"In future tense"



## NATIONAL CLIMATE CHANGE STRATEGY 2008-2025

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## **EXECUTIVE SUMMARY**

The National Climate Change Strategy (NCCS) was prepared pursuant to §3 of Act No. LX/2007 (V. 28.) on the framework for the implementation of the UN Framework Convention on Climate Change and of the Kyoto Protocol thereof. In accordance with the national commitments, the Climate Change Strategy had to be elaborated for the first time for the 2008-2025 period. The objectives of the National Climate Change Strategy shall be implemented by National Climate Change Programmes to be prepared on a biannual basis. The NCCS is also adjusted to the National Sustainable Development Strategy adopted by the Government by Gov. Decree No. 1054/2007 (VII. 9.).

Climate change is a risk threatening both the Hungarian society and the national economy, and forces action. Multiple analyses suggest that our natural values, water resources, flora and fauna, forests, agricultural production yields, buildings, residential environment, public health and quality of life are all threatened by the significant changes in temperatures and precipitation rates, the possible shifting of seasons and the intensification and increased frequency of certain extreme weather phenomena as predicted for the following decades. A group of scientists of the United Nations concluded that Hungary is one of the most vulnerable countries of Europe in terms of the effects of the climate change on biological diversity, i.e., the multiplicity of species.

The scientific background for the NCCS was a research project known as "Global Climate Change: National Effects and Responses VAHAVA (VÁltozás – HAtás – VÁlaszok; 'Change – Effect – Responses')".

The NCCS identifies three major directions of action for the long term climate change **Key elements** policy:

- it foresees 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. The reduction of greenhouse gas emissions should be achieved by reducing the overall energy use in a manner that enables a shift in production and consumption structures towards lower material and energy needs.
- 2. it includes the key elements of the fight against the unfavourable 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. the raising of social awareness of the climate change and the strengthening of climate awareness.

The NCCS is an explicitly intersectoral and all-social framework system and affects all economic sectors and all social groups. Therefore, the relevant strategic objectives and tasks should be integrated into the activities of all sectors (and ministries):

Background, the importance of the Strategy

## The structure of The NCCS addresses the key issues in the following structure the NCCS

### 1. Frameworks for the elaboration of the strategy

#### How did the climate change in the past?

The composition of the atmosphere and the Earth's climate were always changing. Over the past millions of years, colder and warmer periods were alternating as a result of the fluctuations of the orbit of our planet around the Sun, the propagation of novel plant species, large volcanic eruptions etc. However, since the period of industrialisation and particularly in the past decades, the climate has started to warm up at a rate never observed in the past 650,000 years, and this is related to the atmospheric emission of carbon dioxide released by the increased use of fossil fuels since the industrial revolution. The increasing incidence of hot and arid summers and mild winters, and the extreme weather events observed all over the world are indications of a globally dangerous process.

#### Is it certain that these changes are caused by human?

According to the conclusions of the scientific community, the warming by approximately 0.5°C in the second half of the 20th century is highly likely to be of anthropogenic origin and the possibility of a natural fluctuation in the environmental conditions is practically excluded. The latest report by the Intergovernmental Panel on Climate Change addresses the issue more clearly than ever, that is, it can be stated with a high level of certainty that the nature-transforming activities of human, which are harmful in many instances, have reached the Earth's climatic system as well.

#### How may the climate change in the future?

Taking account of the development of the global economy and society and the sensitivity of the Earth's climate, the scientific community estimates a warming by 1.1°C to 6.4°C by 2100 (in comparison with the preceding century).

In Hungary, in addition to the increasing average temperatures, lower average rates of annual precipitation and a rearrangement of the distribution of precipitation (more precipitation in winter and less in summer), as well as an increase in the frequency and intensity of extreme weather events are foreseen. The most critical issue is the supply of precipitation and the (qualitative and quantitative conditions) of the surface and subsurface water resources. On a global level, economic depressions showing high regional variability in extent and significant increases in the emigration from less favourable areas are expected as a result of the changes.

#### 2. Mitigation of the climate change

#### Should emissions be mitigated?

The way in which different regions of the Earth are affected by the climate change is varying. However, an increase of more than 2°C in the average temperature of the Earth may have lingering and sharp effects that are unfavourable for all countries and may not be reversed later. At the time of preparing the NCCS, the share Hungary has to take of the implementation of the Community target was still unknown.

Depending on the Community obligations, the target greenhouse gas emission controls and reductions for Hungary for 2025, i.e., by the end of the current NCCS period, may be as follows:

- in case of a unilateral mitigation by 20% by the Community: reduction by 16% to 25% from the 1990 level.
- in case of a conditional target reduction of 30% by the Community: reduction by 27% to 34% from the 1990 level.

In the case of both reduction targets, the most cost-effective technologies for achieving the reduction should be identified. In the case of both reduction targets, new Community legislation, as well as significant changes in the cohesion policy for the 2014-2020 period are foreseen in view of the Community support for climate protection measures, as foreseen by the Green Book of the European Commission.

#### Are we taking action in time?

According to the generally accepted scientific view, we are at the "last" minute for avoiding a dangerous climate change, i.e., to prevent an increase by more than 2°C of the average temperature of the Earth. In order to achieve this at a probability of 50%, a reduction of greenhouse gas emissions should be started. Furthermore, even such an increase in the average temperature will have major ecological and socio-economical effects although the changes may not be irreversibly harmful. However, the probability of an irreversible climate change is likely to increase upon an elevation of the average temperature of the Earth by 2°C or more.

## 3. Adaptation to the changing climate

#### Should we adapt to the climate change?

Adaptation to the climate change is inevitable because the past emissions of greenhouse gases are expected to have effects in both the present and the future. Different future climate change scenarios require different adaptation strategies. Understanding the detailed scenarios for the changed climate is fundamental for these strategies.

All environmental conditions will change along the climate change and the entire society has to adapt to it. During this, structural changes should be made in the field of transforming production, consumption and the infrastructure. These "fields" may include: water resources; wetlands, ecosystems; biodiversity, agriculture, forest management and fisheries; energy and transport; tourism and recreation; property insurance and human health.

## 4. Implementation of the strategy

#### Government tasks and social tasks

The NCCS applies to the 2008-2025 period and identifies the tasks in accordance with the international obligations. Government reviews will take place two years after adopting the NCCS, and every five years thereafter. In order to implement the NCCS, the Government will adopt a National Climate Change Programme (NCCP) for a two-year period.

Different means are available to different social groups but it is vital to ensure that the various stakeholders use mutual cooperation and coordinated efforts to assist the implementation of the objectives laid down by the strategy. Table 0.1 shows the means available to the different stakeholders:

Government bodies	<ul> <li>development of an appropriate legal/economic system;</li> <li>review and amendment of the support systems;</li> <li>reinforcement and emphasizing of social awareness raising, showing examples;</li> </ul>
Regions	<ul> <li>elaboration of a regional development programme and concept that takes account of the effects of the climate change;</li> </ul>
General public	<ul> <li>reducing the consumption, and the material and energy uses, increasing their efficiency;</li> <li>life style changes;</li> <li>climate-friendly transport;</li> <li>continuous attention to information about the climate change;</li> </ul>
NGOs	<ul> <li>raising and maintaining the attention of society and decision-makers to the issues related to the climate change;</li> <li>participation in the work of decision-makers, social control;</li> <li>society mobilization, launching actions;</li> </ul>
Local communities, municipalities and churches	<ul><li>showing examples;</li><li>exchange of information and experience;</li></ul>
Business sector	<ul> <li>reduction of the material and energy uses along with increasing the efficiency thereof;</li> <li>making the operation of companies more climate-friendly;</li> <li>making products, services and company profiles green;</li> <li>climate-friendly research and development, climate innovation;</li> <li>assumption of the responsibility by society with a view to protect the climate;</li> </ul>
Media	<ul> <li>raising and maintaining the attention of society and decision- makers to the issues related to the climate change.</li> </ul>

Table 0.1 - Various social players and the means available to them

#### Costs and benefits, economic and social effects

The National Climate Change Strategy will not necessarily reduce but even increase the development potential of Hungary because a change in the international economic environment is predicted in which the "carbon-intensity" of a society and economy will also affect the economic and social success of the given country. Protection against climate change may generate other positive additional benefits, e.g., air emissions may be reduced, which makes the economy "cleaner". The mitigation of emissions and the adaptation may create new jobs in the environmental industry, energy industry, agriculture, transport, construction industry etc.

The income from the Green Investment Scheme (GIS) will be primarily used by the households & institutions sector to finance programmes and investments aiming at increasing the energy efficiency of existing buildings. During its operation between 2008 and 2012, the GIS will generate estimated annual incomes of up to HUF 7.5 billion. The allowances allocated against payment under the Emissions Trading System may generate additional income in an estimated amount of HUF 3.3 to 3.7 billion. Obliging the general public to take some low-investment measures producing net financial profit could result in savings of up to HUF 30 billion per year due to the reduction in energy consumption. The Environment and Energy Operative Programme includes approximately HUF 110 billion for green energy development projects. At an average need for support of 25%, a total investment of HUF 440 billion is expected in the fields financed by the Environment and Energy Operative Programme alone until 2013.

In the field of adaptation, from the preparation of the health care sector to the implementation of the Vásárhelyi Plan, to taking regional population retaining measures, to introducing alternative transport modes, from increasing the drought tolerance of agricultural production to settlement planning solutions, there are several measures with mutually synergistic multiple objectives and with development needs amounting to several hundred billion forints in terms of all income holders, whereas the amount of damage thus avoided is at similar annual levels.

In the framework of the energy-climate package published by the European Commission in 2007, an impact assessment was made to investigate the order of magnitude of the costs of emission mitigation for 2020. On the basis of these assessments, it may be concluded that the costs of delaying actions are always higher than those of timely and coordinated actions. The costs of current emission mitigation and adaptation measures are lower than those of similar measures taken after 2012, or than the buying of emission allowances by Hungary at a later phase.

In addition to producing macroeconomic benefits, the measures of the NCCS enable significant savings in energy consumption by the general public; furthermore, they will strengthen social cohesion, enhance the feeling of safeness by the general public and promote sustainability.

#### Implementation monitoring

In order to monitor the implementation of the NCCS and of the National Climate Change Programme, which is to be prepared on the basis of the NCCS, a set of indexes particularly useful in case of emission mitigation should be developed; moreover, indexes reflecting the climatic efficiency of the economy or the carbon dioxide reduction (e.g., greenhouse gas emission per GDP; emission per capita; energy intensity etc.) should also be introduced. Within the Government, the ministry responsible for environmental issues will coordinate the elaboration and implementation of the programme and will discharge its duties with the participation of the affected ministries. The Government will prepare annual reports on the progress of the implementation of the NCCS to the Parliament.

# INTRODUCTION

"Because the world makes haste, and now it will be brought to a head: Are we worth a life and a future?"

Endre Ady

It has already begun... The global processes that change the climate of the Earth because of the prodigal life style of mankind have begun. If we look at the events of the world, we realize that the number of natural catastrophes (floods, droughts, forest fires etc.) related to the climate change is increasing. Extreme weather events have become more frequent in Hungary as well. The recent years have brought yet undetected extremes and unusual weather conditions that have destroyed a significant proportion of the produce, caused damage to the infrastructure and to material property, and quite often put people's safety and health at risk.

Various members of the scientific community represent different standpoints regarding the time and the extent to which these global phenomena will accelerate. However, both the scientific community and the decision-makers agree that there is no time to ponder the chances. Action is required and as soon as possible. Until there is a realistic chance to avoid the unmanageable.

All mankind is responsible for the current situation, although to different degrees. Irrespective of the relative level of Hungarian emissions in comparison with the total emission of the world, it is of vital importance that Hungary also takes the necessary steps. Also because the Carpathian Basin is considered as highly vulnerable – whatever represents a temperature increase by 2°C in global terms may cause an increase by 3°C to 4°C in Hungary.

The accelerated rate of the climate change affects and afflicts all layers of society. Among others, it affects the economy, transport, agriculture, health care, water resources, built environment and so on. Therefore, everyone should take his/her share in the necessary actions.

Both centrally planned measures and non-centrally proposed initiatives are important for the fight against the risks and effects of the climate change – which affect almost all aspects of our lives – to have a realistic chance.

The Parliament and the Government of the Republic of Hungary consider the protection of the climate as an urgent issue to be solved. Therefore, the Parliament has adopted Act No. LX/2007, which requires the elaboration of a National Climate Change Strategy. The Strategy lays down the frameworks of the measures planned for the period 2008-2025. The concrete measures will be included in National Climate Change Programmes, which will apply for 2-year periods.

The strategy described is not without history. It makes use of the work of the experts of several Government bodies, scientists and NGOs. The objective is to ensure that a proper harmony in the existing Government measures and a mobilisation of all layers of society should jointly act towards protecting the climate. The implementation of the Strategy will only be successful provided that all players and stakeholders take into account climate protection issues in their daily and long-term decisions. In everyday life, when we do not choose the comfort of a car, when we use energy and other resources sparingly, when we, as consumers, think about the extra energy use and extra waste caused by our choices. When the individual stops looking at the world as an endless, utilisable object that never runs short of resources, and tries to limit his/her consumption and emissions and tries to appreciate the goods provided by the Earth.

# 1. FRAMEWORKS FOR THE ELABORATION OF THE STRATEGY

"... whoever wishes to improve the fate of mankind should take some risks."

István Örkény

An overwhelming majority of scientist agree that an increase of the average temperature on the Earth by more than 2°C in comparison with the 1700's would result in – among others – severe regional water and food supply conflicts. In addition, various impact assessments and models foresee an increased risk of certain irreversible changes as a result of the warming, such as an accelerated rate of extinction of various plant and animal species. This scientific agreement also provides the basis for Hungarian climate policies, the main aspects and contexts of which are laid down by the NCCS.

Hungary should also respond to the global warming and climate change, more specifically, on the basis of a dual system of objectives. On the one hand, the effects that enhance the climate change should be reduced. On the other hand, we should make preparations to the already inevitable effects.

1.1. Scientific explanation for the climate change

The climate has been constantly changing throughout the geological periods and the history of mankind, and so does today. On a billion-year scale, the natural variability of the Earth's climate is influenced by the astronomic cycles of the orbit of our planet around the Sun, the changes in the intensity of solar radiation reaching the Earth, the composition of the atmosphere, the continental drift and the volcanic activities. However, over the past 200 to 300 years, mankind – by its activities – has become capable of significantly influencing the climatic system on a local, regional and global level.

The temperature of the Earth is determined by the balance between the amount of radiation energy received from the Sun and that emitted from the surface of the Earth towards the outer space. Various gases in the atmosphere allow short-wave solar radiation to freely pass but absorb long-wave radiation from the Earth's surface. As a result, the lower atmosphere warms and also emits heat-rays thereby retaining the heat in the vicinity of the soil surface. Figure 1.1 shows this phenomenon.

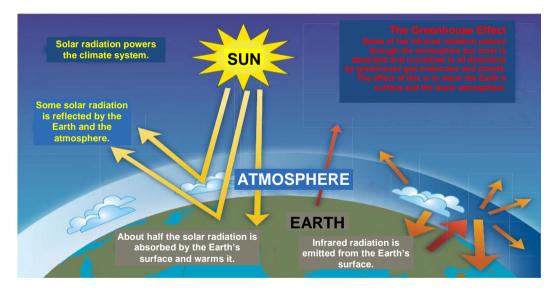


Figure 1.1 - The simplified process of the greenhouse effect. - From: IPCC Fourth Assessment Report, 2007

Greenhouse effect is a natural process without which the Earth's average temperature would be lower by 33°C. The main natural greenhouse gases include water vapour (H<sub>2</sub>O), carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and dinitrogen oxide (N<sub>2</sub>O). Water vapour has the largest contribution to the greenhouse effect but it has a short atmospheric residence time (approximately 10 days). The quantity of water vapour is mostly determined by natural processes and the atmospheric temperatures.

On the contrary, the other three gases are characterised by long atmospheric residence times (10 to 200 years) and the input and output rates and thus their atmospheric levels are more determined by human activities. Since the industrial revolution, the fossil fuel uses by mankind and the increasing agricultural production have caused an increase in the emissions of all greenhouse gases with long residence times. In addition to natural greenhouse gases, artificial greenhouse gases including fluorinated hydrocarbons (HFC-134a), perfluorocarbons (HFC-23) and sulphur hexafluoride (SF<sub>6</sub>) are also emitted by certain industrial activities. Depending on their radiation characteristics, molecular weight and atmospheric residence time, greenhouse gases have different contributions to global warming. Table 1.1 shows the atmospheric residence time (lifetime) and greenhouse effect of various greenhouse gases.

Greenhouse gas	Lifetime (years)	GWP for Given Time Horizon			
_		20-yr	100-yr	500-yr	
CO <sub>2</sub>	variable	1	1	1	
CH <sub>4</sub>	10.8	67	23	6.9	
N <sub>2</sub> O	114	291	298	153	
HFC-134a	14	3,830	1,430	435	
HFC-23	270	12,000	14,800	12,200	
SF <sub>6</sub>	3,200	16,300	22,800	32,600	

 Table 1.1 – Atmospheric residence time (lifetime) and Global Warming Potential (GWP) of various greenhouse gases. – From: IPCC Fourth Assessment Report, 2007.

Human activities also have other effects on the climate. Energy generation, industry and transport represent further sources of smaller or larger particulate matter floating in the air, i.e., aerosol particles. These particles reflect some of the incoming solar radiation towards the outer space, which results is a cooling effect. They may have significant influence in highly polluted areas but unlike greenhouse gases, they do not accumulate in the atmosphere because as a result of the gravitational force and downward airstreams, they are eliminated within a few weeks through dry sedimentation or through wet sedimentation via the precipitation. Moreover, human activities that change the surface of the given area also influence the radiation balance because different types of surfaces reflect the incoming solar radiation to different degrees. Such activities include agriculture and deforestation.

Air samples taken from ice borings suggest that before the industrial revolution, the atmospheric concentration of carbon dioxide did not exceed 300 ppm (as expressed in pars per million units); however, this concentration was 381 ppm in 2006, which is the highest concentration of the past 650,000 years. Studies revealed that the level of methane in the atmosphere has doubled and that of dinitrogen oxide has increased by 20% since the industrial revolution. Nevertheless, when studying the climate change of the present period it is essential to keep in mind that factors for concern include not only the extent of global warming in the past 100 years and in the period until 2100 but also the fact that this change by several degrees occurs within a few centuries, i.e., by 50 to 100 times quicker than during the previous geological periods.

#### 1.1.1. Trends

Temperature records indicate that the Earth's average temperature has increased by 0.7°C since the beginning of the previous century. Since the first recordings in 1861, each of the ten warmest years has occurred after 1990. The warmest year ever was 1998, but 2005 was also close to hit the record.

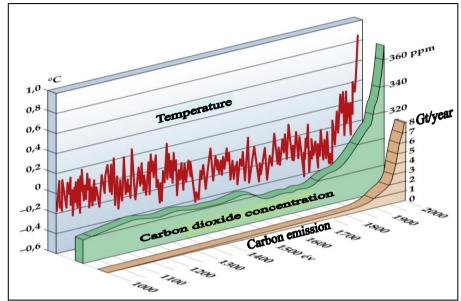


Figure 1.2 – Temperatures, CO<sub>2</sub> levels and CO<sub>2</sub> emissions in the past 1000 years.

According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) published in 2007, snow coverage in the northern hemisphere has shrunk by 10% since the 1960's, and glaciers have withdrawn in most parts of the world. Ice in the Arctic Sea has thinned by 40% in the late summer periods of the past decades, and its size has reduced by 15% since 1950. According to the most recent estimates, the reduction of the sea ice coverage was 8% in the last decade alone. Although sea ice melting does not result in increased sea levels, the disappearance of the ice layer promotes the flow of continental ice into the ocean, which in turn contributes to the elevation of sea levels and modifies the radiation reflection capacity of the surface. While ice surfaces reflect approximately 90% of the incoming radiation, ocean water reflects just above 10%.

The extent of global warming has shown regional differences. Temperature elevations have been greater above the continents and even greater at the higher latitudes of the northern hemisphere (to the north). Since the mid-1970's, the rate of temperature increase in the arctic region has been twice as that of the global average and average temperatures in Alaska have also been warming at a particularly rapid rate in the past two decades, which has had a dramatic effect on the environment, flora and fauna, and human societies.

In the 20th century, sea levels have elevated at an annual rate of 1 to 2 mm mostly as a result of the heat expansion of the oceans and glacier melting. Over the past decades, a number of plant and animal species withdrew to the north, towards the poles. Observations suggest an earlier timing of plant blooming, earlier arrival of migrating birds, earlier onset of the nesting period of certain birds and earlier appearance of insects in most areas along the medium and higher latitudes of the northern hemisphere. In many areas, insects and pests manage to survive the winter much easily.

For the past 10 years, several dramatic floods have been reported throughout Europe. The summer of 2003 was probably the hottest of the millennium that killed more than 35,000 people in Europe. One research project suggests that the probability of such an exceptionally hot summer was twice as a result of the presence of greenhouse gases, and such summers are expected in every third year by the middle of this century. The Fourth IPCC Assessment Report states more positively than ever that human activities are responsible for the accelerating global warming.

## 1.1.2. How will the climate change in the future?

All of the different emission scenarios defined by the IPCC foresee an elevation of the global average temperature in the 21st century. According to the scenario predicting the largest changes, the average temperature of the Earth may be up to 6.4°C higher in 2100 than the average temperature of the 1980-1999 period. In comparison with the same period, the world sea levels will rise by 0.2 to 0.6 metres by 2100 because of the heat expansion of the ocean water resulting from the warming alone. The warming caused by human activities and the resulting elevation of the world sea levels will continue during the 21st century even if we maintain the level of greenhouse gas emissions.

The frequency of sudden and possibly irreversible changes will also increase and these may have serious consequences. Such changes may include:

- melting of the snow covers of Greenland and the Western Antarctica, which may result in an elevation of the world sea levels by up to 12 metres;
- the intensity of the North Atlantic Current, which exerts a cooling effect of 2°C to 3°C in the European region, may decrease;
- the currently frozen northern marshlands may become emitters because methane would be released from the hitherto frozen ground as a result of a melting.

In addition to predicting an increase in the frequency of extreme weather events along with the climate change, social conflicts are foreseen as an indirect effect. The regions of the world that are particularly afflicted by the climate change include states that already have weak control and problem solving capacities. This way, the climate change leads to a further expansion of weak and fragile statehood and increases the probability of violent conflicts.

The climate change will present detectable economic costs, especially for the developing countries: the regression of the agricultural production, the extreme weather events and the resulting migration will all hinder economic development. The climate change will sharpen the deficiency of resources, which may lead to a migration towards the regions with more favourable characteristics.

## 1.1.3. Future climate in Hungary

Along with the global course of the climate, clear changes can be demonstrated in the temperature and precipitation conditions of Hungary. Figure 1.3 clearly shows a dramatic increase – by  $2^{\circ}$ C to  $3^{\circ}$ C – in the daily maximum temperatures over the past three decades (1975-2004). The decreasing tendency of the annual total precipitation is also clearly indicated by the results of the investigations.

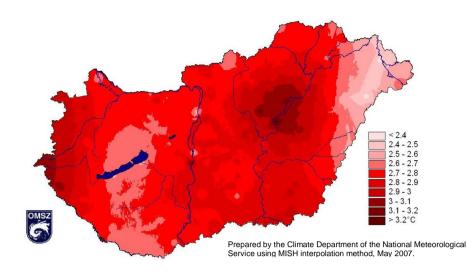


Figure 1.3 – Maximum summer temperatures between 1975 and 2004. – From: National Meteorological Services

The predicted changes in Hungary will equally affect natural ecosystems, forests, agriculture, water management and human health. The PRUDENCE<sup>1</sup> Programme of the European Union provided an opportunity to generate a more detailed estimate of the predicted temperature and precipitation changes in Hungary for the 2071-2100 period (reference period: a 30-year period between 1961 and 1990). Although the model calculations include uncertainties, they may provide opportunities for conducting open integrated studies in Hungary and in the entire Carpathian Basin. Table 1.2 shows the results of these simulations.

Temperature (°C)	Annual	Winter (DJF)	Spring (MAM)	Summer (JJA)	Autumn (SON)
Mean	1.4	1.3	1.1	1.7	1.5
SD	0.3	0.3	0.3	0.4	0.3
Median	1.3	1.3	1.1	1.6	1.5
Precipitation (%)	Annual	Winter (DJF)	Spring (MAM)	Summer (JJA)	Autumn (SON)
	Annual -0.3				
(%)		(DJF)	(MAM)	(JJA)	(SON)

 Table 1.2 – Climate change in Hungary corresponding to an average global warming by 1°C. – From:

 PRUDENCE<sup>1</sup>

PRUDENCE (Predicting of Regional Scenarios and Uncertainties for Defining European Climate Change Risks and Effects) is a

The figures in the table represent data corresponding to a global average warming by  $1^{\circ}C^{2}$  and demonstrate the seasonal temperature and precipitation changes expected in Hungary in case of a warming by  $1^{\circ}C$  on a global level<sup>3</sup>.

The annual total precipitation of Hungary associated with a global warming by 1°C is practically unchanged; both some increase and some reduction may occur. However, the temporal distribution of the precipitation shows considerable differences. A significant reduction in summers and a similarly significant increase in winters are observed. The estimates provided by different models for the transient seasons are not so clear; some indicate a reduction in the area of Hungary, others indicate an increase. Figures 1.4 and 1.5 show the seasonal temperature changes and the standard deviations.

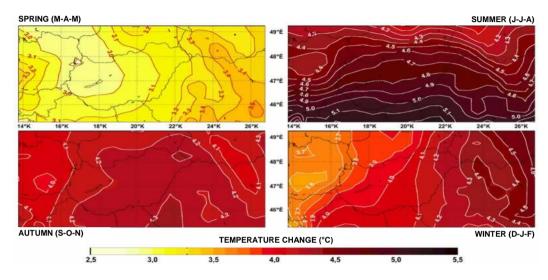


Figure 1.4 – Seasonal temperature changes (°C) for the area of the Carpathian Basin for the 2071-2100 period, as indicated by the results of the European regional (50-km grid resolution) climate modelling applied in the PRUDENCE Project.

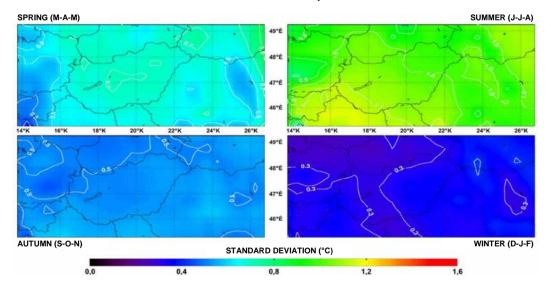


Figure 1.5 – Standard deviations of the seasonal temperature changes (°C) for the area of the Carpathian Basin for the 2071-2100 period, as indicated by the results of the European regional (50-km grid resolution) climate modelling applied in the PRUDENCE Project.

<sup>&</sup>lt;sup>2</sup> The extent of global warming in 2006 was 0.7°C since the industrial revolution.

The global warming by 1°C is expected to occur in 2025.

Therefore, unequivocal warming is predicted in all seasons with the highest rate (4°C to 5°C) in summer and the lowest (3°C to  $3.5^{\circ}$ C) in spring. The extent of the temperature elevation increases from north to south and from west to east in summers and winters, respectively. The models suggest that the highest (0.9°C to 1.1°C) and lowest (0.3°C) standard deviations are observed in summers and winters, respectively; that is, weather forecasts are associated with significantly higher uncertainties in summers than in winters (Figure 1.5).

The changes of rainfalls and snowfalls show opposite tendencies in different seasons. However, what appears to be certain is that the changes in the amount of precipitation may even exceed 30% to 35% both in summers and winters. In summers, the extent of precipitation reduction increases from north to south. The increase in the winter precipitation rates will be the highest in the north-western part of the country. Figure 1.6 shows the seasonal variation of the amount of precipitation.

