts, learning to apply defense techniques and solutions
Business sector	• Climate conscious revision of business plans and business standards • Accepting and incorporating climate innovative solutions in corporate strategies • Voluntary agreements with local stakeholders for adaptation
Media	• Information dissemination, awareness raising • Advertising best practices and disseminating new sustainable behavioural patterns
Education	• Upbringing and education for climate friendly behaviour • Integration of climate change vulnerability, mitigation, and impact assessment in education • Vocational training

Table 6.3. gives an overview of expected sectoral vulnerabilities and adaptation measures.

Table 6.3.Summary of information on vulnerability and adaptation to climate change

Vulnerable area	Examples/comments/adaptation measures carried out
Human health	Vulnerability: temperature waves causing heart and respiratory problems in urbanised areas, appeareance of new pests and diseases Adaptation: preventive measures, healthcare development, formation of air conditioned shelters, vaccination and improved R&D in the field
Water management	Vulnerability: droughts threatening freshwater supply, floods threatening water defense lines and human settlements Adaptation: infrastructural developments, improved water management practices, utilisation of rainwater for irrigation
Forestry	Vulnerability: droughts impairing forest development, extreme weather events causing tree loss, new diseases and pests Adaptation: new drought-resistant species, improved forest management practices and R&D in the field
Agriculture	Vulnerability: droughts causing irrigation problems thus hindering agricultural production, floods and inundations causing inland water Adaptation: land use change, organic agriculture on wetlands, improved defenses, improved irrigation and water use
Urban infrastructure	Vulnerability: heat waves causing heat islands Adaptation: urban area development, forestification where possible increasing greencover, better engineering practices
Tourism	Vulnerability: climate change shortening and shifting tourist seasons Adaptation: climate friendly tourism
Public safety	Vulnerability: migration waves, weather related catastrophes (floods, storms, blizzards) Adaptation: improved civil defenses, improved institutional background, preparation measures, preventive measures

7. FINANCIAL RESOURCES AND TRANSFER OF TECHNOLOGY

7.1. Provision of 'new and additional' resources

Hungary does not belong to the Annex II of the UNFCCC and is fundamentally not obliged to provide financial resources to developing countries, and as a transition economy is not subject to the acquirement thereof. However as an EU member Hungary together with the 10 new EU member states (NMS) have made a commitment to contribute to the EU Development Co-operation Policy (EDCP), and in particular to meet specific targets of official development assistance (ODA) as a percentage of their gross national income (GNI).

Besides the international obligation to allocate aid Hungary has also pledged to work towards the fulfillment of the United Nations Millennium Development Goals (MDGs) and align their national strategies with key points from the Accra Agenda for Action.

The Millennium Development Goals (MDGs) are targets for dramatically reducing extreme poverty in its many dimensions by 2015 – income poverty, hunger, disease, exclusion, lack of infrastructure and shelter – while promoting gender equality, education, health, and environmental sustainability. MDG 8 refers to global partnerships for development. Without basic infrastructure and human capital, countries are condemned to export a narrow range of low-margin primary commodities based on natural endowments, rather than a diversified set of exports based on technology, skills, and capital investments.

In 1996 Hungary became a member of the OECD and prepared its first international development policy (MFA 2003). In 2001, the Hungarian Government approved the concept paper that signalled a shift from ad hoc and decentralized development policy towards a development cooperation, which complies with UN, OECD and EU norms.

Hungarian Development Policy does attempt to comply with all regulative measures obliged by the *acquis communautaire*, including its normative contributions to the European Development Fund (EDF), to act upon the commitments to the Millennium Development Goals (MDGs), adhere to the principles of the 2002 Monterrey Consensus and the 2008 follow-up in Doha. To comply with OECD measures, Hungary's ODA contribution needs to reach 0.33% of GNI.

In 2003, Government Regulations amended the mandate of the Minister of Foreign Affairs (MFA) to establish three main bodies and one advisory committee:

- The IDC Inter-budgetary Committee to determine partner countries and target intervention areas.
- The Inter-Budgetary Technical Working Group to harmonize the different line ministries activates and increase the effectiveness of separate MFA IDC budget.
- The NEFE (International Development Policy) Working Committee (within the MFA) to support the harmonization of NEFE 'programs' with the foreign, security and foreign trade or export ambitions.
- A Social Advisory Board to strengthen the acceptance and support of IDC activities between the social, technical institutions, representatives of the broader public.

In order to determine ID activities, the policy uses the OECD interpretation of development assistance, which includes the following international development activities:

- Technical cooperation. Mainly consists of education, scholarships, vocational training, and knowledge transfer type contributions. This is the most common type of assistance, establishing long-standing relationship with recipient countries.
- Project-based development assistance. The concept is developed to contribute to recipient countries' Poverty Reduction Strategy Papers (PRSP) or Country Strategy Papers (CSP) and finance the implementation of these strategic development plans. Donors can either partly or fully finance

projects based on these strategies. The effectiveness of this assistance is often determined by the broader context and the projects' general socio-economic implications and sustainability.

- Humanitarian assistance. These are emergency types of aids, aimed at assisting victims of either natural disasters, or man-made catastrophes. In these cases, political considerations are negligible, but it is important to ensure the domestic conditions of fast response by assisting domestic NGDOs and other organizations that can deploy assistance (technical or material) to reach the affected areas in the recipient country in a short timeframe.

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

Hungary's donor activities changed considerably over the past 10 years. Hungary is expected to provide assistance to the least developed countries (LDCs). According to the OECD targets, Hungary should have provided 0.17% of its GNI by 2010, and 0.33% by 2015 as ODA. Common targets such as the Millennium Development Goals (MDG) have strong influence over which countries receive ODA from Hungary, and how much.

Hungary's ODA contributions increased from 22.11 million EUR to 100.76 million EUR between 2003 and 2006. This steady climb from 0.03% of GNI to 0.13% of GNI came to a halt in 2007 only to climb again from 0.08% to 0.10% between 2007 and 2009. Data from 2011 shows a 0.02% increase, though it is only a preliminary estimate. Focusing on the 0.17% commitment to be reached in 2010, Hungary in 2006 seemed to be able to reach it. However, this never came through as ODA was 0.08% in 2010. Parallel to this process, Hungary's share of multilateral and bilateral ODA contribution also went through a strong transformation (see Fig. 7.1). Due to the limitation of the sources and the constant development of the MFA's reporting structure, the titles and categories within ODA activities (e.g. education, agriculture, technical cooperation) are not consequent throughout 2003-2011 which means it is very difficult to examine how funds earmarked for one type of activity increased or decreased over time.

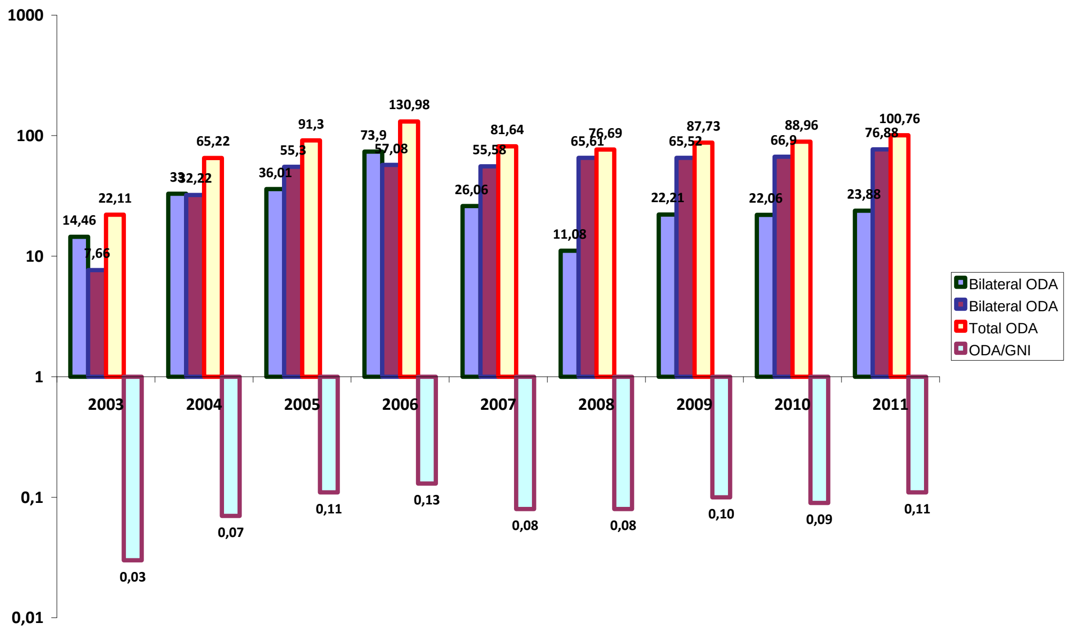


Figure 7.1. Hungary's ODA expenditures, 2003-2011, million euros (on 2011 prices, logarithmic scale)

Source: Lesznai, 2013

7.3. Provision of financial resources

Ministries have bilateral international activities related to their mandates, where they provide specific financial assistance to partner countries, in the form of scholarships, financing trainings, facilitating technical cooperation or small projects, etc. Their role in relation to ODA is merely to provide statistical data based on these activities. Hungary's ODA contributions are financed from a central budget. The Minister of Finance proposes a budget for development assistance in the annual Budget Bill. A certain share is earmarked as international development, and is within the discretion of the MFA. The ministries' budgets and activities are not earmarked as international development, despite that fact that they actually support international development goals which leaves the exact relation between international development and ODA somewhat vague. The DIDC provides an annual statistical analysis of Hungary's ODA for the OECD. It collects information from line ministries on those items that can be accountable as ODA but it would be fair to say that line ministries are not generally sensitized to international development activities.

Over the past 4 years Hungary provided between 14% and 23% of its ODA through bilateral channels (see Table 7.1.). In 2010, bilateral ODA was disbursed among 84 countries, which appears somewhat inefficient considering the scarce financial resources the country can provide for ODA. This type of distribution is also ineffective considering that more than 50% received aid was worth less than 3.500EUR in total.

Table 7.1. Provision of development aid by Hungary, 2003-2011

M Eur$_{2011}$	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Bilateral ODA	14,46	33	36,01	73,9	26,06	11,08	22,21	22,06	23,88
Multilateral ODA	7,66	32,22	55,3	57,08	55,58	65,61	65,52	66,9	76,88
Total ODA	22,11	65,22	91,3	130,98	81,64	76,69	87,73	88,96	100,76
ODA/GNI	0,03	0,07	0,11	0,13	0,08	0,08	0,10	0,09	0,11

Source: Lesznai, 2013

In 2011, the distribution of Hungary's bilateral ODA was between the following areas: education, scholarship, exchange programs cover almost 50%; Security (mostly costs of missions to Afghanistan, Kosovo, Iraq) 20%; Government and Civil Society (mostly capacity building to facilitate democratic institutional development) 10%; and Agriculture (FAO supported and other projects) 7%.

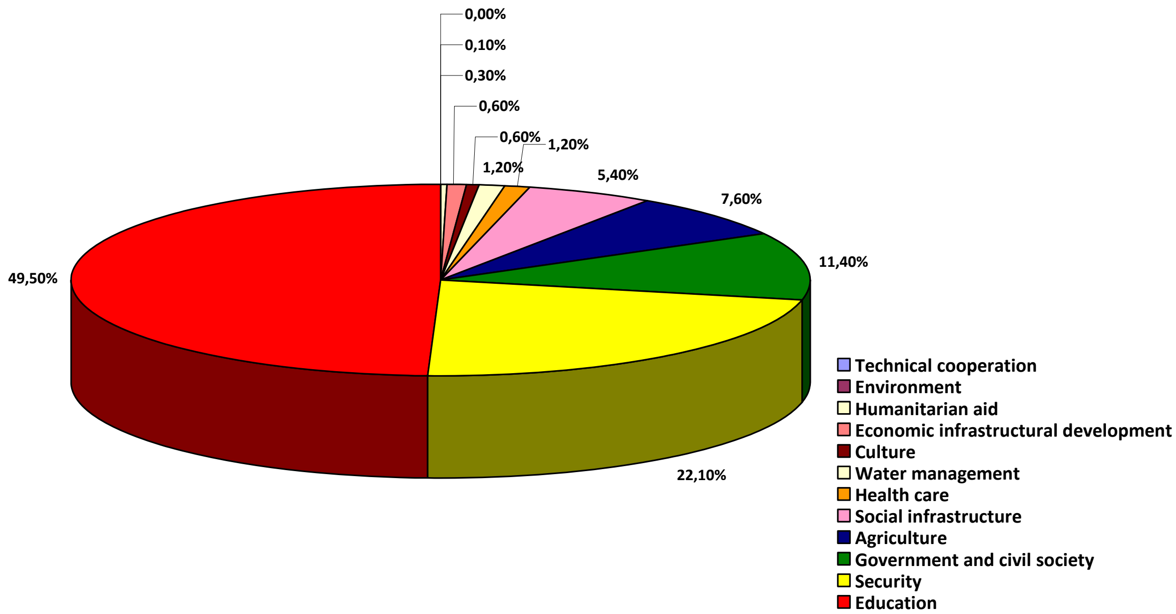


Figure 7.2. Distribution of activities in bilateral development aid

Source: Centre for Policy Studies, CEU

Bilateral ODA between 2008-2011

Bilateral assistance is a more direct interaction between the donor and recipient, all owing political and economic interest representation of the donor countries, as well as the expression of the donor identity. In case of Hungarian development assistance however, the trend is different – most ODA is channelled through multilateral aid and it is disproportionally higher compared to ODA channelled through bilateral agreements.
The reason is the priority given to the international commitments and membership contributions. The already small budget allocated to ODA has to fulfil multinational needs and as such, the portion of bilateral aid carrying the potential to accentuate Hungary's development profile is ever shrinking.

In terms of BDA, Bosnia and Herzegovina, Macedonia,Montenegro and Serbia received continuous aid flows from Hungary in this period. All four countries are part of the EU's Neighbour Policy, and are considered in the FPS. However, bilateral aid allocations show a mixed picture. Between 2008 and 2011 Serbia received the highest amount of ODA among the analysed countries (altogether 10,777,521 EUR in 2011, which corresponds to 19.3% of the overall bilateral aid povided in 2011), demonstrating a 278% increase by the end of the period. A substantial part of ODA was channelled through the educational sector, either in the form of scholarships or training, accounting for 60% of the overall. There was a slight departure in 2009 when the cultural sector received 58% of all the ODA allocated to Serbia. This activity was labelled as "supporting Hungarian Minorities over borders".

Montenegro shows a very different trend. While it received 11% of bilateral ODA in 2008, in 2011 it accounted for only 3.5% of the overall sum, experiencing a staggering 58% decrease. Bosnia and Herzegovina shows a third type of dynamic. Starting with 3.2% of bilateral ODA in 2008, it climbed to 3.7% in 2011. Bosnia and Herzegovina also has a tied aid credit agreement with the Government of Hungary amounting for 41% of its ODA in 2008 and 22% in 2011. Supporting an experimental project to plan and realize a community based rural development, 71% of bilateral ODA was allocated to the agricultural sector in 2011.

The trend in Macedonia’s ODA allocation is somewhat similar, except that Macedonia can only account for an average 0.01% or 35.424 EUR in 2011 of total bilateral ODA between 2008 and 2011. In 2011 ODA was spread across three sectors: 35% went to education and scholarship, 36% was used in agriculture, and 28% was allocated for governance and civil society. While scholarships, trainings and exchange programs accounted for only 4% of ODA in 2008, these types increased markedly by 2011.

7.4. Activities related to transfer of technology

Hungary’s main participation in development assistance is providing scholarships, training programs, trainer exchange programs, and language acquisition. Hungary also provides know- how, capacity building and transfer of good practices in democratic transition and institutional development. These projects are generally focusing on neighbouring countries such as Bosnia and Herzegovina, Serbia, Montenegro, Macedonia and Ukraine, but also to a lesser degree in Kazakhstan, China, and Vietnam(MFA 2010).

Hungarian private sector plays a role in Hungary’s international development assistance projects in a limited number of fields , among the most important being humanitarian aid (donation of foods and medicines) and some aspects of technical assistance (Kiss 2012:374). However, the project -level overview of development activities indicates a more significant contribution. In this respect, we underline the following projects:

- Infrastructure development in Bosnia and Herzegovina (namely the transfer of water purification technology of drinking water in Tuzla)
- Agricultural and food industry training in Kenya (as part of the joint Scholarship Programme with the United Nations' Food and Agriculture Organisation);
- Adult training project in Macedonia;
- Construction activities in Montenegro’s educational infrastructure (kindergarten, primary school, healthcare vocational school and adult training centre);
- Viticultural training and technological improvement in preserving the genetic profile of indigenous goat and sheep breeds in Serbia;
- Bilateral scientific and technological cooperation projects with Ukraine;
- Joint Scholarship Programme with the UN FAO for Vietnamese applicants.

In addition, it is worth mentioning that private companies contributed to agricultural development projects in Afghanistan and Laos: agricultural companies transported seeds and help open the joint scholarship programme with the UN FAO also to Afghanis tan, whilst several projects helped improve technological efficiency of agricultural production in Laos.
The transfer of know-how, technology and good practices are particularly important in agriculture and related manufacturing industry sectors; this includes not traditional production methods of foods and beverages, but also latest technologies in viticulture and environmentally sustainable animal husbandry.

Human capacity building scholarship programmes play a predominant role in international development policy and the joint programmes with FAO are especially relevant in developing countries. Hungarian private sector actors can contribute significantly to international projects mainly in the investment and manufacturing fields, especially when the latter is related to agriculture. Private involvement is smaller in the educational and healthcare sectors where state-ownership is dominant and where non-governmental development organisations play a particularly important role in education.

Recent development relations with Kenya generated an increasing interest in the support to the health sector; the Ministry of Foreign Affairs actively promoted the private sector “to provide Mother and Child Health, Nutrition and Family Planning Services”. In principle, comprehensive health sector projects are opportunities for Hungarian companies construction (planning of hospitals, building and related services), manufacturing of surgical instruments and health-care training. However, the actual participation of private companies in international development projects is conspicuously low. As Ministry of Foreign Affairs underline‘the small amount of winners in international development projects are government agencies and civil society organizations and not private companies', the winner of a health development project in Langas, the second largest slum of Kenya was the non-profit Foundation for Improvement of Medical Services.

8. Research and Systematic Observation

8.1. General policy towards research, systematic observation and their funding

The aim of this chapter is to concentrate on research activities and research-related policy developments that have taken place since the last National Communication.

The most important Hungarian initiative to date on climate change, focusing on adaptation and vulnerability, has been the VAHAVA project[21] carried out by the Hungarian Academy of Sciences (MTA) and the previous Ministry of Environment and Water, now Ministry of National Development that was already referred to in the 4th and 5th National Communication. It was a nationwide project, involving leading researchers from a number of scientific institutions across Hungary.

The project covered several areas related to climate change, such as agriculture, meteorology, medicine, biology, socio-economic and methodological aspects. Its focus was mainly on adaptation and partly on mitigation, looking at both the potentially positive and the negative effects of climate change. Its results were published first as a book in 2007 ("A globális klímaváltozás: hazai hatások és válaszok" – "Global Climate Change: Impacts and Answers in Hungary"), which not only featured important research results but also helped initiate further research projects. A shortened project report in English of approximately half the size of the original Hungarian report has been published in 2010[22].

Using the scientific basis laid out by the VAHAVA project, the Hungarian Parliament has adopted the National Climate Change Strategy (NCCS) for 2008-2025[23].

The National Climate Change Strategy provides a fundamental basis and coordinative background for scientific research, thus delivering efficient and concise formulation and management of future research efforts. The main aims of the strategy are to:

(1) foresee measures in compliance with the EU and international requirements in order to reduce the emissions of climate change gases and to prevent the increase thereof.

(2) elaborate on the fight against the unfavorable ecological and socio-economic effects of the inevitable climate change, and of the improvement of the adaptability to the consequences of the climate change; and

(3) raise the social awareness of the climate change and the strengthening of climate awareness.

The Strategy includes directions for the field of climate change research, both for mitigation and adaptation. In the area of mitigation, the state aims to support demonstration projects for energy production and energy efficiency, such as carbon capture and storage or the development of passive public buildings.

There is a wider range of research topics for adaptation to climate change in the strategy:

- Mapping the gaps in knowledge on climate change adaptation and identifying the reasons;
- Research on domestic climate- and meteorology-related hydrology for more precise predictions;
- Identifying and understanding irreversible effects and their mechanism in the physical, biological and human systems due to climate change;
- Economic calculations to analyze the costs of non-action and the benefits of predictive action, particularly in relation to vulnerability and risks in every field (e.g. health, water resources management, crop production, infrastructure);

[21] http://ec.europa.eu/environment/climat/adaptation/workshops/pdf/budapest/pres_istvan_lang.pdf
[22] http://www.vahavahalozat.hu/files/vahava-2010-12-korrigalt-2.pdf
[23] http://klima.kvvm.hu/documents/14/nes_080219.pdf

- Research on the positive interactions, complementary effects, synergies between adaptation and sustainable development;
- Identifying and analyzing the relationship between adaptation and mitigation, in order to select options that are mutually beneficial;
- Implementation of research results explored by international organizations and other European countries in the field of climate change adaptation, action plans to carry them out, especially exploring those flexible adaptation options that allow for enduring and treating climate shocks;
- Participating in international scientific networks on climate change adaptation;
- Identifying, analyzing and dealing with social and institutional barriers to adaptation;
- Identifying urban planning, architecture, public services and lifestyle know-how used in Mediterranean countries and studying the possibilities of domestic implementation;
- Analysis of the complex effects of climate change on cities.

The document also discusses the so-called "principle of integration", which means that climate change policies should be integrated into every governmental strategy, action plan and programme that may be related to climate change in any way, including the general strategy on research.

The implementation plan of the NCCS is formulated in National Climate Change Programmes (NCCP), which outline activities for a two-year term. Proposed research activities in the first NCCP[24] are the following:

- Database improvement: Improvement of the National Environmental Information System;
- Development of mitigation methodologies
- Complex risk assessment methodology to evaluate the climate effect of plans, programmes, development efforts;
- Climate model development: Regional climate models of Hungary, climate scenario building, better and more precise modelling, interpreting model results according to the needs of users;
- Risk Assessment: Risk assessment of natural disasters;
- Cooperation: Creating favourable conditions for organizing fora, conferences and informal negotiations;
- Development of governmental and ministry strategy guidelines, assigning research institutes and knowledge centres, implementation of the results of research projects carried out with the participation of agricultural enterprises and farmers;
- Creating the possibility of the participation of Central and Eastern European countries in European Union research projects (such as those covered by the EU's 7th Framework Programme) at the level of more developed EU countries.

In addition to the above-mentioned documents it is important to mention the 3rd National Environmental Programme (NEP) for 2009-2014[25]. It sets the main priorities for all kinds of environment-related research in Hungary. According to the NEP, the most important tasks to enhance research efficiency are to reinforce collaboration (domestic, EU and international), to concentrate capacities, networking and support of research centers.

8.1.1. Coordination of research policy

As mentioned in the introduction of this chapter, the research policy's framework is set by the National Climate Change Strategy. The Strategy provides the background for the national climate related research activities and will be coupled by the assignment of necessary resources from the government.

[24] http://www.mtvsz.hu/dynamic/NEP_skv_re.pdf

[25] http://www.kvvm.hu/cimg/documents/NKP-III_tervezet_0324.pdf

A significant part of all research in Hungary is carried out or coordinated by the Hungarian Academy of Sciences (MTA)[26]. Under the Presidium of the Academy there are a number of departments responsible for different fields of science. However, besides this vertically structured organization of departments there are also horizontal committees.

In March 2009, the Presidential Committee adopted a declaration that lists domestic tasks related to climate change. The declaration includes four groups of new research and innovation topics that should be considered in the near future: a) Monitoring of climate change induced processes and tendencies in nature and society; b) Technologies reducing carbon emissions and increased efficiency of natural carbon sinks; c) Upgrading current methods of adaptation; and d) Raising awareness by education and training. Given the important role of the Academy in the Hungarian research scene, these topics will most likely guide researchers in their activities both formally and informally.

In 2010 the Academy published a strategy[27] on the future of our environment, environmental and climatic protection. In this study the question of climatic scenarios (taking into account the 2007 IPCC report), international climate strategies, sustainable development regarding climate change are assessed.
On the other hand, the Academy as a legal body along with the most important governmental institute dealing with climate change and the implementation of the NCCS, the Department for Climate Policy at the Ministry of National Development it is responsible for:

(1) Codification:
  a. regulation of acts related to climate policy
  b. decarbonization itinerary until 2050
  c. dealing with carbon market issues
(2) Coordination
  a. of decarbonization itinerary until 2050
  b. of the decisions made regarding climate policy in the EU
  c. of the decisions made regarding climate policy in Hungary
  d. of national and EU reports regarding climate policy
  e. of Hungarian participation at EU meetings on climate policy
  f. of tasks related to the UN Framework Convention on Climate Change and the Kyoto Protocol
  g. of interministerial reports on medium-term greenhouse gas emission
  h. of interministerial workgroups dealing with decarbonization and adaptation
  i. of carbon market trades together with the Department of Green Economy Development at the Ministry of National Development
(3) Among the tasks related to individual acts of public authority
  a. distributes new entrant reserve emission allowances for new entrants under the EU ETS,
  b. deals with the marketing of GHG emission rights belonging to Hungary,
  c. deals with tasks related to Joint Implementation projects (authorisation and transfer) and supervises accreditation authority.
(4) Among the international and EU tasks
  a. For harmonization of carbon market regulation with the Community regulations on a ministerial level
  b. For supervision of the Community carbon market and strategy on a national basis
  c. For dealing with ministerial tasks regarding the Community climate policy decisions
  d. For supervising whether the European decisions, laws on climate strategy are implemented on a national level
  e. For representing the Hungarian policy on climate change on a Community level

[26] http://www.mta.hu/index.php?id=406&type=0
[27] http://mta.hu/fileadmin/2010/06/mta_strategia_beliv.pdf

f. For preparing the national policy on climate change and participating on the conferences regarding the topic on an international and Community level
g. For representing Hungary on every forum regarding climate change and policy

(5) Functional tasks, such as to
a. Deal with the tasks related to international and national climate policy in cooperation with the Department of Green Economy Development
b. Deal with the allocation and accounting of the GHG emissions allowances
c. Develop the National Climate Strategy and the laws, regulations related to it and supervise their implementation
d. Supervise the revision and the reports of the National Climate Strategy
e. Supervise the transactions within the National Emissions Allowances Registry based on the international law

(6) Other tasks
a. To contribute in the work of the Ministry of Rural Development in developing the greenhouse gas inventory and forwarding it to the Secretary of the UN Framework Convention on Climate Change
b. To help increasing the public awareness of climate change

After three years of preparation (2010-2012) in, discussion with the NGOs, in February 2013 the Hungarian Parliament began the debate on the National sustainable development framework[28], which will hopefully be accepted in the year 2013.

