Faragó T.; F. R. Rijsberman; Gy. Szerdahelyi; M. Poós; J. Gupta, 1994:
Energy use and carbon-dioxide emissions in Hungary and in the Netherlands: ...
Hungarian Commission on Sustainable Development,
Budapest-Hague, 67 p. ISBN 963-03-3678-2

FENNTARTHATÓ FEJLŐDÉS ÉS KÖRNYEZET

SUSTAINABLE DEVELOPMENT AND ENVIRONMENT

ENERGY USE AND CARBON-DIOXIDE EMISSIONS IN HUNGARY AND IN THE NETHERLANDS: ESTIMATES, COMPARISONS, SCENARIOS

Contribution to the national energy and environmental planning
in relation to the energy-climate issues

ENERGIAFELHASZNÁLÁS ÉS SZÉN-DIOXID KIBOCSÁTÁS MAGYARORSZÁGON ÉS HOLLANDIÁBAN BECSLÉSEK, ÖSSZEHASONLÍTÁSOK, JÖVŐKÉPEK

Adalékok az országos energiagazdálkodás és környezetállapot tervezéshez
az energia-éghajlat kapcsolatrendszerben

1994

FENNTARTHATÓ FEJLŐDÉS BIZOTTSÁG

HUNGARIAN COMMISSION ON SUSTAINABLE DEVELOPMENT

Hungarian Ministry for Environment
and Regional Policy

Netherlands' Ministry of Housing,
Physical Planning and Environment

ENERGY USE AND CARBON-DIOXIDE EMISSIONS IN HUNGARY AND IN THE NETHERLANDS: ESTIMATES, COMPARISONS, SCENARIOS

ENERGIAFELHASZNÁLÁS ÉS SZÉN-DIOXID KIBOCSÁTÁS MAGYARORSZÁGON ÉS HOLLANDIÁBAN BECSLÉSEK, ÖSSZEHASONLÍTÁSOK, JÖVŐKÉPEK

DR. TIBOR FARAGÓ,
Hungarian Ministry for
Environment and Regional Policy
DR. GYÖRGY SZERDAHELYI
and *DR. MIKLÓS POÓS,*
Hungarian Ministry of Industry and Trade

DR. FRANK R. RIJSBERMAN
and *JOYEETA GUPTA,*
Resource Analysis, the Netherlands,
on behalf of the Netherlands′
Ministry of Housing,
Physical Planning and Environment

1994

FENNTARTHATÓ FEJLŐDÉS
BIZOTTSÁG

HUNGARIAN COMMISSION ON
SUSTAINABLE DEVELOPMENT

According to the resolution by the United Nations General Assembly in 1988, the urgent need for international cooperation was recognized to cope with the problem of enhancing greenhouse effect of the atmosphere and the increasing risk of the global climate change. The Framework Convention on Climate Change was opened for signature during the United Nations Conference on Environment and Development in June 1992. The preparations of this international legal instrument were started in February 1991 by the Intergovernmental Negotiating Committee and the different interests of various country groups were revealed from the beginning of discussions.

Among other negotiating parties, Hungary as a country undergoing the complex process of transition to market economy could not accept the idea of a common reference period proposed for greenhouse gas emission stabilization commitments for the developed and other countries. Besides this obvious argument, the assessment of the long-term possible future energy demands and the corresponding carbon-dioxide emissions became an important task. Simultaneously, various scenarios of economic development and energy rationalization should have been elaborated for the formulation of a realistic country position in context of the convention.

The solution of this problem was essentially promoted by the fruitful Dutch-Hungarian collaboration in the field of environment protection and the present study summarizes the main results of comparative analysis of the energy consumption trends, the emission estimates and several energy-environment policy options for the two countries.

*

A légköri üvegház-hatás erősödésének kérdése és az éghajlat globális megváltozásának növekvő kockázata miatt az Egyesült Nemzetek Szervezetének Közgyűlése 1988-ban úgy határozott, hogy nemzetközi összefogásra van szükség e probléma megoldása érdekében. Az Éghajlatváltozási Keretegyezményt az ENSZ Környezet és Fejlődés Konferenciáján, 1992 júniusában nyitották meg aláírásra. E nemzetközi megállapodás előkészítése 1991 februárjában kezdődött a Kormányközi Tárgyaló Bizottság keretében. A különböző országcsoportok a tárgyalások során jelentős mértékben eltérő érdekeket képviseltek.

Más átalakuló gazdaságú országokhoz hasonlóan, a magyar fél egyebek mellett nem fogadhatta el az üvegház-hatású gázok kibocsátásának korlátozására alkalmazandó egységes viszonyítási év bevezetését. E viszonyítási szintet eredetileg a fejlett országokra fogadták el mértékadónak. Mindamellett halaszthatatlanná vált a magyar fél számára is elsősorban a hosszabbtávú energiaigények és az azokkal összefüggő szén-dioxid kibocsátások becslése. Ezzel párhuzamosan szükség volt a gazdasági fejlődés és az energiahatékonyság javításának különböző jövőképeire - az egyezménnyel kapcsolatos megfelelő és képviselhető hazai álláspont kialakítása érdekében.

E feladat megoldását jelentékenyen elősegítette a környezetvédelem témájában folytatott hatékony holland-magyar együttműködés. E tanulmány az ennek az együttműködésnek a keretében készült azon összehasonlító elemzések főbb eredményeit mutatja be, amelyek az energiagazdálkodás alakulására, a kibocsátások becslésére és a különböző hosszabbtávú energiapolitikai és környezetvédelmi megoldásokra vonatkoznak.

CONTENTS

TARTALOM

PREFACE

The end of the 1980s presented the world with several societal and environmental challenges of global significance. Here, we point out two because of their long-term implications.

Growing consensus over the potentially hazardous effects of accelerating climate change caused by increasing anthropogenic emissions of greenhouse gases lead to the conclusion in 1992 of the Framework Convention on Climate Change. In the same period, the countries of Central and Eastern Europe returned to democracy and started to put their economies on the road of transition to a market-oriented system.

The Framework Convention on Climate Change contains principles, commitments, an institutional framework and financial provisions to cope with this man-made global environmental hazard. It confirms that developed and developing countries have a common but differentiated responsibility in protecting the world's climate, with developed countries taking the lead by accepting more specific commitments. The commitment to stabilize greenhouse gas emissions applies to both wealthy countries such as the Netherlands and to countries with economies in transition, such as Hungary, although the latter will be allowed a certain measure of flexibility under the Convention.

Fortunately, to a large extent, the challenges of economic modernization and climate protection have a common interest. Both require a more rational use of energy, more efficient production methods, and both benefit from extensive use of renewable energy sources. Moreover, these actions reduce the national dependance on energy imports. If due consideration is given to climate change aspects emissions of carbon dioxide can be kept below certain earlier (or reference) levels while restructuring the economy and turning around the recession, which just precedes the beginning of this economic transition. It is important in this respect that countries such as Hungary will use the opportunity of economic restructuring to find a quick way towards an ecologically sustainable future.

In the Netherlands, the Memorandum on Climate Change (1991) is the central document presenting a comprehensive picture of the climate issue, including an ultimate environmental quality goal and gas-by-gas targets, an international strategy, measures and so on. In it, the Netherlands tried to maximize the net benefit of measures by selecting options which should also be implemented for other reasons than climate protection. The Memorandum places great value on international cooperation, in the fields of both science and technology, and in ongoing policy development, both multilaterally (IPCC and OECD/IEA) and bilaterally.

The Netherlands' - Hungarian bilateral cooperation in the field of environment is based on a Memorandum of Understanding between our two environment ministries. The subject of climate change has been adopted in the annual programmes. Cooperation between our two countries has been fruitful at the highest policy-makers' level as well as at the expert level. Stimulated by the negotiating process for a climate convention, Hungarian experts carried out tentative assessments of national greenhouse gas emissions and their scenarios. At that time, the Netherlands' Government suggested to start bilateral cooperation leading to the formulation of the official Hungarian position in the negotiations. This cooperation intended to identify areas of common interest between the Hungarian economic development and global climate protection. Since the reaction was positive the project formulation for this comparative study started, which included the assistance of Dutch climate and energy experts.

The objectives of the project were to elaborate on a possible Hungarian position on climate change, including its consequences for energy production, energy efficiency and related issues. A possible Hungarian action programme to stabilize carbon dioxide emissions was to be prepared and discussed. Finally, the global environmental implications of greenhouse gas emissions, particularly of carbon dioxide, and the implications for the international position of Hungary in its relation with other European countries were to be presented to all relevant Hungarian organizations.

This publication is an outcome of the collaborative efforts of Hungarian and Dutch experts. On the Hungarian side both the ministries of environment and industry were involved. Of course, the preparation of this report confirms the importance of good international cooperation in dealing with the problem of climate change.

Now that this phase of target setting has been accomplished implementation measures can and should be formulated. Both our countries acknowledge the necessity of continuing our successful cooperation in this field during the next few years.

Budapest | The Hague

8 November 1993

János Gyurkó, | Ha

Minister of Environment
and Regional Policy

Minister of Housing,
Physical Planning and Environment

1. INTRODUCTION

1.1. Human impacts on global climate

The possibility of human impact on the global climate system through anthropogenic emissions of carbon-dioxide from fossil fuel combustion was already known at least a century ago (Arrhenius, 1896). But this was barely considered as a theoretical hypothesis for a long while until the early 1970s. In this decade, the initial research results were available from the Global Atmospheric Research Programme which was devoted from 1974 to the comprehensive investigation of long-term state of the earth's atmosphere. At the same time, severe large-scale and regional climatic anomalies such as the prolonged droughts in the Sahelian belt caused increased concern about the adverse impacts of the regional climate and its causes. During this period many global climate research projects were initiated by various national and international organizations. In this early phase of the investigation into the anthropogenic effects, three large-scale, energy-related, potential climate forcing mechanisms were studied, namely: the heat release from the energy-conversion systems, the enhancement of the greenhouse effect due to the carbon-dioxide (CO_2) emissions from fossil fuel combustion and the transformation of radiation properties (primarily, the albedo) of large surfaces. The conclusions of research studies did not influence policy-making and only the general concern for the problem, the scientific uncertainties and the need for more research were emphasized. "It is estimated that an increase of 0.6 degree C would be detectable as a signal, and such an increase would be observable towards the end of this century if recent trends in fossil-fuel consumption continue.

The concern over the possible increase of atmospheric CO_2 concentration arises because, by the time we are able to see the temperature change, possibly undesirable and irreversible climate changes could have been set in motion. At the same time, it would take of the order of decades to substitute other primary energy carriers for the fossil fuels, so that the atmospheric CO_2 concentration will continue to rise beyond the time that the rise in surface temperature is confirmed. ... In view of the uncertainties, it is not possible to define what will happen as a result of continuing fossil-fuel combustion. ... much more research on the climate system and carbon cycle are required, while at the same time those people involved in energy-strategy decision making must be made aware of the potential CO_2 problem and its magnitude ..." (Williams, 1978).

This period lasted until the first World Climate Conference held in 1979, where it became obvious that the critical problem was (and still is) the emission of greenhouse gases from various anthropogenic activities. The point is that these gases do not affect incoming solar radiation, but absorb reflected long-wave radiation from the surface. Consequently, the increase in concentrations of these gases in the atmosphere can lead to the enhancement of the greenhouse effect and therefore to the increased reradiation of the long-wave radiation towards the earth's surface which, in turn will increase the surface temperature. Most of these gases are natural components of the atmosphere, thus, the risk arises when additional greenhouse gases are emitted from non-natural processes. The otherwise natural balance of the cycle of these gases (i.e., the cycle which involves the various sources, sinks and reservoirs of these gases and all their physical, chemical and biological phases and conversions) is damaged in such a way that the additional input will probably not be "counterbalanced" with the equal enhancement of the sinks.

The main greenhouse gases emitted as a consequence of human activities include: carbon-dioxide, methane, nitrous oxide, chlorofluorocarbons and ozone.

The continuous increase of carbon dioxide concentrations in the atmosphere can be attributed to human activities. Combustion of fossil fuels is the most significant source of CO_2 emissions, but other activities (such as deforestation, wood burning, intensive agricultural activities, drainage of swamps, etc.) also considerably influence carbon dioxide emissions and their cycle. Carbon dioxide concentrations increase annually by about 0.4 %.

Methane is an important greenhouse gas whose atmospheric concentration was constant for a very long time until the beginning of the last century, when it started to increase. This increase has recently accelerated reaching an annual rate of 1-2 % and the methane content of the atmosphere has doubled during the past 200 years. Rice cultivation, swamps, animal husbandry, biomass burning, coal mining and natural gas production constitute the main sources of this gas.

Nitrous oxide plays an important role not only in the development of the earth's radiation balance but also in the chemical processes of the stratosphere. Microbiological processes are the natural sources. The use of nitrogen fertilizers, combustion of fossil fuels, intensive agricultural production and the increasing utilization of fossil fuels contribute to the increase of the atmospheric concentrations of nitrous oxide. In the last 20 years, the rate of this increase is 0.2-0.5 %/year.

Halocarbons containing chlorine and bromine are important greenhouse gases. These gases are used extensively in industry, aerosol propellants, refrigerants, foam blowing agents, solvents and fire retardants. There is no significant tropospheric removal mechanism for the fully halogenated hydrocarbons. Hence, to stabilize the atmospheric concentrations of these gases at 1990 levels would imply a 70-95 % reduction in the emission of these gases.

Considering their differing amounts and radiation characteristics from among the enlisted gases, 55 % of the atmospheric greenhouse effect can be attributed to carbon-dioxide. The single largest anthropogenic source of radiative forcing is energy production and use. The energy sector accounts for an estimated 46 % (with an uncertainty range of 38-54 %) of the enhanced radiative forcing resulting from human activities (Houghton et al., 1990).

Hence, CO_2 is the most important greenhouse gas, and, as a first step, policies need to be adopted to limit its emissions. CFC, the other important greenhouse gas, is being dealt with under the articles of the Montreal Protocol on Substances that Deplete the Ozone Layer. As energy production and consumption are the two most important sources of greenhouse gases, this paper focuses primarily on these aspects.

Reduction of the risks of anthropogenic climate change may be possible basically in two ways: by limiting (or reducing) the greenhouse gas emissions and by increasing the carbon-dioxide "sinks", through, for example, increasing the afforested areas thus improving the carbon fixing capabilities of forests. The role of vegetation cover is important in two senses: burning it up, on the one hand emits a great amount of carbon-dioxide, and on the other hand, the above mentioned carbon fixing capability decreases. Despite the importance of sinks and reservoirs, in this document we shall mainly deal with measures to reduce anthropogenic emissions of CO_2 from fossil fuels combustion as these amount to about 60 percent of all man-made CO_2 emissions.