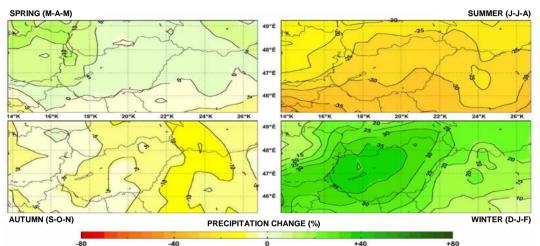


Figure 1.6 – Seasonal variation of precipitation (%) for the area of the Carpathian Basin for the 2071-2100 period, as indicated by the results of the European regional (50-km grid resolution) climate modelling applied in the PRUDENCE Project.

The models suggest that the average intensity of precipitation will increase. While the number of rainstorms and other "high intensity precipitation events" is expected to increase, "low intensity precipitation events" will be rarer. On the other hand, rainstorms will be more frequent and this will increase the risk of sudden flood waves. The analysers of the programme predict that the water level in the rivers of Hungary may decrease to 50% of the current levels in summers. Groundwater levels will also decrease in the absence of appropriate supply, especially in the valleys and low elevation areas such as the Great Plain.

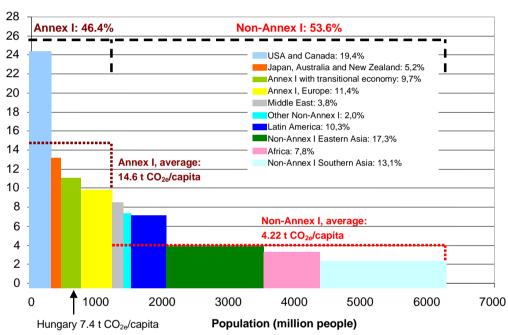
The possible answers to the expected climate change and the adaptation challenges are described in detail in Chapter 4.

12. International obligations The fight against climate change can only be successful by global cooperation. This cooperation is embodied by the United Nations Framework Convention on Climate Change (UNFCCC), which was signed in 1992 and provides the highest level framework of action and harmonization for the international cooperation. In the Framework Convention, the developed, industrialised countries have made a commitment to keep their greenhouse gas emissions in 2000 below the 1990 levels and to keep records of their greenhouse gas emissions.

Already in the 1990's, the commitment made in the Framework Convention appeared unsatisfactory for addressing the climate change problems. This recognition gave rise to the Kyoto Protocol in 1997. In the Protocol, 38 countries with developed or transitional economy made the commitment to reduce their emissions by an average of 5.2% by 2012 in comparison with the base year of 1990.

The Kyoto Protocol came into force on the 16th of February 2005, in which the EU-15 already made the commitment for an average reduction by 8% and Hungary undertook to make a reduction by 6%. At the time of signing the Kyoto Protocol, Hungary took the average of the years from 1985 to 1987 instead of the general base year of  $1990^4$  as the basis for its emission mitigation commitments. In this period, the quantity of greenhouse gas emission was as high as 113 million tons which was reduced to 76 million tons by 2005.

In addition to implementing the commitments for 2012, the Framework Convention and its Protocol laid down criteria for the steps to be taken after 2012 as well. On the basis of these criteria, three negotiation processes were started in November 2005 in relation to the emission mitigation commitments after 2012, expected to be completed in 2010. The main objective of these negotiations is to enrol the countries that have joined the Protocol but – in the absence of a parliamentary approval – are not subject to the obligatory reduction targets into the international climate protection efforts. Moreover, developing countries with considerable greenhouse gas emissions should also undertake emission mitigation objectives according to their capabilities.



t CO<sub>2e</sub>/capita

- Annex I countries with transitional economy: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland Romania, Russia, Slovakia, Slovenia, Ukraine
- Annex I, Europe: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxemburg, Holland, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom

Figure 1.7 – Greenhouse gas emission per capita in different groups of countries in 2004 – From: Fourth IPCC Assessment Report, 2007.

Figure 1.7 shows the average emission data from various regions of the world and indicates that the Annex I countries (countries with developed or transitional economy) representing 20% of the global population were responsible for 46% of the global emissions in 2004 with an average emission rate of 14.6 tons per capita per year, while other countries had an average emission rate of 4.2 tons per capita per year.

<sup>4</sup> 

In accordance with the principle of equity of the Framework Convention, each country could apply different base years. Accordingly, Hungary as a country with a transitional economy chose the average of the years from 1985 to 1987 as its reference period.

It also shows that Hungary, as a small economy, has a negligible contribution to the total emission; however, the emission rate per capita is above the world average and we should thus undertake a reduction above the average in accordance with the principle of responsibility.

### 1.3. The climate policy of the EU

In the Kyoto Protocol, the European Union made a commitment for an average emission reduction by 8% by 2012 in comparison with the base year of 1990, which collectively applies to the EU-15 countries. The extent to which individual Member State should contribute to the collective commitment was laid down by a so-called Burden Sharing Agreement. This joint commitment provided the basis for the frameworks of the EU's climate policy.

The European Climate Change Programme was launched in 2000 with the main objective of elaborating the appropriate strategy for meeting the objectives of the Kyoto Protocol and provides assistance for the development of the system of tools for the emission mitigation efforts. As a result of this programme, the EU introduced an Emissions Trading Scheme (ETS) in 2005. In addition, the recommendations of this programme were the basis for the new Community legislation (Regulation 842/2006/EK) introducing restrictions and controls for the emissions of fluorinated hydrocarbons, which are also greenhouse gases.

Of course, under the Kyoto Protocol, emission mitigation targets individually undertaken in 1997 and not the collective EU commitment of 8% will apply to the Member States having joined the EU after 2004.

## The energy policy and climate change "package" of the EU

At its meeting in spring 2007, the Council of the European Union discussed the energy policy and climate change "package" proposed by the Commission and adopted conclusions that at international negotiations, the EU will promote the objective of reducing the greenhouse gas emissions of the developed countries by 30% by 2020 in comparison with the base year of 1990. In addition, the EU set a separate objective according to which it would undertake to mitigate its greenhouse gas emissions by at least 20% by 2020 in comparison with 1990 levels even in the absence of establishing the international framework scheme. Furthermore, in case of developing an overall global emission mitigation framework scheme, the EU is even willing to undertake a 30% emission reduction by 2020. The energy policy package adopted in March 2007 serves both the implementation of this reduction and the improvement of the energy safety of the EU, and in the framework thereof the following objectives were set for 2020: 20% of the total energy consumption of the EU would be satisfied from renewable sources, 20% energy saving would

be achieved in comparison with 1990, and the ratio of biofuels would be increased to 10% in case of liquid fuels.

The 10 percent commitment applies to all EU Member States; however, as regards greenhouse gas emission mitigation, renewable ratio and energy efficiency, the commitment is a common, Community level commitment that will be distributed among the Member States in the form of a Regulation.

A proposal concerning the distribution of the above commitments between the Member States was published by the Commission on the 23rd of January 2008. For the sectors participating in the EU Emissions Trading Scheme, the Commission proposes a 21% reduction by 2020 in comparison with the emissions in 2005, without differentiation by Member States. As regards other sectors, the efforts expected from individual Member States are again indicated by the proposal in comparison with the emissions in 2005. Emission mitigation in these sectors was distributed among the Member States according to the GDP per capita; therefore, Hungary may still increase its emissions by 10% until 2020 in comparison with 2005. At the same time, these sectors also participate in the emission mitigation efforts of the EU, by contributing to the elaboration of a Community legislation directly or indirectly related to the combat against the climate change (e.g., Regulation on the carbon dioxide emission of vehicles, Directive on the quality of fuels etc.).

As an important step in the climate policy of the EU, the first draft on adaptation was adopted by the Commission on the 29th of June 2007and was released in the form of a Green Paper for public debate in Brussels. The most important element of this is the principle of integration. According to this, the climate policy should be integrated into the development policy, that is, it should be the central element of the cohesion policy. In other words, the interventions related to the climate change should not be planned and implemented independently but in an organic unity with other plans and developments financed from Community funds. (Extracts from the document: "Global warming is a fact. Climate change is happening and it is even accelerating. What we are seeing today are only the early signs of climate change and the result of past greenhouse gas emissions. Europe needs a wake-up call to prevent that climate change takes catastrophic dimensions later this century.")

The mission of the NCCS is to express the concerns for the present and future generations, and to reflect Hungary's global, Community and national responsibility in the combat against the climate change. It should contribute to the transition of the country to a more climate-friendly and sustainable development path, to the improvement of competitiveness, and to the improvement of people's safety and quality of life, while taking account of the natural, social and economic characteristics of the country and the challenges of falling into line with the developed countries (EU).

### 1.4 Mission and future image of the National Climate Change Strategy

## Future image for 2050

#### On a global and Community scale

On a global scale, there is theoretical agreement on greenhouse gas emission mitigation and the developed countries will have to reduce their emissions by 60% to 90% in comparison with the 1990 emission levels. Also, there is a wide international agreement on providing financial support and technological transfer for the developing countries in order to ensure a cost-efficient implementation of the emission mitigation measures and to gain extra emission quotas in exchange.

The EU has a common policy for the actions against the climate change and Community-level policies are in force in all related policies. As regards energy supply, a completely liberalised, uniform market will be established in which strong national/Community intervention will be applied in order to prevent the climate change. This will make energies generated at various places and in various ways available to the all EU Member States and will ensure a cost-efficient emission mitigation in the energy supply.

The EU will play an active role in the more climate-friendly transformation of the less developed countries and will also provide financial and technological support for this. It will thereby ensure that only low emission technologies with low specific raw material and energy needs are applied in the developing countries.

#### In Hungary

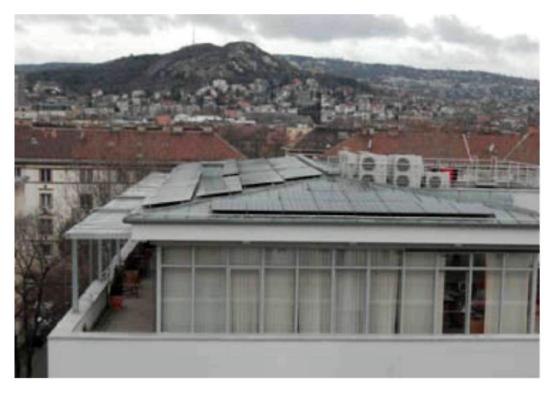
The greenhouse gas emission rate per capita does not exceed the ecologically sustainable level. As a result of the energy efficiency improvements and energy savings, Hungary's current electricity consumption rate will be reduced by 70% and only 5% of the current heat consumption will be required to ensure pipeline hot water supply and the operation of other industrial processes.

Almost 40% of the homes will be operated without greenhouse gas emissions. The emissions from buildings without passive energy systems will also be decreased by 75% as a result of the modernisations carried out in order to reduce the energy consumption.

Owing to the future changes in the transformation of the transport, non-motorised forms and public transport will have more priority. In addition, motorised vehicles will be modified and will be characterised by lower specific consumption rates which will result in drastic reductions in greenhouse gas emissions and vehicles with innovative technologies will come into general use in both personal and public transport.

Industrial greenhouse gas emissions will also decrease significantly as a result of the lower energy needs and lower specific raw material consumption rates.

In agriculture, integrated and ecological farming with low chemical uses will become predominant. By the implementation of the National Afforestation Programme, Hungary's forest coverage will increase to 27.4%.



Picture 1.1 Solar panel system in Újbuda

# 2. BASIC PRINCIPLES AND PRIORITIES OF THE STRATEGY

"There is enough in the world for everybody's need, but not enough for anybody's greed."

Mahatma Gandhi

The NCCS was prepared on the basis of the following **basic principles**:

- **Principle of sustainability:** the measures of the strategy take account of the living conditions and the conditions of satisfying the needs of the future generations.
- **Systems theory:** the strategy interprets the climate change in a dynamic system of the driving forces causing the environmental changes, impacts, conditions, effects and responses.
- **Principle of precaution:** in case the effects of the climate change, i.e., human, natural and socio-economic losses become reality, the strategy foresees the introduction of appropriate precautionary measures even if currently no scientific evidence is available for a clear causal relationship or for the extent of the losses.
- Principle of common but differentiated responsibility: the global nature of the climate change requires the widest possible cooperation of all countries and their participation in an efficient and appropriate international action according to their capabilities and social and economic conditions.
- **Principle of solidarility:** it is based on the fact that each individual and society are interdependent upon each other by their nature and in an active manner, therefore, it emphasises the role of mutual commitments and assistance.
- **Principle of prevention:** it is a general and proven principle that the costs of preventing changes associated with losses may be lower by several orders of magnitude than the foreseeable expenses related to the remediation of the actual damage.
- **Principle of decentralisation/regionalism:** the implementation of the measures related to the climate change and the distribution of the responsibilities and competences should be based on the principle of subsidiarity, that is, all decisions should be made on the lowest possible level where optimal informedness, decision responsibility and the consequences of decisions are best visible and enforceable.
- **Principle of environmental equity:** equal access to public environmental goods and a healthy environment should be ensured to everyone without discrimination on the basis of age, sex, ethnic origins and socio-economic status, and the burden from any environmental damage and the costs of the remediations should be equitably distributed among the various stakeholders.
- Preventing the transfer of environmental impacts: only measures that do not cause comparable environmental impacts in other environmental and natural systems and regions can be adopted.
- **Principle of integration:** safeguarding of the environment is an integral part of all sectoral policies. Accordingly, the criteria and guidelines of the climate change strategy should be integrated into all national government strategies, plans and programmes the activities of which may be directly or indirectly related to the climate change.

According to the principle of integration:

- 1. the climate policy should be integrated into the development policy;
- 2. the climate change should be made the core and organisational force of the cohesion policy;
- 3. the preventive and adaptation measures should be organically integrated into the existing and ongoing legislative activities, development projects, Community-funded operational programmes and action plans;
- 4. for the ongoing developments, climate sensitivity assessments should be performed (the development should be in harmony with the emission reduction and adaptation criteria);
- 5. climate research should be integrated into other scientific studies and research activities;
- 6. both society and the business sphere should be involved in the shaping of the climate policy;
- 7. new social, economic, technological and development directions should be sought;
- 8. when implementing development ideas that affect the climate policy, the principles of decentralisation and regionalism should be applied.

Accordingly and upon preliminary consultations with the professional, social, nongovernmental and environmental organisations, the **priorities of the NCCS** are as follows:

#### Full compliance with the international obligations

The National Climate Change Strategy (NCCS) identifies the directions for Hungary's mid-term climate policy for the 2008-2025 period and was prepared pursuant to §3 of Act No. LX/2007 (V. 28.) on the framework for the implementation of the UN Framework Convention on Climate Change and of the Kyoto Protocol thereof. Complete fulfilling of the international commitments taken by the Republic of Hungary will determine the international reputation of the country (particularly by the European Union); therefore, meeting the objectives of the strategy should be interpreted (in addition to being of universal human interest) as a national interest that will have a long-term impact on both the political and economic relationships of the country and the individual life styles and prosperity of the citizens of Hungary.

#### Fighting against the driving forces of the climate change

Instead of the insufficiency in our technical knowledge, the distortions in our social values and behaviour are the fundamental causes of the climate change. As long as people do not assign value to the basic human living conditions, such as clean air, soil and drinking water, and take the usual life circumstances (including given characteristics of the climate) for granted, and as long as they are unaware of the consequences of the climate change, they will not change their habits and life styles. Without the required shift of approach and awareness from the part of citizens, the civil and the business sector, the combat against the climate change and the strategy – well-substantiated though it may be – may only produce partial and limited results and may become unsuccessful in terms of reaching its objectives. Therefore, among the decisive factors of the value-based politics and public policy-making, the protection of natural resources and the ideas of sustainable development should be given priority and should be regarded as guidelines during the implementation of the NCCS.

In order to change the approach of citizens and business operators, comprehensive social debate should be initiated and citizens should be clearly told that the catastrophe of the climate change may only be avoided if they change their production and consumption habits. In addition to keeping people informed in this field, they should be convinced to participate in the fight against the climate change.

Individual companies and the entire business sphere could also have a considerable contribution to the combat against the climate change. For this very reason, dialogues should be initiated with companies, and partnerships should be established between and together with the business sphere and the government agencies and local municipalities involved in the climate change strategy, jointly working to create a new "green" and/or "sustainability social contract". In order to strengthen the sense of responsibility by the business sphere, it is essential that the current practice of corporate social responsibility (CSR) be modified in accordance with the strategy of fighting the climate change.

#### **Emission mitigation**

The basic means of limiting the risk of the climate change is to mitigate the emissions of greenhouse gases. In order to achieve this, emissions should be efficiently and really mitigated particularly in the energy sector, industry, transport, agriculture and waste management. The households & institutions sector also have significant emission mitigation potentials given that the households sector has been hardly affected by prior and current emission mitigation measures and also because this sector is responsible for about one third of the total emissions.

Basically, the activities directed at mitigating the emissions should be implemented in an order reflecting their cost-efficiency; the application of this principle will ensure reaching the highest rate of emission mitigation on a given cost level.

#### Adaptation to the climate change

Even if a significant mitigation of the greenhouse gas emissions is achieved, the Hungarian society will have to bear the unfavourable effects of the already developed climate change resulting from the human activities of the past decades and centuries. Although to different degrees, the increasing effects of the climate change will affect the entire territory of Hungary, almost all layers, all citizens and all businesses of society. The adaptation to the effects of the climate change applies and should be interpreted as applying to both the members of the Hungarian society and the natural flora and fauna of the country. Primarily, the NCCS makes an inventory of the effects on the natural flora and fauna, the human environment, as well as on human health, water management, agriculture, forest management and the built environment.

# 3. MITIGATION OF THE CLIMATE CHANGE

"Nature is vast, man is tiny. Therefore, the existence of man depends on the relationship he can establish with Nature, on his understanding of Nature and on the way he uses its forces for his own benefit."

Albert Szent-Györgyi

The means of limiting the risk of the climate change is to mitigate the emissions of greenhouse gases. Considerable mitigation of the future greenhouse gas emissions can only be achieved by a global cooperation. Therefore, Hungary should take its share in the combat against the climate change even if the contribution of the country to the climate change is very low on a global scale. A global climate policy scheme will not only entail emission mitigation commitments but will also transform the incentives of the global economy and should also create an economic environment under which economic development inevitably involves mitigation.

**3.1.** As far as climate protection is concerned, Hungary is in a contradictory situation similarly to the other former socialist countries of the region. The level of greenhouse gas emissions is much lower than before the 1990's, the period serving as the basis for the international climate protection commitments. On the other hand, the relatively favourable situation is not a result of a high level of climate awareness but of the elimination of the socialist heavy industry and the structural transformation of the economy.

In the region, Hungary has one of the best indexes in terms of emissions per capita. In the Kyoto Protocol created in the framework of climate protection, Hungary made a commitment for mitigating the annual emissions of the gases causing global warming by 6% between 2008 and 2012 in comparison with the average emission levels between 1985 and 1987. On the basis of the data of the National Greenhouse Gas Emission Inventory, the current emission levels in Hungary are 24.6% lower than its Kyoto commitment according to the latest data for 2005.

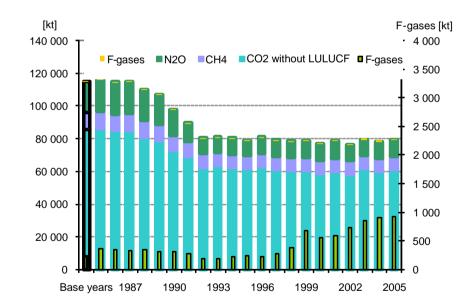


Figure 3.1 shows the future greenhouse gas emissions by Hungary.

Figure 3.1 – Changes in the greenhouse gas emissions (expressed in CO<sub>2</sub> equivalent) without absorption by carbon dioxide sinks. From: National Greenhouse Gas Emission Inventory, 2007.

The emission trends suggest that greenhouse gas emissions in Hungary have remained essentially unchanged particularly since the collapse of the heavy industry in 1992.

- Carbon dioxide (CO<sub>2</sub>) emissions arise primarily from sources in the energy sector, i.e., from fuel combustion; therefore, the reductions observed since the political changes have been the result of a reduced economic performance and the associated lower rate of fuel uses. Additional factors that caused emissions to reduce include the economic restructuring and the structural changes in the fuel uses: coal, which is less favourable in terms of emissions, has been replaced by natural gas in industrial applications.
- As regards methane (CH<sub>4</sub>) emissions, two antagonistic effects have been observed. One effect is a mitigation resulting from the lower number of live animals; the other is an increase in the emissions, which occurs as a consequence of the increasing use of pipeline gas supply.
- Dinitrogen oxide (N<sub>2</sub>O) emissions have mostly changed in parallel with the changes in agricultural production. Emission levels were significantly reduced in the beginning of the period; this was followed by a slight increase and then another reduction.
- The use of **HFC gases** became more intensive in the second half of the 1990's in relation to the restrictions on the use of freon type coolants. The increase is unambiguous although stagnation has been detected since 2003. The primary cause of this is that the use of HFC gases is losing ground in refrigerator manufacturing.
- **PFC** emissions are mostly associated with aluminium production and their tendencies change in parallel. After a significant reduction in the beginning of the period, a slow but steady increase was observed.
- Sulphur hexafluoride (SF<sub>6</sub>) emissions primarily depend on the uses by the electricity generation sector, and the tendencies change according to the manufacturing/consumption needs but show a steady increase.

The following subchapters describe the sectors with the highest responsibility for the emissions. Figure 3.2 shows the emission tendencies for each sector.

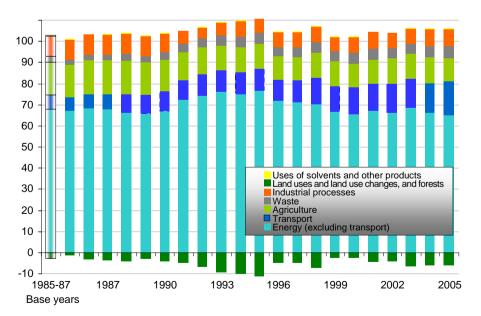


Figure 3.2 – Contribution of each sector to the total Hungarian emissions. From: National Greenhouse Gas Emission Inventory, 2007.

## 3.1.1. Energy

The energy generation sector should play a decisive role in fighting against the climate change and in mitigating the risk of the climate change given that approximately 75% of the greenhouse gas emissions are associated with this sector. When estimating the emissions from this sector, all greenhouse gas emissions from fuels used for the purpose of electricity and heat generation – including those used by households – and from fuels combusted during transport should be taken into account.

The key role of the energy sector is well demonstrated by the 2005 data, according to which almost 81% of the total domestic energy consumption (1,153.2 PJ) was satisfied from fossil fuels. This is extremely unfavourable in terms of both climate protection and energy safety considerations. Namely, Hungary procures more than 77% of the fossil energy carriers from imports. In 2005, renewable energy production represented only a very low percent (4.1%) of the total energy consumption and most of it was achieved in an environmentally non-sustainable manner.

### 3.1.2. Industry

In 2005, the direct energy consumption by the sector was 275 PJ, which corresponds to more than 30% of the total direct energy uses. Industrial energy uses between 1990 and 1997 decreased significantly (by 40%) and then remained unchanged for a few years until a slight increase in recent years.

The fuel structure of the energy consumption is mostly based on natural gas except for the sectors where this option is not available with the given technology (e.g., iron and steel industry). Among fossil energy carriers, natural gas is the most climate-friendly; accordingly, industrial sources are responsible for approximately 34% of the total greenhouse gas emissions.

Structural transformation has been completed in the first half of the 1990's, which resulted in a considerable reduction of the energy uses and emissions. No further essential restructuring is foreseeable in the mid run and endeavours should be rather focussed on preventing the settling of energy-intensive, high-emission sectors. Otherwise, the introduction of energy-intensive forms of production to Hungary may undermine the emission mitigation efforts of the country and thus may place a disproportionately high emission mitigation burden on other business operators and the general public.

In the industry, several energy saving opportunities and thus technological interventions resulting in emission mitigation exist and these are described in the subchapter on energy. Other, non-energetic emission mitigation opportunities (for example, restructuring of the industry, re-using and recycling, using substitute products with lower emissions) are addressed in a separate chapter.

In relation to the structural transformation of the economy, no support should be given to energy-intensive, high-emission sectors that employ few people and satisfy non-Hungarian needs. This means that in granting investment supports, the mid-term extra emission mitigation needs resulting from the implementation of a given facility that increases the level of greenhouse gas emissions should be assessed in order to guarantee Hungary's compliance with its emission mitigation commitments, and whether the proposed facility would still generate financial profit and the costs thereof should also be looked at. Primarily, technologies and sectors characterised by low energy consumption and high added value should be supported, and it should be declared and confirmed by the legislation that only investments in compliance with the above principles can be supported. The Emissions Trading Scheme represents another opportunity for encouraging investments and restricting highly energy-intensive investments.

The maximal utilisation of industrial waste energies, as well as the increasing use of waste and renewable sources to satisfy industrial energy needs should be promoted and encouraged.

## 3.1.3. Transport

Within climate protection, the transport sector is the only one where – similarly to the global trends – energy consumption, as well as the associated climate change intensifying effects will increase in Hungary.

Greenhouse gas emissions will decrease in each sector included in the statistics except for the transport sector where the absolute emission levels increased by 26% between 2002 and 2005 according to the Greenhouse Gas Emission Inventory. According to the inventory, the contribution of direct emissions from transport to the total emissions increased from 6.44% to 16.2% between 1985 and 2005. Similar tendencies have been observed in the European Union, where the contribution of transport emissions is almost twice as high as in Hungary. The ratio of the transport sector in the total energy consumption of Hungary is 21% and represents one of the most important factors in the energy uses of the country.

Within the transport sector, road transport has a ratio of 90% and is thus by far the most important source of emission. Within road transport, personal cars are responsible for more than 50% of the emissions, trucks and freight vehicles for one third and buses and other vehicles for the rest.



Picture 3.1 – The ratio of direct transport emission have increased

As regards transport emissions, it is important to consider the ongoing restructuring of transport, which indicates a decrease in more climate-friendly modes of transport and an increased use of more emission-intensive means.

People increasingly use individual means of transport instead of public transport and business operators also tend to replace railroad shipping by road transport.

As a result, specific energy consumption rates increased by 15% and 20% in personal transport and freight carriage, respectively, within a decade before 2000. Currently, the ratio of more climate-friendly modes of transport is still above the average of the EU-15 and provided that this restructuring tendency proceeds and "reaches" the ratio of the older Member States, a further 20% to 35% increase of the specific emission levels is expected.

In 2005, Hungary had 280 personal cars per 1,000 population, which is the third lowest among the EU-27 countries; in the EU-25 countries, the number of personal cars per 1,000 population is 463. All this suggest a further increase in the number of personal cars per 1,000 population in the future.

The structural transformation of the transport sector and the increasing number of personal cars are expected to entail much higher emission increases in the transport sector than in the EU-15 countries and other developed countries. It is exemplified by the situation of the western economies that it is very difficult to motivate a shift in the restructuring towards public transport from the direction of an already established car transport; therefore, it is highly important to at least maintain the current structure.

As a result of the technological advances in transport, specific carbon dioxide emissions have been reduced significantly, however, these achievements are overridden by the increasing number of cars and kilometres driven. The current emission tendencies may only be successfully and permanently changed by comprehensive measures taken on the level of the transport policy.

### 3.1.4. Agriculture and forestry

The agricultural contribution to the greenhouse gas emissions of the country is 11.2% and methane and dinitrogen oxide represent 24.3% and 67.7%, respectively, of these emissions.

On the other hand, the land use changes and the forests serve as sinks for almost 6% of the total emissions and almost 8% of the total carbon dioxide emissions. The net annual quantity of carbon dioxide absorbed by Hungarian forests is approximately 4 to 5 million tons, which is not negligible in comparison with the total greenhouse gas emissions of the country, i.e., 80.2 million tons as expressed in carbon dioxide equivalent.