8.1.2. Funding

Funding for climate change research in Hungary mainly stems from European Union sources and the National Office for Research and Technology, while there are relatively limited funds available from other national and international sources.

Researchers may apply for funds at the National Innovation Office (NIO)[29] within the "Support for Strategic Research" action scheme of the National Technology Programme. The Programme is divided into five sub-programmes, two of which offer funds for research on climate change, namely those on "Liveable and Sustainable Environment" and "Defence and Security Research". These programmes publish two calls for proposals each year.

The available funds for the National Technology Programme as a whole (including all 5 sub-programmes) were 18 billion HUF in 2009.
In 2008, the two applicable sub-programmes received 9.24 billion HUF in the second round of calls (not limited to climate change-related projects). The first call of 2008 and previous calls also offered funds for climate change research, although in a different structure.
In 2005-2006, according to its own statistics, 20-30% of all project funds granted by the National Office for Research and Technology went to environmental research, which included climate change as well.

[28] http://www.nfft.hu/dynamic/NFFS_rovid_OGYhat_melleklete_2012.05.16_vegso.pdf
[29] http://www.nkth.gov.hu/english

Table 8.1. Distribution of funds granted by areas of applications (in million forints)

Topic	No. of appl.	Applied subsidy	In advance payment	Total costs	Subsidy granted	Total accepted costs	Contracted amount	Actual payments
Climate change	30	1154,15	693,92	1456,6	1154,15	1459,03	921,01	384,44
Renewables	1	2,64	2,38	26,44	2,64	26,44	2,64	2,64
Sustainable and livable environment	5	25,01	7,19	109,04	25,01	109,04	25,01	24,48
Greenhouse gas emissions	4	14,74	12,96	62,8	14,74	62,8	14,74	13,91

European Union funds

Funding from the European Union is available on the one hand from its 7th Research Framework Programme under the specific programme for Cooperation, which includes ten thematic priorities. Despite the fact that the 7th framework programme ends in 2013, the next, 8th framework programme is “on its way”, called HORIZON 2020. Climate change will be a part of Priority 3. Societal changes, for which EUR 3.160 million are available throughout the lifetime of the Framework Programme (2014-2020). The National Office for Research and Technology plays an important role in coordinating and co-financing these European funds for Hungarian recipients.

On the other hand, certain smaller EU funding schemes are supporting climate change-related research in Hungary: The “Intelligent Energy – Europe” programme[30] funds research projects which are specifically targeting topics related to energy efficiency and renewable energy sources. The European joint research initiative “COST” (European Cooperation in Science and Technology) is another vehicle for supporting non-competitive research across Europe. This scheme is funding climate change-related research under its “Earth System Science and Environmental Management” action[31].

Hungarian research institutions are participating in all of these European Union schemes. It is worth noting that these always require cross-border cooperation with institutions in other EU member states to be considered for EU funding.

Other funds

Smaller grants are available from the Academy of Sciences and involved ministries, particularly for funding post-VAHAVA projects. These are primarily intended as seed funding for new research projects, which might later apply for other, more generous funding schemes.

The former Ministry of Environment and Water (now Ministry of Rural Development) has also funded some research and analytic studies in order to prepare for the National Climate Change Strategy and other climate-related strategic decisions, European policy initiatives (e.g. EU white paper on adapting to climate change) and national tasks related to IPCC.

[30] http://ec.europa.eu/energy/intelligent/

[31] http://www.cost.esf.orgeu/domains_actions/essem

Some additional, although rather limited funding has been made available to the Hungarian Academy of Sciences under a cooperation agreement with the Prime Minister's Office for research on specific strategic topics on behalf of the government. One of these research topics is climate change.
International organizations like UNEP (United Nations Environment Programme), WHO (World Health Organization), World Energy Council, Climate Strategies and others are also occasionally funding specific research projects in Hungary.

8.2. Specific research activities

This section briefly introduces the main players contributing to climate change research in Hungary and presents an overview of current research projects, including both exclusively Hungarian projects and joint projects by Hungarian and foreign partners, such as those supported by different funding schemes of the European Union. This is followed by a more detailed presentation of a selection of major research efforts related to climate change, divided into four main areas: climate modelling, impacts of climate change, adaptation to climate change and mitigation of climate change.

8.2.1. Main institutions involved in climate change research in Hungary

Research related to climate change is carried out at a variety of institutions across Hungary. These include the Hungarian Academy of Sciences (MTA), university and college departments, dedicated state institutions such as the Hungarian Meteorological Service, as well as NGOs and private consultancies and think tanks.

Besides its role in coordinating and initiating research activities (as outlined in 8.1.1), the MTA also carries out research through its own institutes as well as through joint research groups attached to Hungarian universities and other scientific institutions. A research group focusing on Adaptation to Climate Change exists with Corvinus University of Budapest, which has played a leading role in both the VAHAVA project (see 8.1) and its follow-up project called "KLIMA-KKT" (see 8.2.5). There are also three research groups at Szent István University (Gödöllő) which cover climate change aspects: the Institute of Mathematics and Informatics deals with mitigation methodologies and environmental informatics, the Agronomy Research Group does so particularly with regard to crop cultivation, while the Plant Ecology Research Group focuses on physiological processes in plants under different climatic conditions and CO_2 concentrations.

The most important specialist institution involved in climate change research is the Hungarian Meteorological Service (OMSZ). Its research focuses on regional climate modelling (see 8.2.4) and it also plays an important role in systematic climate observation (see 8.3).

Some smaller state-funded institutions also contribute to climate change-related research, in particular the National Institute for Environmental Health with its research group on the health effects of climate change. They developed a 3-level warning system based on temperature thresholds defined in time series analysis of the Budapest data of 1970-2000. (see 8.2.5) and the Hungarian Forest Research Institute, which is involved in research related to climate change and forest management.

A particularly strong research focus on climate change can be found at the Department of Meteorology of Eötvös Loránd University in Budapest. Being the only university in Hungary to offer a degree programme in meteorology (with climate research as one possible area of specialization, see 9.3.1), they are involved in several national and international research projects related to climate change (see Table 1) and jointly run observation activities at Hegyhátsál meteorological station together with the Hungarian Meteorological Service (see 8.3.1).

Regarding energy and environmental modelling, the Szent István University's Department of Applied Informatics is practically the only academic institution focusing on energy modelling methodology development and studies in climate change related emissions and mitigation assessment. Several large- scale projects were undertaken with the involvement of international academic institutions from all over the globe utilising mainstream computer model frameworks. Special emphasis is placed on the transfer of know-how to the future generations in the frame of academic education.

A relatively new research institution is the Centre for Climate Change and Sustainable Energy Policy (3CSEP) at Central European University (CEU), an American-Hungarian international graduate university in Budapest. 3CSEP was inaugurated in early 2008 to bundle and strengthen research activities related to climate change and energy within CEU. However, even before the creation of 3CSEP several major research projects related to climate change have been carried out at CEU.

Another academic institution with a long tradition of climate change research is the University of West Hungary's Faculty of Forestry in Sopron. Their research has primarily focused on the impacts of climate change on forestry, as presented in the 4th & 5th National Communications. Recently, its research capacity has been strengthened by the Regional Focus Research Center for Non-boreal Eastern Europe of the NEESPI network (Northern Eurasia Earth Science Partnership Initiative) which is still active in climate research.

The Regional Environmental Centre for Central and Eastern Europe (REC) is an international body headquartered in Szentendre, Hungary. It is running a number of programmes related to climate change and other environmental issues for the countries of the Central and Eastern European region. Besides developing its own programmes, it is also participating in numerous projects funded by the European

8.2.2. Hungary's contribution to the Intergovernmental Panel on Climate Change (IPCC)

Several scientists from Hungary have contributed in recent years to the work of the IPCC, which was acknowledged by the shared Nobel Peace Prize in 2007, following the publication of its 4th Assessment Report (AR4).

To strengthen Hungary's influence on the IPCC and make sure that its findings are fed back into national climate change policy-making, a National IPCC Committee (NIC) has been set up in the wake of AR4 and the Nobel Prize, which meets regularly and brings together scientists involved in IPCC work with Ákos Lukács at the Department for Climate Policy at the Ministry of National Development, who is the National Focal Point towards the IPCC as well as the Hungarian Academy of Sciences. The Hungarian government aims at encouraging scientists from Hungary to participate in as many IPCC activities as possible and hosted a plenary session of the Panel in Budapest in April 2008. A successful IPCC outreach event was also organized in Budapest that month, hosted by Central European University in order to bring together key representatives of politics, science, business and civil society in Hungary to discuss the key messages of the 4th Assessment Report.

The Hungarian government is supporting the work of IPCC through a voluntary financial contribution to the international body, whereas individual IPCC-related activities of Hungarian scientists need to be funded from other sources.

8.2.3. Specific research activities in Hungary

Although the VAHAVA project (see 8.1) was finished in 2006 and its final report published in 2007, the Hungarian Academy of Sciences and the Ministry of Environment and Water (now Ministry of National Development recommended starting a mobilizing network that includes individuals and organizations active in the field of research, innovation and policy on climate change mitigation, adaptation and greenhouse gas emissions.

Participation in the network is voluntary and open to any interested parties. The network currently consists of around 265 individual researchers and 121 institutions. The topics within climate change mitigation and adaptation include: meteorology, wildlife conservation, water management, geographical landscape, agriculture, forestry, energy, traffic, urban development, regional and subregional development, environmental health, tourism, economy, legislation, sociology, insurance, environmental awareness, education, behaviour, awareness-raising, technical assistance, disaster recovery, communications.

The main objectives of the network are:

- Collecting and distributing information on domestic research and innovation topics and events
- Collecting and distributing information from abroad
- Reinforcing domestic research and innovation
- Providing information on domestic climate research and climate policy
- Representative body at research funding institutions
- Cooperating with partners in organizing meetings in the field of climate change

The network has its own webpage at www.vahavahalozat.hu and also aims to publish the most important research and innovation results in its journal called "Klíma-21 Füzetek" ("Climate-21 Booklets", last published in 2011). The network is coordinated by the Office of Climate Change Research Coordination at the Hungarian Academy of Sciences and financed by the Ministry of Environment and Water.

The table below provides an overview of selected research projects related to climate change carried out at Hungarian research institutions as of 2009. In addition to those listed, there are many more European Union projects in which Hungarian partners are involved, often only playing a smaller role in the project consortium. To keep the table readable and the Communication concise, only a few flagship research projects are included.

Table 8. 2. Overview of current research projects on climate change in Hungary

Institution and funding sources	Project	Website
Eszterházy Károly College Faculty of Science Department of Geology	Determination of potential atmospheric (solar-, wind) renewable energy reserves in the Eger region	http://ttk.ektf.hu/foldrajz/
	Regional characteristics of climate change	http://ttk.ektf.hu/foldrajz/
	Development and refinement of statistical meteorological tools	http://ttk.ektf.hu/foldrajz/
	Amending environmental problems associated with climate change and renewable energy into public edication and teacher education	http://ttk.ektf.hu/foldrajz/
	Changes in weather and climate extremes: phenomenology and empirical aproaches	http://dx.doi.org/10.1007/s10584-013-0914-1
	Conservation tillage for rational water management and soil conservation	http://www.mtafki.hu/konyvtar/hungeobull2011_2.html
	2010: Could circulation anomalies cause the strong water deficit of Lake Balaton in 2000-2003?	
University of Szeged Department of Climatology and Landscape Ecology	Association of allergen weeds and their pollen release with the climate change	http://www2.sci.u-szeged.hu/eghajlattan/english.html
University of Szeged Department of Climatology and Landscape Ecology	Urban climatology	
	Human bioclimatology	
	Karst-ecologycal investigation	
Eötvös Loránd University Deparment of Meterology	Changes in extreme meteorological events based on regional climatic-models	http://nimbus.elte.hu/index-en.html
	Climate Change and Impacts on Water Supply (CC-WATERS)	http://nimbus.elte.hu/index-en.html
	Project on developing the flood prevention system on the Upper-Tisza	http://nimbus.elte.hu/index-en.html
	Amount and balance of greenhouse gases in Hungary	http://nimbus.elte.hu/index-en.html
	Greenhouse gas management in European land use systems (GHG-Europe)	http://nimbus.elte.hu/index-en.html
	Integrated non-CO_2 Greenhouse gas Observation System (InGOS).	http://nimbus.elte.hu/index-en.html
	Dynamical downscaling of projected 21st century climate for the Carpathian Basin	

	Analysis of projected drought hazards for Hungary	
	Detecting abrupt climate changes on different time scales.	
University of Pannonia Georgikon Faculty Department of Meteorology and Water Management	Simulation of the changes in the vital processes of corn, based on the dependance of environmental changes	http://w3.georgikon.hu/tanszekek/Meteor/english.htm
	Monitoring of Agrometeorological Research station at Keszthely since 1871	http://w3.georgikon.hu/tanszekek/Meteor/english.htm
Kecskemét College Horticultural Faculty	Research on the growing arid conditions at the sandy highs at the Duna-Tisza Interfluve	http://kfk.kefo.hu/fomenu
Károly Róbert University College	SNORTEX campaign to refine climate change models using changes in albedo obtained from terrestrial, aereal and satellite (downlink) measurements	http://honlap.karolyrobert.hu/hu/node/114
University of Pécs, Department of Geography and Meteorology	Wash out of the gases from the atmosphere	http://foldrajz.ttk.pte.hu/szervezeti-egysegek/foldtani-tanszek
	Changes of biodiversity due to the climate change	http://foldrajz.ttk.pte.hu/szervezeti-egysegek/foldtani-tanszek
National Institute of Environmental Health	The effect of temperature and heat waves on daily mortality in Budapest	
	Impact of Heat on the Urban and Rural Population in Hungary	
	Impact of heat waves on excess mortality in 2011 and 2012 in Hungary	
	Predicted Impact of Climate Change on Daily Excess Mortality and Emergency Ambulance calls between 2021-2050 and 2071-2100	
Hungarian Meteorological Service	Regional climate modelling	www.met.hu
Hungarian Meteorological Service, Eötvös Loránd University Budapest, University of Pécs, funded by NKTH	Dynamic investigation of Hungary’s climate and methodology development for regional climate predictions based on metric models	http://nimbus.elte.hu/res-h.html

Hungarian Meteorological Service, Eötvös Loránd University and further partners (EU project)	Central and Eastern Europe Climate Change Impact and	www.cecilia-eu.org
Hungarian Meteorological Service with European partners	CLIVAGRI: Impacts of Climate Change and Variability on European Agriculture (COST Action 734)	www.cost734.eu
NEESPI Regional Focus Research Centre for Nonboreal Eastern Europe at University of West Hungary	Effects of terrestrial energy, water and biogeochemical cycles and human impacts on the regional and global climate and on the dynamics of ecosystems	http://neespi.nbeeu.nyme.hu
Corvinus University of Budapest with Hungarian Academy of Sciences and further Hungarian partners, funded by NKTH	KLIMA-KKT (Climate change: Environment, Risk, Society)	www.uni-corvinus.hu/index.php?id=18320
Hungarian Academy of Sciences and Corvinus University of Budapest	Joint research group on adaption to climate change (risk analysis and health effects)	http://epi.univet.hu/portal/climadapt
Corvinus University of Budapest with further partners (EU project)	ADAM (Adaptation and Mitigation Strategies: supporting European climate policy)	www.adamproject.eu
Hungarian Academy of Sciences in strategic cooperation with Prime Minister's Office	Examination of the state of the environment in Hungary with particular regard to climate change	www.mta.hu
National Institute of Environmental Health, WHO and EU	Direct and indirect health-threatening effects of climate change	www.oki.antsz.hu/index_en.html
Hungarian Academy of Sciences and Szent István University, Gödöllő	Joint research group on agronomy, focusing on cultivation factors of the environmental and climate protection	www.mta.hu/index.php?id=3046
Hungarian Academy of Sciences and Szent István University, Gödöllő	Joint research group on plant ecology, focusing on plant physiological processes under different climatic conditions and increasing air CO2 concentrations	www.mta.hu/?id=2005&passpars=view_group.php%3Fc_id=239

Hungarian Forest Research Institute with European partners	Greenhouse gas budget of soils under changing climate and land use (COST Action 639)	www.cost639.net
Central European University, Budapest, on behalf of WWF	Overview study on the impacts of and adaptation to climate change in the Danube-Carpathian region	http://3csep.ceu.hu/node/37
University of Szeged, Eötvös Loránd University Budapest, supported by Hungarian Scientific Research Fund (OTKA)	Urban climate research (heat island, temperature and humidity differences, bioclimatological alterations)	www.sci.u-szeged.hu/varosklima/
University of Debrecen	Wind climatology and utilization of wind energy	http://meteor.geo.klte.hu/index2-hu.html
Hungarian Academy of Sciences	Social aspects of climate change, climate-friendly municipalities	www.socio.mta.hu/site/index.php?id=68&L=2
Szent István University, Hungarian Meteorological Service and further partners, funded by National Technology Programme of NKTH	Prevention, forecasting and reduction of negative effects of climate change on agriculture and food production	www.szie.hu/node/1017
Hungarian Forest Research Institute, funded by Operational Programme for Economic Competitiveness (GVOP)	Development of forest management methods for reducing the negative impacts of climate change and protecting the nature	www.erti.hu/temak.php?id=1&kn=gvop&fn=gvop
University of West Hungary, Sopron	FORMAN: Adaptation possibilities to climate change effects on forests	www.nyme.hu/index.php?id=320
Budapest University of Technology and Economics	Development of environment-friendly solar energy technologies	www.energia.bme.hu/index.php/tudomanyosmunka/109-tudomanyos-munka/145-kutatasitemak
Consortium of researchers on behalf of Ministry of Environment and Water	Carbon Dioxide Mitigation Potential in the Hungarian Public Sector	www.kvvm.hu
Consortium of researchers on behalf of Min. of Environment and Water	Greenhouse Gas Mitigation Scenarios for Hungary for the Period up to 2025	www.kvvm.hu

Central European University, Budapest, on behalf of UNEP	Assessment of policy instruments for reducing greenhouse gas emissions from buildings	http://3csep.ceu.hu/proects/reducingghg2
Central European University, Budapest, with funding from Ministry of Environment and Water	CO_2 mitigation potential in the Hungarian residential sector	http://3csep.ceu.hu/node/74
Central European University, Budapest, with Joanneum Research, Austria, on behalf of Climate Strategies	Green Investment Schemes: Maximizing their benefits for climate and society	http://3csep.ceu.hu/node/68
Regional Environmental Centre for Central and Eastern Europe with UNEP	Clean Fuels and Vehicles in Central and Eastern Europe	www.rec.org/rec/programs/pcfv/
Systemexpert Ltd. with Intelligent Energy for Europe	4EM Motor Challenge Programme	www.mcpeurope.net
Systemexpert Ltd.	CIRCLE APM project	http://www.circle-era.net/

8.3. Systematic observation

The main issues of systematic observation in Hungary have been extensively discussed in the previous National Communications and recent changes in this area are less significant than in the field of climate change research. The bulk of observation activities is still carried out by the Hungarian Meteorological Service (OMSZ) and the Department of Meteorology at Eötvös Loránd University (ELTE), which have both been introduced in 8.2.1 and 8.2.4.

The Hungarian Meteorological Service is a central budget institution; being the national meteorological service of Hungary it is responsible for supplying meteorological, atmospheric environmental and climate information, and for the provision of warnings about severe weather situations in Hungary.

Besides short-range, medium-range, and monthly weather forecasts, OMSZ provides climate projections into future with the help of two regional climate models which were adapted at the Hungarian Meteorological Service: the ALADIN-Climate model developed by Météo-France; and the REMO model developed by the Max Planck Institute for Meteorology in Hamburg. The results of the projections have been applied in many national and international projects, such as the ECCONET which analysed the effects of climate change on the inland waterway networks. The OMSZ is also the owner of national climate database, and thus has participated in relevant projects such as the DMCSEE (Drought Management Centre for South-eastern Europe) project which aimed at preparing regional drought monitoring, analysis, and early warning products.

The activity of OMSZ is based on the extended national and international infrastructures including the observational network over Hungary, the running of telecommunication and informatics system for obtaining all the meteorological data from the Global Telecommunication System of the World Meteorological Organization and the intensive co-operations with various international organizations on the research, development and operative activities.

The OMSZ also operates the national Air Quality Reference Centre (AQRC), which carries out field and laboratory calibrations of gas analyses of the Hungarian air quality network. Besides, it is responsible for the operation of the background air pollution monitoring stations, data submission for international organizations (WMO, EMEP), examination of the trace element concentration and their transport, air pollution transport modelling on different time and spatial scales, and expert reports for the national authorities.

8.3.1. Atmospheric observation

Hungary's most important observation site for atmospheric constituents is the Hegyhátsál meteorological station[32], which is jointly operated by scientists from OMSZ and ELTE. Established in 1994, it was among the first European tall-tower stations to take up continuous observation of greenhouse gas concentrations from different levels of its tower (at heights of 10 m, 48 m, 82 m, 115 m) and has produced an invaluable time-series of measurement data since then.

Apart from observation activities at Hegyhátsál, the OMSZ has been granted funding from the National Office for Research and Technology to establish a dedicated network of measuring stations for very precise tracking of the effects of global climate change on Hungary. These stations are being set up between 2006 and 2009 and are designed to be precise enough to make long-term coherent climate change observation possible.

[32] http://nimbus.elte.hu/hhs/

In the field of satellite observation, it has been an important step for Hungary to become a full member of EUMETSAT, the European Organisation for the Exploitation of Meteorological Satellites, in October 2008.

8.3.2. Terrestrial observation and carbon balance

Hungarian institutions have participated in several international research efforts on carbon balance in last couple of years. The Department of Meteorology of ELTE as well as Szent István University of Gödöllő were partners in the "CarboEurope-IP"[33] project which ran from 2004 until 2008, a huge European project with almost 100 partners that worked together on an Assessment of the European Terrestrial Carbon Balance. Goals of the project were to advance the understanding of the role of the European continent in the global carbon cycle and to significantly enhance the understanding of and the methodologies for the observation, quantification and prediction of the terrestrial carbon cycle of Europe. Key research products of CarboEurope-IP included improved quantitative estimates of the European carbon balance and new technologies to help reduce the associated uncertainties.

The OMSZ was also involved in the European project called "Carbon-Pro" (Carbon balance drafting and new resources management tools according to Kyoto Protocol) in 2006/2007. Its overall objective was to assess the characteristics of the main agricultural and forest systems in the CADSES area (Central Adriatic, Danubian and South-eastern European Space) in relationship to the strategies set up by the Kyoto Protocol for agricultural and forest systems and to evaluate their sink capacity.

More recently OMSZ participated/participates in IMECC EU FP6[34] (2007-2011) and InGOS EU FP7[35] (2011-2015) projects. Both projects focus on the monitoring of non-CO_2 greenhouse gases less studied formerly (e.g. methane, nitrous oxide, sulfur hexafluoride, etc.). The projects include near-real-time data reporting and support the pan-European greenhouse gas monitoring network of the European Union (ICOS – Integrated Carbon Observation System[36]) fully operational from 2013. Participation of Hungary in ICOS has been waiting for government approval since the preparatory phase of the network.

Through the OMSZ and the University of Pannonia, Hungary continued to participate in COST Action 725 (already introduced in the 4th and discussed in the 5th National Communication) on Establishing a European Phenological Data Platform for Climatological Applications, which was concluded in April 2009. The main objective of the project was to establish a European reference data set of phenological observations to be used for climatological purposes, especially climate monitoring and detection of changes.

The NEESPI Regional Focus Research Centre at the University of West Hungary in Sopron is likely to also contribute to terrestrial observation activities in Hungary in the future as the NEESPI initiative is focusing on the ability to measure, monitor and model processes that will provide accurate future projections of climatic and environmental changes in the Northern Eurasian region.

8.4. Conclusions

Both the political and organizational framework conditions for climate change research and observation have advanced significantly since the previous National Communication. After important groundwork done by the VAHAVA project (see 8.1), the importance of research related to climate change has been recognized by Hungary's National Climate Change Strategy adopted in 2008 and also found its way into the country's first National Climate Change Programme.

[33] http://www.carboeurope.org/

[34] http://imecc.ipsl.jussieu.fr/index.html

[35] http://www.ingos-infrastructure.eu/

[36] http://www.icos-infrastructure.eu/

The coordination of climate change-related research has also become more institutionalized with the establishment of the Office of Climate Change Research Coordination at the Hungarian Academy of Sciences as well as the National Climate Change Committee (see 8.1.1) and the National IPCC Committee (see 8.2.2).

The research activities themselves have continued to increase in recent years, traditionally strong players in this field have been joined by new institutions and the process towards establishing a dedicated Hungarian research institute for sustainability and climate change has been initiated (see 8.2.1). The research projects cover an ever wider range of topics related to climate change, although both the political statements and the distribution of research activities clearly indicate a stronger focus on impacts and adaptation research than mitigation- related research.

9. Education, Training and Public Awareness

9.1. General policy towards education, training and public awareness

The 3rd National Environmental Programme (2009-2014) (NEP, see 8.1) claims that while Hungarian citizens value the environment, their individual actions still do not reflect sustainable thinking and lifestyles. According to the NEP there are three main areas of environmental education and information where it is important to take action:

- To improve urban life and enforce environmental protection
- To protect common environmental resources and heritage
- To help increase production and consumption in a sustainable way

The National Climate Change Strategy (NCCS) was accepted by Parliament Decree 29/2008 (III. 20.). NCCS highlights that besides providing general knowledge on climate change, it is extremely important to enhance skills for adaptation and problem-solving to be implemented for 2008-2025. The main priorities in raising awareness are life-long learning of sustainable lifestyles and regular transfer of knowledge about adaptive behavior, especially focusing on the importance of how society, business and politics could benefit from new adaptive actions.

The NCCS puts special emphasis on the information dissemination for future generations and the previous Ministry of Environment (now its tasks have been moved to the Deparment of Climate Change Policy at the Ministry of National Development) launched several dissemination and awareness-raising programmes to aid this objective. Besides the work done by the Ministry, significant funding of NGO's was realized through the National Civil Fund for educational, training, awareness-raising and information dissemination purposes.

9.2. Primary and secondary education

The system of climate change education in primary and secondary schools has not changed significantly since NC5 and is still embedded into some of the 10 integrated topics as a cross-cutting issue in the National Base Curriculum.

However, climate change education appears in many further school activities other than the official educational programme.