1.2 Energy-related carbon-dioxide emissions: role of various country groups

The world

The major per capita emissions of greenhouse gases takes place in the industrialized countries.

Emissions from the developing countries are growing and may need to grow further in order to meet their basic development requirements. Table 1 indicates the differences in per capita emissions as a result of energy consumption.

Table 1 Carbon dioxide emissions deriving from energy consumption (ton CO_2 / capita)

Country	1986	1987	1988
Austria	-	-	8.0
Belgium	11.3	-	10.8
Denmark	-	-	12.0
Finland	-	10.2	-
France	6.9	6.3	-
Netherlands	13.9	-	10.4
Ireland	8.4	-	8.3
Japan	7.5	7.8	-
Canada	17.0	15.7	-
Italy	6.4	6.6	-
Switzerland	-	-	6.9
Sweden	-	-	9.0
USA	19.7	18.6	-
Czechoslovakia	15.7	-	-
Poland	12.7	12.5	-
Romania	9.2	-	-
Brazil	1.3	1.4	-
India	0.7	0.7	-
China	1.9	2.1	-
World (1987: 1.08tC/cap)	4.0		

In response to the first "oil price boom" in 1973, the North-American and Western European countries could rationalize their energy consumptions to such an extent that their carbon dioxide emissions had levelled off and even started to decrease.

This did not happen in Eastern Europe and the energy-related carbon dioxide emissions steadily increased in these countries. This can be attributed to the differing characteristics of the utilization of energy in the past 30 years.

While in the fifties, the carbon dioxide emission was still higher in Western Europe, in the eighties the overall energy-related carbon dioxide emissions in the Eastern part of Europe became almost twice as much as those observed in Western Europe. Per capita emissions from the Eastern European countries are quite high in relation to their gross domestic product indicating a high degree of inefficiency in these countries.

Countries with economies in transition

Table 2 presents the energy intensity in Eastern Europe and compares that with the average in Western Europe.

It can be seen that Hungary's energy intensity is twice that of the energy intensity in Western Europe, although it is one of the most efficient users of energy within Eastern Europe.

This implies that measures to improve energy intensity will at the same time reduce the price of production, reduce energy consumption for the same GDP and reduce CO_2 emissions per unit of GDP. The energy saved from efficiency measures can lead to national profits by reducing the demand for imported energy. It also means that more energy is made available for other processes leading to an increased GDP.

Table 2 Energy intensity in Eastern Europe, 1985 (Bron, 1991)

Country	Industry (PJ/Mill/DM GDP)
Albania	2.56
Bulgaria	2.52
CSFR	5.15
GDR	3.95
Hungary	2.71
Poland	3.44
Romania	7.30
Yugoslavia	3.99
Average Eastern Europe	4.50
Average Western Europe	1.35

Table 3 compares the situation in Hungary with that in the Netherlands. As can be seen, although the GDP per capita is less than 1/4 that of the Netherlands, the per capita CO_2 emissions are about half that of the Netherlands.

Table 3
Comparison of economic output and energy supply features for Hungary and the Netherlands (IEA/OECD 1992a; IEA/OECD 1992b)

	Hungary	Netherlands
GDP per capita (US$ 1985)		
1973	1363	7544
1980	1760	8469
1989	2078	9304
1990	1995	9605
Primary energy supply per capita	(Toe per capita)	
1973	2.06	4.67
1980	2.64	4.63
1989	2.81	4.38
1990	2.71	4.44
Primary energy supply per GDP	(Toe per 1000 US$)	
1973	1.51	0.61
1980	1.50	0.55
1989	1.35	0.47
1990	1.36	0.46
Total energy related CO_2 emissions	(Mt CO_2 and per capita tCO_2)	
1990	75.2	184
	7.1	12.3

Consequently, although the primary energy supply per capita is lower than that in the Netherlands, the primary energy supply per unit of GDP is much higher. Thus, theoretically, by improving the energy efficiency the CO_2 emission can be reduced considerably. This further implies that Hungary's GDP can continue to increase without necessarily being accompanied by an increase in CO_2 emissions.

The Eastern-European countries are in a special situation. With the recent recession in the CET countries although the demand for energy has decreased, the inefficiency has remained almost unchanged while some efforts to reduce the environmental effects of the energy sector have been made.

The elements of the transformation to an environmentally more conscious economy in general were formulated both from inside and outside. The principal elements were common in these analyses:

> "How can the planned economies protect their natural environments while meeting growing economic expectations? Price reform, a shift to market mechanisms and energy efficiency laws and standards will play crucial roles. Price reform is a proved way to promote energy-saving behaviour." (Chandler et al., 1990).

2. INTERNATIONAL POLICY PERSPECTIVES ON CLIMATE CHANGE

2.1. From science to policy

The problem of climate change was signalled by the scientific community in the 1970's. The first global discussion on climate change can be traced to the World Climate Conference in 1979 which was organized in recognition of the seriousness of the problem of climate change. Six years later, another meeting was organized by the World Meteorological Organization (WMO), the United Nations Environment Programme (UNEP) and the International Council for Scientific Union (ICSU) at Villach to discuss the role of carbon-dioxide and other greenhouse gases in causing climatic variations. Scientists from 29 developed and developing countries concluded after the seven day meeting that "increasing concentrations of greenhouse gases are expected to cause a significant warming of the global climate in the next century".

In 1988, in response to the call for action by the World Commission on Environment and Development, the Government of Canada invited 300 world experts from 46 countries to attend the Toronto Conference on the Changing Atmosphere. Climate change was widely discussed for the first time by scientists and policy makers and they recommended that countries should: "Reduce CO_2 emissions by approximately 20 % of 1988 levels by the year 2005 as an initial global goal". This historical target is referred to as the Toronto target by the international community.

Later that year, the UNEP and the WMO initiated to set up the Intergovernmental Panel on Climate Change (IPCC). Three working groups were organized to study scientific aspects of the changes in the long-term state of the climatic system, the impacts of and the response strategies to the anticipated climate change and a fourth group was established to facilitate the participation of developing countries in the IPCC process.

The first international political agreement explicitly on the issue of climate change is the Resolution adopted at the forty third session of the General Assembly of the United Nations on 27 January 1989. This Resolution was in response to the growing international consensus reflected in meetings beginning with the first World Climate Conference in 1979, the UNEP-WMO-ICSU Conference held at Villach, Austria in October 1985, the Toronto Conference on The Changing Atmosphere in 1988 and the World Congress on Climate and Development in Hamburg in 1988.

In March 1989, the Heads of States of 24 states were invited to the Hague and declared their commitment to addressing the problem of climate change. In the Continent of Africa, yet another political effort was underway in May 1989 where the Heads of Francophone countries met at Dakar to endorse the Hague Declaration and to set an agenda for action. In June 1989, the EC Council decided that member states had to play their full part in addressing the climate change issue without further delay. One month later, the G7 countries met and declared the need to limit the emissions of greenhouse gases and increase energy efficiency. In Beograd, the Heads of State of Non Aligned Countries met for their Summit meeting in September. They called for a global multilateral approach to the problem of climate change. In October, the Commonwealth Heads of Government met in Langkawi and declared that they were deeply concerned about the deterioration of the Earth's Environment.

These political declarations world-wide, set the ground for the explicit discussion of the issue of climate change at Noordwijk, the Netherlands. This led to the adoption of the Noordwijk Declaration on Climate Change by 67 countries in November 1989. The Noordwijk Declaration proposed, inter alia, that "In the view of many industrialized nations such stabilization of CO_2 emissions should be achieved as a first step at the latest by the year 2000."

Eventually, in November 1990, 137 countries met at the Second World Climate Conference in Geneva, each with its own agenda of action with respect to climate change. These countries then adopted the Ministerial Declaration of the Second World Climate Conference.

2.2. First commitments

Since 1989, countries have been adopting targets in relation to their greenhouse gas emissions. The European Community (EC) countries have stated that they "are willing to take actions aiming at reaching stabilization of the total CO_2 emissions by 2000 at 1990 level in the Community as a whole". Individually, most of these countries have set their own targets and currently negotiations are taking place on how best the common target should be shared between the countries and what instruments should be used to achieve the common target.

The European Free Trade Association Member States have also agreed to stabilize their CO_2 emissions by 2000. The remaining OECD countries apart from Turkey and the US have adopted national targets. Of these countries Austria, Australia, Denmark and France have adopted much tougher targets. For an overview of the targets adopted by these countries see table 4.

Among the Eastern European countries, Poland was the first to declare at the Noordwijk Conference on Climate Change and confirm at the Second World Climate Conference that it was willing to aim at stabilizing its CO_2 emissions by the year 2000 at 1989-90 levels. The representatives of the Czech and Slovak Republic indicated in January 1992 that they would also be able to stabilize their CO_2 emissions by the year 2000 at the 1990 level. Hungary was party to the Noordwijk Declaration requiring countries to investigate the possibility of reducing their CO_2 emissions by 20 % in the year 2005 at 1990 levels.

Table 4 Commitments by some industrialized countries and countries with economies in transition on anthropogenic CO_2 emission stabilization

Commitments on CO_2 stabilization			
Country (group of countries)	p.c. of reduction	Reference year	Target year
Australia	-20	1988	2005
Austria	-20	1988	2005
Canada	0	1990	2000
Denmark	-20	1988	2005
Finland	as EFTA		
France	as EC		
Germany	-25	1987	2005
Japan	0	1990	2000
Netherlands	-3 - -5	1990	2000
Norway	0	1989	2000
Sweden	as EFTA		
United Kingdom	0	1990	2005
EC (jointly)	0	1990	2000
EFTA	0	1990	2000
Hungary	0	1985 - 87	2000
Poland	0	1989	2000

In April 1992, Hungary declared that it would stabilize its CO_2 emissions at 1985-87 levels by 2000.

The Eastern European targets are conditional targets, as they are linked with assistance from other countries to some extent. Research documents prepared on Eastern European countries indicate that it is possible for most Eastern and Central European countries to achieve a stabilization of CO_2 emissions by the year 2000, without prejudicing economic growth.

2.3. The Framework Convention on Climate Change

In January 1989, the United Nations General Assembly stated that climate change "should be confronted within a global framework " and by its 45th Resolution in 1991, it established the Intergovernmental Negotiating Committee (INC) for a Framework Convention on Climate Change. In June 1992, 154 countries became signatories to the Framework Convention on Climate Change - during the United Nations Conference on Environment and Development in Rio de Janeiro.

This unique international law provides a global framework within which limitation and adaptation strategies should be prepared. This international law defines its ultimate objective as achieving the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner" (FCCC, 1992). The accepted principle is that countries should undertake measures "on the basis of equity and in accordance with their common but differentiated responsibilities and respective capabilities" (FCCC, 1992).

Under the Convention each country is expected to prepare:

- national emission inventories;
- national programmes to limit emissions and
- to monitor the results.

The Convention states that industrialized countries must first stabilise emissions of greenhouse gases and then reduce their emissions. For the purpose of the Convention, industrialized countries include some of the eastern European countries such as Hungary. Most of these countries, including the Netherlands and Hungary, have already set some sort of national and/or regional target for the stabilization of their emissions.

The reason why most Central and Eastern European countries have been included as industrialized countries for the purpose of this convention is that although the use of energy per capita, and therefore the related emission of CO_2 per capita, in these countries is not as high as in the OECD countries, it is of the same order of magnitude. It is certainly very much higher than energy use and emissions per capita in developing countries. Moreover, the use of energy per unit of GDP is -- generally speaking -- very much higher than in OECD countries. This indicates that, through the current restructuring of their economies, there is a potential for energy rationalization and reduction of associated emissions per unit of GDP in Central and Eastern Europe.

The economic problems in the formerly centrally planned economies, and the absolute priority given by their governments to economic development, imply that there is a need for a somewhat differentiated position within the group of industrialised countries.

First, the countries may wish to select a baseline for emissions which reflects the position before the current recession (and associated decrease in energy use) rather than the year 1990. Second, the governments of these countries may want to negotiate: a) conditions for access to technology that will be necessary to implement a policy to stabilize emissions; b) financial and economic assistance to enable them to restructure their economies; and c) access to the markets of the European Community that will allow them to develop their economies to levels comparable to those of the EC members.

2.4. Strategies and tasks to address the problem of climate change

As mentioned earlier each country is expected to prepare national inventories of their greenhouse gas emissions, national programmes to deal with these emissions, to consider sharing the available scientific information and technologies through transfer of technology.

National programmes to deal with the emissions of greenhouse gases should begin by focusing on CO_2 and then cover the other greenhouse gases. The emissions of the different gases can be worked out according to the following equation:

$$[GHG] = P \times U \times R \times E$$

(Weenink et al., 1992) where

[GHG] is the emission of the GHG;
P is the number of Persons (population);
U is the Use of products per capita (demand/production factor);
R is the Resources required per unit product (efficiency factor); and
E is the amount of GHG Emitted per unit resource (emission factor).

This generalized equation can be used to develop a policy specifically addressing one or more of the factors described above. Measures geared at addressing the U factor are generally "Volume Measures" and measures directed at the R and E factor are generally "Technological Measures".

In order to ensure that these measures are implemented, different instruments need to be considered. A list of appropriate measures with respect to CO_2 emissions from the "energy" sector, the "transport" sector and the "waste" sector are presented in tables 5, 6 and 7.

The Netherlands has prepared a national inventory of greenhouse gas emissions (Born et al., 1991) and a national programme for reducing its emissions of greenhouse gases. A report of this programme was submitted to Intergovernmental Negotiating Committee in December 1992. A summary of that report is presented in chapter 3. The results of the programme will be monitored and additional policy measures will be taken if seen to be necessary in achieving the national targets.