#### 3.1.5. Waste and waste water

In Hungary, waste management and wastewater treatment are responsible for 6% to 7% of the total greenhouse gas emissions. These emissions consist of methane released by the anaerobic degradation of the collected and disposed municipal (and industrial) wastes or generated during wastewater treatment.

The situation is expected to improve because approximately 2,000 waste disposal sites have to be eliminated until 2009 in accordance with the relevant Community legislation. Recultivation plans have already been prepared for most of these disposal sites, which enables a capturing of the greenhouse gases generated at the abandoned disposal sites and thus an opportunity to avoid the associated atmospheric emissions of methane and to utilise it as an alternative source of energy.

Similarly, the methane generated during wastewater treatment could also be used as an alternative energy source. Due to feasibility considerations, this will mostly be possible in larger cities. One good example is the Northern Csepel Wastewater Treatment Project, in which the energy needs of the Plant are designed to be satisfied from gas engines driven by the generated methane. These solutions will be available to larger cities and other (wastewater) agglomerations above a population equivalent of 15,000.

Experts suggest that in order to mitigate the risk of climate change with high level of certainty, by 2050 the atmospheric greenhouse gas levels should not exceed 450 ppm. Namely, the greenhouse effect at such atmospheric levels is likely to increase to a level that only induces an average elevation of the global surface temperature by 2°C at most. Scientists believe that such warming should not cause irreversible changes.

Currently, greenhouse gas levels are around 380 ppm, which keeps increasing by 2 ppm every year as a result of the accelerating rate of the rise in the global emissions.

In order to meet the goal, global emissions should be reduced by at least 40% until 2050 in comparison with the 1990 emission levels. In 2004, as a result of the previous poor tendencies in terms of climate protection, the emissions were 25% higher than the 1990 levels. Therefore, if the 2004 emission levels are used as the basis for comparison, then global emissions should be reduced by 50% to 80% by 2050.

## 3.2.1. Emission mitigation objectives

Previously, Hungary's emission mitigation endeavours have been defined by the commitment for a 6% reduction by 2012, as specified in the Kyoto Protocol. After 2012, the developed, industrialised (Annex I) countries, including Hungary, should achieve more significant reductions in their emissions than the global average. This is justified by the current per-capita emission levels and the higher than average level of economic development of these countries, as well as the levels of historical emissions, given that the residence time of greenhouse gases may be up to several hundred years.

The objective of the global emission mitigation efforts is to avoid a climate change that would be of dangerous extent. The probability of achieving this objective essentially depends on the level on which the atmospheric concentrations of greenhouse gases (expressed in  $CO_2$  equivalent) stabilise. The lower this level is, the higher the probability of success will be. Table 3.1 shows the emission mitigation needs corresponding to various gas concentrations. (The burden placed on different groups of countries by the global mitigation objective will largely depend on the principles of efficiency and equity applied when distributing these burdens – this is well reflected by the often quite wide intervals.)

3.2. Future image of emission mitigation

Atmospheric	Region	GHG emission					
GHG level			2020			2050	
450 ppm CO <sub>2</sub> equivalent	Global	+10%			-40%		
	EU25	-37%	-	-30%	-90%	-	-78%
	Annex I	-42%	-	-25%	-93%	-	-79%
	Developing		nt deviation	on from the regions	0	ant deviation ence in all re	
550 ppm CO <sub>2</sub> equivalent	Global	+30%			-10%		
	EU25	-28%	-	-20%	-88%	-	-68%
	Annex I	-29%	-	-16%	-90%	-	-68%
	Developing	Significant deviation from the reference in Latin America, the Middle East and Asia		Significant deviation from the reference in all regions			
650 ppm CO <sub>2</sub> equivalent	Global	+50%		+45 %			
	EU25	-18%	-	-8%	-63%	-	-47%
	Annex I	-14%	-	6%	-76%	-	-48%
	Developing	Deviation from the reference in Latin America, the Middle East and Eastern Asia		most regio America	from the re ons, especia , the Middle Eastern Asi	ally in Latin East and	

Table 3.1 – Emission mitigation intervals using all major regime models, as a percentage change from the 1990 levels considering the scenarios of the 450, 550 and 650 ppm CO<sub>2</sub> equivalent. From: Factors Underpinning Future Action – 2007 update, Ecofys, May 2007.

Different stabilisation concentrations mean different emission mitigation challenges globally. The peaking of the concentrations at a higher level requires lower mitigation, but the risk of an irreversible climate change is higher.

In the future, Hungary has to adjust the climate protection commitments to the objectives of the EU as described in Chapter 1. In March 2007, the presidents and prime ministers of the EU agreed to reduce carbon dioxide emissions by 20% by 2020 in comparison with the 1990 levels. The decision also included that the EU would even be willing to make a commitment for a 30% reduction provided that other countries of the world with significant emissions undertake to achieve an appropriate level of mitigation. As yet, no decision has been made on the period after 2020, but the prime ministers foresee a reduction target of 60% to 80% for 2050.

For the EU Member States collectively, in order to achieve the emission mitigation objectives that take account of the entire range of greenhouse gas emitting sectors, individual Member States make different commitments, which will be laid down in the so-called Burden Sharing Agreement. Within the Burden Sharing Agreement of the EU, several methods exist for the distribution of the emission mitigation objectives of the Member States, and on the basis of these, an interval may be defined within which the emission mitigation objectives should be identified. When identifying the emission mitigation objectives, the mitigation requirement predicted for the implementation of the long-term emission mitigation needs (2°C) should be taken into consideration.

For Hungary, it can be posited that an emission mitigation commitment significantly exceeding the EU average would hinder the country in catching up with the Community average in terms of economic development. However, by the early and gradual introduction of the emission mitigation efforts, a subsequent shock effect that may accompany a relatively sudden mitigation requirement can be avoided. Per-GDP emission rates also indicate additional, yet unexploited opportunities for not too expensive emission mitigation opportunities.

Accordingly, the target greenhouse gas emission reductions for Hungary for 2025, i.e., by the end of the current NCCS period, can be summarised as follows:

- in case of a unilateral mitigation by 20% by the EU: reduction by 16% to 25% from the 1990 level;
- in case of a comprehensive global framework scheme, that is, in case of a EU target of 30%: reduction by 27% to 34% from the 1990 level.

In case of realising the conditions for the 30% emission mitigation target set by the EU, Hungary may need to buy emission offset allowances in addition to using domestic means in order to achieve its emission mitigation target for 2025. In the developing countries, the trading in emission quotas derived from more cheaply implemented emission mitigations is already in operation. Provided that the negotiations related to the international framework scheme for the period after 2012 are successfully concluded, a state purchase programme should be established still before 2012 in order to ensure that it will gather appropriate experience before starting to purchase the necessary emission quotas after 2012.

### 3.2.2. Towards a lower-carbon economy

The mitigation of the emissions and the associated redirection towards a more climatefriendly and sustainable development path will not reduce economic competitiveness but, on the contrary, will improve it. Reducing the emissions will also mitigate the socalled carbon-intensity of the economy, that is, a lower-carbon economy will be created. The associated effects on competitiveness include:

- Such economies are characterised by a higher level of energy safety because they are less dependent on imported fossil fuels;
- It is believed that the economic burden caused by the fossil energy carriers will continue to increase in the forthcoming years and decades, therefore, considerable cost savings may be achieved by the operators of a lower carbon-intensity economy if they can make themselves independent of the fossil fuel prices.
- As regards price increases, the exploitation of the resources is expected to peak between the 2010's and 2030's particularly in the case of natural gas and mineral oil.
- An additional factor is the price of carbon dioxide emissions, which already affects certain sectors subject to emissions trading and will most probably increase in the long run. This, in turn, will increase the costs of "carbon-intensive" production and thus reduce the competitiveness thereof.
- Another positive social effect is that the production of renewable energies, which are widely used by low-carbon economies, is often more labour-intensive than the conventional forms of energy generation. Therefore, the conversion will create new jobs.

The redirection towards a path of lower carbon-intensity requires a complete change in attitude. Table 3.2 shows the basic differences between low-carbon and high-carbon economies.

	High-carbon economy	Low-carbon economy		
		tricity		
Energy structure	Electricity is mostly generated from coal, oil and gas	An overwhelming part or all of the generated electricity is derived from low-carbon sources: renewable (wind and solar energy, biomass); carbon dioxide emitting power stations apply carbon capturing and storage; nuclear energy		
Energy efficiency	The efficiency of electricity generation is low and the energy co-generation opportunities are not fully exploited	The efficiency of energy generation is high, and the exploitation of the energy co-generation opportunities will be further extended in parallel with the headway of decentralised electricity generation		
Energy saving	Electricity suppliers are interested in selling as much electricity as possible	Electricity suppliers are interested in selling environment-friendly energy and in reducing the electricity consumption rates		
	Indu	ustry		
	The ratio of energy-intensive sectors is significant in the structure of the economy	The structure of the economy shifts towards less energy-intensive sectors as a result of the transformation of the consumption structure and the reuse of the wastes from materials requiring high specific energy input for their production.		
Energy efficiency	Individual products are produced by technologies with relatively high specific energy consumption in comparison with the Best Available Technique	During the production of individual products, the exploitation of the energy saving opportunities is of primary importance		
Utilisation	In designing products and production processes, no emphasis is placed on the re-use potential thereof	Products will be easier to reuse		
Consumer structure and energy saving by the end-user	When choosing between substitutable intermediers and finished products, the quantities of greenhouse gases emitted during the production phase are not important	In case of inter-substitutable products, the preferred product is the one with a lower greenhouse gas emission, whether during the production or use of the product.		
-	Heat energy			
Energy structure	Heat generation is based on oil, coal and gas	Heat generation is based on low- carbon fuels or technologies, such as biomass.		
Energy efficiency	Heat from other processes and electricity generation will not be used	Heat energy produced by electricity co-generation will become wide- spread		

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	High-carbon economy	Low-carbon economy		
	Heat energy			
Energy saving by the end-user	Buildings are constructed in a manner that requires using and wasting considerable quantities of energy	All new homes are built in a manner requiring much less heating or no heating at all (passive buildings); better planned, micro-scale and community heat generation		
	Most house owners do not invest in the insulation owing to money market and information restrictions, although it would mean an investment with a mid-term rate of return,	Energy audits, a simple service available to all house owners, and reduction of the energy consumption		
	Tran	sport		
Distribution of the various modes of transport	The use of personal cars increases in parallel with the rising income levels, and air transport also increases heavily	People choose more sustainable modes of transport, including an increasing use of local and regional surface public transport means, walking and bicycling		
Distribution of the various modes of transport	The ratio of road transport increases	The ratio of road transport is reduced through conscious planning of the transport needs and choosing sustainable means of transport		
Energy structure	Most vehicles are driven by fossil fuels	Vehicles use low-carbon fuels (electricity and hydrogen in the long run).		
	Fuel suppliers focus on petrol and gasoline	Fuel suppliers establish an infrastructure for the supply of low- carbon fuels.		
Energy saving by the end-user	Consumers prefer cars with a large environmental footprint	Consumers are aware of the environmental footprint of cars and take it more into consideration when making a buying decision.		
	Agriculture			
Type of production	Dominance of chemical fertiliser- and pesticide-intensive, highly mechanised and intensive mass production in large plants	Increasing use of extensive production forms that require less chemicals (i.e., are climate-friendly), and are more labour-intensive		
Market	It produces for the world market and the local market is of secondary importance	The local market is of primary importance: new types of relationships between producers and consumers, the world market is of secondary importance.		
Energy	Mostly related to energy generation systems based on fossil fuels. Water and energy wasting techniques in comparison with the available ones	It uses locally generated renewable energy; Water saving irrigation systems and other energy saving techniques		

Table 3.2 – Future image of high-carbon and low-carbon societies. – From: UK Climate Change Programme, 2006

Basically, the above-mentioned measures should be implemented in an order reflecting their cost-efficiency; the application of this principle will ensure reaching the highest rate of emission mitigation on a given cost level.

Currently, effective emission mitigation could also be achieved by increasing the efficiency of the existing technologies because the various sectors still have significant emission mitigation potentials (e.g., increasing the energy-efficiency of buildings; reducing the carbon-intensity of transport). In addition, the costs of mitigating the greenhouse gas emissions are expected to increase in the long run as a result of the stricter international emission mitigation requirements; therefore, in a longer term, it will be more profitable to carry out investments that would not be worth on a mid-term basis. On the other hand, the following factors may interfere with the strict cost-efficiency ranking and thus should be taken into consideration:

- there are factors (e.g., energy safety) that cannot be quantified on the level of direct costs and benefits, but can be rather regarded as factors of strategic importance that determine the direct costs and benefits;
- current solutions require long-term thinking because the technological and infrastructural solutions providing the basis for the individual solutions can only be implemented in a longer run and, in case of appropriate planning, they may be coupled with the otherwise due renovations of the existing technologies and infrastructure;
- current decisions will exert their effects in a long run, and the already established system has a certain inertia partly because the exchange of the long-term investments will require a longer time to occur and partly because the interests along the status quo can also hinder optimal decision-making at a later phase; in addition, a technology "closing" can evolve resulting in the survival of technologies appearing optimal in the short run but not necessarily competitive in the long run; therefore, when making any decision, its influence on future decision options should be taken into account and decisions entailing good alternatives in a longer run should be preferred.
- attention should be paid to sustainability in a wider sense; therefore, measures that have harmful long-term effects on the sustainability of the environmental and socio-economic processes should be avoided.

There are many opportunities for greenhouse gas emission mitigation in the field of energy generation, transport, agriculture and waste management. These are listed in the following subchapters.

### 3.3.1. Energy generation

In accordance with the future image and target figures of the Energy Policy for 2007-2020, the Renewable Energy Strategy and the National Energy Efficiency Action Plan, the NCCS sets the following objectives to be achieved:

#### STRATEGIC OBJECTIVES

Basically, the uses of fossil energy carriers should be reduced and the energy carrier structure of the Hungarian energy generation sector should be transformed also bearing in mind the considerations of energy safety.

The ecological burden of the country can only be mitigated by reducing the total energy consumption by society. Therefore, absolute energy consumption levels should be maintained in the mid run and then significantly reduced. The basic mid- and long-term goal is to achieve a decoupling of the growth of the GDP from the increases in energy uses.

Large energy efficiency campaigns should be initiated, and both the general public and the institutional energy uses should be encouraged into the direction of savings through influencing consumer behaviour (awareness raising, labelling of energy-saving products, exemplary operation of the government and local municipalities etc.).

The financial policy should be reviewed and transformed (e.g., by eliminating harmful supports, changing the taxation system) according to the climate protection and environmental considerations in order to address the problem and the strategic objectives in an integrated manner.

The state should facilitate and encourage the increase of energy efficiency, and the spreading and use of renewable energy carriers (wind energy, solar energy, geothermal energy, biomass etc.); therefore, the use of renewable energies should be increased from the 55 PJ level of 2006 to 186.4 PJ by 2020 in order to replace fossil energy carriers.

The emissions of the energy sector can be reduced by using the following methods:

- increasing the energy efficiency (reducing specific energy consumption rates);
- increasing energy saving (reducing energy consumption);
- increasing the use of renewable energies;
- using carbon dioxide absorption technologies;
- substituting the fuels, that is, increasing the use of fuels with lower specific emissions.

3.3. Emission mitigation options



#### 3.3.1.1. Energy efficiency, energy saving

Energy consumption by the "end-users" has increased by 1.8% per year since 2000. In the absence of taking appropriate measures, a growing tendency is predicted for the next twenty years although to not such an extent. At the same time, energy efficiency will improve, and above the EU average. This is confirmed by the energy efficiency index (ODEX), according to which between 1998 and 2004, energy-intensity was mitigated by 5% and 11% in the 25 Member States of the European Union and in Hungary, respectively.

The most climate-friendly energy is the energy which has not been produced or used. Accordingly, the most obvious opportunity for emission mitigation is reducing energy consumption. Statistical data show that – although only to a small extent – energy consumption rates have been increasing since the years of the considerable regression following the political changes in spite of the fact that the energy uses per GDP are diminishing, that is, energy efficiency is increasing.

This favourable situation is essentially the achievement of the industry, which has a 18.7% share in energy uses and where the ODEX index was reduced by 22% as a result of abandoning the obsolete capacities and starting up modern production equipment. The energy efficiency of households and the transport sector, which have a share of 35% and 22.5%, respectively, was stagnating in the analysed period. Nevertheless, the energy efficiency of households increased by 25% from the political changes until 1998, basically as a result of modernising the heating systems, and the energy efficiency of the transport sector increased by 20% until 1996, essentially due to the replacement of old vehicles. In the commercial and service provision sector, which represents approximately 20% of the total energy uses, energy consumption is mostly associated with buildings (no calculation is available for this) in addition to transportation. Here again, stagnation is expected.

# Energy efficiency obligations, governmental endeavours

According to the so-called Energy Supply Directive of the EU, Hungary should mitigate its total specific energy consumption by at least 1% each year between 2008 and 2016.

The energy efficiency measures that the government wishes to use are included in Hungary's Energy Efficiency Action Plan. The possible measures include the extension of the eco-labelling scheme applied for refrigerators and washing machines to office machines and cars, as well as the amendment of speed limits in transport. It is expected that state support will be available for the replacement of household machines in the form of tax reductions. Among others, the government wishes to facilitate the establishment of P+R systems in order to promote the use of public transport.

The EU objective of minus 9% in 9 years should not be understood as relating to the total Hungarian energy consumption and only 60% thereof should be taken into account in the calculations. Namely, 40% of the total energy consumption is by sectors falling under the Emissions Trading Scheme of the EU, and this should not be considered because this climate protection initiative also has the aim of increasing the efficiency.

All this means that energy efficiency should be improved by approximately 5% on a national level to meet this objective. In the past 3 to 5 years, the energy efficiency index was improved by 1.7% to 1.8% through state-supported projects alone. According to the expectations of the government, the above-mentioned subsidies of the New Hungary Development Plan (NHDP) will result in a 3% improvement.

Within the National Development Plan, HUF 5.9 billion was allocated for energy efficiency projects between 2004 and 2006. In the relevant programme of the NHDP, HUF 42 billion is allocated for this purpose between 2007 and 2013, and the NHRDP will also grant support for investments facilitating the use of renewable energy sources.

Solutions that arrest the increase in energy uses in the mid term and result in a significant reduction of the energy needs in the long run should be found. Under a given economic structure, two basic methods exist for this: one is to increase the coefficient of efficiency of energy generation and the other is to increase the energy saving by the end-users.

#### > Improving the coefficient of efficiency

The coefficient of efficiency in the power station sector can be improved by increasing the coefficient of efficiency of the existing blocks or by replacing them. Primarily, improvement of the coefficient of efficiency is important in electricity generation, which has the lowest coefficient of efficiency compared to that of the Best Available Technique among the high-emission sectors. The average coefficient of efficiency of electricity generation is 31.8% and this represents a low value also in a European comparison. The coefficient of efficiency of individual electricity generation units ranges between 28% and 79%.

One means of improving the coefficient of efficiency is to build new power stations with high coefficient of efficiency, as well as to apply electricity and heat co-generation, which may result in up to 30% fuel savings in comparison with the separate generation of heat and electricity. The potential for co-generation in new power stations with a better coefficient of efficiency should also be utilised as much as possible, partly by the transformation of the technology and partly by the selection of the site for power stations and heat users.

There is a continuous introduction of new capacities with better coefficient of efficiency. This process is well characterised by the fact that the overall coefficient of efficiency of the electricity generation system in Hungary was improved by 5% between 1990 and 2005. The replacement of obsolete capacities and the establishment of new capacities are determined by the market conditions, which can be influenced to promote an accelerated modernisation of the power stations. One opportunity for influencing the market processes is the quantity of emission allowances allocated to the new and existing power stations in the framework of the Emissions Trading System.

Until 2050, fossil fuel-based energy generation will continue to have a significant role in energy generation, although to an extent which is difficult to estimate. In relation to this, it is essential to determine the expected legislative environment for carbon dioxide separation and storage as soon as possible and this is described in detail in the corresponding chapter.

As regards climate protection, coal has more unfavourable characteristics than natural gas. Therefore, the establishment of coal-based capacities can only be accepted provided that it is directed to the replacement of obsolete blocks and results in a further improvement of the coefficient of efficiency of the power station, and provided that the power station uses good quality fuels and applies the various carbon dioxide separation and storage technologies or biomass is co-incinerated.

# Future of the EU Emissions Trading Scheme

The EU tries to make the rules of the Emissions Trading System uniform and the representatives of the sectors falling under the Emissions Trading System will have to be prepared to the fact that they have to buy the emission allowances or a significant part thereof and that the quantity of possibly free allowances that can be distributed will be based on the Best Available Technique in the case of both existing and new installations. No emission allowances will be allocated for increasing fossil fuel uses characterised by a high specific emission rate and possible increases in such production can only be achieved by improving the coefficient of efficiency without increasing the quantity of fuel uses. In the field of heat generation, the options that can be taken into consideration include replacement of the equipment with low coefficient of efficiency, further utilisation of the potential for co-generation and reduction of the distribution losses of heat supply systems.



#### STRATEGIC OBJECTIVES

It will be necessary to review the support granted to co-generation in order to release funds for supporting other climate protection measures since electricity and heat co-generation is mostly a good business opportunity for investors given that it results in energy savings.

In addition, the applicability testing of energy co-generation should be made stricter.

Part of the energy price compensations for the general public should not be granted in the form of direct support but should be invested into the efficiency of their energy uses. This will result in a long-term reduction of the energy costs, which also compensates the price increases in a longer run.

#### > Energy savings by the households & institutions sector

Particular attention should be paid to the households & institutions sector because this is responsible for a large proportion of the end-user emissions and also because such emissions continued to increase over the past years. On the other hand, this sector has an extremely high potential for emission mitigation, however, the households sector has been hardly affected by the prior and current emission mitigation measures.

Furthermore, it is also worth comparing what people believe about the share of individual energy uses associated with significant greenhouse gas emissions, and what the actual situation is, which is demonstrated in Figure 3.3.

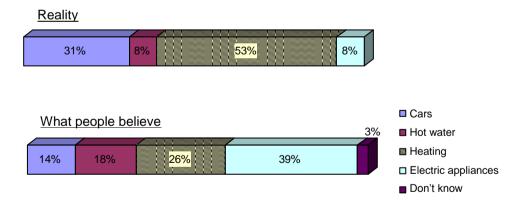


Figure 3.3 – Where do we use the most energy? From: Emnid survey "Zukunft Haus 2003" for Deutsche Energie-Agentur.

According to the survey, 74% of the responders did not know that heating is the biggest energy guttler and almost 30% was not even aware of his/her own heating expenses.

According to the statistical data, there were 4 million households in Hungary in 2004 and their energy uses represented 38% of the total primary energy consumption. The associated greenhouse gas emissions corresponded to one third of the total emission of the country.

Furthermore, households are responsible for 31% of the electricity consumption. Calculating with the existing homes, the annual energy demand including the energy needs of heating, lighting, ventilation, hot water, cooking and electrical household appliances is  $200 \text{ kWh/m}^2$ .

A recent study suggests that the energy consumption related to residential buildings not only implies significant mitigation potential but most of it would be compensated by the reduction in the energy costs. The realisation of these remunerative opportunities alone would result in an overall reduction of  $CO_2$  emissions and energy consumption by approximately 6 million tons and 28 TWh, respectively, in 2025. Between 2008 and 2025, an investment of a total of approximately EUR 12 billion would be required to realise this potential; on the other hand, this would result in an energy cost saving by EUR 19 billion for society.

Table 3.3 shows that replacing a few appliances would contribute to the increasing of the energy efficiency to a significant extent: in energy consumption, the difference between the average model and the best prototype may be more then 10-fold.

	Household (kWh/m²/year)	Refrigerator (kWh/m <sup>2</sup> /day)	Gas boiler (MJ/day)	Air conditioner (kWh/day)
Average model	190	4	210	10
New model	11 0	3	180	7
Best model	68	2	140	5
Best prototype	11	1	11 0	3

Table 3.3 – Opportunities for increasing energy efficiency. – From: Novikova, A. – Ürge-Vorsaztz, D. (2008): Carbon dioxide mitigation potential in the households sector in Hungary

	Energy consumption (for bulbs providing a light equivalent to that of a conventional 40 W bulb)	Life-time (hours)		
Conventional bulb	40 W	1,000-1,500		
Halogene	8 W	10,000		
LED	3.4 W	50,000		

Table 3.4 - Energy consumption and life-time of various light sources

Households consume approximately 11 TWh of electricity annually, which can be reduced by 2.8 TWh using various measures in a manner ensuring complete return of the investment costs within a decade, depending on the consumption habits.

Excluding the energy uses for transport, most (70%) of the energy consumption in the households & institutions sector is used for building heating. In Hungary, most homes have poor thermophysical characteristics. Accordingly, improving the thermotechnical properties of buildings may represent a significant potential for emission mitigation.

In case of the existing building stock, the most important opportunities for intervention include:

- · renovation or replacement of the doors and windows;
- thermal insulation of the building surfaces (insulation of walls, lofts, floor structures);
- heating system upgrading;
- heating control;
- individual control for central heating systems.

Door and window replacements should be coupled with facade renovation, otherwise moulding develops, which is harmful to health. Complex building renovations using the latest technologies (heating system, solar collector, heating control, thermal insulation, door/window replacement) may result in up to 80% energy savings and a corresponding mitigation of emissions. The current economic situation does not encourage the thermotechnical improvement of buildings. However, given the high gas prices for households in recent years, certain measures would be clearly remunerative – within 5-15 years depending on the type of home. Table 3.5 shows the specific costs of the measures for existing buildings.

Measure	Cost of the measure (HUF/kWh/year)			
	Buildings constructed using industrial technology	Old apartment houses	Family houses built before 1992	
Thermostat	4	7	5	
External insulation for walls	9		12	
Subbasement insulation		6	5	
Central condenser-type gas boiler		13		
Roof insulation	pof insulation			

\* the cost estimates take into account the relationships between individual measures

\*\* door and window replacements do not include improving the closing of doors and windows; therefore, the cost per energy saving ratio of such measures is overestimated

Table 3.5 – Costs of various building energetics measures. – From: Novikova, A. – Ürge-Vorsaztz, D. (2008): Carbon dioxide mitigation potential in the households sector in Hungary

If only investments having or close to having a rate of return of within 5 to 15 years are taken into consideration, a continuous implementation of such investments in existing buildings would lead to an annual energy saving of 101 Petajoule by 2025. As a comparison, the total energy consumption of the households was 317 PJ in 2005. As regards buildings, the most significant savings can be achieved in new buildings. Although this would mean lower savings because of the low proportion of new buildings, it is essential that construction methods with low energy needs become wide-spread as soon as possible in the field of constructions in both the households sector and the institutional sector given that the currently constructed buildings will determine the emissions for several decades. A long-term guarantee for a significant reduction in the amount of energy consumed for building heating in both newly built and modernised buildings may be to make building standards more stringent.

The rule tightening in 2006 alone resulted in approximately 30% savings on average in comparison with the buildings constructed according to the 1991 standards.

Moreover, in case of passive buildings constructed using the most advanced technologies, heating needs can be eliminated completely and their total energy consumption can be reduced to 20% of that of conventional buildings. The solutions used in zero carbon dioxide emission buildings include building insulation, the use of appropriate doors and windows, heat exchanger ventilation, solar collectors and heat pumps. In larger family houses and larger office buildings, these solutions could be implemented at 0% to 15% and 0% extra investment costs, respectively. Hot water production also offers cost-effective energy saving opportunities. One possibility with a rate of return of a few years also contributes to water saving, which is an important climate change-related adaptation measure as well, given that less drinking water will be available in the future. Table 3.6 shows the costs of different water-saving measures.

Measure	Cost, HUF/kWh
Water-saving taps, central hot water supply	1
Water-saving taps, hot water production by the household	1

Table 3.6 – Costs reductions in hot water production by various measures. – From: Novikova, A. – Ürge-Vorsaztz, D. (2008): Carbon dioxide mitigation potential in the households sector in Hungary

In case of a continuous introduction of water-saving measures, the resulting sparing hot water use may reduce the current energy consumption of the households for water heating by up to 23 PJ by 2025.