The Hungarian Ecoschool Network[37] introduced in NC4 still continues to recruit schools to adopt the principles of sustainability, not only in their educational programme, but throughout all of their activities and currently has more than 350 schools as members. "Forest Nursery Schools" and "Forest Schools" are schools that provide special environmental and sustainable lifestyle education to their pupils. They are certified by the Association of Environmental and Wildlife Conservation Educational Centers on behalf of the Ministry of Education and Culture.

Having realized that there was no comprehensive and sufficiently simple educational material that could help teachers transfer knowledge about climate change to students, the Corvinus University of Budapest edited a book titled "Klímaváltozásról mindenkinek" ("On Climate Change for Everyone"). Many renowned scientists who had participated in the VAHAVA research project (see 8.1) and its follow-up project "KLIMA-KKT" (see 8.2.5) contributed to this publication. The book has been distributed free of charge to Hungarian schools, thanks to generous sponsoring from a big insurance company.

[37] http://www.okoiskola.hu/

An online project by Eszterházy Károly College of Eger called “Földrajz Netszközkészlet”[38] (Internet Toolbox for Geography) serves a similar purpose for geography teachers offering freely accessible teaching materials in all areas of geography, including climatology and meteorology.

The Hungarian Institute for Educational Research and Development[39] (Hungarian acronym: OFI), one of the background agencies of the Ministry of Human Resources, carries out research, development and innovation activities and provides related services to enhance the development of education in Hungary.

9.3. Higher education

Aspects of climate change are more and more widely taught at Hungarian universities and colleges, either as part of degree programmes on broader subjects such as environmental sciences etc., or as elective courses freely available to students of any subject. However, only one university in the country offers a degree programme which really puts climate change at the core of the curriculum: the Department of Meteorology at Eötvös Loránd University in Budapest[40] offers Climate Research as one of two possible areas of specialization in its MSc programme in meteorology. The following subsections focus on degree programmes which include climate change into their curricula to some extent at least and on climate change-related offerings open to a more general student audience.

9.3.1. Meteorology and climate science

Eötvös Loránd University (ELTE), based in Budapest, is the only educational institution in Hungary to offer a degree programme in meteorology. This is a 2-year MSc programme and offers its students the choice between two specialization branches, weather forecasting or climate research. On can enter the M.Sc. programme if coming from the following B.Sc. cources: meteorological specialization of the earth science B.Sc., environmental physicist specialization of the physicist B.Sc. and the meteorologist specialization of the environmental scientist B.Sc. This MSc programme is offered for the first time in the 2009/10 academic year. The Department of Meteorology is expecting to accept 5-20 MSc students per year and would like to see roughly half of them choose the climate research branch.

The Szent István University in the framework of the Environmental Engineering M.Sc. Programme puts special emphasis on teaching climate-change related energy modelling and strives to provide real life applications in every aspect of climate related problems for the students.

The University of Debrecen is the only other Hungarian university offering a meteorology specialization on bachelor level, namely in its earth science B.Sc. programme, but it doesn’t offer a full degree programme in meteorology[41]. However, its B.Sc. graduates choosing this specialization should be well prepared to continue their studies in the meteorology M.Sc. programme at ELTE. In Debrecen, after being introduced to meteorology and climatology they are taught several subjects related to climate change, such as environmental climatology, global climate change and agricultural climatology.

At the Central European University has the strongest focus on climate change and over a dozen students of its Department of Environmental Sciences and Policy[42] have been doing climate-change related work there so far. At CEU, students with an interest in climate change can do their research at the university’s Centre for Climate Change and Sustainable Energy Policy (see 8.1.1)

CEU is playing a special role also because it is an American-Hungarian institution offering English-language environmental M.Sc. and PhD programmes to a very international student body. Its degree programmes include a 1-year Master in Environmental Sciences and Policy, as well as “MESPOM” (Masters of Environmental Science, Policy and Management), a joint 2-year programme which is still ongoing with partner universities in

[38] http://netszkozkeszlet.ektf.hu/en/index.html
[39] http://www.ofi.hu/english
[40] http://nimbus.elte.hu/index-en.html
[41] http://meteor.geo.klte.hu/index2-en.html
[42] http://envsci.ceu.hu/

the United Kingdom, Sweden and Greece, supported by the European Union under the Erasmus Mundus scheme. Both programmes contain several courses related to climate change and its mitigation.

At the PhD level, the Earth Sciences PhD programme at ELTE offers a meteorology branch, in which currently about 37 doctoral students are enrolled altogether. Roughly half of them are researching climate topics.

9.3.2. Climate change-related studies in other degree programmes

Degree programmes at both bachelor and master level as well as PhD programmes which focus on environmental issues have become more and more widespread at Hungarian universities and colleges in recent years.

At the bachelor level, there are mainly three environmental subjects on offer: “Environmental Studies” is an interdisciplinary programme with a strong focus on natural and life sciences, which can be studied at 11 different universities and colleges in Hungary. “Environmental Engineering” is offered by 6 institutions of higher education and familiarizes students with a wide range of environmental technologies relevant for areas from waste management till nuclear safety. Eight universities and colleges offer a subject called “Agricultural-environmental Management Engineering”. This combines agricultural studies with a strong focus on sustainability and protection of the environment.

The above-mentioned programmes are not specifically geared to climate change but usually include individual courses related to climate change either in the core curriculum or as electives. A few selected examples of such courses are shown below in Table 9.1.

There are also several PhD programmes focusing on environmental research: 6 Hungarian universities have established specific doctoral schools in the field of environmental sciences. The Eötvös Loránd University in Budapest, the University of Pannonia, the University of Debrecen, the University of Szeged, Szent István University in Gödöllő and the University of West Hungary in Sopron. It is generally possible to do climate change-related PhD research at these institutions, although this area is only playing a marginal role in many cases. Besides the PhD programme of the Department of Meteorology of Eötvös Loránd University (see 9.3.1).

The following table gives an exemplary overview of what kinds of courses related to climate change are offered by Hungarian universities and colleges to students in degree programmes which are otherwise not fully focused on climate change. This is not intended to be a complete listing, but aims to highlight typical examples at major institutions in this field and show the diversity of climate change-related studies at Hungarian institutions of higher education.

Table 9.1. Courses related to climate change at Hungarian universities and colleges

Institution	Deparment/Unit	Courses offered (examples)
Budapest University Of Technology And Economics	Faculty Of Chemical And Biochemical Engineering Department Of Chemical And Environmental Process Engineering	Waste management BSc, MSc; Environment management Bsc, MSc; Air quality protection BSc, MSc
	Department of Electric Power Engineering	Energy efficiency in practice
	Department of Energy Engineering	Renewable energy sources
Central European University, Budapest	Department of Environmental Sciences and Policy	Air pollution and climate change; Energy challenges for 21st century; Introduction to international environmental policy & law; Policies for sustainable transport
College of Nyíregyháza	Institute of Environmental Sciences	Renewable energy sources; Sustainable development
Corvinus University of Budapest	Department of Environmental Economics and Technology	Basics of sustainability; Environmental law; Environmental policy; Green economic policy
Eötvös Loránd University	Department of Meteorology	
Eszterházy Károly College, Eger	Department of Geography	Climate change, impacts, reaction; Meteorology and climatology; Renewable energy sources
Károly Róbert University College	Institute of Agricultural and Environmental Science	
Kecskemét College	Horticultural Faculty	
Szent István University	Department of Informatics	Applied environmental informatics; Modelling energy and environmental processes; External costs of energy production
Szent István University, Gödöllő	Department of Environmental Economics	Agriculture and energy production; Economics of renewable energy sources; Environmental policy and law; Global problems of sustainability
University of Pannonia Georgikon Faculty	Department of Meteorology and Water Management	Agricultural engineer specialized on environmental changes BSc, MSc; waste management technologist
University of Pécs	Department of Soil Sciences and Climatology	Geographical impacts of climate change
University of Szeged	Department of Agricultural and Environmental Law	Instruments of the Community against the climate change; International environmental law
	Department of Climatology and Landscape Ecology	Changes in climate; Environmental climatology; Renewable energy sources
University of Debrecen	Department of Meteorology	Renewable energies expert; Earth science B.Sc.; Geography B.Sc.& M.Sc.; Environmental science B.Sc. & M.Sc.

Other activities in higher education related to climate change
As climate change issues have played an even smaller role for earlier generations of students, some institutions of higher education are tapping into the resulting need for further education and offer special adult education programmes like an energy auditor qualification offered by the Budapest University of Technology and Economics, or several summer schools on topics related to climate change. Although not strictly an institution of higher education, it is worth mentioning that the Hungarian Meteorological Service is organizing an international summer school on climate modelling for professionals in this field.

9.4. Awareness-raising

Still more and more activities are taking place in Hungary to raise public awareness on climate change and spread advice for more climate-friendly behavior. Both the government sector and the civil society (through a number of NGOs) are active in this area. Their most important activities are presented below.

9.4.1. European Union

As part of the "You Control Climate Change" campaign of the European Union, a massive advertising and TV campaign was launched in order to raise awareness in Central and Eastern European countries including Hungary, where there is a lower level of concern for the global climate change according to a Eurobarometer survey by the European Commission. On the campaign website they offer knowledge materials (videos, quizzes etc.) on climate change, guides and tips on how to reduce one's carbon footprint and educational materials for teachers.
The campaign includes the "Be a Changer! challenge, in which participants are encouraged to make commitments to the fight against climate change by registering on the website and uploading pictures of their activities to meet their commitments.

9.4.2. Churches

The Catholic Church in Hungary has compiled a small book titled "Felelősségünk a teremtett világ" ("Our Responsibility for the Created World"), which aims at informing and educating the believers on environmental matters. In its section on climate change the book references the VAHAVA research project.

The Calvinist Church published an article on climate change as well in 2012 on their official Hungarian home page.[43]

9.4.3. NGOs

Business Council for Sustainable Development
The Business Council for Sustainable Development in Hungary (as a part of the international WBCSD Network) was formed in May 2005 as an informal business forum by the initiative of Mr. Máté Kriza, an independent business consultant, involving seven Hungarian and multinational companies engaged in or committed to sustainability. In 2006 BCSD Hungary was transformed into a legal organization (association for public benefit). Since then it has successfully invited more and more business companies into its network. Among their goals are sharing of best practices and awareness-raising in the field of sustainable development, within which one of their main themes is energy and climate. Their present activities concern: Organization of business breakfasts on various SD issues; Business dialogue on Vision 2050, focusing on five areas:

- Energy and mobility;
- Agriculture;
- Building;
- Material and waste;
- Ecosystem services

Challenge Europe Climate Advocates

[43] http://reformatus.hu/mutat/a-klimavaltozas-es-a-keresztyenek-/

Challenge Europe is the European element of the British Council's global climate programme. Hungary is one of 15 European countries in which a team of young "climate advocates" is supported by this program. The Hungarian climate advocate team, established in 2008, has so far initiated three projects, which are all related to education and awareness-raising.

Their biggest project is the so-called "Climate Office", which is a carbon-neutral information centre showcasing best practices and motivating Hungarian students to get involved into practical climate protection and carbon mitigation projects. The first Climate Office opened in March 2009 within Szent István University of Gödöllő, but the climate advocates are planning to expand this into a wider network of several similar offices at institutions of higher education.

As another project, they published a "low-carbon guide" circulated among students and young people to promote a low-carbon lifestyle with the support of Hungarian celebrities. They are also running a weblog to share their experiences as well as useful informational materials.

Clean Air Action Group
Most important activities:

- Climate protection
- Decreasing the negative effects of traffic
- Agrarian environmental protection
- Decrease air pollution

Transport and its effects and energy efficiency are the main focus areas of the Clean Air Action Group (Levegő Munkacsoport). The primary target of their activities are decision makers, however, they do work on raising public awareness as well, mostly through their publications. "Éghajlatvédelem" ("Climate Protection") was a brochure on what the population could do to combat climate change, followed by another one that aims to raise awareness among young people in a more humorous form.
The Action Group received a government funding of approximately HUF 84 M in the last 5 years through the National Civil Fund.

Climate Club (Klíma Klub)

The Climate Club (http://klimaklub.hu) is an NGO with a mission to actively get involved in tackling the global, and the ongoing urgent issues of climate change, to foster sustainable development, to help saving water reserves and the endangered species of animals, plants and other important parts of the ecosystem. In 2013 one of its main goals was the organization of the 5th Hungarian Climate Conference, which in fact was one of the main events of the Budapest Water Summit.

The Climate Club provides a forum for its members from corporate, civil and scientific sectors with the aim to facilitate communication and partnerships among the members of these sectors. Its most conspicuous activity is the Hungarian Climate Change Summit, which took place for the first time on February 27, 2009. The main goals are to increase public awareness on climate change and its damaging effects, promote social responsibility taking and educate people to achieve environmentally conscious thinking and a change of perspective.

Energy Club (Energiaklub)
"ENERGIAKLUB" has been active for 20 years in raising awareness about climate change. Their aim is to make energy producers, users and decision-makers regard energy in a different way. Their work concentrates on energy efficiency, renewable resources, climate protection, conventional energy resources and energy policy.[44]

Energy Club created the Climate Change Educational Package, available to primary schools to assist teachers in their efforts to teach pupils about climate change[45]. They also participate in the RE-SEEties, a two-year long project to address the problem of inefficient resource use in cities. The project is supported by the European Union and the South East Europe Transnational Cooperation Programme, with the participation of eight South

[44] http://energiaklub.hu/en/rolunk/about
[45] http://energiaklub.hu/pedagogusok

East European municipalities and several professional institution partners. The goal is to help municipalities develop integrated waste-and-energy solutions, in order to create resource efficient urban communities.[46]

Greenpeace Hungary

Activities of Greenpeace often have a dual purpose, aiming to raise public awareness and, often using public awareness as a tool, putting pressure on decision makers with regard to particular environmental questions. The most prominent example of this is the “Road to Copenhagen” campaign launching in mid-2009, which tries to persuade the government to represent the six most important goals of Greenpeace[47]:

- GHG emissions, after reching their maximum in 2015, have to decline as fast as possible in the following years.
- Developed countries must decrease their emission by 40% measured to the 1990 level
- Developing countries must decrease their emission by 15-30% until 2020 with the aid of the developed ones
- Tropic rain forests must be protected by a special aid mechanism
- Fossil energy sources (fuels) must be exchanged with renewable ones
- Controversial energy sources – such as nuclear energy – must be discarded.

Besides their campaigns and demonstrations, Greenpeace regularly publishes brochures and other publications. One of them is the Hungarian version of their Energy Revolution paper, which is a document on energy issues aimed at professionals. “Save the Climate!”, which was a special edition of a well-known youth magazine, was a more accessible publication for the public, offering everyday tips on how to tackle climate change as an individual.

Hungarian Society for Environmental Education (MKNE)

The Society was established in 1992 and has attracted more than a thousand members by now. They play an important role both in organizing trainings on the methodology of environmental education for teachers and in organizing events in schools for pupils and their families[48]. Goals and Mission of MKNE:

- Increase environmental awareness, knowledge and responsibility of those who regard EE for a mission of themselves, and - through them - of whole Hungarian society.
- Collect and disseminate knowledge and methods of EE; help environmental educators, encourage and organize their co-operation.
- Improve personal effectiveness of environmental educators, develop their ability to make contacts with other people.
- Study, understand and improve personal relationships for creating harmony amongst people and between people and environment.
- Develop ethics based on the respect of nature and man; develop responsible thinking on the planetary and century scale; improve cooperation and patience.
- Identify, train and practice skills and competences needed for the ecological sustainability of the Earth.

National Society of Conservationists (NSC)

The mission of the National Society of Conservationists (NSC), comprising of over 100 Hungarian member groups, is the comprehensive protection of nature, as well as the promotion of sustainable development.[49] The National Society of Conservationists launched a public campaign in 2008 aiming for the support of the people in urging the Hungarian Parliament to pass a law on climate change by 2010 which has not yet been passed. The NSC is still working on the topic. There are only two laws which concern climate change. The one which enforces the accomplishment of the Kyoto Protocol (Law LX. 2007) and the one accepted in December 2012 (Law CCXVII. 2012) regarding the participation in the greenhouse gas trade- and division system of the European Community.

[46] http://energiaklub.hu/projekt/re-seeties

[47] http://www.greenpeace.org/hungary/hu/Mivel-foglalkozunk/Klimavaltozas/A-megoldas/

[48] http://www.mkne.hu/index_english.php

[49] http://www.mtvsz.hu/

Protect the Nature (Védegylet)

The goal of Védegylet ("Protect the Future") is to go a step further than showing what an individual can do to battle climate change and instead emphasize the power of community action. Their events and public awareness campaigns reflect this philosophy. They have been around since 2000 and have been encouraging people to participate in local and national public affairs since then.

Their first important festival focusing on climate change was Globfeszt II, where Wolfgang Sachs, a well-known expert from Wuppertal Institute for Climate, Environment and Energy was one of the keynote speakers talking about climate issues.

Summer Camp was a meeting for university students already active in green and social movements at their campus on climate change and climate justice. The UK group People & Planet was invited to the Camp to help in capacity building and to inspire the students.

"Wake up to Climate Change"53 (Klímaébresztő) film festival was a nationwide film week with about 20 movies on climate change shown in 46 towns and cities. Posters, press statements, leaflets etc. were provided by Védegylet to assist the more than 90 organizers around the country. The film screenings were followed by discussions on how to advance at the community level. In 2013 they have led campaigns against nuclear energy, the over-dredging and over-regulation of the Danube, saving trees in Budapest at the reconstruction of squares are all part of their agenda.

WWF

WWF (Worldwide Fund For Nature) has organized a wide range of climate change-related awareness building activities during the last years addressing households, companies and also decision makers. WWF organized the Earth Hour in Hungary both in 2008 and 2009. This symbolic event was started in 2007 by WWF in Sydney and asked people to switch off their lights and electric appliances for one hour to signal their commitment to keeping global warming below the critical value of 2ºC. The event has been a success in Hungary in both years, in 2008 Pécs made it to the top 10 cities in the world based on the share of the population joining.

In 2008 WWF launched its innovative Climate Change Survival Kit. This Kit includes arange of climate saving appliances, such as efficient bulbs, insulation tapes, rechargeable batteries with charger, a solar lamp and a range of printed materials about climate change and energy efficiency. In an intensive media campaign close to 10,000 people joined WWF in making written pledges.

In 2013 and the preceding years the WWF shared its expertise in designing the National energy strategy and the Renewable energy utilization action plan, and also in reviewing the Action Plan for Energy Efficiency. It successfully applied for an Environment and Natural Resource Thematic Programme and is participating in a Central Europe Programme launching nine projects in eight countries in 2012. The main procests the WWF was involved in in Hungary in the last couple of years were:

- Tiszatarján, aiming to improve quality of life of local communities and the sustainable utilisation of the locally accessible biomass, besides the restoration of the floodplain
- Related to the presidency of Hungary of the Council of the European Union in 2011, our two most important events within the theme of climate and energy were related to the building industry energy, the sector with the most greenhouse gas emissions
- A communication campaign with Bosch on the topic of saving energy, with the focus on modern heating.
- Together with Ecowizer developing a financial plan for small and medium-sized enterprises
- Together with Toyota launching project Green Fleet, which aims making corporate car fleets more eco-friendly
- General climate communication.

9.5. Training

Several organisations in Hungary offer training related to climate change and particularly its mitigation and a large number of conferences and expert workshops are regularly taking place to address such topics. These are partly geared towards general public, but more often to professionals in the fields like construction and engineering. Since issues like climate- friendly and energy-efficient construction haven't been core subjects in most architectural and engineering study programmes at Hungarian universities and colleges so far, there is a particular need for further training in this area. Some major institutions and activities addressing this need are introduced below, but there are many more one-off or smaller- scale training activities taking place in addition to these.

Energia Klub (Energy Club)

Its main goal is to provide information to the public and plays a role in education, be it trainings related to civil service, elementary school education or presentation of a project arranged according to the requirements of the actual administration. [50].

Hungarian Green Buildings Council (HuGBC)[51]
Providing trainings for engineers with the main message of environment and energy friendly design. Trainings on building evaluation.

KÖVET (Association for Sustainable Economies)
One of the main goals of KÖVET, a non-profit organisation and Hungarian member of the International Network for Environmental Management (INEM), is training and education for companies about sustainable development, including climate change mitigation, through conferences, seminars and publications. One of their most successful programmes is "Green Office", which comprises distance learning materials on improving workplace sustainability and a yearly competition among offices for the most successful greening efforts. This scheme is supported by the Leonardo da Vinci programme of the European Union. In 2013 the "Green Office Day 2013" was organized in conjunction with the green office programme where 15 companies competed for the prize.

Passive House60 & Zero Emission Building Conference 2012[52]
Passive house conferences are regular training events organized by the Hungarian Association of Construction Material Producers and the Hungarian Association of Passive House Builders and are accredited as vocational training by the Chamber of Hungarian Architects. They usually feature international experts in the field and serve the purpose of promoting and supporting the idea of climate-friendly passive houses and low-energy buildings in Hungary as well.

9.6. Conclusions

The domestic organizations and institutions backed by significant government support provide a solid background for climate change training and education and through their awareness-raising activities and campaigns contribute significantly to the efforts of the government to accelerate public participation in climate change related efforts.

[50] http://energiaklub.hu/szolgaltatasok
[51] www.hugbc.hu
[52] www.passzivhazkonf.hu

Annex I.

First Biennial Report

Hungary

2013

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1. Introduction

Hungary as a Member State of the European Union and as a Party to the Kyoto Protocol considers efforts against climate change to be one of the most important challenges. Implementing, adopting and planning measures and policies to tackle climate change related threats, designing mechanisms and plans to adapt to climate change and pursuing scientific activities to assess, monitor and decrease climate change vulnerability was and is in the focus of the Hungarian Govenment and the experts.

The recent findings outlined in the Fifth Assessment Report of the IPCC conclude that human activities are highly likely to be causing climate change and that actions against global warming are indispensable. In accordance with these results and responding to the 19^{th} Conference of Parties in Warsaw in 2013, Hungary presents the future commitments, the progress made and other relevant topics in this First Biennial Report, as an Annex to the 6^{th} National Communication. The Biennial Report is a task introduced at the 16^{th} COP and is a supplementary information to the existing reports on greenhouse gas emissions and national reports.

Hungary's first Biennial Report provides information on greenhouse gas emissions and trends, the quantified emission reduction targets, and the progress towards their accomplishment, gives an overview of emissions projections and financial and technical support provided to developing countries. In case of overlapping references will be made to the respective sections of the 6^{th} National Communication of Hungary.

2. Information on GHG emissions and trends

In 2011, total emissions of greenhouse gases in Hungary were ***66.1 million tonnes*** carbon dioxide equivalents (excluding the LULUCF sector) which is *the lowest value* in the whole time series (1985-2011). Taking into account also the mostly carbon absorbing processes in the LULUCF sector, the net emissions of Hungary were 62.4 million tonnes CO_2 eq. in 2011. Being about 6-7 tonnes, the Hungarian per capita emissions are below the European average.
By far, the biggest emitting sector was the energy sector, contributing 71.6% to the total GHG emission in 2011. Agriculture was the second largest sector with 13.2%, while emissions from industrial processes (with solvent and other product use) accounted for 9.8% and the waste sector contributed 5.3%. Compared to the base year, emissions were significantly reduced in the energy (-40.3%), agriculture (-54.0%), and industrial processes (-57.7%) sectors. In contrast, emissions in the waste sector have increased since 1985 (+14.5%). Solvent and other product use and land use, land-use change and forestry (LULUCF) sectors show fluctuating behavior.

The most important greenhouse gas is carbon dioxide, accounting for 75.2% of the total GHG emissions. The main source of CO_2 emissions is burning of fossil fuels for energy purposes, including transport. CO_2 emissions have decreased by 41.8% since the middle of the 80's. Methane represents 12.8% in the GHG inventory. Methane is generated mainly at waste disposal sites and in animal farms, but the fugitive emissions of natural gas are also important sources. CH_4 emissions are by 37.2% lower than in the base year. Nitrous oxide contributes 10.2% to the total GHG emissions. Its main sources are agricultural soils and manure management. N_2O emissions are 60.4% lower compared to base year. The total emissions of fluorinated gases amount to 1.8% but their steadily growing tendency seems to level off since 2008.

By ratifying the Kyoto Protocol, Hungary has committed to reduce its GHG emissions by 6%. Now, our emissions are 43.2% lower than in the base year (average of 1985-87). For the most part, this significant reduction was a consequence of the regime change in Hungary (1989-90), which brought in its train radical decline in the output of the national economy. The production decreased in almost every economic sector including also the GHG relevant sectors like energy, industry and agriculture. Then, between 2005 and 2011, after a period of about 14 years of relatively stagnant emission levels (1992-2005), GHG emissions fell again quite significantly by 16.7 per cent.

The global financial and economic crises exerted a major impact on the output of the Hungarian economy, consequently on the level of GHG emissions as well. After a quite significant drop of 8.4% between 2008 and 2009, our emissions in the following three years (2009-11) remained the lowest in the entire time series. Although the decline in economic output stopped in the first quarter of 2010 and Hungary had a moderate growth of 1.6%, emissions fell again by 2.6% in 2011 after slight increase (+0,8%) in 2010.

Compared to the base year, emissions were significantly reduced in the energy (-40.3%), agriculture (-54.0%) and industrial processes (-57.7%) sectors. In contrast, emissions in the waste sector have increased since 1985 (+14.5%). Solvent and other product use and land use, land-use change and forestry (LULUCF) sectors show fluctuating behavior.

National Inventory Arrangements

The National Inventory of Hungary is under the auspices of the Hungarian Meteorological Service, supervised by the Ministry of Rural Development. The minister responsible for the environment, i.e. the head of the above mentioned ministry, has overall responsibility for the Hungarian Greenhouse Gas Inventory and the Hungarian National System for Climate Reporting. He is responsible for the institutional, legal and procedural arrangements for the national system and the strategic development of the national inventory. As a new feature, the national system has to be operated by the minister responsible for the environment as earlier but, as prescribed by the legislation, in consent and cooperation with the ministers responsible for energy policy and forest management. Within the Ministry of National Development, i.e. the ministry responsible for energy policy, a Climate Policy Department has been established that plays a coordinating and supervisory role in the national system. The head of this department is Hungary's current UNFCCC Focal Point.

The Greenhouse Gas Inventory Division (GHG division) was established in the Hungarian Meteorological Service (OMSZ) for the preparation and development of the inventory. This division is responsible for all inventory related tasks, compiles the greenhouse gas inventories and other reports with the involvement of external institutions and experts on a contractual basis, and supervises the maintenance of the system.

At the very end of 2009, a new government decree on data provision relating to GHG emissions was put into force. This decree confirmed the designation of the Hungarian Meteorological Service as the compiler institute. As a new element, the participation of the Forestry Directorate of the National Food Chain Safety Office (NFCS, Forestry Directorate, formerly known as Central Agricultural Office), together with the Forest Research Institute, is formalized by this decree. These two institutes are responsible for the forestry part of the LULUCF sector and for the supplementary reporting on LULUCF activities under Articles 3.3 and 3.4 of the Kyoto Protocol by making recommendations to HMS of the content of the inventory.