Table 5 Measures to promote energy efficiency

MEASURES TO PROMOTE ENERGY EFFICIENCY
Carbon tax on fossil fuels
Regulatory energy taxes
Accelerated depreciation for energy saving investments
Research and development funds for: a) energy efficiency; b) renewable energy; c) experimental housing
Co-generation of heat and power
Subsidies for home insulation
Subsidies for high efficiency gas boilers
Public awareness programme for energy management in small firms
Long-term voluntary energy use reduction agreements with energy using sectors
Building standards and regulations

Table 6 Measures to reduce CO_2 emissions in the transport sector

MEASURES TO REDUCE CO_2 EMISSIONS IN THE TRANSPORT SECTOR
Differentiated road taxing on cars
Road pricing
Tax advantages for users of public transport
Subsidies for car-pooling facilities
Subsidies for transport management plans
Tighter emission standards
Speed limits and enforcement programmes
Public transport passes for students and military personnel
Public transport investments
Public awareness programme on car fuel consumption
Agreements with car industry to reduce emphasis in advertising on high speed performance and increase emphasis on energy efficiency

Table 7 Measures on waste management to reduce CO_2 emissions

MEASURES ON WASTE MANAGEMENT TO REDUCE CO_2 EMISSIONS
Prevent waste; encourage recycling
Agreements with industry to reduce packaging
Methane recovery from landfills

3. THE NETHERLANDS' POLICY ON CLIMATE CHANGE

3.1. Structure of the Netherlands' climate policy

The Netherlands is a small European country with a population of about 15 million. It contributes less than 1 % to the total increase in global greenhouse gas (GHG) concentrations. The sources of these gases lie in all countries, and each country as a member of the global community has 'common but differentiated responsibilities' in dealing with this issue (SWCC, 1990, 2). Aware of its role in aggravating the greenhouse problem and of the possible consequences of climate change, the Netherlands has adopted the 'precautionary principle' as the guiding principle for its policy plans (VROM, MCC, 1991). This principle was formulated during the Second World Climate Conference as follows:

> "In order to achieve sustainable development in all countries and to meet the needs of present and future generations, precautionary measures to meet the climate challenge must anticipate, prevent, attack or minimise the causes of or mitigate the adverse consequences of, environmental degradation that might result from climate change".

The Netherlands has adopted a two track policy plan:

- Limitation policy: to reduce the emissions of greenhouse gases; and
- Adaptation policy: to address the potential effects of climate change.

The limitation policy focuses on the emissions of greenhouse gases and follows a 'gas by gas' policy. The reasoning behind this is that, as the exact greenhouse warming equivalents for all the different greenhouse gases are not yet known with any degree of certainty, it is more sensible to consider the different gases separately in the first phase of policy making.

The Netherlands does not rule out the possibility of phasing into a 'comprehensive' gas policy once the exact greenhouse warming potentials are known. In such a comprehensive gas policy, a combination of the most effective measures are chosen irrespective of the gas they are focused at.

For each of the greenhouse gases, a policy plan has been developed, although the plans are in different stages of development. The emissions of the gases are then researched and classified on the basis of the 'sectors' that emit them. In the first phase, 'no regrets measures' are adopted in policy plans directed at the appropriate sectors for each gas (see table 8). These no regrets measures are measures that are useful on their own account and have other beneficial side-effects, such as reducing the emission of greenhouse gases. The measures considered can be classified into the following.

- volume measures: measures directed at reducing the volume of consumption; and
- Technological measures: measures directed at improving the technological efficiency of different production processes.

For each measure a range of instruments are used. In order to support planning and implementation, an institutional structure has been identified and linking mechanisms between different departments and bodies have been established. This is followed up by a process of monitoring the plan and evaluating the effects of the plan.

The results of the evaluation are used to define the new policy plan.

The adaptation policy plan considers in the first phase coastal defense strategies and physical planning strategies. The Government is considering developing this policy into an integrated coastal zone management plan.

Table 8 Sectors emitting different greenhouse gases

Gas	Energy and Industry	Transport	Waste	Agriculture	Nature
CO_2	X	X	X		X
CFC	X		X		
CH_4	X	X	X	X	X
N_2O	X	X	X	X	
CO	X	X			
VOC	X	X		X	X
NO_x	X	X			

The focus of this Chapter is on the limitation strategy adopted by the government, and within this strategy emphasis is laid on the gas CO_2. A brief outline of the research structure in the Netherlands is also presented. Integrated research results are necessary to reinforce policy measures and to ensure the elimination of contradictory measures and ineffective measures, while providing insights into new and relevant aspects for planning and implementation.

3.2. Limitation Strategy

National long term target

Since the problem of climate change has global dimensions and since the effects of the problem will be felt over the coming century, the Netherlands' Government will support international efforts towards:

> "stabilising the concentration of GHGs in the atmosphere before the end of the next century at a level well below a doubling of the pre-industrial concentrations. The Netherlands will make a reasonable contribution towards achieving this international objective" (VROM, MCC, 1992).

This objective has been formulated with the aim of keeping the global average rise in temperatures and sea levels within the limits necessary to ensure that adaptation to the change is possible without undue threat to human beings and without loss of the natural heritage. It is based on the reports of the Stockholm Environment Institute prepared for the Advisory Group of Greenhouse Gases (AGGG) and the studies of the Intergovernmental Panel on Climate Change (IPCC).

Studies by IPCC reveal that this long term target can only be achieved if GHG reductions follow the IPCC/1990-D scenario. In this scenario global:

- CO_2 emissions are reduced by 55 % by the year 2100 with respect to 1990;
- CFCs are phased out;
- CH_4 emissions are reduced by, at least, 10 %; and
- N_2O emissions are stabilised.

In order to achieve the global quality targets, the industrialised countries, including the Netherlands, must stabilise their emissions of CO_2 no later than the year 2000. This should be followed by an annual reduction in emissions of 1-2 % over the next few decades.

The Netherlands' long term target supports the ultimate objective of the United Nations Framework Convention on Climate Change (FCCC) of achieving the "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner" (FCCC, 1992).

Emissions of greenhouse gases

In making a reasonable contribution to the international goal, the Netherlands has also developed its own national climate change policy plan. As a first step an inventory of greenhouse gas emissions in the Netherlands was prepared. The greenhouse gas emissions in the Netherlands in 1989/1990 are shown in the following table.

Table 9 The greenhouse gas emissions in the Netherlands (Born et al., 1991)
($^{+}$CFCs include halons, CCl_4, methylchloroform, HFCs and HCFCs)

Greenhouse Gas	Emission average (Kton)
CO_2	182000
CFCs^{+}	21
CH_4	960
N_2O	40
NO_x	560
CO	1100
VOC	490

Although the global warming potential of each gas is not accurately known, it is estimated that the two major greenhouse gases emitted are CO_2 and CFCs.

National gas by gas strategy

The Netherlands formulated targets initially for CO_2 and CFCs in 1989 and then for the remaining greenhouse gases. The targets for the different gases are given in the following table.

Table 10 The targets of the different greenhouse gases (VROM, MCC, 1992)

Gas	Reference Year	Emissions/ Use	1995	2000	Reduction % in 2000 with respect to reference year
CO_2 (Mt)	1989-90	182.0	182.0	173-177	3-5
CFCs (Kt)	1990	7.86	0.06	0.0	100
Halons (Kt)	1990	0.41	0.0	0.0	100
NO_x (Kt)	1988	560.0		240.0	55
VOC (Kt)	1988	490.0		205.0	60
CH_4 (Kt)	1990	960.0	940.0	840.0	10
N_2O (Kt)	1990	40.0	40.0	40.0	0
CO (Kt)	1990	1100.0	820.0	540.0	50

CO_2 targets

Under the existing national environmental policy plans, targets for carbon-dioxide are:

- stabilisation of emissions in 1994-95; and
- reduction of emissions by 3-5 % in the year 2000 with respect to 1989-90.

CFC targets

Under the national follow-up process to the Montreal Protocol on Substances that Deplete the Ozone Layer, there is already a programme for the phase out of CFCs in 1995 or as soon as possible thereafter, but no later than 1997.

CH_4 and N_2O targets

In the case of CH_4 and N_2O, the anticipated emissions are based on an elaboration of existing policies in other fields which have an impact on the emissions of these gases. These targets are:
- Reduction of CH_4 emissions by 10 % in 2000 with respect to 1990; and
- Stabilisation of N_2O emissions by 2000 with respect to 1990.

NO_x, VOCs and CO targets (ozone precursors)

Targets for the reduction of emissions of NO_x and VOCs exist in other policy documents. With respect to NO_x, the target is to reduce emissions by 55 % in the year 2000 with respect to emission levels in 1988. With respect to VOCs, the target is to reduce emissions by 60 % in 2000 with respect to 1988.

The emissions of CO are expected to decrease by 50 % in 2000 with respect to levels in 1990.

Afforestation targets

In addition, the Netherlands have a modest afforestation target, as can be seen below.

Table 11 Afforestation targets (VROM, 1991b)

Afforestation Targets (1988-2000)	
Policy	Hectares
Forestry policy	25,000
Nature policy plan	3,500
Road-side tree planting	8,000
NEPP	a few thousands
Total	40,000

CO_2 strategy

The national CO_2 emissions from fossil fuel burning including feedstocks is 182 Mt CO_2 averaged over 1989/1990. This is about 0.8 % of global CO_2 emissions. The use of natural gas is responsible for about 50 % of CO_2 emissions; oil and coal consumption contribute to 40 % and 10 % of the total CO_2 emissions respectively.

With a population of 15 million, per capita CO_2 emissions is about 12t CO_2 per capita which is about three times the global average per capita CO_2 emissions.

The Netherlands' emissions of CO_2 (in %) per sector are as follows:

Table 12 Sectoral emissions of CO_2 (VROM, NEPP, 1989)

1. Industry	24
2. Electricity	22
3. Transport	16
4. Housing	14
5. Oil-Refineries	8
6. Glass houses	5
7. Waste Incineration	1
8. Others	10

The national target with respect to CO_2, as mentioned before, is to stabilise emissions in 1994-95 and to reduce emissions by 3-5 % in 2000 with respect to the emissions in 1989-90.

The energy 'sector' is entrusted with the task of achieving 75 percent of the national target (13 Mt in 1994-'95, 31-35 Mt in 2000); the transport 'sector' - 15 percent (2.5 Mt in 1994-'95 and 6.5-7.5 Mt in 2000), and the waste 'sector' - 10 percent (1.5 Mt in 1994-'95, 3.5-4.5 Mt in 1994-'95, 3.5-4.5 Mt in 2000).

The energy sector

The energy sector has to reduce annual CO_2 emissions by 31-35 Mt by the year 2000. About 14 Mt of CO_2 emissions have to be prevented annually through lesser use of coal in industry and electricity generation than previously envisaged. Furthermore, the energy producers have plans to construct modern gas combined cycle cogeneration power plants (district heating) which can generate 1250 MW of power while saving 14 PJ of primary energy every year. With respect to energy consumption, the strategy aims at doubling the energy efficiency increase of 1 percent to more than 2 percent every year in order to prevent 17-20 Mt of CO_2 emissions by the year 2000. The probable distribution of the energy conservation efforts are outlined in table 13.

Table 13 Improvement in energy efficiency over the period 1990-2000 (MEC, 1990)

Sector	Share of energy consumption in 1989 in %	Efficiency improvement in 2000/1990, in %
Industry (incl. feedstock)	47	15
Industry (excl. feedstock)		20
Agriculture	6	30
Non-Residential buildings	9	30
Households	20	25
Transport	14	20
Other Enterprises	4	20
Total Netherlands	100	20

In order to achieve the targets of the energy sector, the Government will promote public education and awareness, support public utilities, provinces and municipalities, draw up agreements with industry and pass regulations, provide subsidies for investment, and stimulate innovation and technology development.

Several different measures are being implemented or being considered for implementation. An energy/carbon surcharge of DFL 5.70 per ton CO_2 and DFL 0.44 per GJ energy is being levied on fossil fuels since 1990. (According to the current exchange rates: 1 US$ = 1,80 DFL and 1 US$ =

83,72 HUF.) It raises about DFL 150 million each year. The introduction of substantial regulatory taxes on energy has been studied by the Wolfson Commission and by advisory bodies. The results were published in February 1992. The proposals are being considered. An Act was published in 1991 which promotes specific energy saving and environmental investments, which are technologically innovative and environmentally benign through allowing accelerated depreciation. It is suggested that this provides an incentive for environmentally sound and innovative investment practices.

The Government will be investing heavily into different research projects and technology. Around DFL 6.5 million has been reserved annually for stimulation of agricultural research with a view to increasing the energy efficiency of this sector. A sum of DFL 17 million has been allocated to encourage research with respect to households in terms of gas and electricity consumption. A research programme on improved fuel efficiency in motor vehicles, more efficient road transport and alternative fuels is carried out within an annual budget of DFL 6 million. In the area of renewable energy a sum of DFL 37.5 million is available. The purpose is to accelerate the development of wind energy, photo-voltaic conversion of solar energy, thermal solar energy, geothermal energy, hydropower and energy recovery from waste and bio-mass. A substantial R & D effort will be made on the subject of new conversion techniques, such as fuel cells, heat pumps and small gas turbines. The annual budget is DFL 33 million. Research into environmentally friendly construction methods is being encouraged and ten different types of dwellings are being constructed in the Dutch city of Alphen aan de Rijn. To maintain the level of basic expertise in the field of energy conservation and renewable energy resources two research institutes, the Energy Study Centre (ECN) and the Netherlands' Organisation for Applied Scientific Research (TNO) receive a basic and earmarked subsidy for R & D in this field of about DFL 30 million a year. About DFL 240 million is available to help increase the share of cogeneration (including district heating) from the present 3200 MWe through 5000 MWe by 1995 to 6200 MWe in the year 2000 (MEC, 1990, 9). DFL 10 million is reserved for subsidies in respect of heat pumps, control equipment, energy recovery from waste gases, frequency convertors and similar technologies (MEC, 1990, 38). In order to stimulate the market acceptance of newly developed energy conserving techniques, the Government has initiated a policy in 1990 through which tenders on efficient energy projects are encouraged and supported. A sum of DFL 30 million is reserved with respect to the industrial sector. The incentive scheme for demonstration projects supports new energy saving ideas. DFL 10 million is available for investments in solar energy and another DFL 30 million for wind energy.

Furthermore, subsidies are being offered to promote energy friendly behaviour. Since May 1990, requests for the insulation of existing homes have qualified for a subsidy of 20-30 % of the total investment. Subsidies for home insulation amount to DFL 65 million. The Utilities will also invest the same amount on insulation. Also since May 1990, a subsidy of DFL 350 is available for every residential condensing gasboiler; the Environmental Action Plan (MAP) of the energy distribution sector aims at installing 100,000 appliances each year. DFL 10 million is available for this purpose. For home improvement schemes with respect to exterior walls and roofs, DFL 40 million has been made available.

In addition to taxes, subsidies and investments, the policy focuses on educating specialised groups. These activities include energy management courses for employees of small firms, training courses for process engineers and installation technicians; knowledge transfer to employees of construction firms and housing corporations and public education to influence car purchasing and driving behaviour. About DFL 17 million will be spent annually on public awareness.

Long-term agreements are being drawn up with the relevant sectors. The NOVEM (The Netherlands Society for Energy and Environment), on behalf of the government, actively pursues the process of encouraging energy conservation schemes with branches within the industrial sector.