It is recommended that this measure be implemented in a manner requiring an investment with zero or negative net cost.

In order to ensure implementation, various support schemes may be introduced to encourage energy savings by the households. One possibility is to introduce funding programmes with the purpose of reducing the funding costs that may incur during the efficiency improving interventions by the energy users, and these programmes will be efficient if they can induce significant projects at a low public expenditure.

The simplest forms of support are investment aids, which are clear-cut and do not require the involvement of credit institutions. Another method of support is to grant low-interest loans, that is, to provide interest support or credit guarantee. This type of support is more efficient in larger institutional or industrial projects. In case of low-value projects typically implemented by households, this solution requires significant extra administration and participants are usually not willing to undertake it. The situation becomes different when supports are mediated by a third party that can organise many small projects into one large project. A third possible form of support is to use circulating funds to assist those consumers that can generate the funds required for the investment by their efficiency improvement project but do not have the money available to start the project.

In the field of energy savings by the households and institutions, the following measures have the highest priority:

 Introduction – by gradual tightening – of the energetics standards of buildings at a pre-announced date before 2020 for all new buildings and from 2012 for larger office building projects. In relation to this, ensuring the training of the experts required for the planning and implementation.

- Focussing the income from the Green Investment Scheme to projects with higher investment needs implemented by the households & institutions sector with the purpose of increasing the energy efficiency of existing buildings.
- Obliging the general public to take some low-investment measures producing net financial profit (e.g. following the example of Australia and several Western European countries, glowing filament bulbs should be gradually withdrawn from the market).
- Energy labelling, which may also indicate the saving expressed in money on the product.
- Granting advantage to appliances with low standby consumption, for example, by restricting the marketing of those with high standby consumption and by informing the consumers.
- In case of solutions to satisfy heating and cooling needs, influencing the consumers by information campaigns and energy labelling, and insulation of the buildings.

#### 3.3.1.2. Renewable energy

During the negotiations with the European Union in 2001, Hungary agreed to at least double the 3.6% share of renewable energy within the total energy consumption and to increase the 1% share within electricity consumption to at least 3.6% by 2010. This percentage – which is otherwise the most modest commitment within the entire Community – was achieved already in 2005, and, what is more, the share of green energy in the overall energy production was already above 5% in 2005; on the other hand, it was mostly achieved by the incineration of forest wood in low-efficiency power stations which may not mean a long-term solution. According to the Renewable Energy Strategy of Hungary prepared by the government in parallel with the National Climate Change Strategy, the weight of alternative energy production within the overall energy consumption will be at least 16% and that of green energy within electricity consumption will be 18% in 2020.

As regards the potential for using renewable energy sources in Hungary, several estimates have been published in recent years although with highly varying conclusions. According to these studies, the annual quantity of energy that can be generated using the current alternative technologies ranges between 150 and 1,300 PJ. However, the estimates show no considerable differences as regards the energy that can be generated using the "theoretically" renewable sources: this can amount to up to 2,500 PJ per year. This amount of energy is more than double of the current energy consumption. The studies also agree in attributing the highest potential to biomass in the nearest future, followed by the utilisation of geothermal, wind and solar energy. On the other hand, water energy is also considered as a renewable source; however, in view of the geographical characteristics, and technical and nature conservation aspects, this opportunity could not be considered as a feasible solution in the framework of this Strategy.

The NCCS is in accordance with the objectives set in the Renewable Energy Strategy of the country and takes the objectives set by that strategy as target values. Accordingly, the use of renewable energy should be increased to 186.4 PJ within the final overall energy consumption of the country by 2020.

This may correspond to various percentages depending on the final energy consumption within the overall energy consumption and will most probably remain below the 20%, which was set as the Community average. This is due to the fact that Hungary's overall renewable energy potential is lower than the renewable potential of the average EU Member State – we have relative advantage in comparison with other Member States primarily in the field of biomass production and geothermal energy generation. However, while the application of the former type of energy above a certain level gives rise to environmental problems, the use of the other is currently relatively low within the renewable energy types. Therefore, the NCCS places the primary emphasis on reducing the energy consumption through energy saving and improved energy efficiency instead of necessarily increasing the production of renewable energy.

The target for renewable energy production will be first reviewed during the biannual review of the NCCS and then every fourth or fifth year, during the review of the NCCS and the Energy Policy. Thereafter, if it is concluded that increasing the target for renewable energy production is a possible means – and also desirable as regards the emission mitigation objective –, then the target should be increased. Namely, the costs of certain renewable energy production technologies may reduce significantly until 2020; according to certain predictions, wind energy production may soon become a remunerative investment even without granting support, and the costs of geothermal and photovoltaic energy generation are also expected to diminish.

#### > Biomass

Biomass is a comprehensive term, which includes any types of organic materials from energy plants intended for the specific purpose through agricultural by-products to wastes. The use of biomass for energy generation can be divided into three main categories:

- utilisation by direct incineration, solid biomass;
- biofuel production; and
- biogas.

In 2006, approximately 4.3% of the electricity production was satisfied by biomass utilisation and this percentage was also mostly achieved by incinerating low-quality forest wood at low coefficient of efficiency. According to the relevant surveys, biomass-based electricity and heat generation has considerable extension potential; however, it does not represent a real alternative due to sustainability considerations and its actual emission mitigation potential. When utilising biomass, climate protection and environmental considerations should be carefully reviewed. This type of renewable energy should only be used where and as long as it does not disrupt the natural balance or threaten food safety, and is also favourable in terms of greenhouse gas emission. Biomass production entails the following nature conservation, food safety and climate protection risks:

- the area needs of the raw material required for biomass-based energy generation represents a competition with the other uses of biomass, such as food and feed production, raw material production for agricultural products and utilisation within the natural flora and fauna;
- the associated raw material production also represents an environmental burden and the typically intensive cultivation has high fertiliser and pesticide needs;

- through encouraging energy generation from biomass produced in natural habitats (e.g., by enhancing forest wood production), reducing the size of the natural and close-to-natural habitats and intensifying the cultivation of areas with previous extensive cultivation methods, it reduces biodiversity and, additionally, the extension of the sink;
- through the use of genetically modified and invasive species as energy plants, it threatens species variability and genetic variability of the natural vegetation;
- certain biomass utilisation methods generate more emissions throughout their lifecycle than the fossil energy carriers they were intended to replace; their energy balance is often negative.

Among the possible alternatives of the **use of solid biomass for incineration**, the utilisation of agricultural by-products and biowastes and the production of biomass in forest – which is also sustained in terms of ecologic and economic considerations – are most in accordance with the criteria of sustainability. In this regard, subregional market systems should be preferred, and the new tasks to be solved in this field include the establishment of an ash recollection system and the use of the ash in manuring. The cultivation of both ligneous and herbaceous energy plantations should be as natural and as extensive as possible. The objective is to only produce biomass for incineration in areas to be withdrawn from food production in order to ensure that no further areas are taken away from natural habitats. Furthermore, only species that are confirmed – on the basis of risk assessments – to represent no threat to the surrounding natural habitats by their spontaneous spreading should be used to establish the plantations. In case the transformation (compacting, chopping, drying) of the biomass intended for incineration is inevitable, the energetically most efficient procedure should be used.



#### STRATEGIC OBJECTIVES

In Hungary, only electricity produced from renewable sources is currently supported; however, according to a decision of the Commission in 2006, a Directive on "renewable heat" setting quantitative objectives for the percentage of renewable energy in heating and cooling should also be elaborated. Therefore, the elaboration of a system providing the basis for renewable heat generation and cooling should be initiated.

The lowest acceptable coefficient of efficiency of incineration for biomass-based energy generation should be increased by incentives or mandatory rules for the coefficient of efficiency in order to ensure a higher increase in energy generation from the biomass than the increase in biomass uses.

The support system for renewable electricity generation should be established in a manner to maximise the quantity of fossil fuel replaced. Therefore, biomass-based production is worth encouraging where it can replace relatively large quantities of fossil energy: primarily, this is not the field of condensation electricity generation because even the coefficient of efficiency of the power stations using the Best Available Technique is far below that of the corresponding fossil-based facility. Therefore, it is justifiable to grant support for biomass uses chiefly in the field of co-generation and heat generation, where the coefficients of efficiency achievable with the Best Available Technique biomass-based applications are close to that of fossil energy.

Biofuels are designed to replace a part of fossil fuels and are basically of two types:

- bioethanol produced by the fermentation of carbohydrates derived from plants: with the already available technologies, it can be produced chiefly from wheat and corn in Hungary;
- biodiesel produced by the crushing and purification of oil-containing parts of plants: in Europe, this is mostly produced from rape and sunflower.

First-generation (in other words, starch-based) bioethanol is produced from plants with high sugar contents and its composition is essentially equal to that of the alcohol produced in the food industry. On the other hand, second-generation (lignocellulose-based) bioethanol is produced using the entire plant, but the production technology is still in the pilot-plant phase and is expected to become more wide-spread after 2012-2015. A third generation can also be distinguished, which is essentially an improvement of the second-generation technology. However, this process requires genetic modification of the plants serving as raw material and such technologies are rejected by Hungary.

Support for the first-generation biofuels requires prudence because the latest surveys have revealed several negative features and indirect effects. In some cases, it is doubtful whether their application is more favourable in terms of the greenhouse effect than that of fossil fuels. Moreover, their production can only be profitable at the energy and raw material prices of the recent years if significant support is granted. In addition, their production is associated with environmental and nature conservation concerns as well, since raw material production entails intensive plant cultivation. Furthermore, increases in the demand side of the market of agricultural by-products as a result of the raw material needs would also increase food prices. Another factor to consider is that any additional support is unjustifiable in view of the current mandatory mixing ratio because the extra costs of biofuel production compared to conventional fuels are included in the fuel prices. In summary, although first-generation biofuels would have a favourable effect in terms of climate protection, they should receive no support owing to climate strategic considerations.

#### **Biofuel-related obligations**

The European Union requires that the use of biofuels should be increased to 5.75% by 2010 (Directive 2003/30/EC). The energy policy proposal package adopted in March 2007 by the EU specifies that the biofuel ratio should be increased to 10% by 2020 in case of liquid fuels.

Upon considering various aspects, a maximum of 400,000 hectares of land could be released for the production of raw materials for biofuels. Calculating with the best possible yields, the quantity of biofuel that can be produced in an area of that size could replace 10% of the current consumption of fossil energy-based fuels.

Therefore, the mixing ratio specified by the EU as the target for 2020 can be achieved by domestic production alone. However, the specification of production or utilisation targets in addition to the mandatory ones requires careful analysis and sustainability studies.

In 2005, Hungary consumed 2 billion litres of petrol and 2.8 billion litres of gasoline. According to certain expert estimates, the overall petrol and gasoline need could be satisfied by 2 million hectares of corn and 2 million hectares of rape if first-generation technologies were used. This is close to the current total size of arable lands in Hungary, which should of course chiefly serve food production purposes. The real alternative may present in the form of the second-generation biofuels. The mixing ratio of 10% that will be mandatory in the European Union in 2020 could be satisfied from such biofuels. It is important that future support schemes, if they are necessary, should distinguish between the different types of biofuels on the basis of their actual greenhouse gas emission mitigation potential.

**Biogas** utilisation is favourable in terms of climate protection because it reduces the quantity of methane, a gas that contributes to the atmospheric warming to a large extent. Agro-environmental consequences are also of great importance given that biogas factories are also suitable for the processing, conversion and neutralisation of various agricultural and food production waste materials.

Biogas suitable as fuel for vehicles or as supply to the natural gas network can be produced primarily from animal manure, food production wastes, other selectively collected industrial and household wastes and biofuel production by-products. In the mid run, 1.137 million cubic metres of biogas with a total energy content of 25 PJ can be produced annually from these sources. In comparison with other biofuels, biogas has the best indicators in terms of the quantity of biofuel produced on 1 hectare of land and the kilometres driven, and also has better energy balance for the total production cycle. One obstacle to the spreading of biogas factories is the high investment cost. Although the natural gas legislation allows the supply of biomethane into the natural gas network, the implementation rules are missing and should be elaborated and completed.

#### > Geothermal energy

Hungary has exceptional characteristics in terms of geothermal energy production in comparison with both Europe and other countries of the world. The crust under the Carpathian Basin is thinner by 10 km than the average. Accordingly, the hot magma here is closer to the surface by 10 km and the thermal energy produced by the radioactive reactions in the depth is generally much easily available in Hungary than in other places. Only areas famous for their active volcanoes such as Japan, Iceland, the Philippines or Alaska can boast of more favourable characteristics.

In Hungary, the average temperature increase per kilometre towards the inside of the Earth is 45°C and even higher in the middle of the Great Plain. As a comparison, the world average is 33°C per kilometre.

In Hungary, only heat and no electricity is currently produced on a geothermal basis; only plans exist for the latter despite that 440 geothermal power station blocks with a total capacity of almost 9,000 MW were operated in the world in the end of 2006 The advantage of geothermal power stations is the continuous energy production they allow and in contrary to certain other energy generation technologies using renewable resources, production is not characterised by daily, seasonal or weather-dependent fluctuations.

In addition to direct utilisation, a special type of geothermal heat supply is heat pumping, which moves the heat between media of various temperatures with concomitant electricity consumption. In Hungary, the use of heat pumps is only in the initial stage. Baths and other effluent waters represent a favourable opportunity for using heat pumps because their heat contents can be advantageously utilised by heat-pumping. Another new possibility is heat-pumping using the temperature of atmospheric air and significant improvements in cost-efficiency are expected in this field.

Owing to its favourable features, geothermal energy may represent another point of breakout beyond biomass in achieving the objectives related to the spreading of renewable energy. In spite of some often heard opinions, the re-injection obligation should not be revised under any circumstances.

Without this, geothermal energy would not be derived from a renewable source and the production would also impose a significant environmental burden on the recipient watercourses.

Further significant opportunities are offered by the deep boreholes originally drilled for oil and gas exploration purposes and found to be dry for hydrocarbons. In such cases, the body of the deep borehole can be used as a heat absorption soil probe and depending on the bottom temperature prevailing in the operational depth, technological heat uses (for drying, of for the heating of greenhouses or buildings), geothermal heat supply or possibly central heat supply will be possible both by heat-pumping or by the direct use of water as the media. According to the relevant estimates, a thermal power of 500 to 1,000 MW (an energy yield of 5 to 10 PJ/year by realistic utilisation) practically only derived from renewable sources may be obtained from such uses. Depending on the location of the deep boreholes, on the surrounding communal and economic environment, and on the utilisation, the specific investment needs of such uses may be reduced to HUF 2-3 billion/MW, which is an extremely low value.

It would be worth considering a tender system with low support intensity for a period of 2 to 5 years for the local municipalities, and the affected business operators and land users in order to ensure that the best geothermal heat supply and utilisation opportunities reach the implementation phase as soon as possible.

#### > Wind energy

In Hungary, electricity production from wind energy started in the beginning of the 2000's. In June 2007, 40 wind power stations with a total capacity of 61.675 MW were operated. Wind wheels were rotating at 17 points of the country, most of them (12) being concentrated in a turbine-based wind power station park in the north-western corner of the country, near Levél.

# International perspective of wind energy

The European picture of wind energy is rather heterogeneous. In terms of the overall output, Hungary is above most of its neighbours and even the more environmentally-aware Western European countries; on the other hand, the most advanced countries are ahead by orders of magnitude.

In Slovenia, no wind power stations existed until the end of 2006. The registered capacities of Romania 3 MW, Slovakia 5MW, Switzerland 11,6, Croatia 17.2, Bulgaria 32, the Czech Republic 50, Turkey 51 and Lithuania 55.5 MW, respectively. However, among the countries of the region, Austria, Poland and Ukraine were above Hungary by 965 MW, 153 MW and 85.5 MW, respectively.

The leader of both the European and the global list is Germany with a capacity of 20.62 MW meaning

more than 18,000 wind wheels. Spain and the United States had the second and third highest ranking with capacities above 11,000 MW, followed by India, Denmark, China, Italy, England, Portugal and France in the first ten places.

In the end of 2006, the total registered capacity of the world was 75,000 MW, i.e., 15,000 MW more than in the end of 2005. The trends suggest that the global capacity will be doubled by the end of 2010.

Installed wind energy capacities in Europe amounted to 48,540 MW according to the data from the end of 2006. In 2006, the EU satisfied 3.3% of its energy consumption from wind energy. European trends demonstrate that the capacities will rise to 80,000 MW until 2010, which can satisfy 5% of the total electricity consumption. Long-term prognoses suggest that wind wheels will produce electricity sufficient for satisfying 20% of the EU needs in 2030.



Picture 3.2 – Wind power stations in Mosonmagyaróvár (Photo: Péter Kádár)

The construction of wind power stations have specific nature conservation aspects which are to be taken into consideration during site selection.

A unique characteristic of wind energy in comparison with other renewable energy production technologies is that the rate of energy generation fluctuates owing to the varying wind speeds. Electricity storage is difficult and this means that production should be adjusted to the actual electricity needs, which can be achieved in different ways.

The variability of the wind intensity represents a problem that can be divided into two parts:

- · forecasting wind speeds is inherently uncertain, and
- wind intensities do not adjust to the needs: sometimes, there is no wind for relatively longer periods or, in certain cases, production levels may exceed the needs in valley periods.

Addressing the above-mentioned problems is of vital importance in terms of the Climate Change Strategy because solutions to these difficulties may allow a multiplication of the wind capacities in comparison with the currently authorised levels. The first step in addressing the first problem is to reduce the uncertainties of forecasting to the lowest possible level and then to deal with the remaining fluctuations.

Methods for reducing the uncertainty of forecasting:

- wind power stations should submit mandatory schedules and suitable economic incentives should be devised in order to enhance compliance with those schedules;
- the schedule provision obligation of wind power stations should be modified in a manner to allow schedule submissions within periods of less than a day in advance and schedule amendments shortly before starting the production.

In case of wind power stations, forecasts made 24 hours in advance show a percentage deviation from the actual production that is several times higher than that of forecasts prepared one or two hours before.

The fact that wind does not blow when there is demand for electricity would remain a problem even in the case of perfect forecasts. The Hungarian electricity control system is able to deal with unexpected increases in offer and particularly in demand, that is, addressing the issues of wind power stations is not a new type of problem but the levels of fluctuations are different.

However accurate the forecasting systems are, the remaining fluctuations should continue to be addressed. Furthermore, it should be done on a network level because the provision of own spare capacities for all wind wheel parks would not represent the solution with the lowest costs, which would be also reflected in consumer prices; from the opposite perspective, it would limit the extent of integrable wind capacity to a lower than optimal level at a given consumer price. The methods of addressing the remaining fluctuation include:

- Integration into a network: this is one method of physical and geographical diversification, which reduces the fluctuations of production, increases the amount of available spare capacities, and is in compliance with one of the basic energy policy objectives of the EU, i.e., an increase in transboundary capacities and the establishment of a trans-European energy network. In case it is implemented together with the otherwise ongoing investments, the associated costs can be minimised.
- Control and capacity reserves: the former is required in cases of shorter-term wind speed fluctuations, and this is required in cases when low wind intensities persist for longer periods and the spare capacities have to be used instead. Of course, no extra capacity reserves are required because of the higher level integration of wind energy provided that there was enough before the wind power station projects. Investments into control reserves may become necessary in case of larger national wind power station capacities.
- Energy storage: in case there is no demand for the energy produced at a given point of time, it can be stored and used until periods of higher demand/lower wind intensity. It should be noted that such solutions are normally required in case of a higher percentage of non-controllable capacities and chiefly not because of the wind power stations but because of the nuclear power stations. Provided that the market operates regularly and the price of the production of the control capacities is high enough, the market players would perceive the differences between the values of the electricity generated in different periods and storage power stations would then be built on a market basis as well.

Technology	Coefficient of efficiency (%)	Typical capacity (MW)
Pump-storage power stations	80	100-1000
Power stations with compressed air storage	75	50-100
Energy storage wheel	90	0,001-0,05
Conventional batteries	50-90	0,001-10
Hydrogen fuel cells	40	0,05-1

Table 3.7 - Energy storage technologies. - From: IEA

#### > Solar energy

Direct utilisation of the solar energy represents another great potential. The energy of the solar radiation reaching the surface of the territory of Hungary is 1200 to 1500 kWh/year, which would be theoretically more than sufficient to satisfy the national needs. Even if the utilisation of such an amount is practically still impossible with the available technologies, but levels that are higher than the current ones by several orders of magnitude may be achieved. In 2005, the solar energy utilisation was at the level of 3.8 PJ, which corresponds to 0.35% of the total annual energy consumption of the country. In a European comparison, the picture is worse because the share of solar energy utilisation is 0.01% of the total energy consumption.

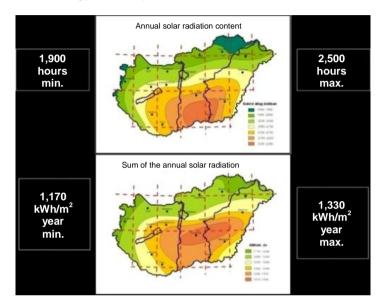


Figure 3.4 – The annual solar radiation content and the sum of the annual solar radiation in Hungary

The simplest way of utilising solar energy is passive utilisation. This requires no equipment and practically no extra costs but the building should be designed and constructed in a manner to enable the maximum utilisation of the solar energy. The structure of the building should have as high heat storage capacity as possible and large windows with good thermal insulation and southern orientation. Appropriate orientation may create sun walls and sun traps which can utilise the weak solar radiation in winters to a greater extent but avoid it in summers.

Among active uses, planar collector systems have become wide-spread in the application of solar collectors for heat energy generation and these are mostly used for heat production in the order of magnitude of a few megawatts. So far, such projects in Hungary have only been implemented in small volumes in certain central heating systems and in the households sector. One major obstacle to the propagation of solar collectors is the currently long rate of return (approx. 15 years); they may play a complementary role in heating and can be used for the satisfaction of a substantial part of the hot water needs.

Since the investment costs of solar collectors are relatively low in comparison with the overall investment costs of an average family house (the cost of the size of solar collectors capable of satisfying 50% to 70% of the hot water needs of an average family house is approximately HUF 800,000 to 900,000), it would be worth considering making it mandatory in larger real estate projects, and family houses may receive support through the Green Investment Scheme for using solar collectors.

Solar collectors have been used for the generation of electricity for a long time, but their energy conversion efficiency is very low, i.e., 13% to 17% of the incoming sunbeams are utilised on average. This low coefficient of efficiency is further reduced by the fact that they do not operate at night. This results in a 10-m<sup>2</sup> surface of solar collector having a peak electricity output of 1 kW. Currently, the costs of the photovoltaic application of solar energy is more than HUF 60/kWh; as a consequence, their use may not become wide-spread until the price of the collectors drops and their coefficient of efficiency increases significantly. At such high prices, granting support for solar collectors is not justified either, because the same support can be used much more efficiently in several other fields. In addition, electricity generation in power stations concentrating sunbeams cannot represent a real mid-term alternative.

Both passive and active uses should be considered in order to achieve the longer-term emission mitigation objectives because primary energy needs may be significantly reduced by their application, especially in the latter case.

#### > Water energy

Hungary is rather poor in actually utilisable water energy and, as a consequence of the climate change, even small hydropower stations should expect a reduction in the water supplies; therefore, in view of the well-known technical and nature conservation considerations, this opportunity could not be regarded as a feasible mitigation solution in the framework of this Strategy.

#### 3.3.1.3. Fuel replacement

Only four of the EU Member States have lower per capita carbon dioxide emissions than Hungary. This low level partly results from the fact that 40% of the electricity production of the public power stations derives from nuclear energy associated with no greenhouse gas emissions, and partly from Hungary having the highest percentage (43%) of energy produced from natural gas within the overall energy consumption in the EU.

Increasing the nuclear energy generation, that is, constructing new nuclear power station capacities will be a theoretically realistic possibility after the prolongation of the lifetime of the blocks of the Nuclear Power Station of Paks in 2025-2030. However, it is obvious that an issue of such importance cannot be evaluated on the basis of climate protection considerations alone. A wider reconsideration would be required, which would take account of the Hungarian endeavours of the long-term national energy policy and sustainable development.

Owing to its chemical composition, natural gas is one of the most favourable energy carriers in terms of specific carbon dioxide emissions. The improvements realised during recent years and those expected to be achieved in the near future will be mostly natural gas-based improvements and thus do not require incentives. It would not be reasonable to grant any support to future natural gas-based projects for other reasons as well: on the one hand, large-scale fossil fuel uses are unsuitable for achieving the long-term emission mitigation objectives. On the other hand, Hungary can only purchase natural gas at an appropriate cost level from one source, which makes gas imports undesirable above a certain level in terms of supply safety.

Due to the above reasons, this Strategy does not address the opportunities of fuel substitution in detail.

#### 3.3.1.4. Carbon dioxide separation and storage

Carbon dioxide separation and disposal means that the process of fossil-based energy generation entails the separation and long-term disposal of carbon dioxide in order to prevent imposing a burden on the atmosphere through carbon dioxide emissions. Although the energy consumption of a power station using carbon dioxide separation and storage is 10% to 40% higher than those without such technology, the net reduction in carbon dioxide emissions may still be 80% to 90%. Primarily, this technology may have relevance in large electricity generating power stations in the future. Apart from demonstration projects, Hungary is not expected to have power stations using carbon dioxide separation and storage before 2025; therefore, this technology has no relevance in the emission mitigation in the mid run.

The theoretically available separation technologies include:

- carbon dioxide separation for storage subsequent to the combustion of fossil fuel;
- conversion of hydrocarbons to hydrogen plus carbon monoxide followed by the conversion of the latter to carbon dioxide, use of the hydrogen as fuel, storage of the carbon dioxide;
- combustion of the fossil fuel using pure oxygen separated from the atmosphere followed by the storage of the resulting almost pure carbon dioxide.
- The theoretical possibilities for the storage of the separated carbon dioxide include:
- geological storage at depths exceeding 800 m:
  - » in exhausted oil and gas fields;
  - » in saline-containing deep layers;
  - » in active oil and gas fields in parallel with the extraction of the oil and gas;
- chemical storage (as carbonates resulting from reactions with metal oxides).

Today, several applications exist in the world for the separation and geological storage of carbon dioxide but have never been used in large (about 500 MW capacity) power stations; therefore, the technology is still in the pilot phase in this sense.

Carbon dioxide separation and disposal technologies may allow fossil energy production to continue to represent a significant proportion within energy generation. According to the primary analyses, Hungary has considerable capacities for the underground storage of carbon dioxide of industrial origin. Most of the carbon dioxide storage capacities could be established by the utilisation of exhausted oil and gas fields and deep-lying saline layers; in addition, converting deep coal mines that are exhausted or cannot be economically developed into storage reservoirs also has a future. The estimated storage capacities are shown in Table 3.8. According to the preliminary estimates, it can be stated that Hungary could ensure the underground storage of the total current annual emissions for up to a few decades; however, it requires further research.

Type of reservoir	CO <sub>2</sub> storage capacity [million tons]			
Deep saline	3,000			
Hydrocarbon field	408			
Coal-containing layers	240			

Table 3.8 – Estimated carbon dioxide capacity of the types of reservoirs available in Hungary From: International and national situation of CO<sub>2</sub> capturing and disposal, National "Eötvös Lóránd" Institute of Geophysics, 2007.

Hungary already uses carbon dioxide storage but only in relation to hydrocarbon mining. Namely, in certain mature oil and gas fields, the residual oil and gas reserves in the bed can be extracted by re-injecting the local gases. This form of carbon dioxide storage is a remunerative investment in a certain run.

As regards the underground storage of carbon dioxide, the ability to store the carbon dioxide for a sufficiently long period of time – for up to ten or hundred thousand years or even millions of years – in an isolated and environmentally harmless manner is a pre-requisite for the recipient geological media. Accordingly, studies are required regarding the complex geological/geophysical effects of underground carbon dioxide reservoirs and their surroundings on the living and non-living natural values. This will ensure that the long-term suitability of reservoirs is confirmed.