The Hungarian Meteorological Service is a central office under the control of the Ministry of Rural Development. The duties of the Service are specified in a Government Decree from 2005. The financial background of operation is determined in the Finances Act. OMSZ has introduced the quality management system ISO 9001:2000 for the whole range of its activities in 2002 to fulfill its tasks more reliably and for the better satisfaction of its partners. The GHG Inventory Division functions as part of the Climate and Atmospheric Environment Department.

The GHG division of the Hungarian Meteorological Service coordinates the work with other involved ministries, government agencies, consultants, universities and companies in order to be able to draw up the yearly inventory report and other reports to the UNFCCC and the European Commission. The GHG division can be regarded as a core expert team of four people. The division of labor and the sectoral responsibilities within the team are laid down in the QA/QC plan and other official documents of OMSZ. The Head of Division coordinates the teamwork and organizes the cooperation with other institutions involved in inventory preparations. He is responsible for the compilation of CRF tables and NIR. Within the team the experts are responsible for different sectors. Besides, a QA/QC coordinator and an archive manager have been nominated.

Some parts of the inventory (mainly energy, industrial processes and waste are prepared by the experts of the GHG division themselves. The calculations of agriculture and LULUCF (except forestry) sector are compiled by the HMS with contribution of external experts / institutions on contractual basis as follows. The forestry related parts are compiled by the Forestry Directorate of the National Food Chain Safety Office and the Forest Research Institute as laid down by the above mentioned government decree. For the calculation of emissions from agricultural soils the Karcag Research Institute of University of Debrecen (Department of Soil Utilization and Rural Development) was contracted like in the last three years. The Research Institute for Animal Breeding and Nutrition had been heavily involved in the calculations for the agriculture sector of the inventory for several years.

The National Emissions Trading Registry is maintained by the National Inspectorate For Environment, Nature and Water.

HUN_BR1_v2
.1

Table 1
Emission trends: summary [(1)]

(Sheet 1 of 3) CRF: HUN_CRF__ v2.1

GREENHOUSE GAS EMISSIONS	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997
	kt CO_2 eq	*kt CO_2 eq*	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq
CO_2 emissions including net CO_2 from LULUCF	82,790.12	71,089.70	67,335.05	60,121.72	59,128.76	57,543.97	56,851.29	62,043.21	60,187.01
CO_2 emissions excluding net CO_2 from LULUCF	85,429.23	73,154.24	69,843.88	63,458.99	64,236.91	63,104.13	62,476.99	63,786.47	62,195.73
CH_4 emissions including CH_4 from LULUCF	13,504.85	12,680.30	12,365.65	10,998.69	10,449.75	9,991.53	10,009.25	10,191.97	10,024.22
CH_4 emissions excluding CH_4 from LULUCF	13,474.10	12,653.14	12,339.15	10,974.27	10,427.95	9,969.29	9,986.10	10,166.98	9,998.78
N_2O emissions including N_2O from LULUCF	17,136.44	12,833.34	9,052.81	7,447.92	7,371.44	8,467.39	7,499.60	8,139.69	8,004.42
N_2O emissions excluding N_2O from LULUCF	17,128.40	12,814.87	9,034.41	7,429.74	7,350.43	8,443.24	7,472.26	8,109.05	7,970.61
HFCs	NA, NO	NA, NO	NA, NO	3.38	3.38	16.89	23.88	21.58	80.06
PFCs	268.49	270.83	233.72	134.82	145.73	158.93	166.82	159.40	161.52
SF_6	73.05	87.62	102.50	99.41	129.84	149.49	169.59	174.63	211.30
Total (including LULUCF)	113,772.96	96,961.78	89,089.73	78,805.93	77,228.89	76,328.21	74,720.45	80,730.49	78,668.53
Total (excluding LULUCF)	116,373.26	98,980.69	91,553.66	82,100.60	82,294.23	81,841.98	80,295.65	82,418.11	80,618.00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[a]	1990	1991	1992	1993	1994	1995	1996	1997
	kt CO_2 eq	*kt CO_2 eq*	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq
1. Energy	79,331.61	68,252.83	67,542.31	61,463.45	61,705.12	59,904.33	59,227.16	60,959.24	59,793.22
2. Industrial Processes	14,637.45	11,572.74	7,450.83	5,853.78	6,967.60	8,419.32	7,876.81	8,061.54	7,664.72
3. Solvent and Other Product Use	284.42	226.15	176.64	199.71	203.80	178.46	205.06	231.31	224.71
4. Agriculture	19,043.88	15,477.47	12,863.70	11,027.51	9,823.67	9,711.28	9,296.02	9,457.62	9,189.00
5. Land Use, Land-Use Change and Forestry[b]	-2,600.31	-2,018.91	-2,463.93	-3,294.67	-5,065.34	-5,513.76	-5,575.21	-1,687.62	-1,949.47
6. Waste	3,075.90	3,451.50	3,520.18	3,556.15	3,594.04	3,628.58	3,690.61	3,708.39	3,746.34
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)	113,772.96	96,961.78	89,089.73	78,805.93	77,228.89	76,328.21	74,720.45	80,730.49	78,668.53

Note: All footnotes for this table are given on sheet 3.

[1] The common tabular format will be revised, in accordance with relevant decisions of the Conference of the Parties and, where applicable, with decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol."

HUN_BR1_
v2.1

Table 1
Emission trends: summary [(1)]
(Sheet 2 of 3) CRF: HUN_CRF__ v2.1

GREENHOUSE GAS EMISSIONS	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
	kt CO_2 eq	*kt CO_2 eq*	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq
CO_2 emissions including net CO_2 from LULUCF	58,176.35	59,693.55	58,710.66	58,559.70	57,481.21	58,332.42	57,755.82	55,259.23	56,326.28	54,309.93
CO_2 emissions excluding net CO_2 from LULUCF	61,418.11	61,384.08	59,467.87	60,822.47	59,237.00	62,247.33	60,714.70	60,476.84	59,572.54	57,969.86
CH_4 emissions including CH_4 from LULUCF	10,011.26	10,106.86	10,022.25	9,801.31	9,861.81	9,864.21	9,466.65	9,299.10	9,177.60	9,138.91
CH_4 emissions excluding CH_4 from LULUCF	9,986.21	10,085.37	9,991.20	9,773.39	9,834.30	9,837.52	9,443.64	9,263.24	9,156.08	9,107.15
N_2O emissions including N_2O from LULUCF	8,179.86	8,175.44	8,403.27	8,985.35	8,376.80	8,347.47	9,266.15	8,636.97	8,406.15	7,910.51
N_2O emissions excluding N_2O from LULUCF	8,143.11	8,136.44	8,359.82	8,941.48	8,331.96	8,301.82	9,220.00	8,590.24	8,362.11	7,866.86
HFCs	151.02	300.07	213.64	288.06	362.11	477.86	582.70	675.45	769.49	839.50
PFCs	193.58	210.81	212.16	199.95	203.88	190.70	201.91	210.25	2.52	3.60
SF_6	168.16	205.49	195.26	226.02	174.27	179.56	329.62	237.72	185.78	252.73
Total (including LULUCF)	76,880.23	78,692.22	77,757.24	78,060.39	76,460.09	77,392.22	77,602.86	74,318.72	74,867.82	72,455.18
Total (excluding LULUCF)	80,060.20	80,322.26	78,439.95	80,251.38	78,143.53	81,234.78	80,492.58	79,453.73	78,048.53	76,039.70

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
	kt CO_2 eq	*kt CO_2 eq*	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq	kt CO_2 eq
1. Energy	58,714.43	58,989.82	56,597.50	58,301.64	56,790.35	60,185.51	57,993.83	56,963.45	56,226.43	54,422.43
2. Industrial Processes	7,655.38	7,333.09	8,159.37	8,004.15	7,320.61	7,203.94	8,401.87	8,936.69	8,311.63	8,096.95
3. Solvent and Other Product Use	230.94	208.48	213.62	257.86	190.66	260.54	324.87	366.32	334.66	366.15
4. Agriculture	9,657.95	9,927.10	9,533.77	9,730.86	9,875.09	9,611.42	9,769.02	9,195.88	9,210.07	9,236.58
5. Land Use, Land-Use Change and Forestry[b]	-3,179.97	-1,630.04	-682.72	-2,190.98	-1,683.44	-3,842.56	-2,889.71	-5,135.02	-3,180.71	-3,584.52
6. Waste	3,801.51	3,863.76	3,935.69	3,956.87	3,966.82	3,973.37	4,002.99	3,991.40	3,965.74	3,917.58
7. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total (including LULUCF)	76,880.23	78,692.22	77,757.24	78,060.39	76,460.09	77,392.22	77,602.86	74,318.72	74,867.82	72,455.18

Note: All footnotes for this table are given on sheet 3.

HUN_BR1_v2.1

Table 1
Emission trends: summary (1)

(Sheet 3 of 3)

CRF: HUN_CRF__ v2.1

GREENHOUSE GAS EMISSIONS	*2008*	2009	2010	2011	Change from base to latest reported year
	kt CO_2 eq	*kt CO_2 eq*	kt CO_2 eq	kt CO_2 eq	(%)
CO_2 emissions including net CO_2 from LULUCF	51,637.97	47,002.75	47,463.84	45,875.71	-44.59
CO_2 emissions excluding net CO_2 from LULUCF	56,527.30	51,055.30	51,608.42	49,740.01	-41.78
CH_4 emissions including CH_4 from LULUCF	8,855.78	8,703.57	8,700.77	8,496.77	-37.08
CH_4 emissions excluding CH_4 from LULUCF	8,832.23	8,680.35	8,677.76	8,459.58	-37.22
N_2O emissions including N_2O from LULUCF	7,042.03	6,580.93	6,501.16	6,814.10	-60.24
N_2O emissions excluding N_2O from LULUCF	7,000.72	6,541.40	6,464.30	6,774.46	-60.45
HFCs	948.64	880.16	958.97	987.62	100.00
PFCs	3.80	2.91	1.01	1.70	-99.37
SF_6	275.50	220.55	234.94	184.37	152.38
Total (including LULUCF)	68,763.72	63,390.87	63,860.70	62,360.25	-45.19
Total (excluding LULUCF)	73,588.19	67,380.67	67,945.41	66,147.73	-43.16

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*2008*	2009	2010	2011	Change from base to latest reported year
	kt CO_2 eq	*kt CO_2 eq*	kt CO_2 eq	kt CO_2 eq	(%)
1. Energy	53,404.91	48,737.30	49,035.92	47,364.11	-40.30
2. Industrial Processes	6,841.22	5,973.91	6,431.83	6,193.99	-57.68
3. Solvent and Other Product Use	406.30	340.09	268.88	309.56	8.84
4. Agriculture	9,113.38	8,577.52	8,531.30	8,758.65	-54.01
5. Land Use, Land-Use Change and Forestry[b]	-4,824.47	-3,989.80	-4,084.71	-3,787.48	45.66
6. Waste	3,822.39	3,751.84	3,677.48	3,521.43	14.48
7. Other	NA	NA	NA	NA	0.00
Total (including LULUCF)	68,763.72	63,390.87	63,860.70	62,360.25	-45.19

Notes:

(1) Further detailed information could be found in the common reporting format tables of the Party's greenhouse gas inventory, namely "Emission trends (CO_2)", "Emission trends (CH_4)", "Emission trends (N_2O)" and "Emission trends (HFCs, PFCs and SF_6)", which is included in an annex to this biennial report.

(2) 2011 is the latest reported inventory year.

(3) 1 kt CO_2 eq equals 1 Gg CO_2 eq.

Abbreviation: LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[b] Includes net CO_2, CH_4 and N_2O from LULUCF.

Custom Footnotes

Table 1 (a)

HUN_BR1_v2.1

Emission trends (CO_2)
(Sheet 1 of 3)

CRF: HUN_CRF__v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year[a]*	1990	1991	1992	1993	1994	1995	1996	1997
	kt	kt	kt	kt	kt	kt	kt	kt	kt
1. Energy	75,560.39	65,071.68	64,305.36	58,675.59	58,848.55	57,004.71	56,283.68	57,947.10	56,772.95
A. Fuel Combustion (Sectoral Approach)	75,196.59	64,775.96	64,024.33	58,405.64	58,603.53	56,698.34	55,964.74	57,637.00	56,518.30
1. Energy Industries	27,577.01	22,633.94	23,292.88	24,222.04	25,388.62	24,556.83	24,392.89	25,251.91	25,186.27
2. Manufacturing Industries and Construction	15,626.67	11,766.39	10,577.67	10,126.91	9,017.77	8,345.98	8,381.61	8,672.03	7,856.06
3. Transport	7,659.11	8,188.18	7,304.24	7,080.34	7,065.77	6,889.55	7,096.87	7,087.66	7,507.43
4. Other Sectors	24,333.80	22,187.45	22,849.53	16,976.34	17,131.37	16,905.97	16,093.37	16,625.40	15,968.53
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	363.80	295.72	281.03	269.95	245.03	306.38	318.94	310.10	254.65
1. Solid Fuels	3.60	6.76	5.23	5.03	5.44	2.07	2.41	1.16	IE, NA, NO
2. Oil and Natural Gas	360.20	288.97	275.80	264.92	239.59	304.31	316.53	308.94	254.65
2. Industrial Processes	9,738.59	7,987.22	5,478.75	4,715.75	5,332.12	6,041.54	6,142.93	5,753.76	5,331.37
A. Mineral Products	3,314.12	3,278.04	2,178.19	1,784.09	2,005.50	2,253.33	2,316.57	2,142.82	2,187.14
B. Chemical Industry	1,616.30	1,056.05	563.01	363.99	456.33	543.81	546.80	605.48	580.30
C. Metal Production	4,257.20	3,208.17	2,248.01	1,943.82	2,303.83	2,629.17	2,577.59	2,419.59	1,835.18
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Production of Halocarbons and SF6									
F. Consumption of Halocarbons and SF6									

G. Other	550.97	444.95	489.54	623.84	566.45	615.23	701.98	585.86	728.75
3. Solvent and Other Product Use	130.25	95.33	59.77	67.65	56.24	57.87	50.37	85.61	91.41
4. Agriculture									
A. Enteric Fermentation									
B. Manure Management									
C. Rice Cultivation									
D. Agricultural Soils									
E. Prescribed Burning of Savannas									
F. Field Burning of Agricultural Residues									
G. Other									
5. Land Use, Land-Use Change and Forestry	-2,639.11	-2,064.54	-2,508.83	-3,337.27	-5,108.15	-5,560.16	-5,625.70	-1,743.25	-2,008.71
A. Forest Land	-2,921.01	-2,560.96	-2,879.03	-3,591.90	-5,218.29	-5,731.01	-5,790.80	-1,890.04	-2,165.59
B. Cropland	198.72	340.27	178.81	79.73	-129.18	-154.57	-220.16	-254.49	-282.17
C. Grassland	11.23	43.28	113.59	110.70	145.48	241.03	284.87	307.75	334.33
D. Wetlands	3.42	3.42	3.42	3.42	2.68	2.68	2.68	2.68	2.68
E. Settlements	68.53	109.45	74.38	60.78	91.16	81.71	97.72	90.85	102.04
F. Other Land	NO	NO	NO	NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
A. Solid Waste Disposal on Land	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
B. Waste-water Handling									
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO2 emissions including net CO2 from LULUCF	82,790.12	71,089.70	67,335.05	60,121.72	59,128.76	57,543.97	56,851.29	62,043.21	60,187.01
Total CO2 emissions excluding net CO2 from LULUCF	85,429.23	73,154.24	69,843.88	63,458.99	64,236.91	63,104.13	62,476.99	63,786.47	62,195.73

Memo Items:									
International Bunkers	431.39	475.04	375.87	385.85	361.15	532.23	523.88	559.56	531.24
Aviation	431.39	475.04	375.87	385.85	361.15	532.23	523.88	559.56	531.24
Marine	NA	NA	NA	NA	NA	NA	NA	NA	NA
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 Emissions from Biomass	1,421.26	1,020.36	1,456.76	1,444.28	1,504.63	1,519.50	1,723.01	1,571.06	1,594.18

Note: All footnotes for this table are given on sheet 3.

Table 1 (a)

HUN_BR1_ v2.1

Emission trends (CO_2)
(Sheet 2 of 3)

CRF: HUN_CRF__ v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1. Energy	55,766.40	56,064.56	53,657.81	55,415.14	53,851.25	57,162.74	55,103.58	54,318.46	53,555.44	51,774.58
A. Fuel Combustion (Sectoral Approach)	55,540.92	55,861.70	53,430.93	55,240.49	53,681.12	56,985.30	54,959.25	54,182.08	53,415.21	51,648.79
1. Energy Industries	26,320.93	26,018.38	23,981.40	23,674.41	21,836.13	22,773.78	20,648.95	18,252.28	19,280.01	20,092.54
2. Manufacturing Industries and Construction	7,046.22	6,410.58	6,394.56	6,904.78	6,236.07	6,933.38	5,999.09	6,667.03	5,258.92	4,993.11
3. Transport	8,377.48	8,849.71	8,837.61	9,282.77	9,879.94	10,340.40	10,815.65	11,714.43	12,519.74	12,905.68
4. Other Sectors	13,796.28	14,583.03	14,217.36	15,378.53	15,728.97	16,937.74	17,495.56	17,548.34	16,356.54	13,657.46
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	225.48	202.86	226.87	174.65	170.13	177.45	144.33	136.39	140.23	125.79
1. Solid Fuels	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO
2. Oil and Natural Gas	225.48	202.86	226.87	174.65	170.13	177.45	144.33	136.39	140.23	125.79
2. Industrial Processes	5,557.49	5,226.05	5,712.70	5,310.68	5,297.70	5,003.23	5,490.58	6,045.93	5,889.66	6,059.66
A. Mineral Products	2,266.73	2,267.86	2,263.18	2,256.41	2,233.44	2,300.73	2,282.71	2,261.90	2,356.03	2,391.17
B. Chemical Industry	518.64	469.21	591.22	519.01	352.76	350.90	451.59	508.52	478.13	522.52
C. Metal Production	1,972.24	1,945.06	2,108.48	1,880.85	2,032.14	1,828.21	2,012.62	2,057.52	2,026.32	2,087.96
D. Other Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
E. Production of Halocarbons and SF6										
F. Consumption of Halocarbons and SF6										
G. Other	799.87	543.92	749.81	654.41	679.37	523.38	743.66	1,218.00	1,029.18	1,058.01
3. Solvent and Other Product Use	94.23	93.47	97.37	96.66	88.05	81.36	68.34	65.47	57.51	71.57

4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry	-3,241.77	-1,690.53	-757.21	-2,262.78	-1,755.80	-3,914.91	-2,958.87	-5,217.61	-3,246.26	-3,659.93
A. Forest Land	-3,142.81	-1,503.33	-493.58	-1,979.69	-1,465.64	-3,581.49	-2,611.79	-4,719.55	-2,726.39	-3,021.08
B. Cropland	-542.15	-635.32	-744.63	-734.12	-752.03	-801.47	-858.56	-928.97	-983.86	-1,056.65
C. Grassland	330.65	331.88	307.62	289.51	281.28	267.91	267.80	256.97	265.38	257.60
D. Wetlands	2.68	2.68	2.68	3.02	3.02	3.02	3.02	3.02	3.02	3.02
E. Settlements	109.87	113.56	170.71	158.50	177.58	197.12	240.67	170.92	195.58	157.18
F. Other Land	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	52.19	46.98	69.93	64.05
A. Solid Waste Disposal on Land	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
B. Waste-water Handling										
C. Waste Incineration	NA	NA	NA	NA	NA	NA	52.19	46.98	69.93	64.05
D. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CO2 emissions including net CO2 from LULUCF	58,176.35	59,693.55	58,710.66	58,559.70	57,481.21	58,332.42	57,755.82	55,259.23	56,326.28	54,309.93
Total CO2 emissions excluding net CO2 from LULUCF	61,418.11	61,384.08	59,467.87	60,822.47	59,237.00	62,247.33	60,714.70	60,476.84	59,572.54	57,969.86
Memo Items:										
International Bunkers	555.59	596.29	634.02	538.11	576.90	591.62	609.46	663.11	651.93	718.11

Aviation	555.59	596.29	634.02	538.11	576.90	591.62	609.46	663.11	651.93	718.11
Marine	NA	NA	NA, NO	NA, NO	NA	NA	NA	NA	NA	NA
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 Emissions from Biomass	1,471.98	1,476.97	1,619.91	1,469.48	1,583.77	2,120.16	2,838.35	4,754.14	4,295.28	4,816.55

Note: All footnotes for this table are given on sheet 3.

Table 1(a) HUN_BR1_v2.1

Emission trends (CO_2)
(Sheet 3 of 3) CRF: HUN_CRF__ v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*2008*	2009	2010	2011	Change from base to latest reported year
	kt	kt	kt	kt	%
1. Energy	50,822.71	46,113.11	46,304.87	44,650.58	-40.91
A. Fuel Combustion (Sectoral Approach)	50,611.60	45,902.76	46,085.33	44,435.45	-40.91
1. Energy Industries	19,294.87	16,113.66	16,573.63	15,932.79	-42.22
2. Manufacturing Industries and Construction	4,911.29	3,708.06	3,882.03	3,780.80	-75.81
3. Transport	12,824.08	12,816.86	11,687.33	11,255.90	46.96
4. Other Sectors	13,581.36	13,264.19	13,942.34	13,465.96	-44.66
5. Other	NO	NO	NO	NO	0.00
B. Fugitive Emissions from Fuels	211.11	210.34	219.54	215.13	-40.87
1. Solid Fuels	IE, NA, NO	IE, NA, NO	IE, NA, NO	IE, NA, NO	-100.00
2. Oil and Natural Gas	211.11	210.34	219.54	215.13	-40.27
2. Industrial Processes	5,575.11	4,826.11	5,186.67	4,962.54	-49.04
A. Mineral Products	2,269.69	1,614.59	1,412.58	1,231.36	-62.85
B. Chemical Industry	393.28	432.63	470.55	543.93	-66.35
C. Metal Production	1,992.54	1,897.75	2,242.87	2,235.70	-47.48
D. Other Production	NO	NO	NO	NO	0.00
E. Production of Halocarbons and SF6					

F. Consumption of Halocarbons and SF6					
G. Other	919.59	881.14	1,060.66	951.55	72.71
3. Solvent and Other Product Use	65.37	47.91	32.57	34.00	-73.90
4. Agriculture					
A. Enteric Fermentation					
B. Manure Management					
C. Rice Cultivation					
D. Agricultural Soils					
E. Prescribed Burning of Savannas					
F. Field Burning of Agricultural Residues					
G. Other					
5. Land Use, Land-Use Change and Forestry	-4,889.33	-4,052.55	-4,144.58	-3,864.30	46.42
A. Forest Land	-4,139.37	-3,211.11	-3,149.11	-2,964.52	1.49
B. Cropland	-1,143.37	-1,260.36	-1,318.08	-1,275.95	-742.08
C. Grassland	232.13	230.26	165.36	197.60	1,659.94
D. Wetlands	3.02	3.02	3.02	3.02	-11.80
E. Settlements	158.28	185.65	154.23	175.56	156.18
F. Other Land	NE, NO	NE, NO	NE, NO	NE, NO	0.00
G. Other	NE	NE	NE	NE	0.00
6. Waste	64.12	68.17	84.31	92.88	100.00
A. Solid Waste Disposal on Land	NA, NO	NA, NO	NA, NO	NA, NO	0.00
B. Waste-water Handling					
C. Waste Incineration	64.12	68.17	84.31	92.88	100.00
D. Other	NA	NA	NA	NA	0.00
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	0.00
Total CO2 emissions including net CO2 from LULUCF	51,637.97	47,002.75	47,463.84	45,875.71	-44.59

Total CO2 emissions excluding net CO2 from LULUCF	56,527.30	51,055.30	51,608.42	49,740.01	-41.78
Memo Items:					
International Bunkers	800.12	684.63	680.81	683.78	58.51
Aviation	800.12	684.63	680.81	683.78	58.51
Marine	NA	NA	NA	NA	0.00
Multilateral Operations	NO	NO	NO	NO	0.00
CO2 Emissions from Biomass	5,910.87	6,397.06	7,477.18	7,119.53	400.93

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[b] Fill in net emissions/removals as reported in CRF table Summary 1.A of the latest reported inventory year. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

Custom Footnotes

HUN_BR1_ v2.1

Table 1(b)

Emission trends (CH_4)
(Sheet 1 of 3)

CRF: HUN_CRF__ v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year[a]*	1990	1991	1992	1993	1994	1995	1996	1997
	kt	kt	kt	kt	kt	kt	kt	kt	kt
1. Energy	164.72	138.66	141.55	120.85	123.85	125.72	127.44	130.31	129.79
A. Fuel Combustion (Sectoral Approach)	43.93	34.06	34.90	22.03	22.04	18.47	17.66	17.55	16.02
1. Energy Industries	0.89	0.67	0.75	0.84	0.89	0.86	0.63	0.59	0.60
2. Manufacturing Industries and Construction	1.24	0.90	0.81	0.76	0.67	0.59	0.64	0.66	0.61
3. Transport	2.15	2.42	2.15	2.00	1.99	1.91	1.83	1.69	1.66
4. Other Sectors	39.65	30.07	31.19	18.43	18.49	15.10	14.57	14.61	13.15
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	120.78	104.60	106.65	98.82	101.81	107.25	109.78	112.76	113.77
1. Solid Fuels	43.95	31.39	30.80	21.16	16.70	18.76	16.31	17.27	17.21
2. Oil and Natural Gas	76.83	73.21	75.85	77.66	85.11	88.49	93.47	95.49	96.56
2. Industrial Processes	0.75	0.62	0.55	0.55	0.59	0.92	1.23	1.27	1.24
A. Mineral Products	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
B. Chemical Industry	0.37	0.34	0.35	0.37	0.37	0.68	1.00	1.05	1.08
C. Metal Production	0.38	0.28	0.20	0.18	0.21	0.24	0.24	0.22	0.16
D. Other Production									
E. Production of Halocarbons and SF6									
F. Consumption of Halocarbons and SF6									
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use									

4. Agriculture	343.98	313.61	292.19	245.90	214.33	188.62	184.41	188.51	179.22
A. Enteric Fermentation	169.79	152.01	144.34	124.73	105.53	93.18	90.31	89.74	87.18
B. Manure Management	169.62	159.19	146.06	120.17	107.81	94.43	93.30	98.14	91.59
C. Rice Cultivation	2.41	2.40	1.80	1.00	1.00	1.00	0.80	0.62	0.44
D. Agricultural Soils	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	2.17	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	1.46	1.29	1.26	1.16	1.04	1.06	1.10	1.19	1.21
A. Forest Land	1.37	1.20	1.17	1.07	0.94	0.97	1.01	1.10	1.12
B. Cropland	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
C. Grassland	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
D. Wetlands	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
E. Settlements	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
F. Other Land	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	132.17	149.64	153.29	155.29	157.81	159.47	162.44	164.05	165.88
A. Solid Waste Disposal on Land	91.30	107.80	112.00	114.52	117.61	119.84	122.28	124.48	127.00
B. Waste-water Handling	40.87	41.84	41.30	40.76	40.20	39.63	40.16	39.50	38.81
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other	NA	NA	NA	NA	NA	NA	NA	0.07	0.08
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CH4 emissions including CH4 from LULUCF	643.09	603.82	588.84	523.75	497.61	475.79	476.63	485.33	477.34
Total CH4 emissions excluding CH4 from LULUCF	641.62	602.53	587.58	522.58	496.57	474.73	475.53	484.14	476.13
Memo Items:									
International Bunkers	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04
Aviation	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04

Marine	NA	NA	NA	NA	NA	NA	NA	NA	NA
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 Emissions from Biomass									

Note: All footnotes for this table are given on sheet 3.