This approach maximises the scope for initiative within the sector, and attempts at providing tailor-made solutions. The agreements between the Government and the individual industrial branches concern the actual energy efficiency improvement figure and the financial support for research and development, energy management, information and training. The annual budget for the above mentioned support is 29 million (Born et al., 1991). Agreements with the agricultural sector on energy auditing and management aimed at saving 5 PJ of energy annually in 2000 are being undertaken (MCC, 1991).

In order to set standards for central heating systems the Netherlands is aiming at a minimum efficiency standard within the context of the European Community. If research substantiates current expectation, it is anticipated that as of 1 January 1993 energy performance standards for housing will come into force. Stricter insulation standards will be developed and applied to government buildings and also to other sectors. Higher efficiency standards for heating equipment and statutory requirements for efficient lighting are also being studied. Standards for domestic appliances are being considered. Several options for linking energy saving to environmental licensing are being investigated. For such purposes, CO_2 can be considered as a 'pollutant'. CO_2 emissions can, in principle, be linked to an environmental license. Research undertaken is expected to show whether such a measure will prove to be effective.

In response to Government policies on climate change and energy conservation the energy-distribution utilities have prepared their Environmental Action Plans which have been summarised in a document for the whole sector (MAP). This sector can reduce CO_2 emissions by 10 Mt by 2000. The public utilities play an important role in giving information to their customers and promoting public awareness, being in close contact with the energy users. They will have particular influence in the promotion of insulation systems in residences and offices. They will also try and develop the potential of district heating on a small-scale. MAP is presently in the implementation stage. The budget of the total scheme is partly financed by government and partly by the utilities themselves through a MAP margin on customer prices and allocation on investment funds (otherwise used for enlarging capacity). MAP provides details about possible measures with respect to different target groups as can be seen from the following table.

Table 14 Possible reductions by the energy distributing sector (MAP, 1990)

Target: to save 10.3 million tons by 2000			
Sector	Measure	Annual Investment	CO_2 saved in Mt
Household	Lighting	100m	0.4
	Heating	270m	0.8
Industry	Lighting	200m	0.9
Government	Heating	110m	0.6
	Fuel switch		1.2
Utilities	Cogeneration	175m	4.8
	Wind power	200m	1.1
	Waste inc.		1.9
Total			11.7

In 1991, this document of the distributing sector was revised and some of the provisions changed. The electricity distributing sector consists of about 35 companies. Each of the companies have prepared their own policy documents explaining the measures that they will take to implement the national policies. As most of these companies are closely connected with municipalities, there is close coordination between their respective policies. Furthermore, every two years the Electricity Producing Sector prepares its own policy plans. This is required by law. According to their policy about 14 Mt of CO_2 emissions will be avoided annually by reduced use of coal in industry and electricity generation than previously envisaged. Furthermore, the energy producers have plans to construct modern gas combined cycle cogeneration plants (district heating) which can generate 1250 MW of power while saving 14 PJ of primary energy every year.

The annual budget of government and utilities' measures for 1992 as of April 1992 is given in table 15.

With the new budget for 1992 and 1993, some of these figures have changed. The changes are presently being calculated.

Table 15 The Energy Conservation Budget for 1992 (VROM, CCD\Paper 3, 1992)

Type of Measure	Total
R & D, demonstration, agreements, regulations, information	184
Cogeneration (incl. district heating)	240
Wind, solar, efficient techniques	58
Tenders	30
Home and building insulation, condensing gas-boilers	75
Home improvement	40
Government buildings	20
Total Government Budget	about 648
Budget of the Utility Sector	253
Total Budget	901

The Transport Sector

About 15 percent of national CO_2 emissions originates from the traffic and transport sector. In reference to the base year 1990, the transport sector is aiming at the stabilisation of CO_2 emissions by the year 1995, the reduction of about 10 percent by 2000, and a further reduction of about 20 percent by 2010.

The Netherlands' Government follows a three track approach directed at technological measures, the reduction of car use by influencing mobility demand and the choice of mode of transport, and at improving the behaviour of drivers through (urban) traffic measures, speed limits, etc.

Several measures have or are being considered for adoption. For example, fiscal incentives through differentiation in road taxes or vehicle-related taxes to stimulate the purchase of fuel-efficient cars are under discussion and a proposal is expected in 1993. Variable costs with respect to cars will be increased by about 50 percent in the period 1990-2010, through taxes on fuels and pricing policy. The details of the proposal are under discussion and a fuel tax was implemented as of July 1991. Tax advantages for car commuters will be reduced. A first step in this direction was implemented as of August 1990 and further steps are being discussed. The implication of this measure is that commuters covering more than 30 kilometres per day in order to reach their office would lose their tax advantage, and this would cost them an additional DFL 550 per year. This measure is expected to reduce kilometres driven by about 0.3 % (VROM Venster, 1992). The long term influences might be greater because of its influence on the choice of housing vis à vis the work place. Reducing subsidies on polluters, as in this case, is necessary to make polluters more aware of the results of their activities. However, this is politically a very sensitive issue and even caused the fall of the government in 1989.

A decision taken in 1990 allows subsidies for corporate transport management plans drawn up voluntarily by companies to reduce the number and length of 'trips'. This may eventually develop into a compulsory legal requirement in the future. The experience thus far shows that through such voluntary plans a 10 % reduction in kilometres driven can be easily achieved by the concerned companies.

A legislative measure was implemented in 1991 incorporating a mandatory check of the engine adjustment as a part of the annual vehicle inspections. Speed limits on highways were fixed at 120 kms per hour and on highways in urban areas at 100 kms per hour in 1988. The speed limits for urban roads are 50 kms per hour and for other roads are 80 kms per hour. Public transport passes are being issued to students and military personnel for budgetary reasons. This system may be extended to other groups of commuters. The preliminary results of issuing public transport passes to students reveals that the scheme has been extremely successful. So much so, that the demand for public transport has increased by 16 %, of which students account for 10 %. This may lead to increased public transport and hence, increased emissions. On the other hand, increased public transport systems may reduce waiting time and other such factors and may in the long run attract the car commuter. Speed limits are enforced and monitored by the police and they have launched public information campaigns with respect to the environmental and other risks to the public and the need for better driving behaviour.

In 1990, the Government decided to invest DFL 20 billion in the period until 2000 on public transport. This includes the construction and maintenance of facilities for rail and inland water ways. DFL 50 million will be invested annually on cycle paths and sheds. Further, a decision to reduce investments on highways from 20 billion to 13.5 billion (1990-2010) was taken in 1990 by the Government. Investments in a pilot project led to the establishment of a car pool lane on the A1 highway. Initial results of the car pool project have been encouraging. 25,000 places have been reserved for car poolers at convenient places on the highway.

The second track measures, if implemented fully and on schedule (including tolls) are expected to lead to a reduction in car use by 35 percent in the year 2010 with respect to autonomous growth. Measures with respect to speed limits are expected to reduce CO_2 emissions from this sector by 2-3 percent. The (voluntary) annual vehicle inspection on the engine's functioning is expected to achieve an additional reduction of emissions by 2 percent. The adoption of emission standards and fiscal incentives for fuel efficient cars will lead to a 35 percent reduction in CO_2 emissions per vehicle by 2010. Furthermore, in addition to the benefits of CO_2 reduction, these measures will result in the reduction of pollution and consequently acidification, congestion and traffic accidents.

Investments in public transport and bicycle facilities amount to some 21 billion guilders in the period 1990-2010.

Waste Sector

Waste management policy aims at reducing annual CO_2 emissions by 1.5 Mt in 1994-95 and by 3.5-4.5 Mt by the year 2000.

In 1995, about 1 Mt of CO_2 emissions will be prevented by measures with respect to synthetic and packaging waste. Around 0.3 Mt of CO_2 emissions is expected to be prevented by the reuse and thermic processing of paper and cardboard and by the implementation of anaerobic fermentation of organic waste. A further 0.4 Mt of CO_2 emissions is expected to be saved by the additional reuse of energy intensive materials (VROM, CCP, 1990). The Government's CO_2 target for this sector can be realised only if all waste subsectors contribute their share.

Several government guided programmes offer opportunities for the integration of the CO_2 aspect. These include the National Research Programme on Reuse, Energy Production from Waste and Bio-mass, Innovation Oriented Research Programme on Environmental Technology, etc. However, the CO_2 dimension will have to be inserted explicitly along with a balanced, coordinated distribution of the required reduction among the different subsectors.

A plan proposed in January 1991, consists of five clusters of reduction measures to be implemented in five phases. The plan has not been implemented entirely. In the period 1992-'95, several demonstration projects and trial installations could be initiated as an introduction to large scale implementation. This way, about 1.6 Mt of CO_2 could be saved by 1995.

The inclusion of CO_2 emissions in Environmental Impact Assessments of landfill sites, incinerators and other such installations is currently under consideration. The possibility of taking CO_2 emissions from waste management installations or from other installations into account before issuing licenses, is also being considered.

CO_2 Sequestering by Biomass

Biomass plays an important role in carbon dioxide sequestering. In the Netherlands, as an initial step the 'bio-mass' policy concentrates on afforestation. The target is to increase the area covered by trees (including forests, orchards and road-side plantations) from 14 to 15 percent by the year 2000. See table 11.

In order to implement this policy, measures with respect to education, information, research, regulation and subsidies have been and are being adopted.

In the Netherlands many laws exist to conserve, regulate and promote forest management and afforestation. These laws deal with, inter alia, physical planning, preservation of forests, soil protection and the conservation of nature. Wood production is also influenced through these laws. Subsidies totaling DFL 3000 per hectare are being provided to promote fast growing forests and wood production. An annual financial contribution of about DFL 1500 per hectare of temporary forests in agricultural grounds (set aside premium) is made. A one time financial allowance for afforestation and an annual subsidy is provided when the forests are open to the public.

In addition to the budgets for the national afforestation efforts and the management of the State forests by the National Forest Service, about DFL 26 million has been reserved annually for financial contributions to forest and landscape development. For subsidies promoting fast growing forests and wood production several millions of DFL are available, as is the case for effect oriented measures. The budget for the set aside premium depends on the number of hectares being planted. The coverage varies according to the contract from 15 to 40 years. The "set aside" rule will be valid only until the Mac Sharry Plan goes into effect.

Recently, there has been considerable worry in the Netherlands about the state of the existing forests. About half of the existing forests are expected to die prematurely for a host of reasons such as acidification and the falling water table. The Government is now investigating the possibility of taking steps to prevent this occurrence.

About 4000 hectares have to be planted annually by the year 2000 in order to reach the targets.

Possible CO_2 strategies for the future

In the recently published Memorandum on Climate Change, a section on the possibility of reducing CO_2 emissions by 20 % in the year 2005 with respect to 1990 as suggested by the Toronto

Conference on the Global Atmosphere was suggested. This section is based on a report of the Energy Study Centre (ECN). It is anticipated that this section will provoke some political discussion and the objective is to create political recognition of the fact that a tougher target is necessary.

The report concludes that in order to achieve the Toronto target, the current rate of reduction of CO_2 emissions will have to be doubled. Although this exploratory study did not examine the potential problems associated with these reduction options, it is clear that the principal obstacles in achieving the Toronto target will be the practical and political feasibility.

A matrix approach, as shown in tables 16 and 17, is used to gauge the potential in six sectors: housing, industry, traffic, waste, energy and others.

Six types of measures were applied:

1. Energy conservation, in general, implies lesser use of fossil fuels. The CO_2 emission reduction depends on the fuel used in the power plant.
2. Fuel Switch implies changing the fuel from coal to natural gas since the CO_2 emissions are higher from coal.
3. Renewable energy (solar/wind) involves no direct emissions of CO_2. The net emission of CO_2 is zero in the use of biomass as a fuel.
4. Carbon stock management can temporarily reduce CO_2 emissions by preventing the carbon within plastics and other such materials from escaping into the atmosphere.
5. CO_2 removal is an option whereby CO_2 is removed from the exhaust gases of a coal-fired plant and stored in, for example, empty gas fields.
6. Reducing the volume of activities is also an option. Such a measure should not, however, be offset by growth in the volume of a corresponding sector in another country.

Table 16 Technological option package (VROM, MCC, 1992)
(Code: Hou. - Housing; Oth. - Other; Ind. - Industry;
Was. - Waste; Tra. - Transport; Ene. - Energy)

Contributions in 2005 from options and sectors to the reduction of the CO_2 emissions (in Mt) according to the technical option package (TOP)							
Measures	Hou.	Ind.	Tra.	Oth.	Was.	Ene.	Total
Vol. measures	-	-	0.0	0.0	0.0	-	0.0
Carbon stock management	-	-	-	-	12.1	-	12.1
Extra savings	6.8	3.8	2.7	4.4	0.8	0.3	18.8
Durable energy	0.1	0.0	0.3	0.1	0.4	0.6	1.5
Choice of fuel	0.2	0.0	0.4	0.0	-	1.7	2.3
CO_2 removal	-	1.8	0.0	0.0	-	4.7	6.5
Total reduction	7.1	5.6	3.4	4.5	13.3	7.3	41.2

Not all these types of measures are possible in all sectors as indicated by the matrix. Furthermore, the choice of one measure may have impacts on the other options. Thus, the removal of CO_2 emissions from a power plant, is an option that leaves little room for further reduction of CO_2 emissions through electricity conservation by end users of the energy from this plant.

ECN has developed two packages of measures that can result in a 20 % reduction in emissions:

1. a technology-oriented package (TOP); and
2. a volume-oriented package (VOP).

In TOP the CO_2 reduction is mainly achieved through further development and use of existing technology. Energy saving measures alone account for 50 % of the reduction in CO_2 emissions.

The VOP option considers both technology and volume-oriented measures. It draws heavily on regulations on waste management and changes in behaviour/attitude. Thirty percent of the reduction is achieved by the adoption of volume-oriented measures such as the transfer of energy-intensive activities to other countries, richly endowed with renewable sources of energy, where the same products can be produced while emitting less CO_2.

Both approaches involve structural changes in the patterns of production and consumption.

The results of the Energy Study Centre report emphasize the need for international co-ordination. A number of measures should not be taken by the Netherlands alone. These include measures that can be taken within the Netherlands, but which may affect the international competitiveness of national industry and is, hence, a source of concern.

The Netherlands will, therefore, continue to encourage further analysis of the Toronto target in association with other countries in international fora. Follow-up research into the possibilities of more radical CO_2 policies will pay due attention to the economic effects of this policy and the implementation problems, for example with the aid of new scenarios.