Although this technology has not been widely applied yet for the purpose of greenhouse gas emission mitigation, current cost estimates indicate that it could be used at relatively low costs (USD 0 to 240 per tCO<sub>2</sub>) under certain circumstances in electricity generating power stations (depending on the carbon dioxide separation and storage technology used by the power station and on the associated benefits, such as the facilitation of natural gas extraction), or, in several cases, at costs below the carbon dioxide quota price forecasted for the current 2008-2012 period.

Before applying carbon dioxide separation and storage in Hungary, it will be absolutely necessary to precisely identify and survey the geological opportunities available in the country.

In case the research results confirm those of the preliminary surveys, then the issue of carbon dioxide separation and storage should be left to the value judgement of the market as regards the power stations of Hungary.

### 3.3.2. Transport

Transport emissions may be mitigated by rationalising and reducing the transport and shipping needs, by extending bicycle and pedestrian transport, by improving the percentage of public transport users and by the propagation of more environmental-friendly modes of transport/shipping (railway, inland navigation, combined freightage). Some European research studies indicate that the primary factor determining the transport needs of a country is the percentage of built areas, therefore, conscious urban planning, making downtown areas liveable, and conscious regional development may contribute significantly to the mitigation of transport needs.

A shift in the emphasis from individual transport to community transport would have a dual effect. On the one hand, it would result in lower emissions; on the other hand, traffic jams could be mitigated, which in turn would further reduce the emissions.

For example, an average individual will be responsible for approximately 50% carbon dioxide emission if he/she travels by train instead of driving the same distance. However, this is not reflected at all in the current costs of using individual or community transport.

The EU intends to improve the specific emission of the vehicle stock by requiring that the average carbon dioxide emission of personal cars newly sold after 2012 should not exceed the level of 120 g/km. It is also an objective to keep the average emission of personal cars put into operation after 2020 below 100 g/km.

The following measures can be recommended in order to mitigate transport emissions:

- To increase the rate of using community transport, projects allowing the secure guarding of personal cars (primarily in outskirt areas) are worth implementing in order to ensure that people can use suitable means of community transport. In order to achieve significant results, it would be reasonable to provide economic incentives (e.g., season tickets at reduced prices) to individuals choosing community transport and representing new passengers in this sense.
- Transport and shipping needs should be optimised by introducing urban road fees, and by excluding or restricting the traffic in certain areas. The possibilities for pedestrian and bicycle transport should be extended by conscious infrastructure development and by the construction of appropriate and safe bicycle roads. It is necessary to cut back car uses over short distances because the fuel consumption of the car is disproportionately high in such cases and this increases the emission of greenhouse gases.
- Owing to the increasing tendency in freightage needs, it is a challenge of increasing emergency to achieve a shift from road shipping towards combined freightage by making use of the potential of railway and waterway shipping. However, this requires establishing better connection points, improving the efficiency of logistics centres, and a close cooperation with the neighbouring countries in international freightage.
- Rationalisation of the freightage needs by ensuring that goods are used locally, in the vicinity of the place of production in order to avoid the "unnecessary" shipping of goods and products.
- An appropriate transport infrastructure should be established; however, user fees should be imposed in proportion of the externalities caused, because granting the transport infrastructure developments for free would again lead to saturation and to the need for further developments.
- The purchase of low-emission vehicles should be encouraged by improving the relevant legislation for both new and old cars.

# About the advantages of public transport

According to a survey by the Clean Air Action Group, almost two thirds of the vehicle travels in Budapest are undertaken by public transport. However, it uses only 0.5% of all passenger vehicles, is responsible for 6% of the transport emissions and causes 3% of the traffic accidents.

On the other hand, one third of the journeys are undertaken by car. For this, people use 99.5% of the vehicles, while causing 60% of the air pollution and 97% of the road accidents.

- The use of renewable fuels should be disseminated but only on condition that the production of the fuel in question gives rise to less greenhouse gas emissions than the savings achieved by its use in view of its entire life-cycle. This is not confirmed for the current technologies and this method of reducing greenhouse gas emissions is not cost-effective at all either, because the cost per unit of carbon dioxide emission reduction can be ten times higher than the prices expected under the EU Emissions Trading Scheme between 2008 and 2012.
- The most effective means of emission mitigation is attitude changing and modification of the leaders' behaviour. Awareness raising and attitude changing needs encouraging. One method is to establish the "eco-driving mode", which includes several principles and practical applications (even acceleration, gear changing, avoiding sudden braking, avoiding the use of air conditioners, appropriate tyre pressure) that may result in up to 5% to 10% fuel savings. In case of a mediumsized personal car, acceleration from 110 km/h to 130 km/h results in a 15% increase in carbon dioxide emissions.

#### STRATEGIC OBJECTIVES

The reduction of the carbon-intensity of transport should be promoted and encouraged. In order to achieve this, maintaining and possibly increasing the percentage of community transport, which is above the EU-25 average. The percentage of bicycle transport in urban transport should be increased and the necessary infrastructural developments will be inevitable in the future. Bicycle road networks should be established not only in larges cities but on a national level as well.

Developing combined freightage and increasing its ratio – particularly as regards the transit road freightage –, and augmenting the efficiency of the intermodal logistics centres.

Conscious and prudent infrastructure development for the development of the urban and suburban transport (chiefly fixed path).

In order to mitigate greenhouse gas emissions, the principle of "common but differentiated responsibility" should be consistently applied, that is, larger emitters should assume higher responsibility for the environmental burden they cause. The external social costs caused by transport (and especially freightage) should be incorporated into the road fee system.

The most important transport-related task is to establish and operate a transport system observing the principles of sustainability in accordance with the strategy of the sector. Both an economic control system that takes account of and enforces the external costs and the reduction of the externalities by the construction of railway lines operating with more advanced machinery and representing a lower environmental burden are important means in achieving the strategic objectives.

Several tasks influencing the transport needs that are under the responsibility and scope of action of the settlements (community transport, urban planning, car-free zones) may represent one of the most important means for the mitigation of the emissions and energy needs of transport. Relying on the contribution of the local municipalities, the government should play an active role in this field as well. More room should be given to local decisions, thus strengthening the situation of the subregions.



### 3.3.3. Agriculture and forestry

In the field of agricultural land uses, it is expected that the large-scale nature of production remains unchanged, the number of individual holdings diminishes and lands become concentrated in large holdings. When considering the emission mitigation potential of agriculture, it should be taken account that agriculture and forestry use natural resources and it is therefore in their elementary interest to protect natural resources. In forestry, the changes in the social expectations for forests are expected to cause a shift in the centre of timber production. In natural-like forests, the volume of timber production is expected to decrease and nature-sparing technologies are expected to gain ground, while the centre of intensive timber production will be shifted to the areas of tree plantations.

The mitigation of agricultural emissions will be possible by land use changes, by the dissemination of biogas uses, by the rationalisation of transport and materials handling and by environmental-friendly plant production practices. In the field of forestry, results can be achieved chiefly by the wider application of forest management methods based on natural forest-dynamical processes (cost and energy use reduction), by the application of conventional and energy-saving timber production, shipment, and tree hauling technologies (directed timber felling that spares the residual stock, cab, wood chute, cableway etc.) and by the plantation of new forests (enhanced carbon dioxide capturing, stabilisation of the mesoclimatic conditions).

The climate protection tools related to agriculture include:

- Nature conserving farming methods, i.e., technologies adjusted to the local habitat characteristics and plant needs, as well as the use of species adapted to the local conditions should be encouraged. Unjustified increasing of the arable lands should be avoided, especially with regard to areas where arable cultivation is impossible due to the local habitat characteristics (areas with inland inundation, floodplains, areas at a risk of erosion). The dissemination of the extensive land use methods (grazing, floodplain landscape management) should be promoted as much as possible.
- As regards tilling, it is important to choose water-saving technologies and tillage methods adjusted to the needs of the plants. By minimising the tilling and reducing the number of soil cultivations, and by keeping the soil surface always "closed", efforts should be made to safeguard the water reserves of the soil and to receive rainwater and store it in the topsoil.
- In agriculture, considerable greenhouse gas emissions are generated through the use of machines. Preferential granting of support to energy-saving machines and (advanced) tools could mean a step forward.
- the establishment of animal keeping farms with high product emissions is only acceptable if the by-products of animal keeping are utilised in closed technological systems on site, and if intensive animal farms are coupled with biogas factories.

The climate protection tasks related to forestry include:

- The support for afforestations should be differentiated according to the mode of cultivation: higher support for the afforestation of arable lands and lower support for the afforestation of grazing lands previously under agricultural use. By increasing the size of forests, the total area of Hungarian forests is expected to rise by 270,000 to 360,000 hectares until 2025. Provided that native trees suitable for the habitat are planted in the framework of afforestations, 25 to 33 million tons of carbon dioxide can be captured by 2025, or even 47 to 58 million in case of planting fast-growing tree species (acacia, poplar, pines). On the other hand, it is obvious that planting tree species with higher carbon absorption is not everywhere desirable owing to nature conservation considerations. Before afforestations/plantation developments, land use aspects and the expected negative effects of the climate change should also be taken into account. For example, forests created in grazing lands may result in net carbon sinking only years later, and for several years, it may emit more carbon dioxide due to the carbon dioxide emissions from the soil.
- Promoting awareness raising in order to increase the social and economic support for forests, and coordinated measures in order to fight off illegal timber logging.
- Strengthening and social and economic recognition of the protection functions (protection of soil, water and biological diversity) of the forest stocks.
- Introduction of forest management methods that are based on natural processes and better serve the protection functions of forests.
- Granting support to research projects by tendering schemes, chiefly for the purpose of selecting the appropriate tree species, and such research will become important just because of the changing climate.

#### STRATEGIC OBJECTIVES

Increasing the natural coverage of the surface serves simultaneously the absorption of carbon dioxide, the establishment of a more favourable microclimate and the increase in ecologic services. This will not only provide help against the effects of the climate change but also contributes to the protection of natural resources.

During the period of the Strategy, we should manage to stop the reduction of green surfaces. During the period of the Strategy, we should manage to stop the reduction of outskirt areas. The increase in the size of forest areas should be ensured by maintaining the rate of afforestations. Land use regulations should be revised in view of the relevant climate protection considerations.

# 3.3.4. Utilisation and re-use of the wastes of products with high energy needs

Waste utilisation and recycling is an important tool in climate policy because significant amounts of energy can be saved by this and also because this is one method of mitigating industrial emissions. Wastes essentially represent wasted material and energy. Therefore, preferring low-waste products and recycling wastes mean an indirect contribution to slowing down the climate change through energy saving. Table 3.9 shows the energy saving achieved by recycling various materials.



Product	Waste utilisation, energy saving		
Iron, steel	~74%		
	(80% CO <sub>2</sub> emission mitigation)		
Aluminium	~95%		
Glass	~50% (25% to 40% according to other sources)		
Paper	~60% (28% to 70% according to other sources)		

Table 3.9 - Percentage of energy saved through re-use

Making material recycling a wide-spread practice should be a priority of the climate policy particularly in the sectors using significant amounts of energy.



#### STRATEGIC OBJECTIVES

Strict professional and social control should be established in order to improve the national waste management practices. Tools and methods should be devised partly in order to extend the utilisation of wastes as alternative energy sources, and partly in order to cut back the emissions that are harmful to the environment and thereby intensify the climate change.

In addition, appropriate waste management methodologies should be elaborated to ensure a more wide-spread and high rate recycling of the products with the highest energy needs. This requires the identification of the possibilities and the use of appropriate economic incentives or legislative solutions (e.g., deposit fees) in order to ensure a reduction of the energy consumption in these sectors.

Further extensions of the collection of paper and glass, which are major components of households wastes, depend as much on informing people and finding comfortable solutions as on economic incentives; these tasks – mostly belonging under the scope of waste management – should be supported from the side of the climate policy and the priorities should be revised from a climate policy perspective.

The utilisation of food wastes for the production of biogas represents a common field of waste management and biomass utilisation, and the main problem of this field is to organise the collection system. However, several operating examples – for example, from German-speaking areas – can be introduced in the short run.

# 3.3.5. Summary of the emission mitigation potential of the individual sectors

The sectors that may be considered as the most important in terms of emission mitigation and the areas within these sectors to which it would be worth focussing can be identified partly on the basis of the absolute emissions of the individual sectors (the higher the emissions are, the more important the given sector or subsector is), and partly on the basis of the extent to which these fields have been targeted by previous climate protection policies. Figure 3.5, which shows the emissions associated with the energy uses of various economic sectors by energy types, assists the selection according to the first criteria.

In most cases, the type of energy carrier is a good indicator of the field of application and the key areas can thus be identified on this basis. The households sector is demonstrated to play a key role in almost all areas, while the institutional and industrial sectors have significant roles in a number of areas. The emissions associated with petrol and gasoline uses are also considerable, which indicates the importance of transport. The relevance of natural gas uses is obvious, which – in view of the more favourable specific emissions – indirectly focuses the attention on the higher use of renewable energies.

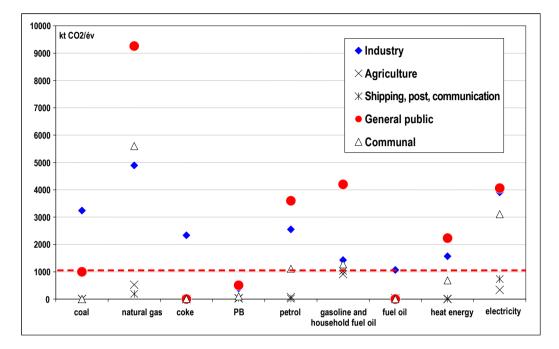


Figure 3.5 – CO<sub>2</sub> emissions from energy generation in each sector by type of energy. – From: Statistical Yearbook of Energy Management, 2005.

In addition to the above, energy conversion in general and electricity generation in particular should be regarded as areas of priority. Besides the emissions associated with energy, the field of waste management should also be reviewed as it is an important factor in the National Greenhouse Gas Inventory chiefly because of the much higher potential of methane to cause global warming than that of carbon dioxide. Finally, carbon capturing by afforestation is an area of particular importance – and thus an area of high priority – in emission mitigation owing to the natural characteristics and forestry traditions of Hungary.

Accordingly, the key areas (priorities) of emission mitigation include:

- To promote the energy efficiency in the households and institutions sector.
- To increase the coefficient of efficiency and the rate of electricity co-generation.
- To facilitate the propagation of renewable energy carriers.
- Direct fuel needs of industrial production and consumption of heat produced elsewhere.
- To ensure that the industrial sector uses electricity primarily for the purpose of the manufacturing technology.
- To restructure the transport system and thereby to reduce its energy needs.
- To facilitate carbon absorption by afforestation.

Table 3.10 shows the measures and achievable emission mitigation values that may arise in case of a maximal realisation of the individual types of measures as defined without detailed market analyses, on the basis of estimations:

Measure	CO <sub>2</sub> emission mitigation potential	Penetration	Assumed CO <sub>2</sub> emission mitigation	Investment costs	Support intensity	Support need between 2008 and 2025
	kt/year		kt/year	Billion HUF		Billion HUF
Increasing the coefficient of efficiency, electricity co- generation	Should be considered as part of the BAU					
Shift to renewable ene	rgy carriers	;				
biomass incinerating power stations	1,143	100%	1,143		Price support ("KÁP")	31.3
wind power stations	544	100%	544			13.9
Biomass-based heat g	eneration					
households	10,252	30%	3,076	615	30%	15.38
communal	5,394	20%	1,079	86	30%	2.16
subregional central heating	10,252	10%	1,025	205	30%	5.13
Energy savings in the	households	and institu	tions secto	r		
tightening the energetic requirements for buildings	23	100%	23			llised even support
improving the thermal protection of buildings, modernising the heating systems	6,540	75%	4,905	8,467	30%	158.8
reducing household electricity uses			700		Will be realised even without support	
reducing communal electricity uses	218	100%	218	89	15%	1.12
upgrading industrial technologies	Should be considered as part of the BAU					
Total	45,166		12,712			227.72

Table 3.10 - Emission mitigation potentials of the sector with estimated maximum values

The table only includes quantifiable data and the emission mitigation achievable in transport, agriculture and forestry has not been estimated.

The market share of biomass-based interventions cannot be increased any further owing to the quantity of available biomass.

It is not certain whether the indicated market shares can be achieved at the given support intensity. However, the 30% has been considered as a fixed EU limit.

In case this objective becomes reality, it should be determined whether all these investments can be physically implemented within the period available until 2025 (availability of the builder capacities, construction times, etc.).

# 4. ADAPTATION TO THE CHANGING CLIMATE

"Let us approximate to the laws of nature as much as possible!" Count István Széchenyi: Stadium Even if the countries of the world significantly reduce greenhouse gas emissions, the accelerating climate change will have its effects. Namely, because of the human activities since the industrial revolution, extreme weather events and higher global average temperatures are already "programmed" into the atmosphere for the following decades. In climate protection, adaptation means the mitigation of the effects and damage associated with the climate change and the efforts made to reduce the sensitivity to the climate change.

The Framework Convention on Climate Change refers to the importance of adaptation in many of its articles. It specifies the obligation for the countries to establish programmes to facilitate the adaptation. In addition, developed countries are also required to provide financial support to the developing countries in order to implement adaptation.

In the combat against the climate change, it is very important that the measures taken to promote adaptation and those directed at mitigating the climate change should be synergistic and should not compromise the effects of each other. One negative example is the increased purchase of air conditioners as a result of the increased frequency of canicular days, i.e., many people try to adapt to the new circumstances this way. However, this causes a further increase in energy consumption and in the associated emissions and leads to increased global warming, let alone the increased heat island effect caused by the hot air released by the many air conditioners. One example for a positive interaction is the afforestation of areas where surface erosion occurs as a result of the climate becoming warmer and more arid. Namely, this also helps to prevent further erosion and to reduce emissions through the  $CO_2$  absorption by the trees.

Thus, adaptation opportunities that should be given priority include those that mitigate the harmful effects of the climate change (i.e., serve mitigation objectives) and also offer other social, environmental and economic advantages and extra benefits.

The adaptation objective of the NCCS is to reinforce and enhance Hungary's adaptability to the climate change.

- **4.1. Evaluation of the situation**, **outlooks** Although to different degrees, the increasing effects of the climate change will affect the entire territory of Hungary and almost all layers of society. The NCCS summarises the effects on the following fields:
  - nature conservation;
  - human environment and human health;
  - water management;
  - agriculture: plant growing, animal keeping, forests;
  - regional development, regional planning, settlement development, settlement planning and built environment.

In addition, the climate change has direct effects on tourism. A warmer climate may result in the prolongation of the tourist season, however, in case of extreme weather conditions, the low water quantities and quality may have an unfavourable effect on natural waters, waterparks and beaches. In the framework of the revision of the Strategy, the chapter on adaptation should be extended to include additional sectors, particularly tourism, security policy and urban planning.

Today, the fact that our economic and social life is based on otherwise limited natural resources and enjoys the benefits of the various services of the ecosystems is increasingly recognised and accepted. Among these, it will be of particular importance in relation to the climate change that natural flora and fauna (especially forests, but any surface coverage as well) create and maintain a more favourable microclimate thereby mitigating the negative and extreme effects, and regulate the water balance of soils and prevent erosion. The role of aquatic habitats in the safeguarding of water quality and in flood protection could also be mentioned.

This recognition is also reflected in the attitude set forth by the NCCS, according to which ecosystems do not simply represent a sector among the others: the conditions of the natural flora and fauna will have an impact on most sectors through the ecosystem services, and global changes influence our everyday life via the changes in these services (Figure 4.1).

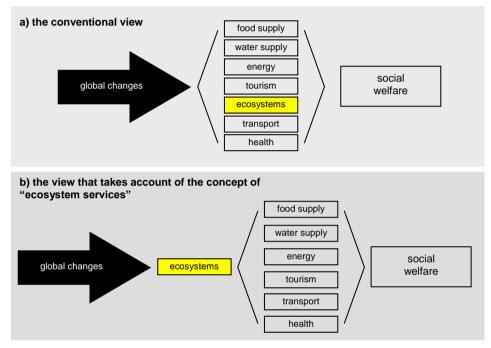


Figure 4.1 – The role of ecosystems in the effects of global changes on social welfare.

### **Ecosystem services**

Man, as a biological creature, is part of the ecosystem and our existence is impossible without the natural flora and fauna and the services provided by them.

Ecosystem services refer to the goods and services of the flora and fauna which are directly or indirectly used by people during their lives and whose quality is thereby influenced. Four basic types of services are distinguished: supply, regulatory, maintenance and cultural ecosystem services. The goods offered by the supply services are directly used or consumed and include food, drinking water, timber and fibre materials. The regulatory functions of the flora and fauna include climate regulation, flood mitigation, water purification and soil generation. Maintenance services include the primary production (through the photosynthesis by green plants), and the biological role in the turnover of the elements or water. The cultural services of the flora and fauna are manifold and include aesthetic, spiritual, educational and recreational functions.

### 4.1.1. Effects on the natural flora and fauna

In Hungary – as in most parts of Europe –, the climate change does not affect an untouched nature but a landscape already modified by man. Natural self-sustaining systems are only present in relatively isolated mosaics and the communication between these spots is increasingly reduced as a result of human activities, which further decreases their sensitivity and vulnerability to the effects of the climate change.

Even the slight climate change of the past decades induced clearly detectable rearrangement processes in nature. Many living beings are migrating towards the poles or to higher regions in mountains but in Hungary, these processes are limited in manmade environments and by the geographical characteristics.

A report by an international group of scientist of the United Nations concluded that Hungary is one of the most vulnerable countries in the world in terms of the effects of the climate change on the natural flora and fauna and on biological diversity. While only certain areas are classified as ecologically highly vulnerable in other countries, there are hardly any areas in Hungary that are not. In Europe, only Belgium faces a less favourable situation, and globally, the Republic of South-Africa.

The natural rearrangement process caused by the climate change results in more vulnerable associations with impoverished species diversity and thereby opens the door to the invasion of further species, and an upsurge of more easily propagating species is generally expected.

In case of a warming by more than a few degrees, zones will shift to an extent that will prevent natural ecosystems form surviving in their current forms and at their current locations. The situation may be further aggravated if transitions will not remain gradual. In case the climate changes significantly, the tasks of nature conservation will include – in addition to conservation efforts – the occasional acceptance or even the facilitation of the change and the natural processes (for example, migration, or settling of new species in case of a local extinction of certain other species).

In Hungary, research studies to assess the potential risks to individual habitats and to quantify the estimable climate sensitivity have been initiated. According to the first estimates made on the basis of the habitat maps, several habitats are now classified as being at critical risk (for example, bog meadows, alder and ash bogs, alder marsh forests, lime-avoiding beech associations). Another task is to estimate the risks from the effects of the climate change, from the habitat changes (e.g., lower groundwater levels) and from the changes in landscape uses (e.g., abandoning arable lands). In view of the above and according to the current scientific knowledge, the climate sensitivity of habitats can be estimated as follows. Habitats that are at direct risk due to the climate change include: aquatic habitats and/or those requiring a cool microclimate (e.g., bogs and marshlands); zonal forests and grasslands (e.g., bog meadows with *Molinia coerulea*, hornbeam-oak associations) are at risk due to the rearrangement of the species composition; and floodplains, sand meadows and forest-steppe forests are at indirect risk due to the predicted further propagation of mass species (invasive species).

In summary, the key changes in the natural flora and fauna of Hungary as a result of the climate change include:

- a shift in the boundaries of the natural vegetation characteristic of the climatic zone;
- a rearrangement in the biocenoses and food chains;

- decline of the species of the natural flora and fauna, especially in isolated habitats;
- reduction of the biological diversity in the long run;
- propagation of invasive species and appearance of new invasive species (e.g., propagation of harmful insects and weeds);
- more arid habitats (e.g., disappearing aquatic habitats, desertifying sand areas);
- damaged ecosystem functions;
- soil drying, damaged biological processes in soils;
- more frequent fires.

#### 4.1.2. Human health

The accelerating climate change and its effects represent a challenge for both people and human cultures adapted to the previous climatic conditions. In the future, the health of the population will be significantly affected by the extreme weather events that will become more frequent and more intensive.

The most important extreme weather events that negatively affect public health include heat records and suddenly rising temperatures. Various population groups are affected by the climate change-related health effects to different degrees. The 2006 Report of the World Health Organisation stated and national studies also confirmed that the most sensitive populations include children below 4 years of age, elderly people above 65, overweight individuals and bedridden patients. Due to the expected high temperatures during heat waves and the heat records in summers, increased mortality and a significant rise in the number of emergency calls (nationally, 800 to 2,600 extra mortalities and 1,500 to 4,800 extra ambulance calls by 2025) are predicted for the period to come.

Higher summer temperatures will have unfavourable effects especially on people living in cities because temperatures may be 2°C to 8°C higher in cities depending on the architectural and urban development conditions. Intensive front effects may aggravate the risk of accidents and reduce working performance.

The increasingly hot summers and more moderate winters may significantly increase the spreading and populations of viruses, bacteria and other pathogens. The incidence of tick-propagated encephalitis was declining between 1990 and 2000 but has been rising since 2001 (80 cases per year on average). In the future, moderate winters and changes in the forest coverage of the country may increase this incidence. A similar rise is expected in the number of Lyme disease cases, hantavirus infections (transmitted by rodents) and West Nile Virus infections (transmitted by mosquitoes). Increases in the incidence of hantavirus infections have been observed since the 1990's – including cases in the Transdanubian, Northern Hungary and the Northern Great Plain – and both this disease and the West Nile Virus infection transmitted by mosquitoes are expected to become wide-spread all over the country: the current annual level of less than 20 cases is predicted to increase. In a longer run, the number of introduced malaria cases may also rise, and leishmaniasis, a protozoal disease transmitted by sandflies, may appear.

Pathogens in water and foodstuffs also represent a higher risk as a result of the increasing temperatures. For example, international data suggest that a temperature increase by 1°C would increase the incidence of salmonellosis by 2% to 5%; accordingly, 10 to 32 additional infection cases are expected to be reported during the predicted heat waves. The number of other bacterial, viral and protozoal diseases (Campylobacteriosis, Hepatitis A, Cryptosporidiosis) is also expected to rise. In periods of drought, the propagation of certain pathogens is favoured by the increasing water temperatures and this may be a priority issue in relation to waterside tourism.

It is important to emphasise that sudden rainfalls and the associated floods may contaminate the vulnerable drink water resources through wastewater spills and infiltration, and thereby increase the risk of infections.

The climate change will modify the pollination period of allergy-causing plants and the quantity of pollen released. The increasing atmospheric  $CO_2$  concentration and the growing temperatures may extend the atmospheric residence time of the pollen of common ragweed, i.e., may prolong the ragweed season.

Under certain weather conditions, the climate change will have negative effects on the concentrations of air pollutants. For example, prolonged sunshine and low air motions result in increased near-surface ozone levels in big cities and in their surroundings. One realistic risk is the extremely high level of nitrogen oxides and nitrogen dioxides, which may lead to smog in extreme cases. Furthermore, high levels of air pollutants increase the number of respiratory diseases.

The reduction of clouds increases the UV-B radiation, which in turn may cause an increase in the number of pigmented and non-pigmented skin carcinomas – this was detected already between 2001 and 2005 (the number of new cases increased from 1,300 to 1,800) – and in the incidence of cataract.

The effects of the warming and the climate change will manifest as human and social losses (early mortality, aggravation of chronic diseases, transient impairment of the health of otherwise healthy individuals). As regards social aspects, the possible consequences include the extra expenditure and costs incurring in the budget of the health care system and the affected families.

Despite all this, an information system that would allow the most important adaptation decisions to be substantiated and reconciled on the basis of cost-benefit calculations has not been established yet. Although it is possible to make approximate estimates on the basis of data from individual subsectors, however, it is impossible to identify the priorities based on substantiated comparisons either within or between the sectors. In addition, the extent to which people are informed about the climate change and about the necessary adaptation, and the way their behaviour could be influenced are not precisely known.