HUN_BR1 _v2.1

Table 1(b)

Emission trends (CH_4)
(Sheet 2 of 3)

CRF: HUN_CRF__ v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1. Energy	125.17	122.62	123.09	119.43	120.81	122.55	115.42	113.40	114.70	113.02
A. Fuel Combustion (Sectoral Approach)	11.34	11.42	10.76	11.52	12.01	13.33	12.33	14.87	15.65	13.62
1. Energy Industries	0.63	0.60	0.54	0.54	0.46	0.48	0.65	1.09	0.83	1.01
2. Manufacturing Industries and Construction	0.57	0.51	0.52	0.56	0.51	0.57	0.51	0.61	0.54	0.55
3. Transport	1.70	1.60	1.46	1.41	1.31	1.31	1.25	2.02	2.09	1.97
4. Other Sectors	8.44	8.72	8.24	9.01	9.72	10.97	9.93	11.15	12.19	10.08
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	113.83	111.20	112.33	107.92	108.80	109.22	103.09	98.53	99.05	99.40
1. Solid Fuels	16.30	14.84	14.83	12.16	13.94	12.61	5.58	1.04	1.02	1.00
2. Oil and Natural Gas	97.53	96.36	97.50	95.76	94.86	96.61	97.51	97.49	98.04	98.39
2. Industrial Processes	1.34	1.29	1.39	1.36	1.38	1.34	1.41	1.60	1.64	1.70
A. Mineral Products	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
B. Chemical Industry	1.16	1.11	1.20	1.19	1.20	1.18	1.23	1.41	1.46	1.51
C. Metal Production	0.18	0.18	0.19	0.17	0.18	0.16	0.18	0.18	0.19	0.19
D. Other Production										
E. Production of Halocarbons and SF6										
F. Consumption of Halocarbons and SF6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use										
4. Agriculture	180.40	185.09	177.32	169.23	170.32	169.71	158.86	152.95	148.79	149.64

A. Enteric Fermentation	86.49	87.39	85.81	82.43	81.49	81.02	78.91	77.85	75.42	75.20
B. Manure Management	93.45	97.25	90.87	86.34	88.40	88.17	79.39	74.56	72.88	73.93
C. Rice Cultivation	0.46	0.45	0.64	0.47	0.42	0.51	0.56	0.53	0.48	0.52
D. Agricultural Soils	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
G. Other	NA	NA	NA	NA	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	1.19	1.02	1.48	1.33	1.31	1.27	1.10	1.71	1.02	1.51
A. Forest Land	1.09	0.98	1.31	1.18	1.19	1.17	1.02	1.62	1.02	1.46
B. Cropland	0.04	0.02	0.11	0.11	0.08	0.06	0.05	0.06	0.00	0.03
C. Grassland	0.06	0.03	0.07	0.03	0.04	0.04	0.03	0.03	0.00	0.02
D. Wetlands	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
E. Settlements	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
F. Other Land	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	168.62	171.26	173.96	175.37	175.80	174.85	174.00	173.16	170.88	169.31
A. Solid Waste Disposal on Land	130.24	133.63	137.17	139.34	141.70	143.10	144.31	145.42	145.48	145.18
B. Waste-water Handling	38.30	37.56	36.72	35.96	33.91	31.56	29.52	27.56	25.14	23.85
C. Waste Incineration	NA	NA	NA	NA	NA	NA	0.02	0.02	0.02	0.02
D. Other	0.07	0.07	0.07	0.07	0.19	0.19	0.16	0.16	0.23	0.26
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total CH4 emissions including CH4 from LULUCF	476.73	481.28	477.25	466.73	469.61	469.72	450.79	442.81	437.03	435.19
Total CH4 emissions excluding CH4 from LULUCF	475.53	480.26	475.77	465.40	468.30	468.45	449.70	441.11	436.00	433.67
Memo Items:										
International Bunkers	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05
Aviation	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05
Marine	NA	NA	NA, NO	NA, NO	NA	NA	NA	NA	NA	NA

Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 Emissions from Biomass										

Note: All footnotes for this table are given on sheet 3.

Table 1(b) HUN_BR1_v2.1

Emission trends (CH_4)
(Sheet 3 of 3) CRF: HUN_CRF__ v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*2008*	2009	2010	2011	Change from base to latest reported year
	kt	kt	kt	kt	%
1. Energy	110.47	113.11	117.94	117.24	-28.82
A. Fuel Combustion (Sectoral Approach)	13.00	13.74	16.02	16.82	-61.71
1. Energy Industries	1.17	1.22	1.24	1.01	13.55
2. Manufacturing Industries and Construction	0.55	0.40	0.47	0.49	-60.93
3. Transport	1.67	1.41	1.28	1.18	-45.30
4. Other Sectors	9.62	10.72	13.03	14.15	-64.32
5. Other	NO	NO	NO	NO	0.00
B. Fugitive Emissions from Fuels	97.47	99.36	101.92	100.42	-16.86
1. Solid Fuels	0.93	0.66	0.56	0.46	-98.96
2. Oil and Natural Gas	96.54	98.71	101.36	99.96	30.11
2. Industrial Processes	1.58	1.40	1.89	2.11	180.18
A. Mineral Products	NA, NO	NA, NO	NA, NO	NA, NO	0.00
B. Chemical Industry	1.39	1.22	1.67	1.90	409.50
C. Metal Production	0.18	0.18	0.21	0.21	-45.33
D. Other Production					
E. Production of Halocarbons and SF6					
F. Consumption of Halocarbons and SF6					

G. Other	NO	NO	NO	NO	0.00
3. Solvent and Other Product Use					
4. Agriculture	143.77	137.81	136.07	134.13	-61.01
A. Enteric Fermentation	73.85	72.79	71.91	71.13	-58.10
B. Manure Management	69.41	64.48	63.76	62.45	-63.18
C. Rice Cultivation	0.51	0.54	0.40	0.54	-77.48
D. Agricultural Soils	NA, NO	NA, NO	NA, NO	NA, NO	0.00
E. Prescribed Burning of Savannas	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	NA, NO	NA, NO	NA, NO	NA, NO	-100.00
G. Other	NO	NO	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	1.12	1.11	1.10	1.77	20.91
A. Forest Land	1.02	1.00	1.07	1.66	21.31
B. Cropland	0.09	0.06	0.01	0.09	44.47
C. Grassland	0.02	0.05	0.01	0.02	-35.17
D. Wetlands	NE, NO	NE, NO	NE, NO	NE, NO	0.00
E. Settlements	NA, NO	NA, NO	NA, NO	NA, NO	0.00
F. Other Land	NA, NO	NA, NO	NA, NO	NA, NO	0.00
G. Other	NA	NA	NA	NA	0.00
6. Waste	164.77	161.03	157.33	149.36	13.00
A. Solid Waste Disposal on Land	143.88	142.39	139.82	132.89	45.56
B. Waste-water Handling	20.53	18.24	16.87	15.68	-61.64
C. Waste Incineration	0.02	0.04	0.05	0.05	100.00
D. Other	0.34	0.36	0.59	0.73	100.00
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	0.00
Total CH4 emissions including CH4 from LULUCF	421.70	414.46	414.32	404.61	-37.08
Total CH4 emissions excluding CH4 from LULUCF	420.58	413.35	413.23	402.84	-37.22
Memo Items:					

International Bunkers	0.06	0.05	0.05	0.05	58.51
Aviation	0.06	0.05	0.05	0.05	58.51
Marine	NA	NA	NA	NA	0.00
Multilateral Operations	NO	NO	NO	NO	0.00
CO2 Emissions from Biomass					

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

Custom Footnotes

Table 1(c)

HUN_BR1_v2.1

Emission trends (N_2O)
(Sheet 1 of 3)

CRF: HUN_CRF__ v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year[a]*	1990	1991	1992	1993	1994	1995	1996	1997
	kt	kt	kt	kt	kt	kt	kt	kt	kt
1. Energy	1.01	0.87	0.85	0.81	0.83	0.84	0.86	0.89	0.95
A. Fuel Combustion (Sectoral Approach)	1.00	0.87	0.85	0.80	0.82	0.84	0.86	0.89	0.95
1. Energy Industries	0.28	0.23	0.24	0.25	0.25	0.24	0.24	0.25	0.25
2. Manufacturing Industries and Construction	0.10	0.06	0.06	0.06	0.05	0.05	0.04	0.04	0.04
3. Transport	0.31	0.33	0.29	0.31	0.34	0.38	0.42	0.45	0.52
4. Other Sectors	0.31	0.24	0.26	0.19	0.18	0.16	0.15	0.15	0.14
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid Fuels	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
2. Oil and Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes	14.65	10.37	5.24	2.87	4.34	6.56	4.35	6.21	5.98
A. Mineral Products	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
B. Chemical Industry	14.65	10.37	5.24	2.87	4.34	6.56	4.35	6.21	5.98
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production									
E. Production of Halocarbons and SF6									
F. Consumption of Halocarbons and SF6									
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	0.50	0.42	0.38	0.43	0.48	0.39	0.50	0.47	0.43
4. Agriculture	38.13	28.68	21.70	18.91	17.17	18.55	17.49	17.74	17.50

A. Enteric Fermentation									
B. Manure Management	6.40	5.65	5.23	4.60	3.92	3.56	3.48	3.29	3.21
C. Rice Cultivation									
D. Agricultural Soils	31.69	23.04	16.48	14.31	13.25	14.99	14.02	14.45	14.29
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	0.04	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
5. Land Use, Land-Use Change and Forestry	0.03	0.06	0.06	0.06	0.07	0.08	0.09	0.10	0.11
A. Forest Land	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B. Cropland	0.02	0.05	0.05	0.05	0.06	0.07	0.08	0.09	0.10
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Wetlands	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
E. Settlements	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
F. Other Land	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	0.97	1.00	0.97	0.95	0.90	0.90	0.90	0.85	0.85
A. Solid Waste Disposal on Land									
B. Waste-water Handling	0.97	1.00	0.97	0.95	0.90	0.90	0.90	0.84	0.84
C. Waste Incineration	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other	NA	NA	NA	NA	NA	NA	NA	0.01	0.01
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total N2O emissions including N2O from LULUCF	55.28	41.40	29.20	24.03	23.78	27.31	24.19	26.26	25.82
Total N2O emissions excluding N2O from LULUCF	55.25	41.34	29.14	23.97	23.71	27.24	24.10	26.16	25.71
Memo Items:									
International Bunkers	0.06	0.07	0.05	0.05	0.05	0.08	0.07	0.08	0.08
Aviation	0.06	0.07	0.05	0.05	0.05	0.08	0.07	0.08	0.08
Marine	NA	NA	NA	NA	NA	NA	NA	NA	NA

Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 Emissions from Biomass									

Note: All footnotes for this table are given on sheet 3.

HUN_BR1_
v2.1

Table 1(c)

Emission trends (N_2O)
(Sheet 2 of 3) CRF: HUN_CRF__ v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
1. Energy	1.03	1.13	1.14	1.22	1.30	1.45	1.50	0.85	0.85	0.89
A. Fuel Combustion (Sectoral Approach)	1.03	1.13	1.14	1.22	1.30	1.45	1.50	0.85	0.85	0.88
1. Energy Industries	0.26	0.25	0.24	0.23	0.21	0.22	0.23	0.26	0.22	0.25
2. Manufacturing Industries and Construction	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04
3. Transport	0.63	0.73	0.76	0.85	0.95	1.07	1.11	0.41	0.43	0.46
4. Other Sectors	0.11	0.11	0.11	0.11	0.12	0.13	0.13	0.14	0.15	0.14
5. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid Fuels	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
2. Oil and Natural Gas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes	5.02	4.40	5.79	6.29	4.04	4.27	5.70	5.59	4.61	2.92
A. Mineral Products	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
B. Chemical Industry	5.02	4.40	5.79	6.29	4.04	4.27	5.70	5.59	4.61	2.92
C. Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D. Other Production										
E. Production of Halocarbons and SF6										
F. Consumption of Halocarbons and SF6										
G. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	0.44	0.37	0.38	0.52	0.33	0.58	0.83	0.97	0.89	0.95

4. Agriculture	18.93	19.48	18.74	19.93	20.32	19.51	20.75	19.30	19.63	19.66
A. Enteric Fermentation										
B. Manure Management	3.28	3.29	3.45	3.36	3.32	3.31	3.21	3.08	2.94	2.87
C. Rice Cultivation										
D. Agricultural Soils	15.65	16.19	15.29	16.56	17.00	16.20	17.54	16.23	16.69	16.79
E. Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F. Field Burning of Agricultural Residues	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
G. Other	NA	NA	NO	NO	NO	NO	NO	NO	NO	NO
5. Land Use, Land-Use Change and Forestry	0.12	0.13	0.14	0.14	0.14	0.15	0.15	0.15	0.14	0.14
A. Forest Land	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
B. Cropland	0.11	0.12	0.13	0.13	0.13	0.14	0.14	0.14	0.13	0.13
C. Grassland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D. Wetlands	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO	NE, NO
E. Settlements	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
F. Other Land	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
G. Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	0.84	0.86	0.91	0.88	0.89	0.97	0.96	0.99	0.99	0.96
A. Solid Waste Disposal on Land										
B. Waste-water Handling	0.83	0.86	0.91	0.88	0.87	0.96	0.94	0.98	0.97	0.94
C. Waste Incineration	NA	NA	NA	NA	NA	NA	0.01	0.00	0.01	0.01
D. Other	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total N2O emissions including N2O from LULUCF	26.39	26.37	27.11	28.99	27.02	26.93	29.89	27.86	27.12	25.52
Total N2O emissions excluding N2O from LULUCF	26.27	26.25	26.97	28.84	26.88	26.78	29.74	27.71	26.97	25.38
Memo Items:										
International Bunkers	0.08	0.08	0.09	0.08	0.08	0.08	0.09	0.09	0.09	0.10

Aviation	0.08	0.08	0.09	0.08	0.08	0.08	0.09	0.09	0.09	0.10
Marine	NA	NA	NA, NO	NA, NO	NA	NA	NA	NA	NA	NA
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO2 Emissions from Biomass										

Note: All footnotes for this table are given on sheet 3.

HUN_BR1_v 2.1

Table 1(c)

Emission trends (N_2O)
(Sheet 3 of 3)

CRF: HUN_CRF__ v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*2008*	2009	2010	2011	Change from base to latest reported year
	kt	kt	kt	kt	%
1. Energy	0.85	0.80	0.82	0.81	-19.44
A. Fuel Combustion (Sectoral Approach)	0.85	0.80	0.82	0.81	-19.35
1. Energy Industries	0.26	0.26	0.26	0.23	-18.83
2. Manufacturing Industries and Construction	0.04	0.03	0.03	0.03	-67.74
3. Transport	0.41	0.37	0.35	0.36	16.87
4. Other Sectors	0.13	0.14	0.17	0.19	-39.81
5. Other	NO	NO	NO	NO	0.00
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	-65.75
1. Solid Fuels	NA, NO	NA, NO	NA, NO	NA, NO	0.00
2. Oil and Natural Gas	0.00	0.00	0.00	0.00	-65.75
2. Industrial Processes	0.02	0.05	0.03	0.04	-99.70
A. Mineral Products	NA, NO	NA, NO	NA, NO	NA, NO	0.00
B. Chemical Industry	0.02	0.05	0.03	0.04	-99.70
C. Metal Production	NA	NA	NA	NA	0.00
D. Other Production					
E. Production of Halocarbons and SF6					
F. Consumption of Halocarbons and SF6					
G. Other	NO	NO	NO	NO	0.00
3. Solvent and Other Product Use	1.10	0.94	0.76	0.89	78.73

4. Agriculture	19.66	18.33	18.30	19.17	-49.73
A. Enteric Fermentation					
B. Manure Management	2.81	2.72	2.70	2.69	-58.01
C. Rice Cultivation					
D. Agricultural Soils	16.85	15.61	15.60	16.48	-47.99
E. Prescribed Burning of Savannas	NO	NO	NO	NO	0.00
F. Field Burning of Agricultural Residues	NA, NO	NA, NO	NA, NO	NA, NO	-100.00
G. Other	NO	NO	NO	NO	0.00
5. Land Use, Land-Use Change and Forestry	0.13	0.13	0.12	0.13	392.68
A. Forest Land	0.01	0.01	0.01	0.01	21.31
B. Cropland	0.13	0.12	0.11	0.12	657.63
C. Grassland	0.00	0.00	0.00	0.00	-35.17
D. Wetlands	NE, NO	NE, NO	NE, NO	NE, NO	0.00
E. Settlements	NA, NO	NA, NO	NA, NO	NA, NO	0.00
F. Other Land	NA, NO	NA, NO	NA, NO	NA, NO	0.00
G. Other	NA	NA	NA	NA	0.00
6. Waste	0.96	0.97	0.93	0.94	-2.75
A. Solid Waste Disposal on Land					
B. Waste-water Handling	0.93	0.94	0.88	0.88	-9.38
C. Waste Incineration	0.01	0.01	0.01	0.01	100.00
D. Other	0.03	0.03	0.04	0.05	100.00
7. Other (as specified in the summary table in CRF)	NA	NA	NA	NA	0.00
Total N2O emissions including N2O from LULUCF	22.72	21.23	20.97	21.98	-60.24
Total N2O emissions excluding N2O from LULUCF	22.58	21.10	20.85	21.85	-60.45
Memo Items:					
International Bunkers	0.11	0.10	0.01	0.01	-90.51
Aviation	0.11	0.10	0.01	0.01	-90.51

Marine	NA	NA	NA	NA	0.00
Multilateral Operations	NO	NO	NO	NO	0.00
CO2 Emissions from Biomass					

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

Custom Footnotes

Table 1(d)

HUN_BR1_ v2.1

Emission trends (HFCs, PFCs and SF_6)
(Sheet 1 of 3)

CRF: HUN_CRF__ v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*Base year[a]*	1990	1991	1992	1993	1994	1995	1996	1997
	kt	kt	kt	kt	kt	kt	kt	kt	kt
Emissions of HFCsc - (kt CO2 eq)	NA, NO	NA, NO	NA, NO	3.38	3.38	16.89	23.88	21.58	80.06
HFC-23	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-32	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-41	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
HFC-43-10mee	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
HFC-125	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00	0.00
HFC-134	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
HFC-134a	NA, NO	NA, NO	NA, NO	0.00	0.00	0.01	0.02	0.02	0.05
HFC-152a	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-143	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
HFC-143a	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00	0.00
HFC-227ea	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
HFC-236fa	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
HFC-245ca	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Emissions of PFCsc - (kt CO2 eq)	268.49	270.83	233.72	134.82	145.73	158.93	166.82	159.40	161.52

CF_4	0.04	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02
C_2F_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C 3F8	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00
C_4F_{10}	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
c-C_4F_8	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
C_5F_{12}	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
C_6F_{14}	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Emissions of SF6(3) - (Gg CO2 equivalent)	73.05	87.62	102.50	99.41	129.84	149.49	169.59	174.63	211.30
SF_6	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01

Note: All footnotes for this table are given on sheet 3.

HUN_BR1 _v2.1

Table 1(d)

Emission trends (HFCs, PFCs and SF_6) (Sheet 2 of 3)

CRF: HUN_CRF__ v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*1998*	1999	2000	2001	2002	2003	2004	2005	2006	2007
	kt	kt	kt	kt	kt	kt	kt	kt	kt	kt
Emissions of HFCsc - (kt CO2 eq)	151.02	300.07	213.64	288.06	362.11	477.86	582.70	675.45	769.49	839.50
HFC-23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HFC-32	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
HFC-41	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
HFC-43-10mee	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
HFC-125	0.01	0.02	0.02	0.02	0.03	0.04	0.05	0.04	0.06	0.07
HFC-134	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
HFC-134a	0.07	0.14	0.08	0.12	0.11	0.18	0.22	0.30	0.31	0.30
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
HFC-143	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
HFC-143a	0.01	0.02	0.02	0.02	0.03	0.03	0.04	0.04	0.05	0.06
HFC-227ea	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	0.00	0.00	0.01	0.01	0.01
HFC-236fa	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
HFC-245ca	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Emissions of PFCsc - (kt CO2 eq)	193.58	210.81	212.16	199.95	203.88	190.70	201.91	210.25	2.52	3.60
CF_4	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	NA, NO	NA, NO
C_2F_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA, NO
C 3F8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

C_4F_{10}	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
c-C_4F_8	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
C_5F_{12}	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
C_6F_{14}	0.00	0.00	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO	NA, NO
Emissions of SF6(3) - (Gg CO2 equivalent)	168.16	205.49	195.26	226.02	174.27	179.56	329.62	237.72	185.78	252.73
SF_6	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Note: All footnotes for this table are given on sheet 3.

Table 1(d) HUN_BR1_v2.1

Emission trends (HFCs, PFCs and SF_6)
(Sheet 3 of 3)

CRF: HUN_CRF__ v2.1

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	*2008*	2009	2010	2011	Change from base to latest reported year
	kt	kt	kt	kt	%
Emissions of HFCsc - (kt CO2 eq)	948.64	880.16	958.97	987.62	100.00
HFC-23	0.00	0.00	0.00	0.00	100.00
HFC-32	0.02	0.01	0.02	0.02	100.00
HFC-41	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-43-10mee	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-125	0.08	0.08	0.09	0.09	100.00
HFC-134	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-134a	0.34	0.30	0.33	0.33	100.00
HFC-152a	0.00	0.00	0.00	0.00	100.00
HFC-143	NA, NO	NA, NO	NA, NO	NA, NO	0.00
HFC-143a	0.06	0.06	0.06	0.07	100.00
HFC-227ea	0.01	0.01	0.01	0.01	100.00
HFC-236fa	NA, NO	NA, NO	NA, NO	0.00	100.00
HFC-245ca	NA, NO	NA, NO	NA, NO	NA, NO	0.00
Unspecified mix of listed HFCs(4) - (Gg CO_2 equivalent)	NA, NO	NA, NO	NA, NO	NA, NO	0.00
Emissions of PFCsc - (kt CO2 eq)	3.80	2.91	1.01	1.70	-99.37
CF_4	NA, NO	NA, NO	NA, NO	NA, NO	-100.00
C_2F_6	0.00	0.00	NA, NO	0.00	-98.65
C 3F8	0.00	0.00	0.00	0.00	100.00

C_4F_{10}	NA, NO	NA, NO	NA, NO	NA, NO	0.00
$c\text{-}C_4F_8$	NA, NO	NA, NO	NA, NO	NA, NO	0.00
C_5F_{12}	NA, NO	NA, NO	NA, NO	NA, NO	0.00
C_6F_{14}	NA, NO	NA, NO	NA, NO	NA, NO	0.00
Unspecified mix of listed PFCs(4) - (Gg CO_2 equivalent)	NA, NO	NA, NO	NA, NO	NA, NO	0.00
Emissions of SF6(3) - (Gg CO2 equivalent)	275.50	220.55	234.94	184.37	152.38
SF_6	0.01	0.01	0.01	0.01	152.38

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] The column “Base year” should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the Conference of the Parties. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

[c]Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO2 equivalent emissions.

[d]In accordance with the “Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part I: UNFCCC reporting guidelines on annual inventories”, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is kt of CO2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.)

3. Quantified Economy-wide Emission Reduction Targets (QEWER)

Under the EU's Climate and Energy Package, Hungary as an EU member is committed to a quantified economy-wide GHG emission reduction target of 20% by 2020, compared to the 1990 levels. This target is coupled with a renewable penetration rate of 14.65% for Hungary and an energy efficiency improvement of 20%; while the RED Directive (2009/28/EC) of the EU set the renewable target for Hungary as minimum 13% of the total gross final energy consumption, the objective defined by the NREAP is 14.65%.

This means that Hungary committed herself to a reduction of 20% of the 96 961,78 kt CO_2 equivalent emissions of 1990 (incl. LULUCF), the target to be achieved is 77 568,8 kt by 2020.

Sectors under the EU ETS are forecasted to provide a basis of GHG emissions savings until 2025. Beginning with 2013, from the third trading period onwards, a single EU-wide cap determines the amount of emissions allowed to be emitted by the EU ETS sectors. Furthermore, from 2013 onwards, a linear reduction factor of -1.74 % per annum applies to achieve a total of 21% of reduction in the ETS sectors. Under the joint Effort Sharing Decision (ESD) of the EU, Hungary took the commitment of a maximum 10% increase of the non-ETS sectors greenhouse gas emissions compared to their 2005 levels by 2020.

Hungary is also influenced by the Kyoto second period target of the EU. The EU has also committed to reduce its emissions by 20% under the Kyoto Protocol's second period, which runs from 2013 to 2020. Despite their identical nature this commitment differs in several important respects from the EU's unilateral 2020 commitment:

- The Kyoto commitment is measured against base years, not 1990.
- LULUCF: the LULUCF sector in the EU is not included in the 20 % target under the Climate and Energy package, but is accounted for under the KP according to the relevant decisions made in Durban.
- Inclusion of nitrogen trifluoride (NF3): NF3 is not included in the Climate and Energy Package, whereas the scope of the second commitment period has been extended to include the additional gas. The impact of NF3 on aggregate EU emissions is insignificant.
- It requires the EU to keep its emissions at an average of 20% below base-year levels over the whole period, not only in 2020;
- It differs in scope (for instance, it does not cover emissions from international aviation since these are outside the scope of the Protocol, but does cover emissions and their removals from land use, land use change and forestry, which the unilateral commitment does not).
- The EU will meet its Kyoto commitment jointly with Iceland.