Table 17 Volume option package (VROM, MCC, 1992)

Contributions in 2005 from options and sectors to the reduction of the CO_2 emissions (in Mt) according to the volume option package (VOP)							
Measures	Hou.	Ind.	Tra.	Oth.	Was.	Ene.	Total
Vol. measures	-	2.5	0.5	3.2	6.2	-	12.4
Carbon stock management	-	-	-	-	6.0	-	6.0
Extra savings	6.6	2.8	2.8	1.7	0.1	0.3	14.3
Durable energy	0.1	0.0	0.3	0.1	0.2	0.5	1.1
Choice of fuel	0.0	0.0	0.2	0.0	-	3.3	3.5
CO_2 removal	-	0.6	-	0.0	-	3.4	4.0
Total reduction	6.7	5.9	3.7	5.0	12.5	7.5	41.3

CFC Strategy

According to the CFC Annual Report of 1990, the Netherlands used 14,321 tons of fully halogenated CFCs in 1986 and that had decreased to 7,208 tons by 1991. The national target is to phase out the use of CFCs and halons by 1995, or as soon as possible thereafter. See table below.

Table 18 CFC Reduction Scheme (VROM, CFC Annual Report, 1991)

Reduction Scheme (Annual consumption in tons (10^3 kg)	1986	1990	1992	1994	1995
Aerosols and carrier gas	3789	650	100	6	6
Foams	8506	5353	3050	300	0
Refrigeration	997	744	176	71	0
Cleaning Solvents	1029	1002	500	200	50
Total CFCs	14321	7749	3826	577	56

The CFC Action Plan was primarily conceived as a plan to address the issue of the depletion of the ozone layer.

Since CFCs also have a greenhouse warming potential, it is clear that reducing the use of CFCs will also imply the reduction of national greenhouse gas emissions. Furthermore, there is a general reduction of inert gases and especially chlorine or bromine containing substances in the atmosphere.

The National budget for this task for 1990 until 1995 is 28 million guilders.

Other greenhouse gas strategy

The national target for CH_4 is to reduce emissions by 10 % in the year 2000 with respect to emissions in 1990. The national target can be divided among different sectors as can be seen in table below. The uncertainty with respect to emissions in 1990 is about 25 %.

The accumulation of methane in the atmosphere is the result of increasing emissions from human activities and the decreasing capacity of the atmosphere to break down the CH_4 molecules because of the increased atmospheric concentrations of CO (Born et al., 1991).

This section deals only with CH_4 emissions.

Table 19 CH_4 emissions per sector in the period 1990-2000 in units of Kton CH_4 per year (Born et al., 1991)

Sector	1990	1995	2000
Oil and gas production and distribution	150	135	120
Transport	8	8	8
Energy and Industry	10	10	10
Agriculture	395	380	355
Nature	120	125	130
Waste	225	260	200
Others	20	20	20
Total	960	940	840

National policy aims at stabilising domestic gas consumption at present levels by the year 2000. However, the export of natural gas will increase. Measures implemented in relation to national energy policy will result in a reduction of CH_4 emissions. Of special interest here is the regular replacement by the distribution companies and improved maintenance of old cast-iron gas distribution networks, resulting in a decrease of leaking pipes which in turn will lead to a decrease in CH_4 emissions.

Transport policy has no express measures aimed at the reduction of CH_4 emissions. However, existing policy to reduce mobility, i.e. the second track approach, will incidentally result in the reduction of CH_4 emissions.

The EC policy on the animal husbandry sector, particular with respect to cattle ("milk quota") will probably lead to a decrease in cattle population and a stable demand of dairy products and meat. These will result in a reduction of emissions. Food efficiency improvement measures may lead to an increase of milk production per head of cattle and improved digestion, resulting in a reduction of CH_4 emissions.

Wetlands management policy aims at preventing further drainage of the peat and peaty soils and even raising water tables in existing agricultural wetlands in order to convert the lands back to their natural use. This may result in an increase in methane emissions.

Regulations with respect to landfills include provisions that newly designed landfills have to be covered and methane has to be recovered from the landfills. Increased separate collection and improved treatment of organic waste, will result in a decrease of the uncontrolled production of wastegas and methane emissions. The recovery of CH_4 from waste water treatment plants for energy purposes is being considered.

The N_2O Strategy

The national target for N_2O is to stabilize emissions in the year 2000 with respect to emissions in 1990. The national target can be divided among different sectors as can be seen in table below (Born et al., 1991). There is an uncertainty of around 40 % with respect to the estimates of 1990.

Table 20 N_2O emissions per sector in the period 1990-2000 in units of Kton N_2O per year (Born et al., 1991; quoted in VROM, MCC, 1992)

Sector	1990	1995	2000
Transport	4	9	14
Energy and Industry	2	2	2
Agriculture	23	19	14
Nature	7	5	4
Waste	4	4	5
Total	40	40	40

Substantial increases of N_2O are expected because of the introduction of catalysts and resulting N_2O emissions per vehicle. The same catalysts, however, will reduce the emission of GHG precursors (NO_x, VOC, CO), roughly compensating for the greenhouse effect from the increased N_2O emissions. Current trends suggest that energy consumption in the transportation sector will increase more than foreseen in the Structure Scheme for Traffic and Transportation and the National Environmental Policy Plan, Plus (1991), which form the basis of the national transportation policy.

Measures undertaken with respect to existing energy and industry policy will lead to a reduction of N_2O emissions. Of special interest is that the national survey of N_2O emissions from fuel combustion plants and mobile sources has just been concluded. Follow up measures are being considered.

Existing policies aim at diminishing the production of animal manure and stimulating manure application. These lead to a reduced supply of Nitrogen to agricultural areas, resulting in a decrease of nitrate leaching into the groundwater and N_2O emissions into the air.

Existing waste policy leads to a reduction of N_2O emissions.

Research projects on a preliminary study of N_2O emissions (experimental), the setting up of a global data base, N_2O emissions in combustion processes in electricity generation, N_2O emissions from traffic now and in the future, GHG from refuse dumps, etc. are being undertaken.

The CO Strategy

The national target for CO is to reduce emissions by 50 % in the year 2000 with respect to emissions in 1990. The national target can be divided among different sectors as can be seen in table below.

Table 21 CO emissions per sector in the period 1990-2000 in units of Kton CO/year (Born et al., 1991; quoted in VROM, MCC, 1992)

Sector	1990	1995	2000
Oil, gas and industry	290	270	260
Transport	750	470	200
Others	80	80	80
Total	1100	820	540

Measures to ensure the safety and the quality of small central heating installations and for large energy installations with a capacity of more than 650 KW are being taken.

These measures have the side effect of leading to a reduction of CO emissions. In the steel industry technical measures are being considered for the reuse of CO emissions from the production process.

Fiscal measures to promote catalysts are being undertaken within the framework of existing transport policy. These measures, help reduce the emission of GHG precursors such as CO.

The NO_x Strategy

The national target for NO_x is to reduce emissions by 55 % in the year 2000 with respect to emissions in 1988. The national target can be divided among different sectors as can be seen in the table.

There is a subsidy being provided to stimulate the purchase of central warming installations that have a high energy efficiency and low NO_x emissions, and a subsidy for low NO_x gas-engines.

It is expected that in 1993, a General Administrative Order with NO_x standards for central warming installation will come into force. There are NO_x emission standards for waste incineration plants in force. Process emissions are regulated by "Dutch Emission Guidelines". These Guidelines are used by Regional Authorities in order to issue permits.

Table 22 NO_x emissions per sector in the period 1988-2000 in units of Kton NO_x/year (Born et al., 1991; quoted in VROM, MCC, 1992

Sector	1988	2000
Energy and industry	172	58
Transport	299	112
Others	89	70
Total	560	240

NO_x requirements for passenger cars are in conformity with EC regulations. Compliance with 1993 EC requirements on a voluntary basis is being promoted by fiscal measures. Under existing policies directed at reducing acid precipitation, a subsidy is being offered for the purchase of cleaner trucks and buses in conformity with stricter NO_x standards. Measures to discourage the use of cars and measures to make use of other modes of transport more attractive should reduce increase in automobility.

Strictly speaking, the NO_x policy is not being paid out from the climate budget. In that sense, it is a no regrets measure. However, the NO_x measures are expensive in themselves and cost in the nature of approximately 800 million guilders (Acidification Abatement Plan, 1989).

The VOC Strategy

The national target for VOC is to reduce emissions by 55 % in the year 2000 with respect to emissions in 1988. The national target can be divided among different sectors as can be seen in table below.

Existing policy to reduce the emissions of VOCs is intended to reduce the problem of forest die back and smog formation. The KWS 2000 strategy to reduce VOC emissions from products and stationary sources is determined in co-operation with industry and local and regional governments.

Existing policy will lead to an improvement of the technologies used in this sector, leading to a reduction of VOC emissions. The VOC measures cost in the nature of DFL 110 million guilders.

Every year the results of the different activities are reported in the Environmental Progress Report. This gives an indication of the success or failure of the policy measures and such an evaluation allows for improvement in measures to achieve existing goals.

Table 23 VOC emissions per sector in the period 1988-2000 in units Kton VOC/year (Born et al., 1991; quoted in VROM, MCC, 1992)

Sector	1988	2000
Energy and industry	223	100
Transport	203	55
Agriculture	24	20
Nature	15	15
Others	24	18
Total	490	205

3.3. The structure of research activities

Climate change research is considered a priority issue in the Netherlands. Research in this field, ranging from fundamental to applied and policy-oriented, is carried out at several universities and governmental institutes. The institutional structure and cohesion of this research area has recently been strengthened considerably through the establishment of the Global Change Programme by the Netherlands Organisation of Scientific Research (NWO), and through the establishment of the National Research Programme on Global Air Pollution and Climate Change (NOP) by seven ministries in 1989. (The participating ministries are as foolows: the Ministries of Environment, Economic Affairs, Transport, Public Works and Water Management, Agriculture, Nature Conservation and Fisheries, Education and Science, Foreign Affairs and Development Cooperation and the Ministry of Welfare, Health and Culture.) The climate research component of the NWO and the NOP programmes have been integrated into a comprehensive national programme. This comprehensive national programme covers five research areas.

1. Scientific processes and feedback mechanisms
   This covers a wide range of topics at several universities and government institutions. It includes atmospheric and oceanic modelling, special attention being given to the role of vegetation, oceans and clouds in the climate system. Considerable experience exists in the field of ice-sheet and glacier research and modelling.

2. Sources and sinks of GHG Carbon cycle modelling
   Field research in the IGBP framework on oceanic and terrestrial biospheric sources and sinks receives special attention. Based on this experience and knowledge global emission inventories of CH_4 and N_2O are being prepared and updated, as well as scenarios of CO_2, CH_4, N_2O, O_3 and other GHG emissions.
3. Ecological and socio-economic impacts
   The impacts both on natural and agricultural ecosystems are being studied. Coastal ecosystems receive special attention. Since the western half of the country is below sea-level, the impact of climate change on its coastal defense system is being evaluated extensively.
4. Integrated modelling
   The coupled effect of policy measures, their consequences for emissions and concentrations and their impact through climate change on society is being studied by means of an integrated modelling effort.
5. Options for sustainable responses to climate change
   Among the many studies initiated in this area, the research on the feasibility of CO_2 removal is worth mentioning. Preliminary results indicate that processes such as coal gasification, fossil-fuel fired installations and fertilizer production are suitable for removal of carbon dioxide from their exhaust gases. The CO_2 could then be stored in depleted gas or oil fields or in aquifers.

The research programme, briefly outlined in this section, is and will continuously be attuned to international research programmes, in particular with the World Climate Programme (WCP), the International Geosphere Biosphere Programme (IGBP) and their sub programmes.

Including other related research, the Netherlands spends an estimated 50-100 million DFL per year on climate related research which is about 0.02 % of its GNP. About 6 million DFL is funded by the EC environmental research programmes STEP, EPOCH and MAST.

3.4. Raising public awareness

Awareness Campaigns

Measures aimed at reducing greenhouse gas emissions tend to be unpopular, because they can have an influence on private consumption patterns and the growth patterns of the country. Although there is considerable political awareness on the seriousness of the issue, governments do not wish to be unpopular with the electorate. There is a very clear need to raise the level of public awareness on the issue and to invite public discussion on the different measures, in order to create public acceptance of the policy measures. Several awareness raising campaigns have been begun. A climate campaign was launched in October 1990 by the Ministry of Housing, Physical Planning and Environment (VROM). It entered into its third phase last autumn. Every phase is accompanied by careful evaluation. The first phase was directed at raising general awareness on the problem. The second phase is directed at teenagers, through information packages for schools. A trendy attractive project was the rap song on the greenhouse effect by Tony Scott, which made it to the hit list for a couple of weeks. The Ministry of Environment is sponsoring communication programmes by a network of NGOs. This network includes environmental organisations, consumer groups, trade unions, churches, etc.

In October 1990, a nation-wide campaign was started by the Ministry of Economic Affairs. Its goals are to improve the awareness of the impact of individual energy use on the environment and to influence the public's attitudes. Since the autumn of 1991, there is also a message especially directed at firms. In 1990, the energy distribution sector started a programme to provide consumers with advice on energy-saving bulbs, heating and insulation. It had a parallel advertising campaign with the motto "Your Gas Company Helps".

Since 1988, the Ministry of Transport and Public Works has two major campaigns. One is aimed at the reduction of high speed driving on highways which at the same time promotes greater energy efficiency and less pollution per kilometre. In TV spots, advertisements, and on billboards the message is that "Speeding is too costly", both in terms of money and in terms of road accidents and environmental damage. In addition to this ongoing campaign, this Ministry has started a long-term national campaign to promote "transport consciousness" in 1991. It is organised, inter alia, through intermediary groups to help people make rational and environmentally oriented choices in their transport behaviour.

Non-governmental organisations play an increasingly important role in motivating citizens to behave more consciously in all every-day situations. The Netherlands' Government considers their advice as a valuable second opinion and, on a project basis, supports them in their research and public education campaigns.

The first results of a large number of public awareness campaigns are available. However, these results are minimal compared with the kind of social support necessary to take the far reaching policy measures necessary. The campaigns have to continue at a high degree of intensity and a greater degree of specificity if public support is to be expected for the far reaching measures necessary to reduce greenhouse gas emissions. A Network Campaign has been established to communicate with different sorts of organizations such as church organizations, womens organizations, labour unions, etc. and it is hoped that through these networks the message gets across to the general public that a change in lifestyle is ultimately necessary. Two initiatives can be mentioned. One labour union in the Netherlands has advised that in view of the world wide economic depression which does not leave the Netherlands' economy untouched, the labour unions should ask for a limited annual increment in salaries, and the money thus saved should be used to create jobs and for environmental measures. Another initiative is that of 90 municipalities covering about 30 % of the Dutch population. These municipalities have become signatories to the declaration of the Climate Alliance which includes a commitment to reduce their CO_2 emissions by 50 % by the year 2010.