No legislative background or economic/technical standards exist for climatic adaptation. No institutional systems or organisational networks facilitating and continuously orientating the adaptation process have been established. What we have is various research sites, certain institutions and civil organisations with the experts of the field; however, the level of coordination between them is very low. There is no key approach and no programme for information dissemination that would promote the social acceptance of the adaptation to the climate change.

### 4.1.3. Water management

The climate change may also induce changes in both the quantity and quality of water available in the country. As regards water quantities, difficulties may arise as a result of prolonged drought periods, floods and inland inundations.

In terms of quality, the reduction in the water quantities may diminish the self-purification capacities of waters. This in turn results in a slower degradation of certain pollutants, which also influences water quality. Sudden rainfalls may represent another risk to water quality. High rates of precipitation increase the load on sewage and gutter systems, which may lead to overflows or to even contaminations and major accidents in extreme cases.

In the decades to come, freshwater resources will have a special strategic role both in the world and in Europe. In this regard, surface water resources have a role of particular importance.

However, as the climate becomes more arid and warmer, the frequency of droughts is expected to increase, especially in the Great Plain. In the European Union, the number of areas and people affected by droughts increased by 20% between 1976 and 2006. In Hungary, two of the droughts with the highest extension occurred in 2003 and 2007. Water insufficiency and drought are not only water management problems. They have direct effects on people, on the natural flora and fauna, and on the economic sectors that use and thus depend on water, such as agriculture, tourism, industry, energy and transport. Droughts also increase the risk of forest fires. In order to cope with the water insufficiency and droughts, the first thing to achieve is to make industrial and household water uses efficient and economical. Water saving means energy saving as well, given that water abstraction, delivery and treatment are associated with high energy needs.



Picture 4.1 - Flood in Budapest in 2006

In Hungary, the importance of flood protection in water management is expected to grow; also because the total property value at risk in areas exposed to flood inundations is more than HUF 5,000 billion. Flood protection is encumbered by the facts that 95% of the surface water resources is of non-Hungarian origin and that water turnover means 112 km<sup>3</sup> and 118 km<sup>3</sup> of water arriving and leaving with the Danube, the Dráva and the Tisza, respectively.

In addition to large and medium-sized rivers, small montane and foothills watercourses will also have an increased risk of floods due to the higher frequency of rainstorms. The implementation of the New Vásárhelyi Plan may provide considerable assistance to coping with the flood waves in the Tisza, the river most exposed to floods. The objective of this programme is to improve the flow conditions of flood waves, and to ensure diversion to the reservoirs and containment of the flood. Figure 4.2 shows the flood reduction reservoirs and the interventions directed at improving the flow conditions, as proposed by the programme.

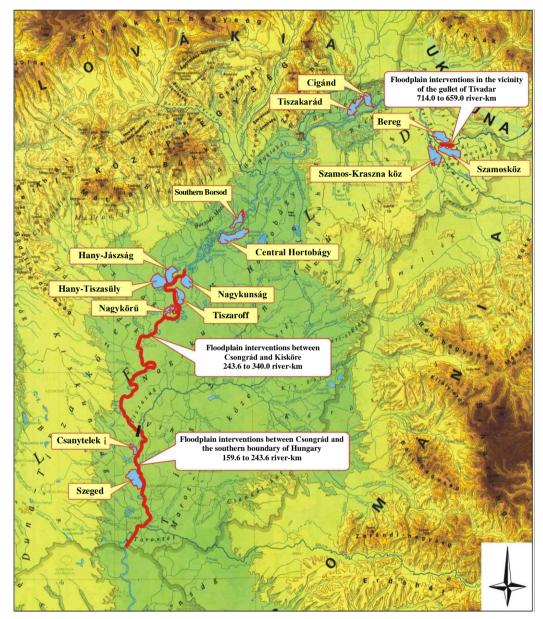


Figure 4.2 – Flood reduction reservoirs and interventions directed at improving the flow conditions, as addressed and proposed by the New Vásárhelyi Plan

Inland inundation is affected by land uses and land use changes; therefore, land uses and the fight against inland inundation should be developed in close harmony. It would be reasonable to identify the areas that are currently exposed to inland inundations and where the evaporation-enhancing, natural "pump-like" effects of forests could improve the situation in connection with the National Afforestation Plan; at the same time, the use of drainage water for irrigation purposes has a beneficial effect on afforestation. With the increase in global warming, irrigation will be necessary at higher frequencies, in higher quantities and in more places. On the other hand, when shaping the strategy of irrigation related to water management, it can be expected that plant growing practices will also adapt to the climate change, for example, through sowing crops with a higher drought tolerance. Irrigation projects based on smaller local water sources may also have to face problems because small watercourses will dry up more often, to a greater extent and for longer periods, which may reduce the safety of water supply. Intensively sinking groundwater levels in summers may have the same consequences. Under such circumstances, water reservoirs ensuring the safety of irrigation will have a more important role. The climate change will force a wider use of the water-saving irrigation technologies and the various micro-irrigation methods in any case.

The climate change will only affect municipal and industrial water management in an indirect way and in a longer run. However, when establishing wastewater treatment capacities, it should be taken into account that the water discharge rates and "natural self-purification abilities" of the watercourses serving as the recipients for treated wastewaters may generally decrease. Another factor to consider is that biological treatment technologies are primarily temperature-dependent and temperature increases may modify the coefficient of efficiency of the treatment technologies in the future.

The water balance of lakes may also change as a result of the climate becoming more arid, of the increased evaporation and of the reduced flow of rivers. Increasing evaporation may reduce the surface of several lakes, especially that of the already small ones and may extinct many of the lakes in the Great Plain. The water turnover in the three largest natural lakes, Lake Balaton, Lake Velencei and Lake Fertő, may slow down and the period of water exchanges may increase. Simultaneous increases in the average salt content and in the saline character of these lakes may also occur. Nutrient levels will probably rise, which will have unfavourable effects on oxygen levels and will thus improve the survival rate of bacterial pathogens.

Subsurface waters are also highly sensitive to the climate change. This fact is of particular importance given that approximately 90% of the drinking water supply and the water supply through public utilities in general is based on such water resources. The climate change primarily affects the recharge and surface extraction of subsurface waters, which are the edge conditions of their flow. The areas at the highest risk in terms of both groundwater and deep groundwater bodies include the Great Plain and – to a lower extent – the karst water resources of the Transdanubian Mountains. Increased evaporation may also cause a drastic reduction of the subsurface water resources.

As a result of the predicted climate change, increased floods and inland inundations and more frequent droughts are expected. In the practice of drainage water management, the tasks of water diversion, containment and storage should be given priority.

# 4.1.4. Agriculture and forestry

Agriculture is highly sensitive to the variability of the weather. The biological balance of the flora and fauna becomes upset from time to time as a result of the unbalanced season changes and this will affect almost all living organisms with relevance in agriculture, from soil microorganisms to pests. In recent periods, Hungary often had the problem of drought in one place and floods and inland inundations in other places. Such extreme water balance conditions represent significant farming risks.

The most important element of the adaptation to the extreme water balance conditions is to choose land uses in accordance with the current habitat conditions. Appropriate agricultural land use changes (conversion of arable lands to grasslands, afforestation of arable areas) may create a sufficiently stable production structure in Hungary; however, in the absence thereof, agriculture may become the sector most exposed to the climate change.

Ice rains are a significant risk factor in agriculture. According to the observations of the past 35 years, the ratio of ice rains within all insured damage types was 20.52%. Areas at the highest risk include Tolna and Baranya Counties in the Southern Transdanubian and the region between the Danube and the Tisza. The economic risks were diminished by the more wide-spread use of mesh protection, particularly in the vineyards of the historical wine production regions.

Within agricultural insurance schemes, the overall proportion of the damage caused by floods and inland inundations is 18.4%. On a national level, 100,000 to 150,000 hectares of lands are affected by inland inundation depending on the annual precipitation rates and floods. As regards the risk of inland inundation, the Berettyó-Körösvidék region is at the first place also as a result of the unfavourable local soil characteristics (high clay content, poor water conductivity, high storage capacity, high dead water content etc.) For similar reasons, the situation in the Tisza-Maros corner is also considered unfavourable.

40% of the agricultural areas of Hungary are affected by soil erosion damage specifically caused by rainwater. Besides agricultural areas, industrial and residential areas as well as the local infrastructure are also afflicted by erosion phenomena (e.g., siltation, mud inundation, landslide etc.).

Wind damage may potentially affect any agricultural areas. Wind erosion, i.e., deflation causes problems by sweeping away the valuable, nutrient-rich top layer of the soil and by burying growing plants. The most exposed areas include the region between the Danube and the Tisza, the Middle Tisza Region, the Győr Basin, the part of Great Plain near the Danube and the Nyírség Region.

Similarly to what was mentioned in the chapter on human health, easily propagating pests, pathogens and weeds may spread excessively as a result of the global warming. Furthermore, new species may appear by displacing the existing ones.

Depending on the species and the rearing method, animal keeping responds to the climate change in various ways. The climate change will have stronger effects on intensive animal keeping. Under intensive rearing, porcine, bovine and poultry animals show increased sensitivity and respond to certain shock effects by reduced performance. The extensive types – for example, Hungarian grey cattle, Mangalitza swine, Racka sheep and dunghill-hens – are characterised by higher adaptability owing to their genetic characteristics and the extensive rearing technologies. Animals will have increased water and shadow needs that should be specifically satisfied. During animal breeding, it is important to take account of the properties enabling a higher tolerance against the effects of the climate change besides performance and quality, and to improve the rearing conditions.

Even today, tree species in forests thrive at or near the boundaries of their natural range defined by the climatic factors. These boundaries only follow the spatial changes in climatic zones resulting from the climate change with a certain delay. The inevitable "correction" is expected to manifest in the form of massive destruction as a result of the increased frequency of consecutive extreme years, which may also lead to significant carbon emissions. The intensification of the climate change is likely to result in situations that will be even more severe than the massive tree loss in the 1980's and 1990's, and will also cause economic and ecologic damage. Warming will have unforeseeable effects on the weakening of trees and on the intensity and spreading of their diseases.

The tree stocks of the forest coverage primarily affected by the warming will include certain forest types in the Great Plain, the *Quercus cerris-Quercus sessiliflora* associations in the Transdanubian hills surrounding the plain areas, and the beech associations vegetating at the boundary of their range; the living conditions of most of the latter may disappear in Hungary. In addition to increasing the frequency of fires, warming also enhances the destruction capacity of them: the spreading rate and intensity.

# 4.1.5. Regional development, regional planning, settlement development, settlement planning and built environment

Today, the climate change is rarely taken into account when developing the built environment although summer heats have considerable effects on the sense of comfort of the people inside the buildings. In building planning, people and the construction industry primarily focus on reducing the heat losses in winter although heat insulation also contributes to summer heat protection.

More emphasis should be placed on the protection of buildings against the summer warm.

At the same time, it is a high priority of the construction authorities and insurance companies to restrict constructions in areas of flood risk by legal and economic means. Table 4.1 shows the effects of the climate change on buildings.

Increase in the average summer temperature by 1.5°C to 1.8°C	- The role of cooling will be higher, the internal temperature comfort cannot be ensured any more by general architectural planning but comfortable houses may be built by passive means (shading, heat storage, ventilation during the night).
	- The role of passive building planning means will increase.
	<ul> <li>In large city environments (heat islands), passive cooling means cannot ensure appropriate internal air comfort any more, but passive means remain sufficient in countryside environments.</li> </ul>
Decrease in the summer precipitation by approximately 7.5% to 8.9%	The irrigation needs of gardens and roof gardens increase.
Increase in the average winter temperature by 1.2°C to 1.4°C	The average heating energy needs decrease by up to 10%.
Decrease in the winter precipitation by approximately 8.2% to 9.7%	The safety factors in the calculation of snow loads still provide insufficient results for the actual loads.
More extreme fluctuations in the moisture content of soils	Risk to the stability of buildings via the foundation

Table 4.1 – Effects of the climate change on buildings

Special attention should be paid to the "critical infrastructure". This concept includes facilities, services and information systems the inoperability of which would have a weakening effect on national safety, the national economy, public health and public safety, and on the efficient operation of public administration.

Although no scientific analyses have been prepared on the critical infrastructure of Hungary, the National Emergency Management Directorate has been conducting studies in this field since 2001. The services that are decisive for the general public, i.e., electricity, gas and drinking water supply (sewage collection), are addressed as priority tasks, and the different branches of transport (road, railway, waterway, air), as well as communication, information networks, energy supply (electricity, fuel, coal, gas, central heating) and the conditions of flood protection facilities are being evaluated.

The increasing effects of the climate change appear as new factors of increasing severity to be considered in relation to the protection of the critical infrastructure, and the vulnerability thereof is enhanced by these factors. The probability of disturbances arising as a result of extreme weather events is expected to increase, especially in the fields of road and fixed pathway transport, electricity supply (damage to long-distance supply lines), drinking water supply (damage to drinking water reserves) and – in relation to these – public supply and info-communication.

4.2. While emission mitigation efforts in climate protection may only achieve their goal in case of a global cooperation, adaptation measures may also be successful individually on local and regional levels. However, it is also true that delaying actions may lead to subsequent natural, social and economic damage that could exceed the expenditure required to prevent and mitigate such effects by several orders of magnitude.

As regards the adaptation to the climate change, the IPCC Working Group dealing with the climatic effects, vulnerability and adaptation has set forth the following considerations:

- Society is already adapting to climatic effects by prevention and fighting but uses obsolete techniques and isolated solutions. These should be treated as initial considerations.
- The vulnerability of different regions of the world in terms of the climate change depends on climatic risks as well as the level of development of the given region.
- The enforcement of sustainable development makes countries more resistant to the effects of the climate change.
- Adaptation measures should not be in conflict with emission mitigation.
- The above-mentioned considerations serve as guidelines for the elaboration of both the sectorial and horizontal tasks.

### 4.2.1. Natural flora and fauna and nature conservation

Natural flora and fauna adapts in two ways: the fact that the flora and fauna can themselves adapt to the changing environment (autonomous adaptation) is the result of the self-sustaining and self-regulating ability thereof; however, the process of adaptation may also be facilitated by external intervention (planned adaptation). The main objective of the actions proposed by this strategy is to maintain or possibly enhance the inherent adaptation capacity of the flora and fauna. The main opportunity for mitigating the harmful effects of the climate change is the improvement of the adaptation capacity of the habitats to the climate change.

Natural ecosystems were exposed to climate changes in past geological periods as well, but the extent and speed of those changes were natural and the Earth was then covered by a contiguous natural landscape which allowed living beings to migrate. However, the situation is different today.

The adaptation capacity of the flora and fauna is largely dependent on the conditions of the natural habitat. The more natural and diverse the living system and its species diversity and water supply are, the higher the resistance and the adaptation capacity of the flora and fauna will be. However, the naturalness of the direct environment of the habitats (habitat mosaics), the diversity and richness of the production area and of the habitat, and the intercommunication within the wider cultural landscape for the various species of the habitats are equally important; therefore, it is vital to maintain or restore the natural communication between the habitats.

Evaluation methods based on the conventional economic approach are difficult to apply in case of nature conservation. Our economic and social life is based on otherwise limited natural resources and enjoys various benefits (services) of the ecosystems without expressing it in financial terms. Although there are methods to express the benefits in financial terms, it is impossible to provide precise calculations of the damage caused by the climate change or of the benefits of a given intervention (risk mitigation/prevention) in the field of nature conservation in contrary to several other sectors.

While under stable environmental conditions, many species and habitats can be conserved by maintaining natural areas of appropriate size, the conditions of the wider environment, which is mostly managed by other sectors, will have an enhanced role under a changing climate, when species are expected to migrate and habitats are expected to shift. In case of a significant climate change (the chance of which will be very high in the decades to come), it will be necessary to integrate nature conservation considerations into all affected sectorial activities in order to preserve the biological diversity. Adaptation cannot be successful without inter-sectorial cooperation and coordinated regulation. Mostly, this means the completion of ongoing programmes (agriand forest-environmental programme, forest management based on natural processes, ensuring contiguous forest coverage, the EU Water Framework Directive which takes ecological considerations.

Accordingly, the tasks to be completed can be divided into two main groups:

(A) In order to promote local adaptation, to preserve and increase the existing biodiversity and maintain and improve the naturalness thereof (also in non-protected areas):

- Nature conservation: elaborating the priority lists of habitats and species considered as sensitive to the climate change; preserving and regenerating the biological (landscape, species, genetic etc.) diversity; restoring the water retaining capacity of aquatic habitats and developing the possible means for ensuring extra water supply; implementing or continuing the necessary habitat reconstruction projects; preserving the heterogeneity, mosaic-like character and different successive stages of the habitats; introducing approaches that reduce the increasing risk of invasion and promote acceptable (least bad) colonisation; strengthening the monitoring activities in order to track the processes.
- Water management: eliminating the necessity of water drainage; operating the reservoirs in accordance with the ecological considerations; revising the system of water rights authorisation (soil and deep groundwater uses). Implementing the complex water management system specified by the Water Framework Directive in accordance with the ecological regulations and nature conservation considerations.

- Forest management: wider application of forest management practices based on natural processes, maintaining a contiguous forest coverage, applying natural forest renovation methods, converting forests which are inappropriate to the habitat and/or have non-native species, maintaining the park forests with lower closure in the forest-steppe zone, preserving the (landscape, habitat, species, successional, genetic etc.) diversity of forests and the natural processes and natural values of forests as much as possible; creating buffer areas in the vicinity of sensitive habitats.
- Agriculture: preserving or revitalising the elements of traditional landscape management (lawn mowing and grazing); creating buffer area in the vicinity of sensitive habitats and – especially in these areas but possibly everywhere – shifting towards less intensive farming methods that cause lower environmental burden; land use changes.

**(B)** In order to enhance the intercommunication through the landscape surrounding natural areas and to facilitate the migration of species (measures mostly related to areas currently without protection):

- Nature conservation: ensuring migration between the areas having natural flora and fauna; evaluating the areas with various protection status and the National Ecological Network in terms of climate change considerations, identifying the conflict points; developing the nature conservation areas and Natura 2000 areas and regular revision of the boundaries thereof in line with the movements of species and biocenoses.
- Water management: water management in accordance with the recommendations of the EU Water Framework Directive and taking ecological considerations into account; restoring the water retaining capacity of aquatic habitats, and developing the possible means for ensuring extra water supply. The water supply and water levels should follow their natural course as closely as possible and areas that were originally exposed to water coverage or currently affected by inland inundation should be given back to nature in accordance with the relevant sections of the New Vásárhelyi Plan. Water management in floodplains should follow the natural course as much as possible (e.g., water level management); review of the drainage systems; increasing the size of aquatic habitats.
- Forest management: separating the regulation related to natural-like forests and tree plantations; applying the conclusions of climate change-related forestry research studies in forest renovation; disseminating farming methods that are based on natural processes and ensure a contiguous forest coverage (according to the Pro Silva principles), reducing the size of areas where clear-felling can be authorised; establishing large scale forest plantations possibly using native tree species that are appropriate to the habitat, developing a system of field-protection forest belts, increasing the area of grazing lands with trees both in the existing forest zone and in the forest-steppe areas of the Great Plain.
- Agriculture: increasing the heterogeneity and mosaic-like character (balks, hedges, alleys, small land parcel sizes) of the agricultural landscape; applying soil and water saving technologies; prioritising extensive and ecological farming methods.
- Transport: incorporating nature conservation considerations into road track planning, enhanced application of the relevant rules in force; creating ecological corridors (corridors for wild animals) across main roads and motorways and planting hedges and forests of native species along their edges.

Horizontal tasks:

- Shaping the climate policy of the nature conservation sector and coordinating it with the forestry, agricultural, energy and water management sectors:
  - » enforcing the nature conservation considerations in the sectorial regulations and support schemes;
  - » coordinating the climate policy of the nature conservation sector with the agriand forest-environmental programmes, with the activities of the Water Framework Directive and with the rural development policy;
  - » integrating the ecological considerations of the climate change (e.g., preservation of biodiversity) into the regional regulation plans and authorisation schemes and into the system of means to be elaborated to ensure sustainable use.
- Establishing a permanent professional consultation body on inter-sectorial climate policy in order to improve adaptation activities and to facilitate the integration into other sectors.
- Widening the knowledge base, and initiating/continuing scientific research projects to study the effects of the climate change in order to ensure a more successful adaptation.
- Making society more conscious about the issue and increasing the involvement of people in the decisions on the measures and the implementation thereof.
- Establishing a national monitoring network in order to monitor the ecological changes related to the climate change, through integration into the existing monitoring systems, and possibly in connection with the international monitoring networks.

## 4.2.2. Human health

Primarily, people should be prepared to adapt to changes that they cannot control. Human health may be preserved and improved in an extremely large number of ways. Important tasks include:

- People should be kept informed of the possible risks (e.g., ozone alarms).
- The Climate Health Network already operating in the capital city should be extended to the whole country.
- A Heat Plan should be prepared, with particular view to prepare the general public.
- The internal organisational and operational structure of the public health care system should be revised in order to ensure an overall integration of the requirements of the climatic adaptation.
- The possibility of introducing additional vaccines and the existing vaccination practices should be reviewed.
- The conditions of the supply adjusted to the special needs of the population groups with increased sensitivity to the climate change should be established.
- It is important to ensure a continued adoption of the international experience and a continued increase of the professional skills in health care on all affected levels and based on the relevant research results.

- In relation to the increasing temperatures, conditions that do not present health risks should be established and required in both indoor and outdoor workplaces.
- Cooled rooms that are isolated from the heat and are also suitable for public use should be established.
- Urban "heat zones" that warm significantly and present health risks should be identified. Public transport should be extended and relief facilities (for example, drinking water wells, tree planting, cooled public rooms, general shading, ventilation) should be provided in these zones.
- When settlement plans are prepared and settlement structures are established, the possibility of urban heat zones should be taken into account as a realistic risk and the development of such zones should be prevented by conscious urban planning and cautious architectural solutions.
- The opportunities and necessity for amending construction standards should be identified with a view to enhance the compliance of the planned buildings with the changed weather conditions and the protection that the buildings can provide against the increasing temperatures.

#### 4.2.3. Water management

The use of subsurface water reserves as well as industrial and other water uses should be reduced in order to protect and preserve the quality and quantity of drinking water. The efficiency of wastewater treatment should be increased, and we should be prepared for both floods and drought periods.

Figure 4.3 shows the current subsurface water reserves and the consumption rates in Hungary and Figure 4.4 shows the changes in the subsurface water reserves and the consumption rates in case of an increase in the average emission by  $2^{\circ}$ C.

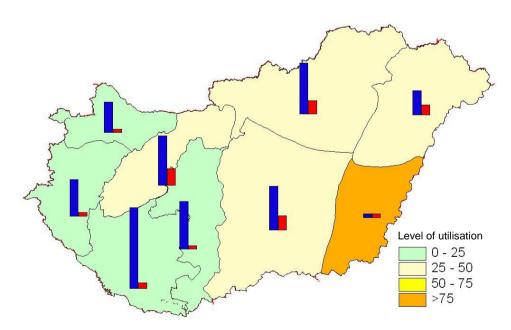


Figure 4.3 - Current subsurface water reserves and consumption rates

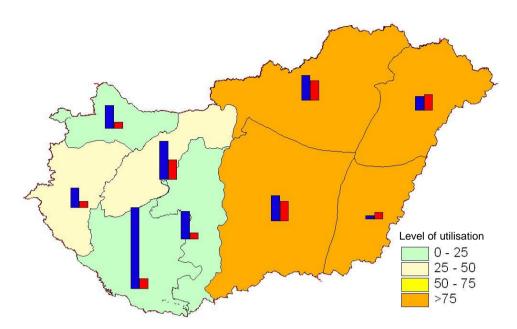


Figure 4.4 – Subsurface water reserves and consumption rates upon the climate change (in case of an increase by 2°C)

In the field of water management, the following measures must be absolutely adopted:

- New water-saving methods should be devised. Communication campaigns that promote saving should be launched. The efficiency of water uses should be increase partly by technology changes and partly by information dissemination.
- Water retaining should be promoted partly by a complex approach to the operation of inland inundation systems (e.g., subsoil loosening, review and possible renovation or abandoning of the drainage and channel systems), partly by the preservation and restoration of aquatic habitats.
- Implementing the New Vásárhelyi Plan.
- Addressing the climate change-related issues of the EU Water Framework Directive as priority tasks, particularly within the system of relations between climate change, water quality utilisation and good ecological conditions.
- Elaborating the flood risk maps and risk management plans required by the EU Flood Directive.
- Water supply based on subsurface karst water reserves requires special attention and significant investments and training due to the increasing incidence of larger rainfalls, in order to guarantee the safety of water supply.
- In the field of industrial water uses, sectors where water-based cooling technologies may be substituted by other technologies should be identified and possibly encouraged.
- Rainwater collection channels should be upgraded to be able to receive sudden large quantities of rainwater.
- The complex hydrological consequences of the climate change should be investigated and the knowledge base should be extended, with particular view to the areas of the water systems of the Danube and the Tisza that require international cooperation.

# 4.2.4. Agriculture and forestry

The main challenges in agriculture include the growing and breeding of species that are the most suitable under the changing conditions and the enhanced enforcement of the nature conservation considerations. While in plant growing, soil-friendly farming methods and water-saving cultivation methods should be used, in animal keeping, technologies should be improved. It would be useful to increase the biological diversity of the cultivated species and varieties by increasing the biodiversity of the cultures, and to preserve the traditional landscape types that have good adaptation capacity through supports granted for cultivation and through gene banks. Use should be made of the relative advantages of the climate change, for example, the increasing number of sunny hours should be used to increase the production.

In forestry, the tasks include increasing the size of forests, safeguarding the viability and biodiversity of forests and mitigating the risk of forest fires.

In order to achieve the above goals, the following measures and actions should be taken:

- Accelerating plant improvement and selecting the most appropriate variety range based on adaptation capacity studies. Besides performance and quality, the climate change should also receive emphasis in the improvement of animal species.
- Water-saving irrigation technology, multivalent cultivation serving the prevention of inland inundation and drought, improvement and dissemination of the technologies used in hail damage fighting.
- Establishing an information system in order to ensure water retention and a contiguous vegetation coverage in the most affected regions and to restore aquatic habitats. Wide-spread application of the approaches elaborated in the framework of the agri-environmental programme, including the implementation of nature-friendly farming in sensitive natural areas and in the Natura 2000 areas and their surroundings to as great extent as possible.
- Increasing the mosaic-like character of the landscape (balks, hedges, alleys).
- Increasing the number of animals belonging to native species through granting state support, and improving the conditions of extensive animal keeping.
- Insulation and ventilation of animal farms using "climate-friendly" methods by developing technologies based on renewable energy sources in as high percentages as possible.
- Environment-friendly use of the manure produced during animal keeping and establishment of a tendering system encouraging the collection and local use of the produced biogas.
- Providing the foundations of a new agricultural insurance system.
- Increasing the size of forests in line with the National Afforestation Programme and with the use of tree species which are suitable for the habitat conditions and are either native or otherwise appropriate according to the relevant investigations.
- Creating field-protecting forest belts, increasing the size of grazing lands with trees.
- Maintaining the park forests of lower closure in the forest-steppe zone.
- Revising the National Forest Programme in accordance with the climate protection objectives.

- Forest management taking natural forest dynamic processes into account and resulting in a contiguous forest coverage.
- Maintaining a stock of large wild animals that would not interfere with close-tonatural renovation methods and could be maintained in the long run, as well as mitigating the damage caused by wild animals by reducing the stock.
- Assessing the opportunities for fire risk mitigation, adopting forest fire prevention measures, and eliminating the most flammable types of plantations from the areas at high fire risk.
- Remediating the forests damaged by natural disasters as soon as possible.