Table 2(a) HUN_BR1_v2.1

Description of quantified economy-wide emission reduction target: base year[a]

Party	*Hungary*	
Base year /base period	1990	
Emission reduction target	% of base year/base period	% of 1990 [b]
	20.00	20.00
Period for reaching target	BY-2020	

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Optional.

Table 2(b) HUN_BR1_v2.1

Description of quantified economy-wide emission reduction target: gases and sectors covered[a]

Gases covered		*Base year for each gas (year):*
CO_2		1990
CH_4		1990
N_2O		1990
HFCs		1990
PFCs		1990
SF_6		1990
NF_3		1990
Other Gases (specify)		
Sectors covered[b]	Energy	Yes
	Transport[f]	Yes
	Industrial processes[g]	Yes
	Agriculture	Yes
	LULUCF	No
	Waste	Yes
	Other Sectors (specify)	

Abbreviations: LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] More than one selection will be allowed. If Parties use sectors other than those indicated above, the explanation of how these sectors relate to the sectors defined by the IPCC should be provided.

[f] Transport is reported as a subsector of the energy sector.

[g] Industrial processes refer to the industrial processes and solvent and other product use sectors.

Table 2(c) HUN_BR1_v2.1

Description of quantified economy-wide emission reduction target: global warming potential values (GWP)[a]

Gases	*GWP values [b]*
CO_2	2nd AR
CH_4	2nd AR
N_2O	2nd AR
HFCs	2nd AR
PFCs	2nd AR
SF_6	2nd AR
NF_3	2nd AR
Other Gases (specify)	

Abbreviations: GWP = global warming potential

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Please specify the reference for the GWP: Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) or the Fourth Assessment Report of the IPCC.

Table 2(d) HUN_BR1_v2.1

Description of quantified economy-wide emission reduction target: approach to counting emissions and removals from the LULUCF sector[a]

Role of LULUCF	LULUCF in base year level and target	Included
	Contribution of LULUCF is calculated using	Activity-based approach

Abbreviation: LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

Table 2(e)I

HUN_BR1_v2.1

Description of quantified economy-wide emission reduction target: market-based mechanisms under the Convention[a]

Market-based mechanisms under the Convention	*Possible scale of contributions (estimated kt CO_2 eq)*
CERs	
ERUs	
AAUs[i]	
Carry-over units[j]	
Other mechanism units under the Convention (specify)[d]	

Abbreviations: AAU = assigned amount unit, CER = certified emission reduction, ERU = emission reduction unit.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[d] As indicated in paragraph 5(e) of the guidelines contained in annex I of decision 2/CP.17 .

[i] AAUs issued to or purchased by a Party.

[j] Units carried over from the first to the second commitment periods of the Kyoto Protocol, as described in decision 13/CMP.1 and consistent with decision 1/CMP.8.

Table 2(e)II

HUN_BR1_v2.1

Description of quantified economy-wide emission reduction target: other market-based mechanisms[a]

Other market-based mechanisms (Specify)	*Possible scale of contributions (estimated kt CO_2 eq)*

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

Table 2(f) HUN_BR1_v2.1

Description of quantified economy-wide emission reduction target: any other information[a,b]

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] This information could include information on the domestic legal status of the target or the total assigned amount of emission units for the period for reaching a target. Some of this information is presented in the narrative part of the biennial report.

Custom Footnotes

4. Progress in achievement of QEWER target

4.1. Mitigation actions and their effects

Legislative and policymaking activities in climate change and the energy sector have been united under the auspices of the Ministry of National Development with the establishment of a sovereign State Secretariat of Climate Change and Energy Policy with two aides of the state secretary – a deputy state secretary for energy policy and another deputy for green economy development and climate change. The most important task of the Secretariat was formation of the long-term energy strategy of Hungary, as well as submission of the National Action Plan for Renewable Energy to the European Commission. Recently the administration was reformulated into a State Secretariat of Development, Climate Policy and Key Public Services.

In the following section, the framework of climate change policies will be outlined. Details are provided in Chapter 4 of the 6th National Communication of Hungary.

The general context of policy development is the Programme of National Cooperation. Although in itself the Programme of National Cooperation is not focused on the GHG mitigation, the implementation of the Programme includes several such elements, and the Programme itself has some priorities that serve this purpose. Some relevant key elements are:

- the promotion of the European initiative to employ "green" technologies and to research the energy efficiency of buildings and construction materials.
- Launching of a large scale energy efficiency program aiming at reconstruction of pre-fab buildings, thermal insulation projects of other building types, reconstruction of public buildings, etc.
- Encouragment of renewable energy investments.

A cornerstone of climate change policy is the National Climate Change Strategy which was revised in 2013. Its key characteristics are as follows:

- Main areas of intervention are:
    - Energy efficiency in buildings
    - Renewable energy utilisation
    - Transport (road tolls, other economic incentives, modal split change)
    - Afforestation
- New element is increased emphasis on adaptation to climate change.
- The responsibility of the government is to create the necessary regulatory-legal framework; to review and adjust the subsidy systems; to raise the awareness of the society by giving priority to sustainability and providing good example.
- The residential sector is a key field of change: peoples' lifestyle needs to be changed; a large-scale reduction of demands for energy and materials must be achieved (by subsidised energy efficiency projects, among others);
- Industry and other enterprises also need to reduce their energy consumption, adopt emission reduction measures, to "green" their profile, products, services.
- NGOs, civil organisations shall have increased role in the dissemination of information, awareness raising and civil control.

As the new EU Sustainable Development Strategy adopted by the European Council requires, Hungary prepares and regularly updates its National Sustainable Development Strategy (NSDS). The new NSDS has been adopted by the Hungarian Parliament in 2013.

Beginning from 1995, a regularly (every six year) revised and updated National Environmental Protection Programme (NEP) is prepared. The recent National Environmental Protection Programme 2009-2014 (NEP-III) was adopted by the Parliament in 2009. Similarly to the previous programmes, the NEP-III identifies general objectives, which are then broken down to specific actions, so-called thematic action programmes or TAPs. The general objectives are the following:

- Improving the quality of the environment and life locally
- Preservation of naturals resources
- Promotion of sustainable lifestyle, production and consumption
- Improvement of environmental safety.

The following TAPs are relevant from the aspect of GHG mitigation:

- Reinforcing environmental awareness
    - Education, training within the education system from the elementary school to the university
    - Environmentally conscious production and consumption
    - Access to environment-related information, information dissemination
    - Combating climate change
    - Reduction of GHG emissions (EU-ETS system, improvement of energy efficiency [NEEAP]),
    - Reducing the environmental impact of transport (reducing demand, restructuring modal split, alternative fuels)
    - Reducing emissions from the agriculture (improvement of production efficiency)
    - Afforestation according to the National Afforestation Programme.
- Environment and health
    - Transport and environment (Reverse the tendency of shifting to individual transport)
- Protection and sustainable utilisation of waters
    - Utilisation of the energy of geothermal waters
- Waste management
    - Prevention (reduction of waste quantities)
    - Utilisation of wastes and recycling
    - Reduction of landfilled waste

The National Sustainable Development Strategy has recently been reformulated and accepted by the government and is an important element together with the National Environmental Programme. The New Széchenyi Plan (NSZP) is an economic development programme and as such provides an operative background for the realisation of strategic objectives.
The programmes of the NSZP concerning GHG mitigation are as follows:

- Energy policy
    - Energy policy is to serve economic growth and job creation, together with security of supply, resource diversification, and the reduction of import dependence;
    - Production and utilization of renewable energies is to be encouraged.

- Transport
    - Creating the financial resources necessary for a sustainable transport system;
    - Encouraging intermodal transports;
    - Enforcing environmental and climate policy considerations;
    - Transformation of the primary energy mix – a greater proportion of renewable energy is necessary;
    - Development of an adequate traffic and transport system, nodes as well as intermodal and multifunctional logistics centres and related industrial parks established in these nodes to reduce road transit.

The Green Investment Scheme (GIS) (Hungarian: Zöld Beruházási Rendszer – ZBR) is considered to be a key source of funding GHG mitigation projects and efforts. Several of the policies described in this report have been or will be financed at least partly from GIS sources. The GIS is planned to be restructured with the following priorities in mind:

- Complex (deep) energy efficiency revamp of multi-flat and family houses, to increase the approximately 40% energy saving achieved by GIS programmes so far to at least 60%;
- Support for the construction of new highly efficient buildings;
- Loan guarantee for the investors of the above projects, so that they could take loans at better conditions to provide their own share for the other supports from the GIS.

Maximum 5% of the GIS revenues can be used for covering the administrative costs of the GIS. It is also required by the regulation that the supported project should be additional (i.e. not implemented without the support).

The impact of policies and measures are summarised in the following table.

Table 4.1 The impact of policies and measures in CO_2 equivalent

	Policy name	Status	2015 ($ktCO_2$-eq./yr)	2020 ($ktCO_2$-eq./yr)	2025 ($ktCO_2$-eq./yr)	2030 ($ktCO_2$-eq./yr)
1	Promotion of renewables	implemented	5 600,25	8 821,2	11 299,1	13 061,0
2	Nuclear power	adopted	2 762,66	5 172,8	7 875,8	10 593,8
3	"Liveable panel buildings" sub-program	implemented	509,7	953,5	1 374,1	1 592,7
4	"Our home" reconstruction sub-program	implemented	402,9	844,4	1 324,6	1 861,8
5	"Power saving households" program	implemented	535,4	1 117,1	1 439,7	1 573,6
6	Renewable Public Institutions Sub-Program	implemented	366,6	722,1	1 058,1	1 360,4
7	Reduction of power demand of public institutions	implemented	495,3	972,8	1 451,6	1 866,4
8	District heating efficiency sub-program	implemented	135,1	242,0	312,7	347,2
9	Reducing the energy use of enterprises	implemented	655,9	1 477,6	2 182,0	2 737,5
10	Horizontal measures	implemented	126,3	336,7	547,2	757,7
11	Reducing the energy demand of cargo and passenger transport	implemented	38,7	98,2	111,8	122,4
12	Directing transport to railways	planned	51,3	80,6	89,7	89,7
13	Directing transport to public transport and developing public transport	planned	19,6	52,4	84,7	106,5
14	Reducing road transport emissions	adopted	727,5	1 549,7	2 578,0	3 622,7
15	Environmental awareness in agriculture	adopted	na	Na		
16	Less nitrate get into water and N-cycle	implemented	na	Na		
17	Draw attention to decrease GHG emission in agriculture	implemented	na	Na		
18	National Forest Programme for increasing forest area	implemented	500,00	700	1 000,00	1 300,00
19	Frame for forestry management and forest protection	implemented	na	Na		
20	Mitigation of agricultural emissions with partial change of nitrogen fertilizer utilization and cultivations change	implemented	200,00	Na		
21	Support for perennial herbaceous energy plantation by the European Agricultural Fund	implemented	na	Na		
22	Complementary financing to support the plantation of energy crops by the European Agricultural Fund	implemented	na	Na		
23	Rural development for sustainable and modern agriculture	implemented	na	Na		

24	Climate protection by efficient manure management and biogas	implemented	135,00	Na		
25	New waste management instruments	adopted	2,14	4,62	12,70	16,96
26	Setting up regional waste management projects	implemented	17,14	20,77	34,29	51,83
27	Packaging waste governmental regulation	adopted	6,43	23,08	39,37	58,43
28	Budapest municipal door-to-door separate waste collection	adopted	12,86	20,77	31,75	45,24
29	Landfill recultivation, remediation	adopted	2,14	4,62	11,43	16,02
30	Prevention	adopted	0,00	9,23	25,40	29,22
31	Waste landfilling tax	implemented	4,29	13,85	31,75	39,58

Source: HUNEMITS calculations

The total effect from policies and measures is summarised in Table 4.2.

Table 4.2. Total effects of policies and measures until 2030.

Gg CO_2-equivalent per year	**2015**	**2020**	**2025**	**2030**
Estimated emission savings from PAMs	13 307.19	23 237.98	32 915.95	41 250.61

4. 2. Estimates of emission reductions and removals and the use of units from market-based mechanisms and land use, land use change and forestry activities

Average 2008–2011 emissions in Hungary were 40.8 % lower than the base-year level, well below the Kyoto target of -6 % for the period 2008–2012. In the sectors not covered by the EU ETS, emissions were significantly lower than their respective target, by an amount equivalent to 33.6 % of the base-year emissions. LULUCF activities are expected to reduce net emissions by an annual amount equivalent to 1.9 % of base-year level emissions. Hungary intends to use flexible mechanisms at the government level by selling an amount of Kyoto units equivalent to 3.5% of base-year emissions per year. Taking all these effects into account, average emissions in the sectors not covered by the EU ETS in Hungary were standing below their target level, by a gap representing 31.1 % of the base-year emissions. Hungary was therefore on track towards its Kyoto target by the end of 2011.

	Mt CO_2 equiv.	2008	2009	2010	2011	2012	Average of 2008-2012	Total of 2008-2012
1	Total GHG emissions	73.6	67.4	67.9	66.1	63.7	67.7	338.7
2	Verified emissions under the EU ETS	27.2	22.4	23.0	22.5	21.3	23.3	116.4
3	Non-ETS emissions	46.4	45.0	45.0	43.7	42.4	44.5	222.4
4	Initial Assigned Amounts (AAUs)	108.5	108.5	108.5	108.5	108.5	108.5	542.4
5	Allowances issued under the EU ETS	25.1	23.9	25.7	25.0	32.8	26.5	132.5
6	Non-ETS target	83.3	84.6	82.8	83.5	75.7	82.0	409.9
7	**Difference between target and actual emissions (non-ETS domestic)**	37.0	39.6	37.8	39.8	33.3	37.5	187.5
8	Expected carbon sequestration from LULUCF	2.2	2.2	2.2	2.2	2.2	2.2	11.1
9	**Difference between target and actual emissions (non-ETS domestic) incl. carbon sequestration**	39.2	41.8	40.0	42.0	35.5	39.7	198.6
10	Planned use of Kyoto mechanisms by government (net transfer of AAUs + purchase of CERs+ERUs)	-4.0	-4.0	-4.0	-4.0	-4.0	-4.0	-20.0
11	Emission reduction units (ERUs issued in JI projects)	0.0	1.2	1.4	1.6	3.1	1.5	7.3
12	**Difference between target and actual emissions (non-ETS, domestic, incl. Kyoto mechanisms and carbon sinks)**	35.2	36.6	34.7	36.4	28.4	34.3	171.3

Source: EEA Report,2013

Progress towards EU 20/20/20 goals (ESD)

Total GHG emissions of Hungary decreased by 3.7% between 2011 and 2012, based on approximated GHG inventories for the year 2012. When considering the scope of the EU's climate and energy package, which includes emissions from international aviation, Hungarian emissions in 2012 are approximately 55% lower compared to 1990 levels (98 980.69 Mt). Hungary therefore reaches its 20% reduction target and beyond, eight years ahead of 2020. This on the other hand should not mean that the country has no dedicated tasks, as the reduction of emissions can be accounted to the decline in economic activity and economic growth beyond expectations.

Aggregated projections from Hungary indicates that the total emissions will further decrease between 2012 and 2020 (and 2025, see the next chapter in the Biennial Report for forecast figures). With the current set of national domestic measures in place, emissions are expected to reach a level in 2020 which is 65% below 1990 levels. Implementing the additional measures (at planning stage or realised at lower implementation levels) is expected to achieve a reduction of 74% below 1990 levels in 2020.

The projected reductions are to be achieved both in the sectors covered by the EU ETS (mostly energy supply and industry), where an emission cap is determined at EU level, and in the other sectors covered by national emission targets under the Effort Sharing Decision (ESD). Beyond the EU ETS itself, the largest reductions are expected via measures supporting renewable energy under the Renewable Energy Directive (RED) and implementation of efficiency measures and energy saving measures.

The average annual emissions and removals from LULUCF in the 2008-2011 are as follows: -1.15 Mt CO_2 equivalent for the average (Art 3.3.) net carbon stock change, -1.06 Mt from Forest Management (Art 3.4).

Concerning non-ETS emissions in Hungary, the absolute gap between the average non-ETS emissions in 2008-2012 and the Kyoto targets are 37.5 Mt CO_2 equiv. (excl. carbon sinks), which is 32.5% less than the targeted value.

Thus, the average 2008–2012 emissions in sectors not covered by the EU ETS, including the effect of carbon sinks, are less than the target for non-ETS sectors.

Despite these promising results, energy efficiency measures in the residential and services sectors are of key importance in the provision of further emission reductions by 2020.

Concerning the national GHG targets under the ESD: 2012 non-ETS emissions were below the 2013 ESD targets and 2020 non-ETS emissions are projected to be lower than the 2020 ESD target with the existing measures. Concerning the national targets for the RES share in the gross final energy consumption, the 2011 RES share was above the RED and NREAP 2011–2012 trajectories.

Concerning energy efficiency, some progress is made in reducing energy consumption but further improvements are necessary to further develop policies or to better implement the existing ones.

Regarding the current progress towards 2013 ESD targets, we can draw the following conclusions. If we consider the proportional targets of 2020 by 2013 – the so called 2013 ESD targets – then the reduction of -5% is the proportional goal until 2013 and +10% by 2020 for non-ETS sectors is allowed. The actual emissions from non-ETS sectors are 18% less in 2012 than the 2005 values and 6.9 Mt (13%) below the 2013 ESD target.

Considering the projected emissions in 2020 in non-ETS sectors and comparing them with the targets for 2020, the *With Existing Measures* scenario forecasts a –8% aggregate emission reduction (a 11 Mt reduction) compared to the target whilst the With Additional Measures scenario forecasts a 21 Mt reduction and a -16% relative gap.

Overall, the projections show that with the current measures, the non-ETS emissions in 2020 will be below the 2020 targets.

Bringing together the results of the current progress towards the 2013 targets (based on 2012 proxy data) and projected progress to 2020 targets (based on Member States projections) allows for an overall assessment of the progress achieved so far by Hungary towards her objectives under the ESD. Thus Hungary is presently considered to be on track towards her respective 2013 ESD targets, i.e. 2012 non-ETS emissions were below these targets.

If a modified base year (2005) would be set for the 2020 ESD targets (adjusted according to Art. 10) then for Hungary it would mean a 16% reduction target or a 57 Mt CO_2 equivalent emission cap in the non-ETS sectors until 2020. This is expected to be reached already under the assumptions of the WEM scenario, which forecasts a 43 Mt emission (WAM forecasts GHG emissions equivalent with 40 Mt of CO_2 by 2020). Thus Hungary is expected to reach her 2020 target with the current set of policies and measures through domestic emission reductions alone even if a more demanding base year is chosen.

Overall, combining the above findings Hungary is well on track towards its ESD targets with 2012 emissions below 2013 ESD targets and current policies and measures being sufficient to achieve 2020 targets through domestic emission limitations or reductions only.

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Table 3

Progress in achievement of the quantified economy-wide emission reduction target: information on mitigation actions and their effects

Name of mitigation action[a]	*Sector(s) affected[b]*	*GHG(s) affected*	*Objective and/or activity affected*	*Type of instrument[c]*	*Status of implementation[d]*	*Brief description[e]*	*Start year of implementation*	*Implementing entity or entities*	*Estimate of mitigation impact (not cumulative, in kt CO_2 eq)*
Promotion of renewables	Energy	CO_2	Increase the share of renewables within total energy consumption	Economic|Fiscal|Regulatory	Implemented	General promotion policy according to the Renewable Energy Action Plan	2009	Ministry of National Development	8,821.20
Promotion of nuclear power	Energy	CO_2	Increase the share of nuclear energy within the energy mix, improve saftey of supply	Other (Nuclear)	Adopted	Extension of technical lifetime by technical measures, increase of the capacity by improving effciency and control systems. Two new 1000 MW untis from 2025 and 2030	2012/ 2020	Hungarian Power Companies	5,172.75
"Liveable panel buildings" sub-program	Energy	CO_2	Reduction of district heating heat demand in pre-fab (panel) buildings	Economic|Regulatory|Information|Education	Implemented	Subsidy for revamp projects (ZBR Climate Friendly Home Panel I. and II. Sub-programs);Individual measurement and control in district heating Regulation on energy performance and efficiency of buildings;Energy certification of buildings; Operation and development of an energy efficiency consultancy network; Energy efficiency training material for schools	2015	Ministry of National Development	953.50

"Our home" reconstruction sub-program	Energy	CO_2	Reduction of heat demand in residential buildings (individual or central-heated family homes and multi-home residential buildings)	Economic| Education| Information| Regulatory	Implemented	Investment subsidies (NEP program, ZBR Climate Friendly Home Energy Efficiency Sub-Programme);Support for the construction of energy efficient new buildings;Complex (in-depth) reconstruction of buildings of traditional technologies, including the use of renewables; Minimum efficiency criteria and regular inspection for household boilers; Regulation on energy performance and efficiency of buildings;Energy certification of buildings;Operation and development of an energy efficiency consultancy network; Energy efficiency training material for schools; "Eco" labelling of household boilers and water heaters		Ministry of National Development	844.40
"Power saving households" program	Energy	CO_2	Reduction of power demand in households	Regulatory| Information| Education	Implemented	Promotion of energy-efficient lighting equipment; "Eco" labelling of electric household water heaters and air conditioners; Energy efficiency training material for schools		Ministry of National Development	1,117.10
Renewable Public Institutions Sub-Programme	Energy	CO_2	Reduction of heat demand in buildings through complex energy-efficiency reconstruction	Economic| Regulatory| Information	Implemented	Investment support (New Széchenyi Plan, KEOP operative programs, ROP); Regulatory suport for ESCO-type projects; Increasing energy awareness of municipalities, energy advice		Ministry of National Development	722.10
Reduction of power demand of public institutions	Energy	CO_2	Reduction of power demand of public institutions	Economic| Regulatory| Information	Implemented	Investment support (New Széchenyi Plan, green economy development program); Encouraging energy saving measures in the Regional Operative Programs (ROPs); Increasing energy awareness of municipalities, energy advice; Minimum efficiency requirements for office equipment	2012	Ministry of National Development	972.80

District heating efficiency sub-program	Energy	CO_2	Improvement of efficiency of heat transport and distribution	Economic	Implemented	Investment support for distribution pipeline upgrading, heating substations, control and data acquisition systems	2012	Ministry of National Development	242.00
Reducing the energy use of enterprises	Energy	CO_2	Minimisation of energy losses, improvement of energy efficiency and competitiveness	Economic| Information| Regulatory	Implemented	Modernisation of process technology at SMEs (heat recovery, efficient motors) by support form the New Széchenyi Plan [KEOP], preference loans; Energy efficient reconstruction of industrial, agricultural and other (commercial, services) buildings;Large energy consumers: Compulsory employment of energy managers and energy reporting;Voluntary agreements in industry (energy audits, efficiency improvements	2012	Ministry of National Development	1,477.60
Horizontal measures	Energy	CO_2	Reduce the energy demand of municipalities, public institutions	Regulatory| Information| Research| Voluntary Agreement	Implemented	Including energy efficiency principles and criteria in public procurement procedures; Information exchange, information platform; Strengthening and coordination of sustainable energy-related R&D activities;Cooperation with energy companies to enhance their DSM activities	2012	Ministry of National Development	336.70
Reducing the energy demand of cargo and passenger transport	Transport	CO_2	Reducing the energy demand of cargo and passenger transport		Implemented	Development of the cycling route networks (KÖZOP subsidies), Creating low-traffic zones, Toll system for heavy vehicles, Environment friendly transport campaigns		Ministry of National Development	98.20
Directing transport to railways	Transport	CO_2	Reducing the energy demand of cargo and passenger transport	Other (Information)	Planned	Electrification and modernization of railway lines (KÖZOP subsidies); Procurement of new, energy efficient railway engines; Campaigns to promote railway transport	2014	Ministry of National Development	80.60

Directing transport to public transport and developing public transport	Transport	CO_2	Reducing the energy demand of passanger transport	Other (Information)	Planned	P+R systems; Bus fleet modernisation / replacement;Campaigns to promote public transport	2014	Ministry of National Development	52.40
Reducing road transport emissions	Transport	CO_2	Reducing the fuel demand of cars, increasing the share of renewables in car fuel		Adopted	Supporting the manufacturers of efficient/renewabkle fuel cars by providing favourable market conditions	2014	Ministry of National Development	1,549.70
Environmental awareness in agriculture	Agriculture, Forestry/LULUCF	CO_2, CH_4, N_2O	Support of agricultural production methods that are environmentally friendly	Economic	Adopted	The National Agri-Environmental Programme (NAEP), a sub-programme of the National Environmental Programme, approved by the Government Resolution 2253/1999 (X.7.) Korm, includes several horizontal and zonal targets. One of them is to increase the territorial proportion of semi-natural forest management. NAEP also looks at afforestation as a tool of implementing some of its measures, such a forest plantation on flood areas in order to protect wetland habitat. The NAEP objectives were integrated into the agri-environmental measures of the National Rural Development Plan (NRDP) in 2004.	2014	Ministry for Rural Development, State Secretariat for Rural Development	NA

Reduction of nitrate emission in waters and N-cycle	Agriculture	N_2O	Protection of waters against pollution caused by nitrates from agricultural sources.	Economic	Implemented	New Nitrate Action Programme: the earlier Government Decision No. 49/2001. (IV. 3.) on protection against the nitrate contamination of waters from agricultural sources (Nitrate Decree for short) referred to in the previous report was replaced and partly superseded by Government Decree 27/2006. (II. 7.), amended by Government Decree 81/2007. (IV.25.). The new decree also identifies the nitrate sensitive areas, contains an extended list of settlements in these areas (67 settlements were deleted from the list, 320 added), states the general rules of protection against nitrate pollution and prescribes an overall, coherent, nation-wide action plan.	2006	Ministry for Rural Development, Agricultural and Rural Development Agency	NA
Awareness raising in agriculture to reduce GHG emissions	Agriculture, Forestry/LULUCF	CO_2	Competitiveness of agriculture, forestry and food industry; Improvement of the condition of the environment; Quality of life in rural areas	Economic	Implemented	The New Hungary Rural Development Strategic Plan is the sequel of AVOP. Its actions are grouped into three different sets: Set 1: Competitiveness of agriculture, forestry and food industry Set 2: Improvement of the condition of the environment. Set 3: Quality of life in rural areas. The three sets are supplemented by a Technical Assistance package.	2007	Ministry for Rural Development, Agricultural and Rural Development Agency	NA

National Forest Programme for increasing forest area	Forestry/LULUCF	CO_2	Increasing forest area	Economic	Implemented	The National Forest Programme 2006-2015 sets the following strategy objectives: At least maintaining the current level of forestation but preferably its increase must be ensured. Neither the quantity nor the quality and value of the forests must not decrease. Use of wood in the society, as an environmentally friendly raw material, shall be encouraged. The Forest management shall ensure that the increased demands for wood would be met, without endangering sustainability. Knowledge and information on forests shall be increased in the society.	2006		700.00
Framework for forestry management and forest protection	Forestry/LULUCF	CO_2	The objective of the Act is, through the regulation of the relation between forests and the society, and, in particular, through the determination of sustainable requirements of forest management, to assure the maintenance, the protection, the growth, and the increase of its positive effects on the environment, the society and the economy.	Economic	Implemented		2009	Ministry for Rural Development	NA