3.5. Some international aspects

Parallel to national public awareness campaigns, it is also important that countries should act together to reduce their emissions. This will provide them with the added impetus from a competitive point of view to develop more environment friendly technology and goods.

A study conducted by The Energy Study Centre on the feasibility of the Toronto Target emphasizes the need for international co-ordination. A number of measures should not be taken by the Netherlands alone. These include measures that can be taken within the Netherlands but which may affect the international competitiveness of national industry and is, hence, a source of concern. The Netherlands will, therefore, continue to encourage further analysis of the Toronto target in association with other countries in international fora. Follow-up research into the possibilities of more radical CO_2 policies will pay due attention to the economic effects of this policy and the implementation problems, for example with the aid of new scenarios. In 1991, a list of possible technical, organisational and policy measures compiling the suggestions of the government, research institutes and NGOs was put together providing a range of options to the government (Swager et al., 1991). Some of these options can be found as adopted measures in different policy documents.

The greenhouse problem cannot be addressed alone. Countries will have to cooperate with each other in addressing the issue within a global strategy. The Framework Convention on Climate Change presents a framework within which different governments can function.

As a first step, industrialised countries need to stabilise their emissions. The Netherlands has developed its own detailed plan to try and reduce its emissions by 3-5 % in the year 2000. Certain Eastern European countries such as Hungary are also expected to stabilize their emissions of CO_2 by the year 2000. The Netherlands would like to support some of the Eastern European countries including Hungary to stabilize their emissions. Bilateral cooperation programmes within the context of existing Memorandums of Understanding are being developed.

Developing countries are also expected to make a contribution towards addressing this global problem. The Netherlands' Ministry for Development Cooperation has reserved an amount of DFL 325 million in 1993 (about US$ 200 million) increasing to DFL 400 million (about US$ 235 million) in 1994 to facilitate environmental projects, including climate change relevant projects, in developing countries.

4.1. Key features of energy sector and the carbon-dioxide emissions

The energy consumption of Hungary has been almost steadily increasing during the last 30 years (HNC, 1992) as can be seen from the following table.

Table 24 Energy consumption in Hungary

year	GDP (1980:100)	energy consumption, PJ
1960		591
1970		917
1980	100.0	1261
1985	109.1	1324
1986	110.7	1319
1987	115.2	1357
1988	115.2	1337
1989	115.4	1316
1990	110.8	1244
1991	102.2	1175

In this period, the proportion of coal and its volume decreased within the total energy produced and consumed, whilst the proportion of hydrocarbons and electricity generation steadily increased. The steady increase in the overall energy use by 1987, interrupted only by a stagnation period of three years in the first half of the eighties, broke down after 1987 and since then the overall domestic energy consumption has been steadily decreasing at an average rate of 3 % per year. In comparison with the past data, the overall energy consumption in 1990 was already so low that energy consumption lower than that was registered only before 1977. Stagnation characterised the breakdown of the Hungarian economy after 1987 and resulted in a standstill and a following decrease in energy demands; the annual GDP in 1990 fell short of the production in the previous year by 4 % and it was about 7 % less in 1991.

Considering the European average, the per capita energy consumption in Hungary is relatively high, however, the European average is considerably modified by the contribution of countries with warmer climates. The per capita energy consumption in Hungary is generally less than that in countries of similar or somewhat cooler climates. (In this context, the importance of consideration of space conditioning energy aspects was highlighted in several studies; e.g., by Faragó, 1992.)

It is clear from the data that the specific carbon dioxide emission of Hungary is roughly double of that averaged over all the countries. At the same time it is considerably less than that in most European countries of similar or somewhat cooler climate.

In Hungary the overall emission reached 88.6 $MtCO_2$ in 1985 with the following components: population (residential sources) 19.7 Mt; services 4.7 Mt; transportation 7.8 Mt; electricity by MVMT (Hungarian Electricity Trust) 24.9 Mt; heat-energy supply by MVMT 2.6 Mt; industry 24.7 Mt; agriculture 4.2 Mt. Based on the 1987 data, the greenhouse gas emissions of transportation origin can be estimated as follows: 7.8 $MtCO_2$; 0.016 $MtCH_4$; 0.47 MtCO.

Table 25 Energy-related CO_2-emissions by primary energy sources and sectors in 1990 (in units of $MtCO_2$)

	Power plant	Industry	Households	Total
Lignite	10.4	4.6	4.7	19.7
Hard coal	-	5.0	5.2	10.2
Natural gas	2.7	14.9	5.2	22.8
Oil	0.9	19.0	2.6	22.5
Total	14.0	43.5	17.7	75.2

The primary background for the energy-related national anthropogenic ghg-emissions is given by the ministerial and government's documents on the energy strategy planning. The main features of the new approach to the energy support and were expressed also at the World Energy Council Congress in 1992 (Hungary, 1992). According to this document, the major elements of the new Hungarian energy policy include among others: "... the improvement of energy efficiency, partially by encouraging energy conservation and partly by influencing the restructuring of production; the establishment of market conditions in energy supply and the development of a liberalized pricing policy reflecting relative international values (which will .. also serve as a basic factor in motivating people to rationally conserve energy); ... the assertion of environmental protection priorities in the field of energy".

From the data, it is also discernable that economic development and energy consumption are closely interconnected. The energy intensity in Hungary, that is the energy amount required to produce a unit of GDP, is unfavourable in comparison with other developed countries. The low energy efficiency is a result of the low economic efficiency. The per capita GDP production in Hungary is 3-4 times surpassed by the same indicator of the industrialized countries selected for comparison.

Based on the energy consumption data and the characteristics of the energy carriers, an estimation of the domestic (energy-related) carbon dioxide emission can be made. Its per capita value is generally used in international comparisons.

Table 26 {*tc \f O "26 "*}Energy use and efficiency use in different countries (1989)

Country	GDP (10^9 USD)	GDP/capita USD	energy use Mtoe	efficiency toe/capita	toe/M$
Hungary	26	2240	32.00	3.02	1230
Austria	73	9550	23.83	3.13	326
Belgium	90	9070	47.33	4.77	525
Denmark	61	11950	17.94	3.50	294
Netherlands	138	9460	65.11	4.46	472
Europe ('85)				2.14	
USA	4548	18630	1943.4	7.96	427

Table 27 Carbon dioxide emissions deriving from energy consumption in Hungary

Year	tC/capita	$MtCO_2$	tCO_2/capita
1980	2.3	89.5	8.4
1985	2.2	88.6	8.3
1986	2.2	87.0	8.1
1987	2.2	87.3	8.2
1988	2.1	83.4	7.9
1989	2.1	80.9	7.7
1990	1.9	75.2	7.2
1991	1.9	72.7	7.0

4.2. Basic emission scenarios and their analysis

Until 1980, only a few studies which referred partially to the problem of national greenhouse gas emissions from human activities appeared in Hungary (e.g., Mészáros et al., 1984). The concrete first assessments in this context were published a few years ago as part of pure technical calculations or general climate related principal analyses without any direct response policy aspects (Jászay, 1989, Faragó et al., 1990, 1991). Despite the very tentative methodological basis of these estimates and the uncertainties about the assumptions on the future economic performance and the related changes in the energy demands, we recall the features of the principal scenario.

- the annual rate of increase in the energy demand by the households and the communal sector was supposed to decrease (due to the expected improvements in energy conservation or more intense use of renewable energy resources) from 6 % for the recent decade to 2.5-3.0 %;
- a similar change in the demand for the electric energy by the industry was expected to be 1.2-1.4 % as compared to the recent 2.6 %; the overall annual increase in the electric energy use was set to 1.5-2.0 % for these medium-term calculations;
- modest or no increase in the direct use of the fossil fuels; and
- the overall annual increase in the energy consumption was taken as 0.6-0.8 % for the country by the turn of the century.

The analysis included also the recent and possible further changes in the energy-efficiency. This factor improved essentially during the period of 1971-1987: 30 % or 1.8 % per year. Based on some assumptions, among others, a scenario was developed with a conditional 1.3 % annual increase in energy efficiency during the forthcoming decades to meet the international recommendations to cut the CO_2 emissions by 20 %.

The new planning activities of the Hungarian energy policy for the forthcoming decades and preparations of the Hungarian position on the energy related CO_2 emissions in the context of the FCCC proceeded simultaneously in 1991-1992.

The elaboration of the new Hungarian energy policy began in the Ministry of Industry and Trade in 1990. Its strategic planning document was approved by the government in June 1992 and then submitted to the Parliament (MIT, 1992). However, at least by the time of this publication it has not been passed. This document pays due attention to environmental considerations and specifically to the energy-related atmospheric emissions. Its main objectives refer among others to the "compliance with the new environmental protection ... challenges; more intensive utilization of renewable energy sources, ... energy efficiency."

This document by the department of energy addresses both the problem of energy supply/ production structure and the estimated volume of future energy demand. The initial "climate policy" formulated in the first half of 1992 was based on the draft version of the energy policy paper. The main difference is in the time horizon: the government energy policy paper primarily sets assumptions by the turn of the century, whilst the possible greenhouse gas emissions stabilization commitments should be evaluated on a "thereafter" basis and as a minimum, the numerical estimates should be accomplished for the forthcoming two decades, i.e. by 2010. We think that it is a typical difference between the economic and environmental planning.

As concerns the principal assumptions, it is expected that as soon as the economy recovers and begins to develop into a more modern structure, the decreasing tendency in energy demand will stop and, partly due to the growth in the economy and the new production structure, a certain increase in demand -- mainly in electricity -- may be expected. The actual size of the change largely depends on factors outside the energy sector: in 2000 electricity consumption will be 43-46 billion kWh, while total energy demand 1200-1300 PJ with decrease in the energy intensity.

The policy strategy plan includes already the most critical environmental criteria: "According to the Helsinki and Sofia Agreements, which are well known, by 1993 the SO_2 emission will be 30% lower than in 1980, and NO_x emission will stop at the 1987 level by 1994. Most recently (in Rio de Janeiro, 1992) we undertook that in 2000 our CO_2 emission will not exceed the level of 1985-1987." The background analysis which led to the latter undertaking is given and analyzed below.

In 1991 a Climate Sub-committee to the Hungarian National Committee for UNCED was established in Hungary. This inter-departmental committee was charged with the development of a Hungarian position on climate change and on the then planned and negotiated international convention on climate change. Besides the other climate-relevant issues such as the regional impacts of climate change or the afforestation possibilities in the country and the corresponding enhancement of the carbon dioxide sinks, the primary objective of these activities was to set realistic energy-related CO_2 emission assessments and scenarios for the forthcoming decades and to figure out if the country can adopt certain emission stabilization targets.

The principal elements of the estimates were published (HNC, 1992) and the official position expressed during the international negotiations on the climate convention was guided by these background approaches. The main steps of the numerical analyses were:

- definition of three scenarios for GDP growth for Hungary in the period 1990 -2010;
- assumptions for increases in energy efficiency and demand for electric energy;
- discussion of several sources of uncertainty in the steps outlined above which are not translated into the emissions scenarios;
- definition of two main scenarios for the supply of electric energy, one which relies on expansion of nuclear energy, and one which relies on a new combined mine and power station for Hungarian lignite / brown coal;
- calculation of the resulting total demand for fossil fuels, both for production of electric energy, combustion and other uses for the years 2000 and 2010; and
- calculation of emissions of CO_2 related to the use of these fossil fuels in 2000 and 2010.

Perspectives of the development of the national economy basically determine the changes in overall energy demands. These estimates are remarkably uncertain because of the current transitional economic period. Hence, more variants are taken into account in estimating both the expected energy consumption and the atmospheric emissions associated with that.

Scenarios for GDP growth

The starting point is that the current recession will end in 1993. The GDP is expected to rise to the 1990 level and then it starts to increase after 1993. The anticipated changes in the structure of domestic production should be considered in order to evaluate the future energy demand. This is essential because there are great differences in energy intensity even within the industrial sector (the most energy intensive sector with the 57.8 % of the overall energy consumption in 1988). The specific energy demand of the basic material industry and the manufacturing industry differ considerably from each other. The former produces 14 % of the overall industrial GDP and requires at the same time 60 % of the overall industrial energy consumption. The latter, however, produces 64 % of GDP of industry, but its share is only 24 % in industrial energy consumption. On the basis of the 1988 data, energy intensity of the basic material production industry (relating to GDP) is 11 times more than that of the manufacturing industry.

More concretely, the three scenarios for GDP growth, referred to as "a", "b" and "c" -- or fast, medium and slow growth -- all assume that the current recession of the Hungarian economy will end within the period 1990-1995, resulting in a small positive, zero, or small negative growth of the economy in the period 1990-1995. The slow growth scenario for the first decade as a planning option was lately omitted (more exactly it was replaced with the scenario "b" for this period) and both the climate-policy paper (HNC, 1992) which was published in March 1992 and the energy policy paper (MIT, 1992) issued in July 1992 deal only with medium and fast growth rate variants. Accordingly, the annual average rate of growth for the 1990s is assumed to be: 3 % per year in the medium or moderate development scenario and 4 %/year in the accelerated one. The further details (for half-decades) and the predictions for the second decade were necessary for the complementary analyses.

The difference between the three scenarios is mainly the rate of growth assumed in the period 1995-2000 (3-6 % average annual growth). All three scenarios assume rapid (4-5 % annually) growth in the first decade of the new millennium. The growth rates in the three scenario's are summarized in table 28.

Table 28 Annual average growth rates used in GDP growth scenarios (in %)

	1990-1995	1995-2000	2000-2005	2005-2010	
Scenario "a"	1.0	6.0	5.0	5.0	fast
Scenario "b"	0.0	4.5	4.5	5.0	medium
Scenario "c"			4.0	5.0	slow

The growth per decade in the scenarios "a" and "b" by 2000 is 41 % and 25 %, respectively, which approximately correspond to the above mentioned average annual growth rates for the decade (4 % and 3 %).

It can be noted that all three scenarios assume relatively high growth rates, which will require considerable investments in the economy. Lower growth rates are not investigated because high economic growth is currently viewed as an absolute imperative by the government.

Because of the rapid changes in the economy at the present time -- the so-called economy in transition -- it is very difficult for government departments to obtain agreed forecasts for the economy as a whole, let alone sectoral growth forecasts. Some government departments are involved in planning the privatization of state monopolies, and negotiations with international banks and donors. This will clearly influence the rate and type of economic growth that will occur. However, this has not led, so far, to generally accepted economic growth rate forecasts, or priorities (set by the government) for growth or investment in certain sectors.