# 4.2.5. Regional development, regional planning, settlement development, settlement planning and built environment

It is the responsibility of regional development and regional planning to identify regional development objectives and to ensure the potential for creating settlement networks and space use categories that take account of the effects of the climate change. When implementing development ideas that affect the climate policy, the role played by the local municipalities should be relied on and increased room should be provided for local decisions.

The tasks of regulating national and regional planning include:

• avoiding constructions in high-water beds (floodplains, foreshores) and waterside zones, water drainage and storage in order to facilitate water management in general.

### Regional challenges of the adaptation to the climate change: the Sand Plateau between the Danube and the Tisza

The Sand Plateau between the Danube and the Tisza is one of the most arid regions of Hungary. In this area, the significant decrease in the groundwater levels, the permanent and severe water insufficiency and the alarming signs of desertification have resulted in an ecological crisis which is also associated with economic and social problems.

Research studies suggest that natural factors, and especially the climate change, are mostly responsible for the unfavourable changes in the water conditions, which were also strengthened by the negative effects of human activities.

According to the climatic scenarios, the temperatures in the region between the Danube and the Tisza will increase to a greater extent than the global figures and the Sand Plateau is one of the most vulnerable regions of Hungary.

The annual mean temperature of the area may increase by 0.5°C to 1.9°C during the following 30 years and the amount of precipitation is expected to undergo a simultaneous decrease by almost 10% and the frequency of extreme conditions will be higher; the number of dryer years will increase and the number of years with more precipitation will decrease.

The adaptation to the expected negative effects of the climate change will be of strategic importance in this region in terms of resolving the ecological crisis of the area and of ensuring the conditions of sustainable development in a longer run. The central elements of this include retaining the local water reserves and establishing the potential for recharging, and the rationalisation of land uses, which serve both the preservation of the natural characteristics of the region and the sustainable utilisation of the landscape resources. In order to facilitate the recovery of the region from the current crisis, complex rural development programmes should be prepared to help to solve the economic, social and environmental problems of the region by concrete measures.

- avoiding construction in the areas exposed to inland inundations in order to reduce conflicts and prevent damage;
- avoiding constructions in areas at a risk of landslides or having other geological risk sources in order to avoid the risks enhanced as a result of the climate becoming more extreme;
- avoiding the accretion of the areas of settlements to be developed and not to be developed by constructions, in order to maintain the contiguity of the ecological network;
- preparing regional plans for the settlement aggregates (agglomerations of large cities, agglomerating regions, settlement groups) most exposed to conflicts (depletion of the natural environment, development of heat islands, damage to the ecological network);
- delineating the areas where afforestation can be considered, identifying the areas unsuitable for intensive agricultural uses.

The tasks of regulating settlement planning and development include:

- selecting land uses and construction rates with appropriate intensity that facilitate sustainable development (avoiding too high or too low population densities);
- protecting, maintaining and developing the system of green surfaces and green areas of settlements;
- promoting and applying differentiated settlement systems (by dividing larger cities into quarters and facilitating this at recreation areas and health resorts independently of size) in order to avoid heat islands and to facilitate resettling in close-to-natural environments;
- promoting compact cities and reducing the necessity for transport (between home and the workplace, between raw material resources and processing sites etc.) or at least minimising the growing thereof by mixed/combined and appropriate land uses;

increasing or at least maintaining the biological activity level;

- promoting rainwater management (storage and use in buildings and gardens);
- increasing the focus on areas affected by surface movements (avoiding constructions in these areas, elaborating special approaches for areas that already have buildings etc.).

As regards the built environment, architectural solutions that reduce energy consumption should be devised and disseminated to ensure wide-spread application. The tensions between the built environment and the natural flora and fauna should be reduced and another task is to ensure an enhanced protection of the critical infrastructure. In order to achieve the above goals, the following measures should be taken:

 Revising the construction standards and regulations in force and making requirements more stringent in line with the effects associated with the climate change (risk of floods and landslides, structural stability, external insulations, material fatigue), as well as conducting the experiments and technical calculations required for substantiating them.

- It is desirable that 30% of the territory of Hungary be left under the direct control of natural processes; as regards the rest of the country, the burden on natural areas should be reduced.
- Elaborating and disseminating methodologies for climate-aware construction (orientation of the building, prevailing winds etc.) among the experts preparing settlement and building plans.
- Ensuring regular sources of support intended for the improvement of the energetic performance of buildings.
- Providing architects and building material producers and suppliers with comprehensive technical information (climate-aware material quality and planning).
- Conducting joint comprehensive risk analyses for individual types of critical infrastructures by the emergency management organisation and the affected public supplier.
- Placing increased emphasis on ensuring ecological intercommunication when planning large scale infrastructural development projects (high-speed road network etc.). As a result, the uses of green areas should be restricted and green-field investments should be avoided.

# 5. IMPLEMENTATION OF THE STRATEGY

"Everything is difficult for one and nothing is impossible for many." István Széchenyi The most important consideration of climate protection is that the sooner society and the government realise the necessity of acting, the lower the costs will be. Measures facilitating the mitigation of the greenhouse gas emissions that cause the climate change and measures facilitating the adaptation to the harmful effects should be planned and applied as soon as possible. This is a high-priority consideration and is in accordance with the two basic principles of environmental policies, i.e., the principle of prevention and the principle of precaution.

In climate policy, mitigation and adaptation measures should be planned, implemented and controlled in harmony with each other and in a synergistic way. In case these measures are implemented without taking the principle of systems approach into account, they may weaken or even quench each other's effect and the associated costs may increase to an extent that would impair the efficiency of the measures.

During the implementation of these measures by the government, it is important that the measures of more than one affected ministries should be harmonised and the considerations of climate protection should be integrated in all political and governmental decision-making. Individual ministries already operate various support schemes to assist the different sectors in the fight against the climate change.

The success of implementation will largely depend on whether in addition to being able to manage the final result and the actual situation we can also cure the root of the problems. Climate policy objectives may be most successfully achieved if production and consumption become less material and energy intensive but this requires the cooperation of all social and governmental stakeholders.

Reducing the energy intensity of production largely depends on energy prices given that the market will only shift towards this direction if the investment is associated with cost savings. Figure 5.1 shows the main considerations of the climate protection efforts.

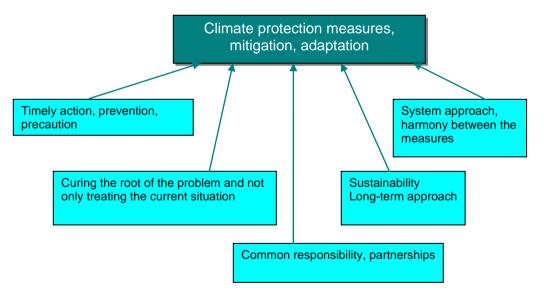


Figure 5.1 – Basic principles of implementation

The combat against the climate change is an issue that the state cannot solve with the means available to the government alone. Increased climate-awareness of society, strengthening of climate-friendly production and consumption habits, as well as lowering the energy uses and increasing the environmental awareness of the business sector and the cooperation and support of the media are also needed.

Different means are available to different social groups but it is vital to ensure that the various stakeholders use mutual cooperation and coordinated efforts to assist the implementation of the objectives laid down by the strategy. Below is a list of the means available to the different stakeholders in a tabular format:

Carranaant	development of on oppropriate logal/appropriate system;	
Government bodies	<ul> <li>development of an appropriate legal/economic system;</li> </ul>	
	<ul> <li>review and amendment of the support systems;</li> </ul>	
	<ul> <li>reinforcement and emphasizing of social awareness raising, showing examples;</li> </ul>	
Regions	<ul> <li>elaboration of a regional development programme and concept that takes account of the effects of the climate change;</li> </ul>	
General public	<ul> <li>reducing the consumption, and the material and energy uses, increasing their efficiency;</li> </ul>	
	life style changes;	
	climate-friendly transport;	
	continued attention to information about the climate change;	
NGOs	<ul> <li>raising and maintaining the attention of society and decision- makers to the issues related to the climate change;</li> </ul>	
	• participation in the work of decision-makers, social control;	
	mobilizing society, launching actions;	
Local	showing examples;	
communities,		
municipalities and churches	<ul> <li>exchange of information and experience;</li> </ul>	
Business sector	<ul> <li>reduction of the material and energy uses along with increasing the efficiency thereof;</li> </ul>	
	making the operation of companies more climate-friendly;	
	making products, services and company profiles green;	
	climate-friendly research and development, climate innovation;	
	<ul> <li>assumption of the responsibility by society with a view to protect the climate;</li> </ul>	
Media	<ul> <li>raising and maintaining the attention of society and decision- makers to the issues related to the climate change.</li> </ul>	

Table 5.1 – Various social players and the means available to them

The following chapter describes the means and measures with which the government may accelerate the redirection of the economy and society towards a more climate-friendly path.

5.1. The national climate change and energy management policy should be in harmony with the corresponding Community policy, which requires not less than a new industrial revolution within 10 to 15 years with the ultimate objective of creating an economy of low carbon dioxide emissions.

The NCCS applies to the 2008-2025 period and identifies the tasks in accordance with the international obligations. Government reviews will take place two years after adopting the NCCS, and every five years thereafter. In order to implement the NCCS, the Government will adopt a National Climate Change Programme (NCCP) for a two-year period. Within the Government, the ministry responsible for environmental issues will coordinate the elaboration and implementation of the programme and will discharge its duties with the participation of the affected ministries.

The government shall prepare annual reports for the Parliament about the implementation of the programme and the associated experience.

The steps of implementing the strategy will be assisted by the Climate Change Commission, a consulting body with members including the representatives of the affected ministries, of the Hungarian Academy of Science and of non-governmental environmental organisations, as well as an individual representing the rights of future generations and the key players of the business life. The minister for the environment shall be responsible for the overall coordination of the Strategy. A Climate Change Working Group composed of the leaders in high positions at the affected ministries should be created in order to establish successful inter-sectorial coordination and a harmony between the different sectorial policies of the government, and this Working Group may also create various expert subgroups as necessary.

The government should encourage and promote both the mitigation of the emissions of gases causing global warming and the adaptation to the climate change. In this regard, the concrete package of measures – the planning and situation treatment tasks – shall be included in the National Climate Change Programmes. These programmes will foresee the appropriate steps on national and regional levels. The following chapters describe the possible directions without using an order of relevance or claiming completeness.

# 5.1.1. Means of the government for the mitigation of the climate change

Awareness-raising, the regulatory role of the government and the acts of society should be addressed together. The government should devise regulatory means that induce changes in the entire structure of production and consumption while simultaneously promoting the environmental awareness and the desirable change in the productionconsumption habits of all social players.

The government has several means to direct the social players towards low-emission technologies and solutions while it should of course take the load-bearing capacity of the general public and the economy into account throughout the whole process. The governmental means devised for the implementation should only be applied in accordance with the load-bearing capacity of the central budget and with the legal background of Community support schemes.

However, various factors may hinder the implementation of the emission mitigation measures recommended by the NCCS. The inappropriate operation of the market or the state in relation to the climate change (failures by the market and government), various socio-economic circumstances and technological conditions may make the necessary steps difficult. Primarily, the following tasks are necessary:

- Eliminating "market failures" in order to ensure the dissemination of climate-friendly solutions that are already profitable but still not in wide-spread use. The possible methods to achieve this include:
  - » Facilitating market competition in areas that are important in terms of climate protection, particularly in the energy market. Namely, the lack of competition is the cause of the higher consumption rates in many cases (e.g., unsparing consumption due to the non-controllability of the consumption of central heating).
  - » Eliminating information limitations because the lack of the necessary information also represents a limitation on the dissemination of profitable investments. The costs saved by energy saving are normally not indicated although it would provide consumers with an important piece of information to consider. For example, the labelling on household appliances or the energy certificates of buildings, as well as the indication of the consumption and carbon dioxide emission rates of personal cars are used to meet this goal.
  - » Elaborating loan schemes to encourage investments characterised by high initial investment costs but by a short rate of return. These include building insulation, as well as the wide-spread use of low-energy bulbs.
  - » A market pricing of carbon dioxide should be ensured. Namely, emissions without a price or with an inappropriate price would impair the competitiveness of climate-friendly products and services. In addition, this would ensure a continued predominance of technologies that could be unfavourable for future generations. One means of the government in carbon dioxide pricing is to ensure the conditions for emissions trading or to levy an emission tax.
  - » Granting support for investments or for operational costs may also be necessary in certain cases. Given that this would require public expenditure, it is only recommended to be applied in case previous steps are not enough for achieving the desired result.
  - » Part of the price compensations for the general public should not be granted in the form of direct support but should be invested into the efficiency of their energy uses, which would result in a long-term reduction of the energy costs.
- Furthermore, eliminating "government failures" in order to strengthen the contribution of the government, the possible means of which include:
  - » Increasing the focus on climate protection considerations and making them legally obligatory when elaborating the support and incentive schemes and the sectorial policies of the government. Eliminating support schemes that are harmful in terms climate protection by revising the investments implemented using state funds.
  - » Preparing an environmental tax reform, which shifts the loads from taxes that are unfavourable in terms of welfare (e.g., labour taxes) to those that are favourable in terms of welfare (e.g., taxes on environmentally harmful activities such as resource uses or contaminations). In addition to environmental benefits, it will also induce employment benefits and will honour processes that treat resources (raw materials, energy etc.) more efficiently.

- » Making energy efficiency and climate-friendly solutions the primary selection criteria in public purchases.
- » Emphasising the exemplary role of the public sphere. The technologies and operational principles used by public institutions may penetrate into additional sectors of the economy via the employees of and the companies in contact with such institutions. In addition, public institutions using energy-efficient equipment and introducing such operational principles may achieve significant public cost savings.
- Social and economic circumstances
  - » Addressing the adverse interests in certain measures. One example is that the lack of interest from the part of energy producers, traders and suppliers in the implementation of energy saving measures may act against such measures.
- Technological circumstances
  - » Supporting demonstrational programmes that play an important role in climate protection (e.g., creating systems enabling carbon dioxide separation and storage in wind power stations, establishing hydrogen storages, constructing public buildings with zero energy consumption).
  - » Disseminating standards and technological knowledge that are positive in terms of the climate.

### 5.1.2. Means of the government for adaptation

Adaptation requires a fundamental change in the approach of the entire society. This change will be much easier if people do not perceive it as coercion but as a shift that brings improvements.

People need to switch from the approach of fighting against "natural disasters" to that of preventing them, of consciously adapting to the effects of the climate change and of living together with its consequences. The potential risks inherent to human behaviour should be considered with special care and at a high professional/scientific level during the planning of the means facilitating the implementation of the Strategy.

#### > Education, training, awareness raising

It is important to extend the education related to everyday knowledge on the justifiability and processes of adaptation at all levels of public and adult education (including the training of the political elite). In addition to transferring the relevant information, the objectives include (a) learning a problem-oriented, flexible, general adaptive behaviour, and (b) learning to solve practical situations and problems related to the effects of the climate change. The most important activities in this field include: behaviour in preparation to preventive fighting and utilising the capacities for grassroots activities and self-supporting.

It is absolutely necessary to facilitate a change in social approach (cooperation, common assumption of responsibility) in relation to individual social groups. The first important step is environmental education: promoting environmentally aware behaviours and environmentally responsible lifestyles, and ensuring that within the environmentally aware point of view, climate awareness accompanies our entire life starting from early childhood through various age groups. Establishing regular information dissemination campaigns that would affect people's behaviour<sup>5</sup>, encourage good adaptive behaviour and reach as many layers of society as possible; and harmonising the contents thereof. It is of vital importance to emphasise that the reasonable response activities of climatic adaptation may also result in social, business and international political benefits. Information dissemination should place special emphasis on the possible positive and negative interactions between adaptation means and mitigation means.

It is important to provide regular, consistent and practical information and to operate information systems that are geographically close to the people and deal with local problems (regional and local levels).

#### > Research and development

During its implementation, the Strategy wishes to pay special attention to the scientific work related to the effects endangering our values to be preserved and to research projects related to systems particularly sensitive to the climate change. For announcing research topics in the form of projects for players of the research, development and innovation (R&D&I) network, the following main research areas can gain focus:

- Assessing the lack of information in the climatic adaptation of the country and analysing the causes that induce and maintain it.
- Granting special support to Hungarian climate meteorological and climate-related hydrological research studies in order to increase the accuracy of probability forecasts of increasing depth in both space and time that enable a genuine substantiation of the decisions expected in the future.
- Identifying the possible irreversible consequences of the climate change in physical, biological and human systems in order to have a better understanding of their mechanisms.
- In relation to the vulnerability and risk analyses, conducting economic calculations in order to analyse the losses deriving from non-action and to calculate the benefits of prevention in all affected sectors (e.g., health care, water management, plant growing, infrastructure).
- Assessing the positive interactions complementarity, synergy between adaptation and sustainable development to the required depth.
- Assessing and analysing the close relationships between adaptation and mitigation, selecting and applying solutions that are favourable in terms of both.
- Research projects and action plans providing the basis for importing new research and innovation achievements and successful applications developed by international organisations and European countries in the field of climatic adaptation. With particular attention to identifying the conditions of all those flexible adaptation alternatives that could ensure the tolerance to the increasing climatic shock(s) associated with enhancing burdens and the efficient addressing of unexpected events.

<sup>&</sup>lt;sup>5</sup> According to the Stern Review, one of the most important elements of the response activities is to induce behavioural changes, which facilitates emission mitigation and – to an even greater extent – the issue of adaptation.

- Active participation in the international system of institutions and networks for adaptation, exchanging information and experiences.
- Exploratory analysis of the social and institutional obstacles and the factors causing the difficulties of (social) learning, and addressing and developing solutions to these problems.
- Investigating the solutions used by Mediterranean regions in the field of urban planning, architecture, public services and lifestyle and the possibilities for implementing them in Hungary in order to import the most efficient technologies and methods ("know-how").
- Investigating the complex effects of the climate change on cities (e.g., urban planning, mortality caused by heat waves, green areas, roads, conditions of buildings, water quality, water retention, waste management etc.).

#### > Development and extension of the databases and monitoring systems

It is vital to gradually establish the national open knowledge base of climatic adaptation in a network format and to ensure full access thereto. The regularly updated data and information stored in the corresponding IT systems include the entire range of national climatic data and forecasts, as well as detailed information on the system of regulations related to adaptation, the practical technologies and methods and the international experience for each affected sector and social activity. Tasks to be solved include the collection and exchange of domestic experience, as well as the improvement of the measures and taking additional steps depending on such collection and exchange.

Database development: assessing (a) cost, damage and results data and (b) data related to naturalities and any associated supplementary information that provide the basis for the sectorial and overall future decisions and indicator systems to the required and sufficient depth; establishing data systems, gradually initiating data collection and processing, and developing and connecting the existing databases.

Improvement of the monitoring systems: gradual establishment and operation of instrumental monitoring systems satisfying the special information needs of climatesensitive areas and sectors in making adaptation decisions, with particular view to reasonable intersectorial cooperation and professional coordinability. Improving and developing the existing monitoring systems and extending them to include measurements of the direct and indirect effects of the climate change.

Adaptation requires an efficient and rapid cooperation between a number of regional or central state agencies. Several agencies are already conducting activities in the field of adapting to the effects of the climate change; however, the establishment and development of the databases and rapid and direct connections are urgent tasks due to the increasing weather extremes in the future. It is important to improve the flow of information between individual authorities and to strengthen the efficient joint actions thereof. Table 5.2 shows the government agencies with tasks in various fields of adaptation.

ricultural institutions, professional organisations, and authorities, ofessional bodies and hunting agencies (hunting associations) aling with animal health, food production, plant protection, grape d wine production, hunting and soil protection restry authority, notary, inspectorate, national park directorates	
restry authority, notary, inspectorate, national park directorates	
Forestry authority, notary, inspectorate, national park directorates	
National park directorates and inspectorates	
Health agencies, general practitioners, local organisations of the National Public Health and Health Officer Services, National Ambulance Service, inspectorate, epidemic control agencies, emergency management organisation, fire fighting services	
cal municipalities, chambers of engineers, inspectorates, itional Public Health and Health Officer Services	
n n c	

#### > Additional means

The role of the insurance sector should be re-interpreted. The weather is becoming more and more capricious and this increases the losses of this sector and also presents an indirect burden on many layers of society depending on the type of damage. Partly because of this and in order to ensure a more just distribution of the burdens, it will be necessary to elaborate a governmental risk assumption and risk financing scheme organised around a new basis that takes account of the increasing effects of the climate change and extends the scope of risk assumption.

Recommending the introduction of a requirement for preparing sectorial climate policy programmes in relation to the sectors most threatened by vulnerability in terms of adaptation.

The responsibility of climatic adaptation should not only be assumed by the government and the local municipalities but also by the business sphere, by the NGOs and – to a significant extent – by the local communities, i.e., by the citizens. The objectives specified in this strategy may only be successfully implemented provided that society understands and accepts them and actively participates in their implementation.

The consumption behaviour of society plays a key role in the emission levels because the extension of the range of products, services and opportunities has resulted in an unsparing use of resources, large-scale generation of wastes and other environmental damage. Therefore, society can influence the emission levels both directly and indirectly through its consumption and thereby can also influence the extent of the climate change.

Successful implementation of adaptation is impossible without the active support of society. One example is water consumption, which will certainly become a key issue in the periods to come. In drought periods, it will be especially important that society realises the necessity of restricting water uses and that people use water sparingly.

In the future, the migration associated with the climate change, i.e., the addressing of the issue of climate refugees, may represent a difficulty of increasing severity.

5.2. Social tasks Emigration due to the changes in climatic conditions may give rise to serious social concerns to which society should also be prepared.

The following chapters describe the possible tasks of each social player required for the efficient implementation of the Strategy.

## 5.2.1. General public

People and households can contribute to the highest extent to the modification of the macrostructure of consumption. By reducing their consumption or redirecting it to a sparing path, they will also reduce their emissions and costs. Households may contribute to the implementation of the objectives of the NCCS in three main fields:

- A more sparing material and energy consumption would result in emission mitigation and costs savings in the households. The most fundamental factor is that households should try to use products as long as possible or at least to prevent waste generation if the former is not feasible. People should reach the level of understanding the phenomenon that not all resources (including, inter alia, water, energy, electricity) are available in unlimited amounts and will therefore learn to use them sparingly and efficiently.
- The general public has a key role in the field of transport. People have more means in the field of transport; on the one hand, they may minimise the number and frequency of journeys and rationalise them (e.g., more people travelling by the same car) as much as possible or may choose public transport. On the other hand, people should choose means with smaller ecological footprint (for example, railway, bus) when planning long-distance journeys. Road traffic rates have been increased by 3% to 4% annually since the mid-1990's. Similarly, the proportion of individual transport is steadily growing. Sooner or later, the increases in the market price of fuels are likely to force people to get out of their cars, but it would be better if people chose it consciously.
- It is important that the people consume in a climate-aware manner. In addition to looking at the prices, they should also take other factors affecting the climate change into account. For example, these include the fact whether the product was manufactured locally or was transported through several countries.

### 5.2.2. The business sector

The players of the business sphere may influence the implementation of the objectives of the NCCS both directly and indirectly. The business world includes a wide range of entities such as manufacturers, distributors, wholesalers and retailers, service providers, consulting companies, private companies and enterprises.

According to public opinion surveys, two fifths of the Hungarian companies pursue some type of social activities or take conscious steps for the protection of the environment. However, only the top 8% participates in climate protection initiatives or has elaborated a climate policy strategy.

The participation of companies in the social assumption of responsibility and the creation of voluntary associations for climate protection purposes are typically characteristic of more developed business cultures. It is an important factor to consider that investment decisions today pay more attention to whether the company is willing to undertake environmental and climate protection tasks. Today, many environmentally aware consumers prefer manufacturers and products that participate in such actions. In addition, more and more companies aim at introducing climate protection measures such as energy saving measures, environmentally aware corporate management systems and life-cycle approaches in their operation.

The above-mentioned research has revealed that the social commitments of Hungarian companies depend on the culture taken over from the parent company rather than being a characteristic feature of the sector or country where the company is operating. Therefore, Hungarian companies should participate more consciously and more intensively in this field.

The business sphere may contribute to the objectives specified in the NCCS in the following ways:

- By rationalising the resource, energy and material uses and by implementing adaptation measures that do not interfere with the mitigation objective related to climate protection (e.g., passive protection instead of air conditioners or reduced use). Companies can achieve cost savings by this.
- By making their products, services and corporate profile "greener", for example by placing appliances with higher energy efficiency on the market and by withdrawing less efficient products. In many cases, companies can widen their clientele by this measure.
- By undertaking mutual commitments between companies through voluntary agreements. Multinational companies have already undertaken commitments to mitigate their carbon dioxide emissions and to reduce their ecological footprint.
- They increase their share of responsibility in the field of climate protection for example by participating in awareness raising programmes and by cooperating with NGOs.

# 5.2.3. NGOs

Non-Governmental Organisations (NGOs) play an important role in social awareness raising, inter alia, in topics related to consumption habits, energy, transport and nature conservation. In many cases, it is the actions of green organisations that make the general public think of the most important climate protection issues. The most important task of the NGOs is to mobilise society and to convey the climate protection messages to people and to provide society with information in order to help in deciding what could be done against the climate change.

- NGOs have already achieved several results through awareness raising campaigns and actions. In the future, their most important task may be to facilitate the implementation of the objectives of the NCCS through their active relationship with society.
- Through their long-term approach, NGOs may contribute to the operation of the Strategy by participating in the control tasks. In addition, it is important that NGOs also participate in the elaboration and implementation of the action plans related to the Strategy.
- NGOs have an important role in drawing the attention of decision-makers to the importance of the climate change and to the necessity of taking appropriate measures as soon as possible. Through their activities and actions and – in many cases – through their initiatives (research, expert opinions, consultations with the general public etc.), NGOs may significantly contribute to the achievement of considerable results.

## 5.2.4. Local communities, municipalities and churches

The Strategy may only be successful in case of the development of a common social responsibility and commitment towards the future. The Report of the UN Commission on Sustainable Development published in March 2007 under the title "Combating the climate change" also recommends that impact assessment and adaptation issues should typically be local tasks and points out that there may be several common features between the actions required in various areas or economic sectors. In climate protection, it may be more efficient to elaborate both mitigation and adaptation solutions on a local level than to have the government trying to regulate all possibilities in advance by centralised measures.

Settlement Climate Programmes are already in place in several settlements in both Europe and the United States: on the one hand, these settlements try to adapt to the climate change as much as possible and to minimise the negative effects thereof; on the other hand, they try to mitigate their greenhouse gas emissions. It is also extremely important in Hungary that as many regions and settlements elaborate concrete local ideas and measures related to the climate change as possible. These measures are not legally binding but are optional parts of action programmes and may also produce favourable results for local municipalities.

Local communities may promote self-organisation and also have to bear great responsibility in terms of showing example. Namely, something that somebody has already "tested" and is "apparently" working well often spreads as solution. One part of society does not invest in projects using renewable energy because they would not dare to start new investments even if they were aware of the possibility and had the required funds. Local communities may also play a key role in disseminating investments and solutions that improve energy efficiency (e.g., local energy co-generation).

Typically, the questions related to energy efficiency and the sparing use of water are issues for which solutions can be more easily found on community level than on the level of individual families. Local communities know the local possibilities and the local people, and may devise more efficient solutions for achieving the objectives of climate protection provided they are otherwise willing to take joint action in this field. Local communities play a key role in coordinating between citizens, in keeping people informed and in receiving direct feedback from them.

Schools, kindergartens, public institutions and public education centres have a vital role in this process because they may raise the awareness of the subsequent generations and may change the existing less climate-aware approaches by consciously representing socially desirable forms of behaviour.

Throughout history, churches and religious communities have always played a key role in educating and shaping the approaches and lifestyle of society. Today, it is not less important that churches and religious communities convey messages in harmony with the protection of the Earth to people.