Mitigation of agricultural emissions with partial change of nitrogen fertilizer utilization and cultivations change	Agriculture, Cross-cutting	CO_2, N_2O	Achieve 4-9 tons of CO2 equivalent GHG emission reduction per hectare using modern soil preparation and fertilization practices.	Economic	Implemented	Farmers use such soil preparation and fertilization practises on which the used amount of fossil fertiliser can be reduced with 50 kg/hectare in the case of nitrogen agent. Nutrient holding capacity of the soil can be significantly improved compared to the past, and the loss of soil carbon per hectare can be reduced to 2 tons / ha / year amount.	2009	Ministry for National Economy	NA
Support for perennial herbaceous energy plantation by the European Agricultural Fund	Agriculture	CO_2	The objective of the measure is to support perennial, herbaceous energy plantation. With this measure the law-maker wants to stabilize the food product chains, improve the living standards of the rural population, improving soil structures. Dissemination of renewable energy sources is also priority.	Fiscal	Implemented	The purpose of the grant is supporting perennial, herbaceous energy plantation and it is necessary to maintain this practise for at least five years. With this measure the energy plant planted area will be increasing. Growing power plant not emitting new carbon into the active carbon cycle, biomass energy has additional climate change benefits. According to the act the power plant planted area must be more than 1500m2.	2007	Ministry for Rural Development, Agricultural and Rural Development Agency	NA
Complementary financing to support the plantation of energy crops by the European Agricultural Fund	Agriculture	CO_2	The objective of the measure is to give additional support for those farmers who grows perennial herbaceous energy plantats.	Fiscal	Implemented	Farmers have opportunity to take additional support who can fulfill the conditions of SAPS, and grows energy plants for energetical use. Farmer can get 45 euro per hectare subsidisation.	2007	Ministry for Rural Development	NA

Rural development for sustainable and modern agriculture	Agriculture	CO_2	Removing obstacles that hinder farmers and producers through the amendment of legislation and regulations.	Economic	Implemented	Ignác Darányi Plan: The first pillar aims at removing obstacles that hinder farmers and producers through the amendment of legislation and regulations. The second plans to reduce bureaucracy through the setting up of customer-friendly offices and by reducing administrative requirements. The third pillar focuses on changing people's way of thinking and on providing training courses. The fourth pillar will support rural areas in Hungary by launching jointly financed European Union and Hungarian tenders for rural development projects. The fifth and final pillar includes the preparation, launching and running of national programmes, including for example the Farmstead Programme and the Demographic Land Programme.	2012	Ministry for Rural Development, State Secretariat for Rural Development		NA

Climate protection by efficient manure management and biogas	Energy, Agriculture, Cross-cutting	CO_2, CH_4	Replace the old manure management system with its deep open lagoons and avoid the methane (CH4) emissions caused by them.		Implemented	The project activity will replace the old manure management system with its deep open lagoons and avoid the methane (CH4) emissions caused by them. Manure will instead be transported from the barns to the gastight digesters of the biogas plant, where the emitted methane is captured, stored and finally destroyed in the CHP. The heat produced from the CHP facilities will replace fossil fuels in the existing heating systems of the barns and thus reduce carbon dioxide (CO2) emissions. The digestate (manure and other substrates after the biogas treatment) will be used as a fertilizer in a similar way manure is used today. But because of the added co-substrates nitrogen (and nutrient) content in the digestate will be higher than in the manure alone. So the use of digestate instead of manure will reduce the need for artificial fertilizer.	2010	Biogáz Unió Zrt. (private company) UNFCCC	NA
New waste management instruments	Energy, Waste management/waste	CO_2, CH_4	Waste reduction, increased recycling, decreased amount of waste to landfill.	Information| Economic| Other (Planning)	Adopted	Main principles and obligations, separate collection, recovery restrictions	2013		4.62
Setting up regional waste management projects	Energy, Waste management/waste	CH_4	Selective waste collection, increases recycling and composting	Other (Education)	Implemented	Infrastructural development as well as landfill construction			20.77
Governmental regulation on packaging waste	Waste management/waste	CO_2	Set the minimal recycling targets	Regulatory	Adopted	Regulations for recycling, they decrease waste landfilling		Ministry of National Development	23.08

Budapest municipal door to door selective waste collection	Waste management/ waste, Energy	CO_2	To increase the amount of selectively collected municipal paper, plastic and aluminum waste	Economic| Education| Voluntary Agreement	Adopted	EU-cofunded infrastructural development.			20.77
Landfill recultivation and recovery.	Waste management/ waste, Energy	CH_4	Proper closure of filled landfills	Regulatory	Adopted	EU-funded project for the nationwide landfill recovery and recultivation.		Ministry of National Development	4.62
Prevention of waste generation	Waste management/ waste	CH_4	Prevention of waste generation	Education| Regulatory|Other (Planning)	Adopted	Prevention plans must be prepared			9.23
Waste landfilling tax	Waste management/ waste	CH_4	Levy on landfilling		Implemented	Landfill fee is introduced and increases gradually in the following years.	2013	Ministry of National Development	13.85

Table 4 HUN_BR1_v2.1

Reporting on progress[a, b]

	Total emissions excluding LULUCF	*Contribution from LULUCF*[d]	*Quantity of units from market based mechanisms under the Convention*		*Quantity of units from other market based mechanisms*	
Year[c]	*(kt CO_2 eq)*	*(kt CO_2 eq)*	*(number of units)*	*(kt CO_2 eq)*	*(number of units)*	*(kt CO_2 eq)*
(1990)	116,373.26	-2,600.30				
2010	63,860.70	-4,084.71				
2011	62,360.25	-3,787.48				
2012	NA	NA				

Abbreviation: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] For the base year, information reported on the emission reduction target shall include the following: (a) total GHG emissions, excluding emissions and removals from the LULUCF sector; (b) emissions and/or removals from the LULUCF sector based on the accounting approach applied taking into consideration any relevant decisions of the Conference of the Parties and the activities and/or land that will be accounted for; (c) total GHG emissions, including emissions and removals from the LULUCF sector. For each reported year, information reported on progress made towards the emission reduction targets shall include, in addition to the information noted in paragraphs 9(a–c) of the UNFCCC biennial reporting guidelines for developed country Parties, information on the use of units from market-based mechanisms.

[c] Parties may add additional rows for years other than those specified below.

[d] Information in this column should be consistent with the information reported in table 4(a)I or 4(a)II, as appropriate. The Parties for which all relevant information on the LULUCF contribution is reported in table 1 of this common tabular format can refer to table 1.

Custom Footnotes

Table 4(a)I HUN_BR1_v2.1

Progress in achieving the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector in 2011 [a,b]

	Net GHG emissions/removals from LULUCF categories [c]	*Base year/period or reference level value* [d]	*Contribution from LULUCF for reported year*	*Cumulative contribution from LULUCF* [e]	*Accounting approach* [f]
	(kt CO_2 eq)				
Total LULUCF					Activity-based approach
A. Forest land					Activity-based approach
1. Forest land remaining forest land					Activity-based approach
2. Land converted to forest land					Activity-based approach
3. Other [g]					Activity-based approach
B. Cropland					Activity-based approach
1. Cropland remaining cropland					Activity-based approach
2. Land converted to cropland					Activity-based approach
3. Other [g]					Activity-based approach
C. Grassland					Activity-based approach
1. Grassland remaining grassland					Activity-based approach

2. Land converted to grassland					Activity-based approach
3. Other [g]					Activity-based approach
D. Wetlands					Activity-based approach
1. Wetland remaining wetland					Activity-based approach
2. Land converted to wetland					Activity-based approach
3. Other [g]					Activity-based approach
E. Settlements					Activity-based approach
1. Settlements remaining settlements					Activity-based approach
2. Land converted to settlements					Activity-based approach
3. Other [g]					Activity-based approach
F. Other land					Activity-based approach
1. Other land remaining other land					Activity-based approach
2. Land converted to other land					Activity-based approach
3. Other [g]					Activity-based approach
Harvested wood products					Activity-based approach

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Parties that use the LULUCF approach that is based on table 1 do not need to complete this table, but should indicate the approach in table 2. Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[c] For each category, enter the net emissions or removals reported in the most recent inventory submission for the corresponding inventory year. If a category differs from that used for the reporting under the Convention or its Kyoto Protocol, explain in the biennial report how the value was derived.

[d] Enter one reference level or base year/period value for each category. Explain in the biennial report how these values have been calculated.

[e] If applicable to the accounting approach chosen. Explain in this biennial report to which years or period the cumulative contribution refers to.

[f] Label each accounting approach and indicate where additional information is provided within this biennial report explaining how it was implemented, including all relevant accounting parameters (i.e. natural disturbances, caps).

[g] Specify what was used for the category “other”. Explain in this biennial report how each was defined and how it relates to the categories used for reporting under the Convention or its Kyoto Protocol.

Custom Footnotes

Table 4(a)I HUN_BR1_v2.1

Progress in achieving the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the contribution of the land use, land-use change and forestry sector in 2012 [a, b]

	Net GHG emissions/removals from LULUCF categories [c]	*Base year/period or reference level value [d]*	*Contribution from LULUCF for reported year*	*Cumulative contribution from LULUCF [e]*	*Accounting approach [f]*
	(kt CO_2 eq)				
Total LULUCF					Activity-based approach
A. Forest land					Activity-based approach
1. Forest land remaining forest land					Activity-based approach
2. Land converted to forest land					Activity-based approach
3. Other [g]					Activity-based approach
B. Cropland					Activity-based approach
1. Cropland remaining cropland					Activity-based approach
2. Land converted to cropland					Activity-based approach
3. Other [g]					Activity-based approach
C. Grassland					Activity-based approach
1. Grassland remaining grassland					Activity-based approach

2. Land converted to grassland					Activity-based approach
3. Other [g]					Activity-based approach
D. Wetlands					Activity-based approach
1. Wetland remaining wetland					Activity-based approach
2. Land converted to wetland					Activity-based approach
3. Other [g]					Activity-based approach
E. Settlements					Activity-based approach
1. Settlements remaining settlements					Activity-based approach
2. Land converted to settlements					Activity-based approach
3. Other [g]					Activity-based approach
F. Other land					Activity-based approach
1. Other land remaining other land					Activity-based approach
2. Land converted to other land					Activity-based approach
3. Other [g]					Activity-based approach
Harvested wood products					Activity-based approach

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Parties that use the LULUCF approach that is based on table 1 do not need to complete this table, but should indicate the approach in table 2. Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[c] For each category, enter the net emissions or removals reported in the most recent inventory submission for the corresponding inventory year. If a category differs from that used for the reporting under the Convention or its Kyoto Protocol, explain in the biennial report how the value was derived.

[d] Enter one reference level or base year/period value for each category. Explain in the biennial report how these values have been calculated.

[e] If applicable to the accounting approach chosen. Explain in this biennial report to which years or period the cumulative contribution refers to.

[f] Label each accounting approach and indicate where additional information is provided within this biennial report explaining how it was implemented, including all relevant accounting parameters (i.e. natural disturbances, caps).

[g] Specify what was used for the category “other”. Explain in this biennial report how each was defined and how it relates to the categories used for reporting under the Convention or its Kyoto Protocol.

Custom Footnotes

Table 4(a)II

HUN_BR1_v2.1

Source: HUN_CRF__ v2.1

Progress in achievement of the quantified economy-wide emission reduction targets – further information on mitigation actions relevant to the counting of emissions and removals from the land use, land-use change and forestry sector in relation to activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol[a,b, c]

GREENHOUSE GAS SOURCE AND SINK ACTIVITIES	*Base year*[d]	*Net emissions/removals*[e]					*Accounting parameters*[h]	*Accounting quantity*[i]
		2008	2009	*2010*	*2011*	Total[g]		
	(kt CO_2 eq)							
A. Article 3.3 activities								
A.1. Afforestation and Reforestation								-4'849.09
A.1.1. Units of land not harvested since the beginning of the commitment periodj		-1,130.17	-1,103.09	-1,206.00	-1,120.36	-4,559.62		-4'559.62
A.1.2. Units of land harvested since the beginning of the commitment periodj								-289.48
A.2. Deforestation		46.72	89.57	48.53	70.45	255.28		255.27546
B. Article 3.4 activities								
B.1. Forest Management (if elected)		-2,784.02	-1,891.82	-1,679.71	-1,523.02	-7,878.57		-5316.66667
3.3 offset[k]							0	0
FM cap[l]							5316.66667	-5316.66667
B.2. Cropland Management (if elected)	0	NA	NA	NA	NA	NA	0	0
B.3. Grazing Land Management (if elected)	0	NA	NA	NA	NA	NA	0	0
B.4. Revegetation (if elected)	0	NA	NA	NA	NA	NA	0	0

Note: 1 kt CO_2 eq equals 1 Gg CO_2 eq.

Abbreviations: CRF = common reporting format, LULUCF = land use, land-use change and forestry.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] Developed country Parties with a quantified economy-wide emission reduction target as communicated to the secretariat and contained in document FCCC/SB/2011/INF.1/Rev.1 or any update to that document, that are Parties to the Kyoto Protocol, may use table 4(a)II for reporting of accounting quantities if LULUCF is contributing to the attainment of that target.

[c] Parties can include references to the relevant parts of the national inventory report, where accounting methodologies regarding LULUCF are further described in the documentation box or in the biennial reports.

[d] Net emissions and removals in the Party's base year, as established by decision 9/CP.2.

[e] All values are reported in the information table on accounting for activities under Article 3, paragraphs 3 and 4, of the Kyoto Protocol, of the CRF for the relevant inventory year as reported in the current submission and are automatically entered in this table.

[f] Additional columns for relevant years should be added, if applicable.

[g] Cumulative net emissions and removals for all years of the commitment period reported in the current submission.

[h] The values in the cells "3.3 offset" and "Forest management cap" are absolute values.

[i] The accounting quantity is the total quantity of units to be added to or subtracted from a Party's assigned amount for a particular activity in accordance with the provisions of Article 7, paragraph 4, of the Kyoto Protocol.

[j] In accordance with paragraph 4 of the annex to decision 16/CMP.1, debits resulting from harvesting during the first commitment period following afforestation and reforestation since 1990 shall not be greater than the credits accounted for on that unit of land.

[k] In accordance with paragraph 10 of the annex to decision 16/CMP.1, for the first commitment period a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3 paragraph 3, may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under forest management under Article 3, paragraph 4, up to a level that is equal to the net source of emissions under the provisions of Article 3, paragraph 3, but not greater than 9.0 megatonnes of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3, paragraph 3.

[l] In accordance with paragraph 11 of the annex to decision 16/CMP.1, for the first commitment period of the Kyoto Protocol only, additions to and subtractions from the assigned amount of a Party resulting from Forest management under Article 3, paragraph 4, after the application of paragraph 10 of the annex to decision 16/CMP.1 and resulting from forest management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix of the annex to decision 16/CMP.1, times five.

Custom Footnotes

Table 4(b) HUN_BR1_v2.1

Reporting on progress[a, b, c]

Units of market based mechanisms			*Year*	
			2011	*2012*
Kyoto Protocol units[d]	*Kyoto Protocol units*	*(number of units)*		
		(kt CO_2 eq)		
	AAUs	*(number of units)*		
		(kt CO2 eq)		
	ERUs	*(number of units)*		
		(kt CO2 eq)		
	CERs	*(number of units)*		
		(kt CO2 eq)		
	tCERs	*(number of units)*		
		(kt CO2 eq)		
	lCERs	*(number of units)*		
		(kt CO2 eq)		
Other units[d,e]	*Units from market-based mechanisms under the Convention*	*(number of units)*		
		(kt CO_2 eq)		
	Units from other market-based mechanisms	*(number of units)*		
		(kt CO_2 eq)		
Total		*(number of units)*		
		(kt CO_2 eq)		

Abbreviations: AAUs = assigned amount units, CERs = certified emission reductions, ERUs = emission reduction units, lCERs = long-term certified emission reductions, tCERs = temporary certified emission reductions.

Note: 2011 is the latest reporting year.

[a] Reporting by a developed country Party on the information specified in the common tabular format does not prejudge the position of other Parties with regard to the treatment of units from market-based mechanisms under the Convention or other market-based mechanisms towards achievement of quantified economy-wide emission reduction targets.

[b] For each reported year, information reported on progress made towards the emission reduction target shall include, in addition to the information noted in paragraphs 9(a-c) of the reporting guidelines, on the use of units from market-based mechanisms.

[c] Parties may include this information, as appropriate and if relevant to their target.

[d] Units surrendered by that Party for that year that have not been previously surrendered by that or any other Party.

[e] Additional rows for each market-based mechanism should be added, if applicable.

Custom Footnotes

5. Projections

The projections presented herewith are developed for the years 2015, 2020 and 2025. The projections rely on energy demand forecasts, latest emission factors and technological data and use parametric assumptions as presented The detailed sectoral impact of measures is enumerated in Chapter 5 of the NC for the industry, energy and power sector, transportation, public sector, agriculture and forestry sectors.

Throughout the development of the projections the impacts of EU level policy requirements and specific domestic policies were considered (e.g. Renewable Energy Directive, EU ETS). For the sake of a concise and methodologically sound forecast the HUNMIT model was developed and adapted to the present forecast which is a bottom up model enlisting all measures, their technical and economical characteristics. The model is capable of selecting an optimal set of measures allowing for a cost efficient emission reduction.

Table 5.1. summarises total emissions for the two scenarios (with and without LULUCF).

Table 1.2. Total emissions in the WEM and WAM scenarios (Gg. CO_2 equiv.)

	2010	2015	2020	2025
Without measures scenario	67 679,05	63568,7	65945,7	69473,6
WOM including LULUCF	*63 694,31*	*66193,0*	*68731,3*	*69473,6*
With existing measures	67 679,05	63 475,56	59 840,24	58 598,03
WEM including LULUCF	*63 694,31*	*60 680,07*	*58 046,54*	*56 391,17*
With additional measures	67 679,05	61 515,11	56 774,2	55 400,29
WAM including LULUCF	*63 694,31*	*58 719,62*	*54 980,5*	*53 193,42*

It is visible that the two scenarios do not differ significantly at the end of the forecasting period. This indicates that the WEM scenario already incorporates a large share of potential abatament measures and mitigation options.

HUN_BR1_v2.
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Table 5

Summary of key variables and assumptions used in the projections analysis[a]

Key underlying assumptions		*Historical[b]*						Projected			
Assumption	*Unit*	*1990*	*1995*	2000	2005	2010	2011	2015	2020	2025	2030
GDP growth rate	*%*	-3.30	1.50	5.20	4.10	1.10	1.60	0.40	1.70	1.70	
Population	thousands	10,375,000.00	10,337,000.00	10,222,000.00	10,098,000.00	1,014,000.00	9,986,000.00	9,886,303.00	9,832,048.00	9,753,643.00	
Population growth	%	-0.19	-0.37	-0.32	-0.38	-0.30	-0.41	-0.10	-0.10	-0.20	
International oil price	USD / boe							86.00	88.50	89.20	
International coal price	USD / boe							22.00	22.60	89.20	
International gas price	*USD / boe*							53.80	61.50	58.90	

[a] Parties should include key underlying assumptions as appropriate.

[b] Parties should include historical data used to develop the greenhouse gas projections reported.

Custom Footnotes

Table 6(a) HUN_BR1_v2.1

Information on updated greenhouse gas projections under a 'with measures' scenario[a]

	GHG emissions and removals[b]							GHG emission projections	
	(kt CO_2 eq)							(kt CO_2 eq)	
	Base year (1990)	1990	1995	2000	2005	2010	2011	2020	2030
Sector[d,e]									
Energy	79,331.60	68,252.80	59,227.20	56,597.50	56,963.40	49,035.90	47,364.10	41,843.60	40,785.20
Transport	14,637.40	11,572.70	7,876.80	8,159.40	8,936.70	6,431.80	6,194.00	5,898.60	5,695.10
Industry/industrial processes	14,637.40	11,572.70	7,876.80	8,159.40	8,936.70	6,431.80	6,194.00	5,898.60	5,695.10
Agriculture	19,043.90	15,477.50	9,296.00	9,533.80	9,195.90	8,531.30	8,758.70	9,860.30	9,860.30
Forestry/LULUCF	-2,600.30	-2,018.90	-5,575.20	-682.70	-5,135.00	-4,084.70	-3,787.50	-1,793.70	-2,206.90
Waste management/waste	3,075.90	3,451.50	3,690.60	3,935.70	3,991.40	3,677.50	3,521.40	1,874.10	1,888.40
Other (specify)									
Gas									
CO_2 emissions including net CO_2 from LULUCF	82,790.10	71,089.70	56,851.30	58,710.70	55,259.20	47,463.80	45,875.70	42,982.50	41,601.60
CO_2 emissions excluding net CO_2 from LULUCF	85,429.20	73,154.20	62,477.00	59,467.90	60,476.80	51,608.40	49,740.00	44,776.20	43,808.40
CH_4 emissions including CH_4 from LULUCF	13,504.90	12,680.30	10,009.20	10,022.20	9,299.10	8,700.80	8,496.80	6,905.40	6,913.60
CH_4 emissions excluding CH_4 from LULUCF	13,474.10	12,653.10	9,986.10	9,991.20	9,263.20	8,677.80	8,459.60	6,905.40	6,913.60
N_2O emissions including N_2O from LULUCF	17,163.40	12,833.30	7,499.60	8,403.30	8,637.00	6,501.20	6,814.10	7,192.60	7,203.50
N_2O emissions excluding N_2O from LULUCF	17,128.40	12,814.90	7,472.30	8,359.80	8,590.20	6,464.30	6,774.50	7,192.60	7,203.50
HFCs	NA	NA	23.90	213.60	675.40	959.00	987.60	742.70	448.90
PFCs	268.50	270.80	166.80	212.20	210.30	1.00	1.70	1.90	1.90
SF_6	73.10	87.60	169.60	195.30	237.70	234.90	184.40	221.30	221.70
Other (specify)									

Total with LULUCF[f]	113,800.00	96,961.70	74,720.40	77,757.30	74,318.70	63,860.70	62,360.30	58,046.40	56,391.20
Total without LULUCF	116,373.30	98,980.60	80,295.70	78,440.00	79,453.60	67,945.40	66,147.80	59,840.10	58,598.00

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] In accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", at a minimum Parties shall report a 'with measures' scenario, and may report 'without measures' and 'with additional measures' scenarios. If a Party chooses to report 'without measures' and/or 'with additional measures' scenarios they are to use tables 6(b) and/or 6(c), respectively. If a Party does not choose to report 'without measures' or 'with additional measures' scenarios then it should not include tables 6(b) or 6(c) in the biennial report.

[b] Emissions and removals reported in these columns should be as reported in the latest GHG inventory and consistent with the emissions and removals reported in the table on GHG emissions and trends provided in this biennial report. Where the sectoral breakdown differs from that reported in the GHG inventory Parties should explain in their biennial report how the inventory sectors relate to the sectors reported in this table.

[c] 20XX is the reporting due-date year (i.e. 2014 for the first biennial report).

[d] In accordance with paragraph 34 of the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", projections shall be presented on a sectoral basis, to the extent possible, using the same sectoral categories used in the policies and measures section. This table should follow, to the extent possible, the same sectoral categories as those listed in paragraph 17 of those guidelines, namely, to the extent appropriate, the following sectors should be considered: energy, transport, industry, agriculture, forestry and waste management.

[e] To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors (i.e. cross-cutting), as appropriate.

[f] Parties may choose to report total emissions with or without LULUCF, as appropriate.

Custom Footnotes

Table 6(c)

HUN_BR1_v2.1

Information on updated greenhouse gas projections under a 'with additional measures' scenario[a]

	GHG emissions and removals[b] (*kt CO_2 eq*)							GHG emission projections (kt CO_2 eq)	
	Base year (1990)	1990	1995	2000	2005	2010	2011	2020	2030
Sector[d,e]									
Energy	79,331.60	68,252.80	59,227.20	56,597.50	56,963.40	49,035.90	47,364.10	40,201.00	39,040.90
Transport	14,637.40	11,572.70	7,876.80	8,159.40	8,936.70	6,431.80	6,194.00	5.42	5,289.40
Industry/industrial processes	14,637.40	11,572.70	7,876.80	8,159.40	8,936.70	6,431.80	6,194.00	5,415.00	5,289.40
Agriculture	19,043.90	15,477.50	9,296.00	9,533.80	9,195.90	8,531.30	8,758.70	9,273.90	9,273.90
Forestry/LULUCF	-2,600.30	-2,018.90	-5,575.20	-682.70	-5,135.00	-4,084.70	-3,787.50	-1,793.70	-2,206.90
Waste management/waste	3,075.90	3,451.50	3,690.60	3,935.70	3,991.40	3,677.50	3,521.40	1,531.80	1,445.60
Other (specify)									
Gas									
CO_2 emissions including net CO_2 from LULUCF	82,790.10	71,089.70	56,851.30	58,710.70	55,259.20	47,463.80	45,875.70	41,192.20	39,711.70
CO_2 emissions excluding net CO_2 from LULUCF	85,429.20	73,154.20	62,477.00	59,467.90	60,476.80	51,608.40	49,740.00	42,985.90	41,918.60
CH_4 emissions including CH_4 from LULUCF	13,504.90	12,680.30	10,009.20	10,022.20	9,299.10	8,700.80	8,496.80	6,425.80	6,341.40
CH_4 emissions excluding CH_4 from LULUCF	13,474.10	12,653.10	9,986.10	9,991.20	9,263.20	8,677.80	8,459.60	6,425.80	6,341.40
N_2O emissions including N_2O from LULUCF	17,163.40	12,833.30	7,499.60	8,403.30	8,637.00	6,501.20	6,814.10	6,617.00	6,620.40
N_2O emissions excluding N_2O from LULUCF	17,128.40	12,814.90	7,472.30	8,359.80	8,590.20	6,464.30	6,774.50	6,617.00	6,620.40
HFCs	NA	NA	23.90	213.60	675.40	959.00	987.60	508.70	283.10
PFCs	268.50	270.80	166.80	212.20	210.30	1.00	1.70	1.90	1.90
SF_6	73.10	87.60	169.60	195.30	237.70	234.90	184.40	234.90	234.90
Other (specify)									

Total with LULUCF[f]	113,800.00	96,961.70	74,720.40	77,757.30	74,318.70	63,860.70	62,360.30	54,980.50	53,193.40
Total without LULUCF	116,373.30	98,980.60	80,295.70	78,440.00	79,453.60	67,945.40	66,147.80	56,774.20	55,400.30

Abbreviations: GHG = greenhouse gas, LULUCF = land use, land-use change and forestry.