The above given scenarios assume homogeneous growth in all sectors of the economy. This is important because some sectors of the economy are much more energy intensive than others (as mentioned above, up to 11 times more for raw materials production as compared with manufacturing or services). If some sectors of the economy grow faster than others this may therefore have a significant impact on energy use, even when the overall growth rates do not change. This phenomenon is usually referred to as structural change of the economy. It is likely that structural changes will take place in the Hungarian economy, but these are obviously difficult to forecast. This issue is discussed in more detail under the paragraph on uncertainties, and also explored in the following chapter.

Energy efficiency and demand for energy

Accordingly, prospective changes in energy intensity are also determining to the assessment of the energy consumption perspectives. The relationship between energy consumption and GDP was relatively steady between 1960 and 1980. During this period, the average annual rate of increase of the GDP reached 5.1 % (270 % altogether) and that of the energy consumption was 3.9 % (216 % altogether). Consequently, the so-called "energy-elasticity" value, i.e. the energy consumption increase required for an 1 % increase in GDP, was 0.76 in this period. Since 1980, the energy intensity has kept decreasing until 1990. Its consecutive values were as follows: 1030 kJ/HUF (Hungarian Forints) in 1980; 992 kJ/HUF in 1985; 918 kJ/HUF in 1990. (According to the current exchange rates: 1 US$ = 1,80 DFL and 1 US$ = 83,72 HUF.) Thus, the energy consumption from 1989 to 1990 decreased more than the GDP, that means that the production of the basic material industry requiring much energy (metallurgy and chemical industry) more drastically decreased than the production in other sectors. In 1990-1991, however, changes took an opposite turn, then the production moderated more in the sectors of minor energy demand because of the collapse of COMECON markets (Council for Mutual Economic Aid), therefore energy intensity increased to 940 kJ/HUF in 1991. Regarding this as a temporary change, notable improvement of energy demanding is expected in the future.

In this estimation, the energy consumption increase as a consequence of the expected rate of increase of the GDP can exceed the energy savings due to anticipated improvements in the energy intensity. Consequently, certain increase of energy demand is expected to be in the next two decades.

A certain catch-up effect in the rate of growth for the demand for electrical energy, is expected and the share of electrical energy in the overall energy use will probably increase during the period 1990-2010 while the use of coal (other than for the production of electrical energy) will probably decrease.

The overall increase in the energy efficiency in the economy assumed in the analysis ranges from 3 %/year to 3.5 %/year in the period 1990-2000. Instead of this factor, the energy intensity is used (i.e., its inverse value) and the energy-policy paper sets it for the present decade at -3.0 %/year and -3.5%/year for the whole energy use and -2.0 %/year and -2.5 %/year for the electricity intensity in accordance again to a medium rate and an optimum rate improvement scenario (MIT, 1992). For clarity, we reiterate the formula (with slight modifications) for the energy demand assessments from this energy policy document by the department of energy:

$I(t) = E(t)/G(t)$

$R_G(t) = [G(t)-G(t-1)]/G(t-1)$, $R_I(t)=[I(t)-I(t-1)]/I(t-1)$

$$R_E(t) = [E(t) - E(t-1)] / E(t-1)=$$
$$=[I(t)*G(t) - I(t-1)*G(t-1)] / I(t-1)*G(t-1)=$$
$$=[\{I(t)-I(t-1)\} *G(t-1) + I(t)*\{ G(t)-G(t-1)\}] / I(t-1)*G(t-1)=$$
$$=R_I(t) + R_G(t)*[I(t)/I(t-1)] \text{ or } R_G(t)+R_I(t)*[G(t)/G(t-1)], \text{ from which}$$

$$R_E(t) = R_I(t) + R_G(t),$$

where R_G, R_E, R_I are the annual rates of change for the GDP, energy demand and intensity; G, E, I are the absolute annual terms for year t, respectively.

The neglect in the last equation is based on the condition that the interannual change in the energy intensity $I(t)/I(t-1)=1+R$ (or in the GDP, i.e. the term $G(t)/G(t-1)=1+R_G$ is small.

These assumptions and formula are applied to both the total energy demand and the electric energy demand in such a way that the medium rate growth (3 %) is related to the smaller decrease in the energy intensity (-3 % and -2 % for the total energy and the electricity demand) and the faster rate growth (4 %) is related to the higher decrease in the relative energy demand (-3.5 % and -2.5 %) by 2000 (MIT, 1992). A similar approach was used for the second decade (HNC, 1992). The results are summarized in table 29.

Table 29 Energy demand scenarios for Hungary

Year	Growth rate	Total energy, PJ	Electricity, TWh
1990		1244	39.5
2000	("b") medium	1200	43
2000	("a") fast	1300	46
2010	("c") slow	1340	51
2010	("b") medium	1383	56
2010	("a") fast	1550	61

In order to assess in detail the possible variants of economic development from the point of view of energy utilization, it is necessary to mention in advance that the modern economic level of countries of developed market economies has been achieved under the conditions of dynamic increase of their electricity consumption. Besides the rapid decrease of overall energy intensity, the electricity intensity has increased considerably in those countries. Since the energy intensity of the manufacturing sectors capable for deriving higher profit considerably falls behind that of the basic material production and the situation in the sphere of services is even much more favourable as compared to the manufacturing industry, therefore, any kind of positive modernization change in the economic structure, effective organizational transformation can remarkably moderate the overall energy intensity.

Therefore, assuming that further development of the economy makes possible a more considerable decrease of energy intensity, the necessary development of power station capacity up to the turn of the millennium can be achieved by a gas turbine program which is of smaller unit of power and requires less capital expenditure. (The costs of investment of gas-fired power stations of open or combined cycle, capable for running in peak regime, are much smaller than those of nuclear and coal-fired power stations, their effectivity is outstanding and their influences on the environment are slight. At the same time, this sort of power stations increases our dependence on the hydrocarbons import, there is also a significant risk concerning the oil-price on the world market and the running costs of such power stations, especially the fuel costs, are higher than those of the base power stations.) After the turn of the millennium, additional basic nuclear power station ("A" energy variant) or lignite-fired (or coal-fired) base power station ("B" variant) can be put into operation.

The assumptions given above are not out of line with those used in other countries. In the Netherlands, for example, it was concluded that the autonomous rate of increase in energy efficiency was about 1 %/year. The word "autonomous" refers to the increase in energy efficiency through technological development and private sector investments in the economy without a specific government policy to promote increased energy efficiency.

The objective of various government policies now in place in the Netherlands is to raise this energy efficiency increase to 2 % /year.

Sources of uncertainty

The main sources of uncertainty in this analysis should also be taken into account (HNC, 1992), namely:

- uncertainty in the growth rate of the economy, and therefore in energy use, which is linked to economic growth;
- uncertainty over changes in the productive structure of the economy;
- possible changes in energy use due to changes in the climate itself (reduced heating due to warming); and
- uncertainty over the fuel sources (e.g., coal or nuclear energy) used for electricity production.

As outlined above, the uncertainty in the growth rate of the economy led to the exploration of three scenarios for economic growth, and the uncertainty in the fuel sources for electricity production led to the development of two scenarios, one focusing on nuclear energy, and one on Hungarian lignite.

It should be noted that a change in the productive structure of the economy could lead to major savings in energy use (see table 34), but due to lack of data no calculations for a possible change in structure have been made. The resulting scenarios are therefore rather "pessimistic" forecasts and this is one of the reasons leading to the formulation of several alternative scenarios.

Similarly, during the deliberations on the climate-policy paper (HNC, 1992), it was pointed out that possible reductions in emissions would depend largely on increased energy efficiency. The document assumes fairly modest increases in energy efficiency, however, arguing that the changes in technology and associated investments are costly, and possibly not affordable for Hungary in its present economic condition. A very important issue for the emission scenarios is that the various assumptions on which they are based are consistent with each other. This concerns, for instance, the assumptions on: a) economic growth; and b) energy efficiency increases. These two issues are not independent. Sustained high economic growth rates imply high levels of investment and increases in income. High levels of investment, in turn, imply changes in technology, new equipment, etc., which will provide opportunities for increased energy efficiency. Similarly, increases in income could also provide funds necessary for environmental measures. High growth rates can therefore be linked -- particularly when stimulated through government policy -- to high increases in energy efficiency.

In a situation where there are insufficient funds for measures to increase energy efficiency -- investments in new technologies, equipment etc. -- there is also a low probability of high economic growth. Assumptions of high economic growth can therefore be combined with relatively high increases in energy efficiency, and vice versa. In both cases the CO_2 emissions will be relatively low compared with the scenarios developed by the Climate Sub-committee, which all assume high economic growth (after an initial period) combined with moderate energy efficiency increases.

Scenarios for the supply of electric energy

The energy supply policy for Hungary is a very sensitive - and more or less unresolved - problem. Political, international, economic, environmental aspects related to the energy supply policy elements include, e.g.:

- the recent international and environmental problems of use of hydroelectric energy;
- diversification of the energy supply, role of public opinion, environmental and other aspects of development or expansion of nuclear power plants;
- issues of coal mining such as the questionable economic value of some mines; and
- environmental drawbacks in relation to the more intense exploitation of domestic large reserves of poor quality lignite with a high sulphur content.

For both the formulation of the energy-policy and the climate-policy documents, two scenarios for electric energy supply were developed, one which relies on a new mine-head lignite power plant, and one which assumes that the nuclear energy production will be increased by about 50 % over the current level. In both scenarios the short term - up to the year 2000 - needs in increased electricity production in Hungary (due to reductions in import) are assumed to be covered through increased import of natural gas and other measures. The choice for lignite-based or nuclear energy production would take effect in the period 2000 - 2010.

Because of the political sensitivity of decisions on energy supply policy, it would appear to be most practical to decouple the decisions on climate change and energy policy. This can be done through use of the worst case assumption for electric energy supply as concerns the emissions of CO_2, i.e., the lignite-based scenario. This does not imply a preference for either scenario, or any other option, but rather it shows that when a decision on the climate change issues is possible for the "worst case" scenario for electric energy supply, then the decisions on the latter subject can be made later independently.

The main point is that decision makers should be reasonably assured that a decision on a position on climate change now will not implicitly force them to a decision on electric energy supply later. This does not mean that the analysis should hide the issues on energy supply, but simply that a more lengthy public debate is probably necessary to develop an acceptable position on energy supply. The analysis based on the worst case for energy supply would demonstrate that the climate policy decision would not have to be delayed until then.

Total demand for fossil fuels

The type of the planned base power station primarily specifies the fossil fuel quantity consumed for electricity production. In case of the medium growth rate, i.e the "b" variant of economic development, the required fossil fuel quantities (PJ), depending on the type of the new base power station, are indicated below.

Table 30 Fossil fuel demand for electricity production
(for medium growth rate "b" scenario by 2010)

Year	Base Power Station	Solid (PJ)	Oil (PJ)	Gas (PJ)	Total (PJ)
1990		97	12	41	150
2010	"A" Nuclear	60	37	190	287
2010	"B" Lignite	137	37	201	375

Emissions of CO_2

Considering the estimated quantities of carbon dioxide emissions from the overall energy consumption "sector" in case of each variant of economic development, it can be seen that the nuclear power station option more or less would help to achieve CO_2 emission stabilization. However, it is impossible to disregard the public opinion on the nuclear power stations as potential hazard sources and the unresolved problem of the final deposition of burned-out heating elements and other radioactive wastes. Estimates of carbon dioxide emissions ($MtCO_2$ or Mtons of CO_2) from the total domestic energy consumption "sector" are as follows (HNC, 1992, MIT, 1992).

The year 1990, as starting point for economy growth assessments, was also used here as potential reference year for energy-related CO_2 stabilization target setting. As mentioned before such a reference was critically analyzed and refused because of the recession of the domestic economy and instead the pre-recession period of 1985-1987 was adopted for further comparisons and CO_2 stabilization policy formulation. This position was reiterated also in the government's energy-policy document (MIT, 1992). Table 32 summarizes the emission scenarios in conjunction with the average emission level for the above mentioned period.

Considering several alternative variants of economic development after the turn of the millennium and assuming decreasing specific energy consumption, increase of the energy intensity is expected and this can be met by putting into the operation of either coal-fired or nuclear base power station, which in extreme cases may be associated with such an increase of carbon dioxide emission that significantly higher than the emission level during the reference period (in case of the development of coal-fired power station, rapid increase in energy demand and moderate improvements in energy efficiency).

Table 31
CO_2 emission scenarios for Hungary by 2010 ($MtCO_2$)
subtotals for most relevant sectors and to the total emission

	Electricity	Transport	Others	Total
1990	14.0	8.8	52.3	75.2
2000 ("a")	19.7	11.5	51.9	83.1
2000 ("c")	17.9	12.2	42.7	72.8
"A" Nuclear	Power	Base	Station	
2010 ("a")	24.4	15.2	50.1	89.8
2010 ("b")	21.6	13.4	45.9	80.9
2010 ("c")	18.8	13.4	46.1	78.3
"B" Lignite	Based	Power	Station	
2010 ("a")	36.9	15.6	48.7	101.2
2010 ("b")	30.6	13.8	45.5	89.9
2010 ("c")	27.6	13.8	45.7	87.1

Table 32 Hungarian energy-related CO_2 emission scenarios (in units of $MtCO_2$)

Economic development	New basic power stations	1985-87	2000	2010
Fast	coal-fired	88	83	101
Middle	coal-fired	88		90
Slow	coal-fired	88	73	87
Fast	nuclear	88	83	90
Middle	nuclear	88		81
Slow	nuclear	88	73	78

For comparisons of these results with emission estimates in other countries it is useful to know that:

- fossil fuel used for material production (chemical industry) is assumed not to contribute to emissions;
- constant emission factors are used for coal, oil and gas, even though the very high emission factor for coal is partly caused by the use of low quality Hungarian coal, but also by the current, old coal based power plants which will have to be reconstructed; and
- as far as it could be determined no temperature correction (i.e. correction for climatic conditions) has been applied in the comparative studies.

In the year 2000 the scenarios are only different because of different assumptions for economic growth and the electric energy supply scenarios are only different in 2010. In the period 2000-2010 the three economic growth scenarios are very similar. With reference to the reference period it can be seen that the emissions increase substantially only for the fast economic growth and coal-fired new base power station case. In all other cases, the emissions are expected to decrease or to preserve the more or less constant level.

Compared with this reference level more scenarios do not show an increase in emissions in the period up to 2010. Only in the case of fast economic growth, and in the case of medium economic growth combined with the lignite scenario, do the emissions increase.

Based on the above results originally three possible positions were outlined by the experts in early 1992 that the Hungarian government could assume, which boil down to the following.