## 5.2.5. Media

Recently, environmental issues and climate protection have become popular topics in written and other media. The media has a vital role in drawing green topics – especially the issue of the climate change and that of making all layers of society aware of the tasks specified in the NCCS – into the focus of attention and to maintain them on the agenda. The fact that the topic is of increasing popularity is not accidental because the issue of the climate change is a factor that increases the number of spectators, and society is more interested in this phenomenon and in the expected or predicted consequences.

As a result of the alarms by scientists and based on their own experiences (the storm on 20 August 2006, hail in 2007, storms, drought, heat, mild weather in winters), people have recently started to realise the actual change of the climate, the overuse of nature and the effects thereof on the environment and on the animals and plants living on the Earth.

Public opinion surveys related to the climate change revealed that the number of publications in the press about the challenges of the global warming and global climate policy was 5 times higher during the first 6 months of 2007 than during the 12 months of 2006 (approximately 2.5 times higher). It is expected that the press will cover the issue even more frequently in the future. Media may also act as a driving force by continuously reminding political decision-makers and economic sectors of the importance of the topic by speaking about climate change-related issues. Furthermore, media provide opportunities for the dialogue with the NGOs and ensure feedback to the Hungarian leaders in the field of climate protection.

The key role of the internet, which has become available for many by today, cannot be ignored in this accelerating world. In order to ensure a rapid flow of information, it is important to publish appropriate information materials about the topic for various age groups and to create websites encouraging sparing uses and providing information on climate events.

The costs of the measures foreseen by the NCCS and in the future National Climate Change Programmes cannot be accurately specified in advance; therefore, the detailed cost estimates of implementation will be included in the action plans. International cost analysis studies are being published in the field of climate change. Two international analyses are worth special attention.

### 5.3. Costs and benefits

#### > The Stern Review

The Stern Review<sup>6</sup> published in the autumn of 2006 suggests that the climate change represents the biggest challenge ever faced by the world economy. According to the Stern Review, mitigation of the greenhouse gas emissions should be considered as an investment into the future because the advantages of efficient and rapid emission mitigation far exceed the costs thereof. The authors of the Stern Review used economic models to assess the costs of achieving emission mitigation as a function of the target levels.

According to the Review, the overall GDP of the world may range between +4% and -12% in case of a 80% reduction in comparison with the 1990 levels. Our studies suggest that 1% of the GDP should be sacrificed annually for the purpose of stabilising the greenhouse gas concentrations at the level of 550 ppm by 2050. On the other hand, non-action may result in a loss of global GDP by 5% – or by up to 20% according to the worst case scenarios – for the world economy in a few decades.

A comprehensive interdisciplinary analysis coordinated by Sir Nicholas Stern, a former senior economist of the World Bank (Stern Review: "Stern Review on the Economics of Climate Change - Climate action now will avoid future economic chaos", 31 October 2006).

The results described in the Stern Review should be further refined, especially because the tools available to economics cannot easily address the complex system of processes of the climate change.

#### > Cost benefit analysis of the European Commission

In the framework of the energy-climate package published by the European Commission in 2007, an impact assessment was made to investigate the order of magnitude of the costs of emission mitigation for 2020.<sup>7</sup> The model used for the analysis simulates the expected course of greenhouse gas emission mitigation and the effects thereof on the GDP of the EU.

The main conclusions of the assessment include:

- Provided that developed countries outside the European Union and the most developed developing countries also make commitments, the mitigation objective of the EU would be 30%. The cost of this is a 2.8% GDP reduction by 2020.
- Two scenarios have been prepared for the case the EU undertakes a unilateral commitment for a 20% reduction. Provided that the price of carbon dioxide emission allowances will be high, then GDP will reduce by 1.4% in 2020 in comparison with the situation without carbon limits. According to the other scenario with lower carbon dioxide prices, the effect on GDP would be minus 0.3%.

However, on the basis of these assessments, it may be concluded that the costs of delaying actions are always higher than those of timely and coordinated actions. The costs of current emission mitigation and adaptation measures are lower than those of similar measures taken after 2012, or than the buying of emission allowances by Hungary at a later phase. It is economically reasonable that Hungary should turn to a more climate-friendly sustainable development path as soon as possible. The total cost of implementing the NCCS will have an effect on the entire economy and will affect all households. However, the implementation not only entails financial burdens but also represents opportunities for macroeconomic and household-level savings. One well detectable example for this is the improvement of energy efficiency, which results in significant savings for the families, improves the income generation capacity and competitiveness of enterprises and may also contribute to the creation of new jobs.

The government will assign the required funds for biannual climate change programmes or longer-term activities in order to implement the NCCS. In addition to the available funds of the central budget, the government will also spend the income from the international or EU Emission Trading Schemes for mitigation and adaptation purposes. The use of this income will be defined by the government in view of the recommendations of the Climate Change Committee.

The joint implementation projects within the frameworks of international flexibility mechanisms will also serve the implementation of the objectives specified by the NCCS. Joint implementation projects may be supported primarily in the following fields: energy efficiency improvement, biogas collection and utilisation, geothermal energy uses and afforestation.

<sup>&</sup>lt;sup>7</sup> European Commission Staff Working document accompanying to the Communication From the Commission to the Council, The European Parliament, the European Economic and Social Committee and the Committee of the Regions. Limiting Global Climate Change to 2 degrees Celsius: The way ahead for 2020 and beyond Impact Assessment, Brussels, 2007

In this case, the Hungarian government will essentially support emission mitigations achieved with the help of non-Hungarian investors by emission allowances.

Another possibility is to trade in the emission quantity allowances in the international emission trading scheme. Similarly to other Central European countries, Hungary is expected to have emission levels below its Kyoto commitments. The resulting extra emittable Assigned Amount Units (AAUs) may be used to trade with other states that have ratified the Kyoto Protocol or with persons authorised to trade in such units. According to the provisions of the NCCS, the generated income can be used for reducing greenhouse gases, for afforestations, for maintaining existing forests (extension and maintenance of sinks) or for adaptation.

Several ministries already have tenders in place to facilitate energy efficiency, energy saving, emission mitigation or carbon capturing by afforestations. It is important that these support schemes should be operated in harmony and in synergy with each other.

The income from the Green Investment Scheme (GIS) will be used by the households & institutions sector to increase the energy efficiency of existing buildings. The expected annual income of the GIS will be up to HUF 7.5 billion between 2008 and 2012. The allowances allocated against payment under the Emissions Trading System may generate additional income in an estimated amount of HUF 3.3 to 3.7 billion. Obliging the general public to take some low-investment measures producing net financial profit could result in savings of up to HUF 30 billion per year. The Environment and Energy Operative Programme includes approximately HUF 110 billion for green energy development projects. At an average need for support of 25%, a total investment of HUF 440 billion is expected in the fields financed by the Environment and Energy Operative Programme alone until 2013. It is recommended that this measure be implemented in a manner requiring an investment with zero or negative net cost.

The National Climate Change Strategy will not necessarily reduce but even increase the development potential of Hungary because a change in the international economic environment is predicted in which the "carbon-intensity" of a society and economy will also affect the economic and social success of the given country. Protection against the climate change may generate other positive additional benefits, e.g., air emissions may be reduced, which makes the economy "cleaner". The mitigation of emissions and the adaptation create new jobs in the environmental industry, energy industry, agriculture, transport, construction industry etc.

In the field of adaptation, from the preparation of the health care sector to the implementation of the Vásárhelyi Plan, to taking regional population retaining measures, to introducing alternative transport modes, from increasing the drought tolerance of agricultural production to settlement planning solutions, there are several measures with mutually synergistic multiple objectives and with development needs amounting to several hundred billion forints in terms of all income holders, whereas the amount of damage thus avoided is at similar annual levels.

#### **Green Investment Scheme**

The operation of the Green Investment Scheme (GIS) is regulated by Government Decree No. 323/2007 (XII. 11.) in force as of the 1st of January 2008. The GIS creates an opportunity for Hungary in the first (Kyoto) commitment period, that is, between 2008 and 2012, to sell its excess emission quota at a higher price than otherwise.

The basis for this is that the GIS guarantees that the income will only be used for financing emission mitigation programmes and investments in a manner that is transparent and controllable for the buyer country (hence the adjective "green"). The measures of the NCCS will not only result in macroeconomic benefits but also allow people to achieve significant savings in the field of energy consumption. They will strengthen social cohesion, enhance people's sense of safety and promote sustainability.

### 5.4. Implementation monitoring

A detailed system of indicators should be developed in order to monitor the implementation of the NCCS and the National Climate Change Programme elaborated on the basis of the NCCS and to measure the results of the actions. This is particularly useful in emission mitigation but indicators representing the climate efficiency of the economy or the extent of carbon dioxide mitigation are also worth introducing (e.g., greenhouse gas emission per GDP unit, emission per capita, energy intensity etc.).

Measuring adaptation measures is much more difficult and complex. Primarily, it is difficult to verify to what extent adaptation occasionally counteracts mitigation objectives or is in harmony with them. For this purpose, a database, an information system and an institutional background collecting and analysing adaptation-related information should be created. The institutional background may be established within the structure of the ministry for environment. This institution will also be responsible for monitoring.

The principles of accountability and transparency should be applied both during the revisions of the Strategy and during the preparation of the annual reports on the programme. The reports submitted to the Parliament should be easy to understand, focused to the point, verifiable and publicly available. In addition to the reporting obligation of the government, the involvement of an independent organisation that would monitor the efficient and successful implementation of the NCCS and of the National Climate Change Programmes should be considered.

According to the international commitments, Hungary also has to prepare reports on the fulfilment of the concrete commitments towards both the United Nations and the European Union. This particularly applies to the emission mitigation objectives undertaken in the Kyoto Protocol. Hungary submits annual reports on the greenhouse gas emissions (GHG Inventory) for the UN and the EU. Furthermore, Hungary prepares regular national reports for the United Nations.

## Carbon dioxide intensity

The fact that relatively low carbon dioxide emissions are associated with the generation of one GDP unit in Hungary, indicates efficient industrial energy uses in a regional comparison. In 2005, 233 tons of carbon dioxide were emitted by Hungarian industrial facilities belonging under the EU Emission Trading Scheme to generate a GDP of USD 1 million.

Only Latvia has a lower "carbon dioxide intensity" among the countries of the region that joined the EU in 2004 (178 tons per USD 1 million).

Estonia has the worst indicator (769 tons) followed by Poland (666 tons) and the Czech Republic (659 tons).

These numbers may be used as indicators of the specific energy consumption of the industry but do not sufficiently reflect the overall energy efficiency of the country. The companies under the emission trading scheme cover 30% to 40% of the overall greenhouse gas emissions and energy consumption in both Hungary and the EU.

In addition, Hungary has to prepare biannual reports to the EU on future greenhouse gas emissions and on the implementation of the climate policy measures. On the basis of the data provided by the Member States, the European Commission prepares annual progress reports on the achievement of the Kyoto objectives. In addition, the European Union publishes annual reports on the emissions registered in the emission trading scheme operated by the Member States.

With the leadership of the EU, an international network is being designed in order to monitor the adaptation efforts and this will be intended to facilitate the exchange of climate protection effects, information and experiences between individual Member States.

Both the national and international reporting obligations reinforce the principles of transparency and international comparability; however, the collection, processing, evaluation and regular publication of the data imposes great burden on the administration. This also requires allocating appropriate human and financial resources during the implementation of the NCCS.

NGOs will have an important role to play by participating in the work of forums controlling the operation and implementation of the Strategy. In this regard, the government not only counts on their support in elaborating action plans but also in assessing and monitoring the results even by the use of their own assessments and information systems.

Social processes	Mitigation "Avoiding the unmanageable"	Adaptation "Managing the inevitable"	
Human health	Health losses resulting from heat waves may be up to 0.5% to 1% of the GDP	Efficient adaptation to the expected effects of the climate change may reduce the health losses	
Social and political	Aggravating conflicts between the general public and the central administration as a result of the increasing energy prices Launching energy efficiency programm support from the central budget) will reveal to the social conflicts and may create long-ter		
safety	Conflicts between energy producers and the central administration as a result of including the social cost of carbon	uniformity of interest between the general public and the central administration.	
	Pressure to soften the social cost of carbon		
Migration	Evacuation of more than 200 million people by 2050 owing to the increasing sea levels.	As a result of efficient adaptation, no significant migration is expected	
	Hungary can be affected as a potential host country		
unerences	Increasing the proportion of biofuels slightly reduces emigration from the rural areas.	By 2015 to 2020, the increase in energy efficiency and the decrease in labour force needs may increase the profitability of environmental programmes and the retention of the rural populations	
	Large-scale technologies need little labour force and detectable growth in the employment rates cannot be expected.		

Table 5.3 summarises the global social effects of the endeavours similar to the measures of the NCCS.

Table 5.3 – Social effects of the emission mitigation and adaptation measures – From: UN SigmaXi Study



# ANNEX 1

# POLICIES, MEASURES AND MEANS FOR EMISSION MITIGATION AND ADAPTATION

# A. Policies, measures and means for implementing emission mitigation

Policies, measures and means	Limitations and possibilities			
Energy generation				
Reducing the support to fossil fuels;	Implementation is hindered by the resistance resulting from individual interests.			
Taxes or carbon levies on fossil fuels.				
Granting support for the introduction of technologies based on renewable energy;	May be useful for creating a market for low-emission technologies.			
Renewable energy obligations;				
Granting support to manufacturers.				
Introduction of a carbon footprint indicator in order to monitor energy consumption	Voluntary tool			
Reducing the overall energy consumption by economic regulatory means, by imposing taxes or quotas.	Transforming the tax system, increasing consumer taxes and simultaneously reducing other types of taxes.			
Industry				
Providing benchmark information; Performance standards; Supports, tax credits.	May be useful for facilitating the transfer of technology.			
Tran	isport			
Obligatory CO <sub>2</sub> standards for road transport.	The partial coverage of the vehicle stock may limit efficiency.			
Investing into the attractive means of public transport and into the non-motorised forms of transport.				
Influencing the necessity of mobility by infrastructure planning.				
Buildings				
Standards and labelling.	Standards should be regularly revised.			
Energetics coding and certifications for buildings.	Making new buildings attractive.			
Financial incentives for thermotechnical development projects.				
Agriculture				
Financial incentives and regulations for a better land management and for an efficient use of manure.	May encourage synergy with sustainable development.			

Policies, measures and means	Limitations and possibilities	
Forest management		
Financial incentives for increasing the size of forests, for maintaining existing forests, and for encouraging close-to-natural management and protection of forests;		
Regulating the conditions of sustainable forest management.	Private forest managers without appropriate funds and assets.	
Inordinate farming in undivided lands under joint ownership.		
Making society recognise the public services of forests and increasing the reputation of forest managers.		
Waste		
Financial incentives for a better waste and wastewater management.	Facilitate the spreading of the technology.	
Incentives or obligations on the use of renewable energy.	Availability of low-cost fuels.	
Regulating waste management.		
Research and development in the field of emission mitigation		

# B. Technologies and measures to mitigate emissions

Can be implemented by 2012	Can be achieved by 2025			
Energy generation and industry				
Better supply and distribution efficiency;	Carbon Capturing and Storage (CCS) in new gas- biomass- and coal-fired high-emission power stations;			
Decentralisation of energy generation;				
Improved energy efficiency;	The existing fossil fuel-based power stations with an input heat capacity of 500 MWh or higher may be obliged to apply CCS technologies.			
New gas power stations with high coefficient of efficiency;				
Renewable heat and other energy (solar, wind, geothermal and bioenergy);	Technologically, the coefficient of efficiency of renewable energy uses will improve.			
Heat and electricity co-generation;				
Wherever it is possible, only heat and electricity co- generation should be applied in biomass-fired power stations.				
Transport				
More fuel-efficient vehicles, the specific CO <sub>2</sub> emission	Wide-spread use of second generation biofuels;			
for personal cars is 120 g;	The specific CO <sub>2</sub> emission of personal cars does not			
Switch from road transport to railway and other public transport systems;	exceed 100 g;			
	More efficient airplanes;			
Increasing the use of non-motorised modes of transport; Rationalisation of the freightage needs.	Better electrical and hybrid vehicles with stronger and more reliable batteries.			
	Vehicles with alternative driving.			

Can be implemented by 2012	Can be achieved by 2025			
Buildings				
Efficient lighting and natural lighting; More efficient electrical appliances, heating and cooling systems and reduced energy consumption by these	Constructing public and residential buildings by technologies that ensure feedback and control and thereby reduce their energy consumption to a negligible percentage of the current rates.			
appliances; Reducing the thermotechnical characteristics of buildings (insulation, heat insulation, heating control);	Construction permits for public and residential buildings with zero carbon dioxide emission only.			
Passive and active solar energy planning for cooling and heating.				
Agric	ulture			
Better and more efficient soil cultivation in order to increase carbon storage in soils;	Increasing the yields.			
More efficient animal keeping and manure management in order to reduce methane emissions;				
Target-oriented energy plant growing for the replacement of fossil fuels;				
Disseminating extensive plant growing and animal keeping methods to replace the intensive ones.				
Forest ma	anagement			
Disseminating forestry methods ensuring a close-to- natural and contiguous forest coverage;	Increasing the size of afforestations in order to improve the biomass production capacity and carbon capture (by applying selected species that do not threaten the			
Ensuring the continuation of forest renovations; Transformation of forests that have unfavourable structure and/or are in poor conditions;	biodiversity).			
Using forest biomass for bioenergy generation;				
Increasing the size of forests by afforestations.				
Waste				
Collecting and neutralising the methane emissions of waste disposal sites;	Biocovers and biofilters in order to optimise methane oxidation.			
Composting organic wastes and utilising the resulting biogas;				
Controlled wastewater treatment;				
Recycling and waste minimisation.				

# C. Measures to adapt to the effects of the climate change

#### Government means

Development of an appropriate legal/economic system.

#### **Research and development**

Continued observation and application of the achievements of the international research on the climate change.

For example, the research areas include climatic and meteorological and climate-related hydrological studies for assessing and understanding the potentially irreversible consequences of the climate change in physical, biological and human systems; vulnerability and risk analyses, economic calculations in all affected sectors.

#### **Education and training**

Strengthening social awareness raising.

Reducing the consumption, and the material and energy uses, increasing their efficiency.

#### Natural flora and fauna and nature conservation

Promoting local adaptation in order to preserve and increase the existing biodiversity and maintain and improve the naturalness thereof;

Enhancing the intercommunication across the landscape surrounding natural areas in order to facilitate the migration of species.

Shaping the climate policy of the nature conservation sector and coordinating it with the forestry, agricultural, energy and water management sectors.

#### Human health

Elaborating a Heat Plan with particular view to prepare the general public.

Revising the internal organisational and operational structure of the public health care system in order to ensure an overall integration of the requirements of the climatic adaptation.

#### Water management

Revising the authorisation and operational schemes of water installations, elaborating regional water safety system plans.

Rational treatment of the municipal rainwater streams, revising the drainage systems on an "as necessary" basis and enabling them to receive sudden large quantities of rainwater.

#### Agriculture and forestry

Accelerating plant improvement and selecting the most appropriate variety range based on adaptation capacity studies.

Increasing the size of forests and maintaining the park forests of lower closure in the forest-steppe zone.

Creating field-protecting forest belts, increasing the size of grazing lands with trees.

Disseminating forestry methods that ensure contiguous forest coverage.

Ensuring the remediation of forests damaged by natural disasters.

Conducting forestry research studies and experiments in order to ensure long-term adaptation.

#### **Built environment**

Revising the construction standards and regulations in accordance with the effects associated with the climate change.

Elaborating and disseminating methodologies of climate-aware construction among the experts preparing settlement and building plans.

# ANNEX 2

# TERMINOLOGY

- Adaptation adjustment by human and social systems to the present and expected future effects of
  phenomena and changes partly resulting from the climate change. During adaptation, impact
  bearing systems will respond to changes exceeding their tolerance by modifications, which may
  include changes in the processes or in the structure of the system.
- Anthropogenic effects caused by human beings.
- Equivalent CO<sub>2</sub> the concentration of carbon dioxide that would cause a greenhouse effect equivalent to that caused by a given mixture carbon dioxide and other greenhouse gases.
- **Climate –** the statistical aggregate of the states of the atmosphere over a longer period of time.
- Climate change Climate change refers to any change in climate whether due to natural variability
  or as a result of human activity. This usage differs from that in the Framework Convention which
  defines 'climate change' as "a change of climate which is attributed directly or indirectly to human
  activity that alters the composition of the global atmosphere and which is in addition to natural
  climate variability observed over comparable time period."
- Intergovernmental Panel on Climate Change The World Meteorological Organisation (WMO) and the UN Environmental Programme (UNEP) founded the Intergovernmental Panel on Climate Change in 1988. In the reports of the IPCC, several thousand scientists provide an authentic summary of the climate change, of its effects and of the possible preventive measures. The current IPCC Reports on the climate change are widely accepted, scientifically authentic documents and also provide a scientific background for the international negotiations on climate protection.
- **First commitment period** the period between 2008 and 2012 is defined within the scheme of the Kyoto Protocol as the first period when the average of greenhouse gas emissions should fulfil the compulsory mitigation objective. Instead of one target year, a five-year period was chosen in order to compensate for the annual emission fluctuations caused by uncontrollable factors (e.g., weather).
- United Nations Framework Convention on Climate Change (UNFCCC) an international convention for ensuring a stabilisation of the global GHG emissions on the 1990 levels in order to combat the climate change.
- Afforestation planting of new forests in areas that historically have not been covered by forests.
- Global warming a change in near-surface temperature also referred to as global temperature resulting from the greenhouse effects caused by the atmospheric emissions of greenhouse gases. Although the term "global warming" was initially used to describe the increasing surface temperature of the planet, it could not include all the effects, e.g., storms, floods, droughts and heat waves that this "warming" will cause. Therefore, "climate change" is preferred as a term describing both the warming and its consequences.

- Global warming potential (GWP) a generally accepted index indicating the radiative forcing of a unit mass of a given greenhouse gas over a defined period of time (generally 100 years) – that is, the extent to which the atmosphere is warmed by it – relative to that of the same quantity of carbon dioxide.
- Annex I Parties the industrialised countries listed in Annex I to the UN Framework Convention on Climate Change having committed themselves to the aim of returning to their 1990 levels of greenhouse gas emissions during the 2008-2012 period of the Kyoto Protocol. They include the 24 original OECD countries, the European Union and 14 economies in transition.
- Annex II Parties the countries listed in Annex II to the UN Framework Convention on Climate Change having special obligations to provide financial support and to promote the transfer of technologies to developing countries. They include the 24 original OECD countries and the European Union.
- **Emissions** in the climate change context, emissions refer to the release of greenhouse gases and/or their precursors and aerosols into the atmosphere over a specified area and period of time.
- Mitigation in the climate change context, mitigation refers to an anthropogenic intervention to
  reduce the sources or enhance the sinks of greenhouse gases; for example, to a more efficient use
  of fossil fuels in industrial processes or in electricity generation; to a switch to solar energy or wind
  energy; to improving the insulation of buildings; and to increasing the size of forests in order to
  capture more carbon dioxide from the atmosphere.
- Emission trading (ET) one of the three Kyoto mechanisms by which an Annex I Party may sell or buy Kyoto Protocol units to or from another Annex I Party. This allows Annex I Parties to buy units from other Annex I Parties and to use them for the purpose of fulfilling their own Kyoto objectives.
- Kyoto Protocol an independent international agreement which requires separate ratification by the signatory parties but is connected to the Framework Convention. The Kyoto Protocol contains legally binding GHG emission mitigation targets for industrialised countries: they should reduce their emissions of the six greenhouse gases during the first commitment period (2008-2012) to approximately 5% below the 1990 levels. No mitigation targets are specified for developing countries. In addition, the Protocol introduces novel market-based implementation mechanisms the so-called Kyoto mechanisms (or flexibility mechanisms) in order to ensure the cost-efficiency of the implementation of the emission mitigation.
- **Kyoto mechanisms or flexibility mechanisms** the Kyoto Protocol has established three procedures to increase flexibility and to reduce the overall costs of fulfilling the mitigation objectives. These include the clean development mechanism, emission trading and joint implementation.
- **Sink** in the climate change context, any process or activity or mechanism that removes a greenhouse gas or aerosol or a precursor of a greenhouse gas from the atmosphere. Forests and other habitats that are covered by vegetation are considered as sinks because they remove CO<sub>2</sub> through photosynthesis.
- **Vulnerability** is the degree of exposure (non-protected range) of a system in which it is actually damaged and vulnerable. The extent of vulnerability depends on the sensitivity of the system to the effects of climate changes and weather events beyond its tolerance limits.
- **Stabilisation** in the climate change context, it is a uniform objective for stabilising the GHG levels around 450 to 550 ppm or for maintaining it at a level twice as high as that before the industrial revolution. This is the level where the harmful effects of the climate change are believed to be avoidable (the rate of global warming would not exceed 2°C). The current level is around 380 ppm.

According to the IPCC, GHG emissions should be reduced by 50% to 80% during this century to achieve this level.

- Greenhouse gases (GHGs) atmospheric gases that are responsible for the global warming and the climate change. The main greenhouse gases include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>) and dinitrogen oxide (N<sub>2</sub>O). Less frequent but very strong GHGs include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF<sub>6</sub>). Different GHGs have highly variable heat absorption capacity.
- **Greenhouse effect** atmosphere acts similarly to the walls of a greenhouse, i.e., allows visible light to pass and absorbs the emitted infrared energy and thereby retains the heat. Human activities such as fossil fuel combustion and other GHG emissions cause additional GHG emissions and thereby enhance the natural greenhouse effect and make the Earth warmer.

# **ANNEX 3**

# LIST OF ABBREVIATIONS AND UNITS

List of abbreviations:

- CO<sub>2</sub> carbon dioxide
- CH<sub>4</sub> methane
- N<sub>2</sub>O dinitrogen oxide
- HFC fluorinated hydrocarbon
- PFC perfluorocarbon
- SF<sub>6</sub> sulphur hexa-chloride
- AAU Assigned Amount Unit
- BAT Best Available Techniques
- BAU business as usual
- CDM Clean Development Mechanism
- CCS Carbon capture and storage
- EBRD European Bank for Reconstruction and Development
- EEA European Environment Agency
- EREC European Renewable Energy Council
- ESCO Energy Servicing Company
- ETS Emission Trading Scheme
- FINADAPT Finnish Adaptation Strategy
- GDP Gross Domestic Product
- GPI Genuine Progress Index
- GWP Global Warming Potential
- HMV Home Mechanical Ventilation
- IEA International Energy Agency
- IPCC Intergovernmental Panel on Climate Change
- ISEW Index of Sustainable Economic Welfare
- KÁP Compensatory Price Completion Fund
- EEOP Environment and Energy Operative Programme
- KSH Central Statistical Office
- KvVM Ministry for the Environment and Water
- LED light-emitting diode
- LULUCF Land Use, Land Use Changes and Forestry
- MÉTA Database Hungarian Habitat Mapping Database
- MTA Hungarian Academy of Science
- NEEP National Energy Efficiency Programme
- NCCP National Climate Change Programme

- NCCS National Climate Change Strategy
- NEP National Environmental Programme
- ODEX energy efficiency index
- P+R park and ride
- PB propane-butane (gas)
- PRUDENCE Predicting of Regional Scenarios and Uncertainties for Defining European Climate Change Risks and Effects
- PSPS Pumped-Storage Power Station
- NHDP New Hungary Development Plan
- UNCCD United Nations Convention to Combat Desertification
- UNEP United Nations Environmental Programme
- UNFCCC United Nations Framework Convention on Climate Change
- UV-B ultraviolet-B radiation
- GHG greenhouse gas
- VAHAVA Changes, effects, responses
- NVP New Vásárhelyi Plan
- WGBU Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen
- WMO World Meteorological Organization

## List of units

- ppm pars per million
- J joule
- PJ petajoule
- W watt
- kW kilowatt
- MW megawatt
- kWh kilowatt hour (1 kWh = 3.6 MJ)
- MWh megawatt hour
- GWh gigawatt hour
- TWh terawatt hour
- ha hectare
- t ton
- kt klioton
- Mt megaton