[a] In accordance with the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", at a minimum Parties shall report a 'with measures' scenario, and may report 'without measures' and 'with additional measures' scenarios. If a Party chooses to report 'without measures' and/or 'with additional measures' scenarios they are to use tables 6(b) and/or 6(c), respectively. If a Party does not choose to report 'without measures' or 'with additional measures' scenarios then it should not include tables 6(b) or 6(c) in the biennial report.

[b] Emissions and removals reported in these columns should be as reported in the latest GHG inventory and consistent with the emissions and removals reported in the table on GHG emissions and trends provided in this biennial report. Where the sectoral breakdown differs from that reported in the GHG inventory Parties should explain in their biennial report how the inventory sectors relate to the sectors reported in this table.

[c] 20XX is the reporting due-date year (i.e. 2014 for the first biennial report).

[d] In accordance with paragraph 34 of the "Guidelines for the preparation of national communications by Parties included in Annex I to the Convention, Part II: UNFCCC reporting guidelines on national communications", projections shall be presented on a sectoral basis, to the extent possible, using the same sectoral categories used in the policies and measures section. This table should follow, to the extent possible, the same sectoral categories as those listed in paragraph 17 of those guidelines, namely, to the extent appropriate, the following sectors should be considered: energy, transport, industry, agriculture, forestry and waste management.

[e] To the extent possible, the following sectors should be used: energy, transport, industry/industrial processes, agriculture, forestry/LULUCF, waste management/waste, other sectors (i.e. cross-cutting), as appropriate.

[f] Parties may choose to report total emissions with or without LULUCF, as appropriate.

6. Provision of financial, technological and capacity-building support to developing country Parties

Hungarian Development Policy does attempt to comply with all regulative measures obliged by the acquis communautaire, including its normative contributions to the European Development Fund (EDF), to act upon the commitments to the Millennium Development Goals (MDGs), adhere to the principles of the 2002 Monterrey Consensus and the 2008 follow-up in Doha. To comply with OECD measures, Hungary's ODA contribution needs to reach 0.33% of GNI.

Development aid and assistance to developing countries is however not the primary focus of Hungary's foreign affairs due to the economic crisis and the acute financial problems of the central budget. Moreover climate change related subsidies and support to developing countries is practically absent. In the followings a short overview is given of financial, technological and capacity building transfers with emphasis on private sector activities. For more information, please refer to Chapter 7 of the 6th National Communication of Hungary.

The Hungarian private sector has so far made a rather moderate contribution to the international development policy goals of Hungary. One of the principal reasons is that the Hungarian business environment has been on the verge of recession since 2006. Secondly, micro-and small companies dominate the corporate landscape and the vast majority is incapable of taking part in international development projects. The few large companies are mostly multinational and they are embedded in the international development network of their owner's country. Recent crisis-management measures generated distrust between foreign-owned companies and the Hungarian government, especially within the banking sector. SMEs are very interested in participating in international development projects although they lack relevant capacities and only a few provide significant technological added value in international markets. They cannot finance the investment needs of larger-scale projects and capacity problems are additionally aggravated by human resource problems.

6.1. Finance

The participation of Hungarian financial private companies in international development activities is limited. Foreign ownership has dominated the Hungarian banking sector since the second half of the nineties (Várhegyi 1998: 908); since 1997 the ratio of foreign ownership in the overall banking assets has been above 60%.

The role of domestic private ownership is even weaker if we consider that most Hungarian financial companies are locally oriented saving banks. In fact, only one bank with (partial) domestic ownership has a realistic potential to significantly participate in international development activities, notably the OTP Bank.

The international development preferences of the foreign-owned banks are in practice unrelated to Hungarian international development policy.

The international financial crisis has had negative consequences on the position of Hungarian banks. Sustained crises clearly undermine the willingness to participate in development activities. In addition, Hungarian private financial companies have been constrained by a special extra banking tax and the burden of an early repayment scheme for credits denominated in foreign currencies. The consequence of these crisis-management measures is that the multinational banking groups devaluate their Hungarian affiliated banks in their regional financial strategies, fundamentally undermining aid development activity of these banks.

The only private Hungarian bank active in international projects is the OTP Bank which besides its operations in Hungary currently operates in 8 countries in the region. Among these, Serbia, Montenegro and Ukraine might be relevant in international development projects.

Hungary's main contribution to the financial development in certain DAC countries is through the activities of two specialized state-owned financial institutions, the EXIMBANK (Hungarian Export-Import Bank Private

Limited Company) and the MEHIB (the Hungarian Export Credit Insurance Private Limited Company). Their role is to facilitate the sale of Hungarian goods and services to international markets.

EXIMBANK and MEHIB are technically supporting Hungarian companies in countries considered as more uncertain markets. Concerning their role in international development, the most important is the provision of tied aid credits. However, in this enduring crisis period, in particular because of the drying up of liquidity and a credit crunch in Hungary, the steadily increasing number of indigent companies created a more general use for the services of these institutions and as a consequence, the number of companies interested in tied aid credits and international development projects has been rising.

6.2. Technology development and transfer

Private sector plays a role in Hungary's international development assistance projects in a limited number of fields, among the most important being humanitarian aid (donation of foods and medicines) and some aspects of technical assistance. However, the project-level overview of development activities indicates a more significant contribution. In this respect, the following projects should be mentioned:

- Infrastructure development in Bosnia and Herzegovina (namely the transfer of water purification technology of drinking water in Tuzla)
- Agricultural and food industry training in Kenya (as part of the joint Scholarship Programme with the UN FAO)
- Adult training project in Macedonia
- Construction activities in Montenegro's educational infrastructure (kindergarten, primary school, healthcare vocational school and adult training centre)
- Viticultural training and technological improvement in preserving the genetic profile of indigenous goat and sheep breeds in Serbia;
- Bilateral scientific and technological cooperation projects with Ukraine;
- Joint Scholarship Programme with the UN FAO for Vietnamese applicants

In addition, it is worth mentioning that private companies contributed to agricultural development projects in Afghanistan and Laos: agricultural companies transported seeds and helped open the joint scholarship programme with the UN FAO also to Afghanistan, whilst several projects helped improve technological efficiency of agricultural production in Laos.

6.3. Capacity-building

The transfer of know-how, technology and good practices are particularly important in agriculture and related manufacturing industry sectors; this includes non-traditional production methods of foods and beverages, but also latest technologies in viticulture and environmentally sustainable animal husbandry. Human capacity building scholarship programmes play a predominant role in international development policy, and the joint programmes with FAO are especially relevant in developing countries. Hungarian private sector actors can contribute significantly to international projects mainly in the investment and manufacturing fields, especially when the latter is related to agriculture. Private involvement is smaller in the educational and healthcare sectors where state-ownership is dominant and where non-governmental development organisations play a particularly important role in education. Recent development relations with Kenya generated an increasing interest in the support to the health sector; the Ministry of Foreign Affairs actively promoted the private sector to provide Mother and Child Health, Nutrition and Family Planning Services. In principle, comprehensive health sector projects are opportunities for Hungarian companies in construction (planning of hospitals, building and related services) and manufacturing of surgical instruments and health-care training.

Tied aid

The practice of tied aid plays a specific role in Hungarian international development policy. Tied aid has a strong domestic legitimacy not only within the private sector and intermediary organizations but also with most relevant government agencies. Under the present economic and social conditions the domestic legitimacy of international aid can hardly be based solely on altruism; it requires additional tangible results that may raise public awareness and support. Tied aid is considered as a form of international aid that also supports the export market and thereby indirectly promotes the well-being of Hungarian citizens as well.

General capacity problems can be partly overcome through cluster development and a successful example is a water related cluster that started in January 2008. This cluster brought together different areas of the water industry and by 2013, it had 10 active members in construction, public utility (water and drainage systems) operation, potable water purification, communal and industrial wastewater treatment and environmental services (e.g. flood prevention). This is a good example in providing motivation and capacity to international development projects.

HUN_BR1_v2.1

Table 7

Provision of public financial support: summary information in 2011[a]

Allocation channels	*Year*									
	Hungarian forint - HUF					*USD[b]*				
	Core/ general[c]	*Climate-specific[d]*				*Core/ general[c]*	*Climate-specific[d]*			
		Mitigation	*Adaptation*	*Cross-cutting[e]*	*Other[f]*		*Mitigation*	*Adaptation*	*Cross-cutting[e]*	*Other[f]*
Total contributions through multilateral channels:			300,000,000.00					1,300,000.00		
Multilateral climate change funds[g]			300,000,000.00					1,300,000.00		
Other multilateral climate change funds[h]										
Multilateral financial institutions, including regional development banks										
Specialized United Nations bodies										
Total contributions through bilateral, regional and other channels										
Total			300,000,000.00					1,300,000.00		

Abbreviation: USD = United States dollars.

[a] Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[b] Parties should provide an explanation on methodology used for currency exchange for the information provided in table 7, 7(a) and 7(b) in the box below.

[c] This refers to support to multilateral institutions that Parties cannot specify as climate-specific.

[d] Parties should explain in their biennial reports how they define funds as being climate-specific.

[e] This refers to funding for activities which are cross-cutting across mitigation and adaptation.

[f] Please specify.

[g] Multilateral climate change funds listed in paragraph 17(a) of the “UNFCCC biennial reporting guidelines for developed country Parties” in decision 2/CP.17.

[h] Other multilateral climate change funds as referred in paragraph 17(b) of the "UNFCCC biennial reporting guidelines for developed country Parties" in decision 2/CP.17.

Custom Footnotes

Each Party shall provide an indication of what new and additional financial resources they have provided, and clarify how they have determined that such resources are new and additional. Please provide this information in relation to table 7(a) and table 7(b).
Documentation Box:

HUN_BR1_v2.1

Table 7

Provision of public financial support: summary information in 2012[a]

Allocation channels	*Year*									
	Hungarian forint - HUF					*USD[b]*				
	Core/ general[c]	*Climate-specific[d]*				*Core/ general[c]*	*Climate-specific[d]*			
		Mitigation	*Adaptation*	*Cross-cutting[e]*	*Other[f]*		*Mitigation*	*Adaptation*	*Cross-cutting[e]*	*Other[f]*
Total contributions through multilateral channels:										
Multilateral climate change funds[g]										
Other multilateral climate change funds[h]										
Multilateral financial institutions, including regional development banks										
Specialized United Nations bodies										
Total contributions through bilateral, regional and other channels							750,000.00			
Total							750,000.00			

Abbreviation: USD = United States dollars.

[a] Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[b] Parties should provide an explanation on methodology used for currency exchange for the information provided in table 7, 7(a) and 7(b) in the box below.

[c] This refers to support to multilateral institutions that Parties cannot specify as climate-specific.

[d] Parties should explain in their biennial reports how they define funds as being climate-specific.

[e] This refers to funding for activities which are cross-cutting across mitigation and adaptation.

[f] Please specify.

[g] Multilateral climate change funds listed in paragraph 17(a) of the “UNFCCC biennial reporting guidelines for developed country Parties” in decision 2/CP.17.

[h] Other multilateral climate change funds as referred in paragraph 17(b) of the “UNFCCC biennial reporting guidelines for developed country Parties” in decision 2/CP.17.

Custom Footnotes

Each Party shall provide an indication of what new and additional financial resources they have provided, and clarify how they have determined that such resources are new and additional. Please provide this information in relation to table 7(a) and table 7(b).
Documentation Box:

Table 7(a)

HUN_BR1_v2.1

Provision of public financial support: contribution through multilateral channels in 2011[a]

Donor funding	Total amount				Status[b]	Funding source[f]	Financial instrument[f]	Type of support[f, g]	Sector[c]
	Core/general[d]		Climate-specific[e]						
	Hungarian forint - HUF	USD	Hungarian forint - HUF	USD					
Total contributions through multilateral channels			300,000,000.00	1,300,000.00					
Multilateral climate change funds [g]			300,000,000.00	1,300,000.00					
1. Global Environment Facility									
2. Least Developed Countries Fund			300,000,000.00	1,300,000.00	Provided	Other (grant)		Adaptation	Other (governance)
3. Special Climate Change Fund									
4. Adaptation Fund									
5. Green Climate Fund									
6. UNFCCC Trust Fund for Supplementary Activities									
7. Other multilateral climate change funds									
Multilateral financial institutions, including regional development banks									
1. World Bank									
2. International Finance Corporation									
3. African Development Bank									
4. Asian Development Bank									
5. European Bank for Reconstruction and Development									
6. Inter-American Development Bank									
7. Other									
Specialized United Nations bodies									

1. United Nations Development Programme									
2. United Nations Environment Programme									
3. Other									

Abbreviations: ODA = official development assistance, OOF = other official flows.

[a] Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[b] Parties should explain, in their biennial reports, the methodologies used to specify the funds as provided, committed and/or pledged. Parties will provide the information for as many status categories as appropriate in the following order of priority: provided, committed, pledged.

[c] Parties may select several applicable sectors. Parties may report sectoral distribution, as applicable, under “Other”.

[d] This refers to support to multilateral institutions that Parties cannot specify as climate-specific.

[e] Parties should explain in their biennial reports how they define funds as being climate-specific.

[f] Please specify.

[g] Cross-cutting type of support refers to funding for activities which are cross-cutting across mitigation and adaptation.

Custom Footnotes

Table 7(a) HUN_BR1_v2.1

Provision of public financial support: contribution through multilateral channels in 2012[a]

Donor funding	*Total amount*				*Status[b]*	*Funding source[f]*	*Financial instrument[f]*	*Type of support[f, g]*	*Sector[c]*
	Core/general[d]		*Climate-specific[e]*						
	Hungarian forint - HUF	*USD*	*Hungarian forint - HUF*	*USD*					
Total contributions through multilateral channels									
Multilateral climate change funds [g]									
1. Global Environment Facility									
2. Least Developed Countries Fund									
3. Special Climate Change Fund									
4. Adaptation Fund									
5. Green Climate Fund									
6. UNFCCC Trust Fund for Supplementary Activities									
7. Other multilateral climate change funds									
Multilateral financial institutions, including regional development banks									
1. World Bank									
2. International Finance Corporation									
3. African Development Bank									
4. Asian Development Bank									
5. European Bank for Reconstruction and Development									
6. Inter-American Development Bank									
7. Other									
Specialized United Nations bodies									

1. United Nations Development Programme									
2. United Nations Environment Programme									
3. Other									

Abbreviations: ODA = official development assistance, OOF = other official flows.

[a] Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[b] Parties should explain, in their biennial reports, the methodologies used to specify the funds as provided, committed and/or pledged. Parties will provide the information for as many status categories as appropriate in the following order of priority: provided, committed, pledged.

[c] Parties may select several applicable sectors. Parties may report sectoral distribution, as applicable, under “Other”.

[d] This refers to support to multilateral institutions that Parties cannot specify as climate-specific.

[e] Parties should explain in their biennial reports how they define funds as being climate-specific.

[f] Please specify.

[g] Cross-cutting type of support refers to funding for activities which are cross-cutting across mitigation and adaptation.

Custom Footnotes

Table 7(b) HUN_BR1_v2.1

Provision of public financial support: contribution through bilateral, regional and other channels in 2011[a]

Recipient country/ region/project/programme[b]	Total amount		Status[c]	Funding source[g]	Financial instrument[g]	Type of support[g, h]	Sector[d]	Additional information[e]
	Climate-specific[f]							
	Hungarian forint - HUF	USD						
Total contributions through bilateral, regional and other channels								

Abbreviations: ODA = official development assistance, OOF = other official flows; USD = United States dollars.

[a] Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[b] Parties should report, to the extent possible, on details contained in this table.

[c] Parties should explain, in their biennial reports, the methodologies used to specify the funds as provided, committed and/or pledged. Parties will provide the information for as many status categories as appropriate in the following order of priority: provided, committed, pledged.

[d] Parties may select several applicable sectors. Parties may report sectoral distribution, as applicable, under “Other”.

[e] Parties should report, as appropriate, on project details and the implementing agency.

[f] Parties should explain in their biennial reports how they define funds as being climate-specific.

[g] Please specify.

[h] Cross-cutting type of support refers to funding for activities which are cross-cutting across mitigation and adaptation.

Custom Footnotes

Table 7(b) HUN_BR1_v2.1

Provision of public financial support: contribution through bilateral, regional and other channels in 2012[a]

Recipient country/ region/project/programme[b]	Total amount		Status[c]	Funding source[g]	Financial instrument[g]	Type of support[g, h]	Sector[d]	Additional information[e]
	Climate-specific[f]							
	Hungarian forint - HUF	USD						
Total contributions through bilateral, regional and other channels		750,000.00						
Eastern Europe / Energy efficiency programme - Ukraine		750,000.00	Provided	ODA	Grant	Mitigation	Energy	

Abbreviations: ODA = official development assistance, OOF = other official flows; USD = United States dollars.

[a] Parties should fill in a separate table for each year, namely 2011 and 2012, where 2014 is the reporting year.

[b] Parties should report, to the extent possible, on details contained in this table.

[c] Parties should explain, in their biennial reports, the methodologies used to specify the funds as provided, committed and/or pledged. Parties will provide the information for as many status categories as appropriate in the following order of priority: provided, committed, pledged.

[d] Parties may select several applicable sectors. Parties may report sectoral distribution, as applicable, under “Other”.

[e] Parties should report, as appropriate, on project details and the implementing agency.

[f] Parties should explain in their biennial reports how they define funds as being climate-specific.

[g] Please specify.

[h] Cross-cutting type of support refers to funding for activities which are cross-cutting across mitigation and adaptation.

Custom Footnotes

Table 8

Provision of technology development and transfer support[a,b]

Recipient country and/or region	*Targeted area*	*Measures and activities related to technology transfer*	*Sector*[c]	*Source of the funding for technology transfer*	*Activities undertaken by*	*Status*	*Addit*

[a] To be reported to the extent possible.

[b] The tables should include measures and activities since the last national communication or biennial report.

[c] Parties may report sectoral disaggregation, as appropriate.

[d] Additional information may include, for example, funding for technology development and transfer provided, a short description of the measure or activity and co-financing arrangements.

Custom Footnotes

Table 9 HUN_BR1_v2.1

Provision of capacity-building support[a]

Recipient country/region	*Targeted area*	*Programme or project title*	*Description of programme or project* [b,c]

[a] To be reported to the extent possible.

[b] Each Party included in Annex II to the Convention shall provide information, to the extent possible, on how it has provided capacity-building support that responds to the existing and emerging capacity-building needs identified by Parties not included in Annex I to the Convention in the areas of mitigation, adaptation and technology development and transfer.

[c] Additional information may be provided on, for example, the measure or activity and co-financing arrangements.

Custom Footnotes

7. Other reporting requirements

As described in Chapter 3 of the 6th National Communication, Hungary annually accounts for the national greenhouse gas emissions through her inventory (National Inventory Report to the UNFCCC).

As an EU Member State Hungary is furthermore obliged to present a comprehensive Biannual Report for the inspection of progress in climate change mitigation, energy policy goals and other importan relevant aspects.

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List of Abbreviations

4CE	Consumer Choice and Carbon Consciousness for Electricity
5FP	See FP5
6FP	See FP6
ACFBC	Atmospheric Circulated Fluid Bed Combustion
ATOMKI	Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen
AVOP	Agriculture and Rural Development Operational Programme
BAT	Best Available Technology
BAU	Business As Usual
CAAG	Clean Air Action Group
CAC	Command and Control
CASMOFOR	Carbon Sequestration Model for Forestations
CCGT	Combined Cycle Gas Turbines
CDM	Clean Development Mechanism
CEE	Central and Eastern Europe
CEEWEB	Central and East European Working Group for the Enhancement of Biodiversity
CER	Certified Emission Reduction
CEU	Central European University
CHP	Combined Heat and Power
COP-9	the 9th Conference of the Parties
COST	European Cooperation in the Field of Scientific and Technical Research
CRT	Cathode ray tube
CCS	Carbon Capture and Storage
CSO	Central Statistical Office (KSH, Központi Statisztikai Hivatal)
DAC	Development Assistance Committee
DG	Directorate General
DH	Distric heating
DRI	Direct Reduced Iron
EAP	Environmental Action Programme
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EDP	European Development Programme
EDOP	Economic Development Operational programme (GOP)
EE	Energy Efficiency
EECPO	Program Office for Environmental Education and Communication (Könkomp, Környezeti Nevelési és Kommunikációs Programiroda)
EEOP	Environment and Energy Operational Programme
EIB	European Investment Bank
EIOP	Environment and Infrastructure Operational programme
EiT	Economies in Transition
EP	Electro Photographic Technology
EPBD	Energy Performance of Buildings Directive

EPC	Energy Performance Contracting
ESCO	Energy Services Company
ESD	Energy Savings Directive or Effort Sharing Directive
ETS	Emission Trading Scheme
EU	European Union
EUA	EU Allowance Unit
EU-ETS	European Union Emission Trading Scheme
EUMETSAT	European Organisation for the Exploitation of Meteorological Satellites
EuP	Energy-using Products
EUR	Euro
FFV	Flexi-Fuel Vehicle
FP5	EU Fifth Research and Development Framework Programme (1999-2002)
FP6	EU Sixth Research and Development Framework Programme (2003-2006)
GCCP	Global Climate Change and Vegetation
GCTE	Global Change and Terrestrial Ecosystems
GHG	Greenhouse Gas
GIS	Green Investment Scheme
GKM	Ministry of Economic Affairs (Gazdasági és Közlekedési Minisztérium)
GOP	Economic Development Operational programme
HEO	Hungarian Energy Office (Energia Hivatal)
HSRFR	Hungarian Scientific Research Fund Programmes (OTKA, Országos Tudományos Kutatási Alapprogramok)
HUF	Hungarian Forint
HVAC	Heating, Ventilation and Air-Conditioning
HVD	Hungarian Forestry Database
IEA	International Energy Agency
IEF	Industrial Energy Consumers' Forum (Ipari Energiafogyasztók Fóruma)
IGBP	International Geosphere and Biosphere Program
IGCC	Integrated Gasification Combined Cycle
IMF	International Montery Fund
IPCC	Intergovernmental Panel on Climate Change
IPCC	Intergovernmental Panel on Climate Change
IRR	Internal rate of return
ISPA	Instrument for Structural Policies for Pre-Accession
JI	Joint Implementation
KSH	Hungarian Central Statistical Office (Központi Statisztikai Hivatal)
KTI	Institute for Transport Sciences Non-Profit Ltd. (Közlekedéstudományi Intézet)
KvVM	Ministry of Environment and Water (Környezetvédelmi és Vízügyi Minisztérium)
LCD	Liquid crystal display
LRRT	Low Rolling Resistance Tyre
LTER	Long Term Ecological Research (Hosszú távú ökológiai vizsgálatok)
LULUCF	Land Use, Land-Use Change and Forestry
M	Million
MAC	Marginal Abatement Curve

MAVIR	Hungarian Transmission System Operator Company Ltd.
MBT	Mechanical Biological Treatment
MDG	Milennium Development Goals
GKM	Ministry of Economy and Transport (Gazdasági és Közlekedési Minisztérium, predecessor to KHEM and NFGM)
KHEM	Ministry of Transport, Telecommunication and Energy (Közlekedési, Hírközlési és Energiaügyi Minisztérium, descendant to GKM)
MOL	Hungarian Oil Company
MTA	Hungarian Academy of Sciences (MTA, Magyar Tudományos Akadémia)
Mtoe	Million tons of oil equivalent
MVH	Agricultural and Rural Development Office (Mezőgazdasági és Vidékfejlesztési Hivatal)
MVM	Hungarian Power Companies
NAP	National Allocation Plan
NBC	National Base Curriculum (Nemzeti Alaptanterv)
NC3	Third National Communication to the UNFCCC
NC4	Fourth National Communication to the UNFCCC
NCCS	National Climate Change Strategy
NE(E)AP	National Energy Efficiency Action Plan
NEP(P)	National Environmental Protection Programme
NEP I	First National Environmental Program (NKP I., Első Nemzeti Környezetvédelmi Program)
NEP II	Second National Environmental Program (2003-2008) (NKP II., Második Nemzeti Környezetvédelmi Program)
NFGM	Ministry for National Development and Economy (Nemzeti Fejlesztési és Gazdasági Minisztérium, descendant to GKM)
NGO	Non-governmental Organization
NHDP	New Hungary Development Plan
NHRDP	New Hungary Rural Development Plan
NHRSP	New Hungary Rural Development Strategic Plan
NIR	National Inventory Report
NKTH	National Office of Research and Technology (NKTH, Nemzeti Kutatási és Technológiai Hivatal)
NMS	New EU Member States (Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia)
NOAA	National Oceanic and Atmospheric Administration
NPP	Nuclear Power Plant
NREAP	National Renewable Energy Action Plan
NSZP	New Széchenyi Plan (Új Széchenyi Terv)
NUTS	Nomenclature of Territorial Units for Statistics
O&M	Operation and Maintenance
ODA	Official Development Assistance
ODYSSEE	Database on energy efficiency data and indicators, for the EU-15 members and Norway
OECD	Organisation for Economic Co-operation and Development
OKTVF	National Inspectorate for Environment, Nature and Water (Országos Környezetvédelmi, Természetvédelmi és Vízügyi Főfelügyelőség)
OMSZ	Hungarian Meteorological Services (Országos Meteorológiai Szolgálat)
PaMs	Policies and Measures
PHARE	Poland and Hungary: Assistance for Restructuring their Economies (EU programme)
PJ	Petajoule
PPA	Power Purchasing Agreement

PV	Photovoltaic
R&D	Research and Developments
REC	The Regional Environmental Centre for Central and Eastern Europe
REEEP	Renewable Energy and Energy Efficiency Partnership
RES	Renewable Energy Sources
RES-E	Renewable Energy Sourced Electricity
RES-H	Renewable Energy Sourced Heat
RFMRE	Research Fund Management and Research Exploitation
RTIF	Research and Technology Innovation Fund
SAPARD	Special Accession Programme for Agriculture and Rural Development
SAPS	Single Area Payment Scheme
S&T	Science and Technology
SEFF	Sustainable Energy Financing Facility
SME	Small and Medium Enterprise
TAP	Thematic Action Programme
TDOP	Transportation Development Operational Programme
TPES	Total Primary Energy Supply
UEC	Unit electricity consumption
UNDP GEF	United Nations Development Programme, Global Environment Facility
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
UTDS	Unified Transportation Development Strategy
ÚMVP	New Hungary Rural Development Plan
VAHAVA	VÁltozás-HAtás-VÁlaszadás (Change-impact-response) Research Project
VET	Electricity Act
WHO/ECEH	World Health Organization - European Centre for Environment and Health
WRI	World Resources Institute
ZBR	Zöld Beruházási Rendszer (Green Investment Scheme)

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