- Hungary cannot make any commitment for the next few years;
- Hungary will commit itself to reducing emissions to the level of a comparable EC/EFTA countries; or
- Hungary will join the EC position to stabilize its emissions by 2000 at the 1985-1987 reference level, and discuss possibilities for technology transfer to improve energy efficiency with the EC.

These positions evolved gradually during the preparation of the Hungarian position on the FCCC-negotiations. The first position was taken out of the list, and the various ministries negotiated the acceptability of the remaining two options.

4.3. Alternative scenarios

Purpose and bases of alternative assessments

It will be shown in the next chapter, however, that the scenarios in section 4.2 are rather pessimistic scenarios. As discussed in the previous sections, the main reasons for this are that the scenarios:

- do not assume structural change in the economy;
- combine high economic growth estimates with moderate energy efficiency increases; and
- use constant emission factors for coal, thereby not accounting for the expected reconstruction of the coal based power plants.

The numbers given hereafter are largely meant to demonstrate the issues; it should be realized that they represent scenarios based on a series of assumptions for trends that are very difficult to forecast (such as economic growth and energy use).

As an assessment tool a policy-oriented model of energy use and related CO_2 emissions (Hungarian Energy-related EMISsions, HEEMIS) has been derived (Rijsberman, 1992) to, first, understand the results of the Hungarian analysis and the assumptions on which these are based and, second, be able to analyze alternative scenarios. The HEEMIS model was calibrated to reproduce the results given in the Hungarian report (HNC, 1992). This model, HEEMIS, follows the structure of the computations prepared for the Hungarian climate-policy document (HNC, 1992), but it allows more detailed analysis and generates alternative scenarios for energy use and emissions by use of various assumptions on, for instance, rates of increase in energy efficiency and changes in the structure of the economy.

The first advantage of the HEEMIS model is that it makes all assumptions, on which the calculations for the formulation of the Hungarian position (HNC, 1992; Government of the Republic of Hungary, 1992) are based, explicit and transparent. Second, it makes it much easier to explain to non-experts what is involved in the calculations, and to show them interactively what would be the effect of alternative assumptions that they may want to make.

The policy-oriented alternative model

A simple policy-oriented (spreadsheet) model of energy use and related CO_2 emissions in Hungary was developed (Rijsberman, 1992). This model, HEEMIS, follows the structure of the computations prepared by the Hungarian experts (HNC, 1992), but it allows more detailed analysis and generates alternative scenarios for energy use and emissions. The main advantage of HEEMIS is that it consistently follows through all the calculations for sectors of the economy. Initially the data are used for the six subsectors that were used for the earlier energy efficiency assumptions (HNC, 1992), but the model is set up for more detailed analysis as well. This will be particularly useful to analyze the impact and relative contribution of specific measures to improve energy efficiency and/or reduce emissions.

The model simulates the period 1990-2010 in five year time steps. It consists of the following four blocks.

1. assumptions and scenarios for economic growth (by economic subsector, or overall for the economy as a whole), assumptions for energy efficiency increases (by economic subsector); assumptions for use of electricity, coal, gas and oil (as percentages of total energy in the sub sector), and scenarios for energy sources for electric energy supply;
2. data on economic production of each of the economic subsectors (share of GDP), energy intensity of the economic subsectors, and emission factors;
3. calculations of energy use, fossil fuel demand, and finally CO_2 emissions for each of the economic subsectors; and
4. presentation of results in tables and graphs.

The HEEMIS model, described in the next chapter, uses a set of linked tables for economic growth, energy efficiency (or energy intensity), fuel use, and emissions. This facilitates analysis of the impact of specific measures (usually associated with a specific economic sector or energy using activity) and generally makes the calculations more transparent. The results of the Hungarian analysis have been reproduced with HEEMIS (in the series of linked tables) and are presented in detail in the next chapter.

The demand for fossil fuels is calculated as follows.

$$F_{ij} = G_i * I_i * c_{ij}$$

where

F_{ij} demand of sector [i] for fuel [j] in Mton;
G_i share of GDP of sector [i] in Mrd Forint;
I_i energy intensity of sector [i] in kJ/Ft; and
c_{ij} fuel coefficient of sector [i] for fuel [j]
(relative share of the different fuels per sector).

All four variables in the equation given above are time-dependent (on an annual basis).

The first analysis with HEEMIS was therefore a check that it produced the same results for identical assumptions as those reported by the earlier Hungarian climate-policy paper (HNC, 1992). This proved to be the case.

The HEEMIS model was subsequently used to analyze the following alternative assumptions.

- structural change in the economy, i.e., 0 % growth for the energy intensive AIP subsector (mining, building materials), and a slightly increased growth for the remaining subsectors (to generate the same overall growth in the economy as in the scenarios without structural change);
- lower economic growth rates combined with low increases in energy efficiency; and
- high economic growth rates combined with higher energy efficiency increases.

The Hungarian assumptions outlined above do not appear to take into account the specific nature of the Hungarian economy at the current time, however. Various observers of the Hungarian economy (e.g. World Bank, 1990) have noted that the current energy intensity (use of energy per unit of GDP) is very high, and that this offers opportunities for additional increases in energy efficiency. An example of energy intensity for several countries is given in table 33.

"A scenario for development in the countries of Eastern Europe assumes a growth rate of 3 percent a year. This rate represents an optimistic future in which planners somehow find a way to maintain past economic growth without radically changing their economies. Current trends would increase energy demand by almost 50 percent ... by 2025. But ... a combination of economic reform and the introduction of energy-efficient technology could hold energy demand virtually constant." (Chandler et al., 1990)

It must be realized that the energy intensity can be decreased in several ways.

This can be elucidated through an example concerning production of buses. In comparing a Hungarian bus with, say, a German bus, it can be seen that the production of the Hungarian bus costs 20-30 % more energy than the German bus. In addition the Hungarian bus may use up to 10 % more fuel (diesel oil) than the German bus (the energy used by the bus during its lifetime may be 20-50 times greater than that used in its production). The greatest difference between the buses is, however, that due to quality difference the price of the German bus may be 3 to 4 times as high as the Hungarian bus.

Table 33 Energy intensity in selected countries (World Bank, 1990)

Country	Ton oil equivalent / 1000 US$ GDP
Hungary	1.63
Poland	1.76
Belgium	0.53
Germany	0.42

The best solution for development of the Hungarian economy is unlikely to be the increase of the production of the buses outlined above, but rather to improve the quality of the buses. This is also the likely outcome of the kind of joint-ventures that are currently developed between companies from, for instance, Western-Europe and Hungary. In our fictitious example, the production of the "new" Hungarian bus may require only 10 % more energy than the German bus, may use as much fuel in its operation, and may be half as expensive.

Table 34 Fictitious example about energy intensity in bus production and use

	German bus	"old" Hungarian bus	"new" Hungarian bus
Price (currency units)	100	25	50
Energy for production (energy units)	100	125	110
Energy intensity (energy/price)	1	5	2.2
Energy use (energy units)	3000	3300	3000

In this example the energy use in the production process decreased only 13 %, but the overall energy intensity decreased by more than 100 %. That is, in this fictitious case the energy intensity can decrease sharply with relatively small decreases in absolute energy use, or conversely, the economy could grow without necessarily increasing energy use proportionally, if the type and quality of production is improved during the period of transition. In addition, in this example, the most important gains in absolute energy use are not in the production of the bus, but in its operation or use, even though the percentage decrease there is only 10 %.

As concerns the possibilities of increased rates of energy efficiency improvements, it is a frequently mentioned argument that there is no money available at present in Hungary for environmental improvements and/or energy efficiency measures. It is important to point out, however, that increased energy efficiency -- at realistic energy prices -- has often proven to be economically efficient as well, which means that it will be promoted by private investments without government intervention.

A crucial point here is the consistency of the assumptions in the scenarios. GDP growth scenarios that presume annual increases of 4-5 % over an extended period of time are consistent with very high levels of investment, and with gradually higher levels of income. In other words, if the economy is indeed growing fast then there is also money available for environmental improvements, and conversely, the economy can only grow so fast if there is considerable investment, implying technological improvement and energy efficiency improvements. In such a fast-growing economy, governments can stimulate the direction of private investments towards energy efficiency improvements through realistic energy prices, research and development programmes, investment credits/tax facilities, etc.

Given the problems that Hungary has also to find affordable and socially acceptable sources of energy, it is clearly also in the national interest to adopt a government policy to promote increased energy efficiency, and use of renewable energy resources, rather than focusing the bulk of public investments on development of nuclear energy and use of fossil fuels only.

Fast growth scenarios for GDP are consistent with high rates of energy efficiency improvements. If there is indeed no money for investments in clean and energy efficient technologies, then sustained GDP growth of 4-5 % per year is also unlikely. The scenarios used during the preparation of the Hungarian position on the FCCC and on the possible CO_2 emission stabilization commitment (see 4.4) effectively use a high GDP growth rate, combined with moderate energy efficiency increases. This produces rather pessimistic, or "worst case", energy demand forecasts. A more likely combination would be to combine high GDP growth with large energy efficiency increases, and low growth with more moderate increases.

In addition to the 1-2 % increase in energy efficiency that can be expected through general technological development in a growing economy, the specific structure of the Hungarian economy offers potential for increased energy efficiency per unit of GDP. This concerns both decreased energy use in production, and increased GDP growth through quality improvements (without increased energy consumption). For the possibilities of reduced energy use in production (see the above "bus production" example) the World Bank (1990) has estimated the potential for increased conservation in several industrial subsectors. Their estimates are reproduced in table 35.

Table 35 Potential for energy conservation in production process (World Bank, 1990)

Sector	Potential for energy conservation (%)
Metallurgy	20
Engineering	10
Building materials	20
Chemicals	20
Light industry	11
Food industry	16

There are no data available on the improvements in energy intensity that can be expected from increased quality of production and related price increases, without necessarily increasing energy use, but it is believed that such improvements could be quite significant.

A further possible increase in energy efficiency is more efficient electric energy production through, for example, reconstruction of the current old coal-based power plants (which have a very low efficiency), or expansion of co-generation of heat and power. This increased energy efficiency has the effect of improving the CO_2 emission rates per unit of electric energy produced. As explained in more detail in the section on emissions, these emission rates are kept constant in the earlier Hungarian analyses (MIT, 1992, HNC, 1992).

Alternative scenario 1: Structural change

The following comments can be made with respect to the CO_2 emission scenarios that have been generated for Hungary.

- The three scenarios for GDP growth all presume very high (4-5 %) annual growth rates in the 10 years from 2000-2010. At the same time energy efficiency increases of 22.5 % are assumed. If there is indeed GDP growth of 5 % annually, this would require a rate of investment in the economy that would most probably also support a higher rate of increased energy efficiency.

- As pointed out in the earlier Hungarian report (HNC, 1992), the mining industry of Hungary (AIP) is 11 times more energy intensive than the manufacturing industry (FIP) or the commercial / services sector. The current restructuring of the economy, and development in the coming years, will most probably lead to a larger share the manufacturing and commercial / services sectors of the economy, which is likely to reduce significantly the overall energy intensity of the economy. GDP growth scenario's which take this effect into account result in significantly lower CO_2 emissions.

For example, if a GDP growth scenario is used in which the output of the mining (AIP) sector is held constant, then the overall growth rate in the economy is equal to that of the homogeneous growth rate scenarios if the other sectors grow about 0.2 % faster.

For the fast growth GDP scenario (a), assuming the lignite scenario for electric power supply (A) this results in:

Table 36 CO_2 emissions: scenario 1

	1990	2000	2010
Homogenous growth	76	85	101
Structural change	76	78	85

Alternative scenario 2: Lower GDP growth

Calculations have also been made for somewhat lower economic growth assumptions (1 % lower in 2000-2005, and 2 % lower in 2005-2010). The resulting scenarios are still assuming steady economic growth of 3-4 % per year.

Table 37 CO_2 emissions: scenario 2

	1990	2000	2010
Fast growth	76	85	101
Slower growth	76	85	89

Alternative scenario 3: Higher energy efficiency increases

Instead of the energy efficiency increases of 1.5-2.5 % per year for the economy as a whole, (as formulated on page 44) used before for the formulation of the Hungarian energy- and climate-policy, energy efficiency increases are assumed still for the economy as a whole, it would be better to look at the potential of individual subsectors of 1.5, 3, 4, and 5 % per year in successive 5 year periods.

Table 38 CO_2 emissions: scenario 3

	1990	2000	2010
Lower energy efficiency increases	76	85	101
Faster energy efficiency increases	76	82	84

The results of the analysis presented above demonstrate that for each of the assumptions separately (the combined effect would obviously be much stronger), and for the worst case scenario for electric energy supply (the lignite scenario) the emissions of CO_2 in 2010 will be below the reference level selected by the Hungarian government (87.6 Mton CO_2, the 1985-87 level).

This means that either in case of lower economic growth (the pessimistic view), or in a case of high economic growth but combined with a government policy to induce structural change and increased energy efficiency stabilization of CO_2 emissions can be considered a realistic possibility, at least until 2010.

4.4. Elements of response policy to curb the emissions

Structural change with changing total energy demand

At the same time, one of the elements of highest priority of the country's energy policy is that everything should be done for the reduction of energy intensity in accordance with the experiences of the industrialized countries. Direct energy savings can only marginally contribute to this. Eventually, the primary task is to improve the overall economic efficiency. First of all, transformation of the economic structure, controlled by market relations, can make it possible to improve efficiency and to reduce energy intensity. In the Hungarian industry, a small proportion of the GDP (about 20 %) is produced in the basic materials producing sectors which are great energy consumers. Thus the proportion of their energy consumption within the industrial energy consumption is about 70 %. Changing the production structure while reducing the proportion of the energy-intense sectors is the most important possibility of reducing the overall energy intensity and it is also a prerequisite for improving the economic efficiency.

Improved efficiency of energy production

Electricity production coupled with heating services (co-generation) in comparison with electricity production by condensation has a significant energy saving possibility. The difference is well illustrated by contrasting the mean values of specific heat consumption for these two energy production technologies: 11000-12000 kJ/kWh with electricity production by condensation and 4000-5000 kJ/kWh with co-generation. It is planned that the development of the electricity system by 2000 is going to be realized by the use of gas turbines of combined cycle for heat and electricity production. Such a power station with 150 MW capacity has been put into operation in Százhalombatta and the establishment of additional ones is planned in such regions where the magnitude of space heating requirements makes possible (efficient) the use of such systems. The implementation of about 700 MW co-generation energy production capacity is expected by 2000. This has great importance also from the point of view of moderating the carbon dioxide emissions.

Energy savings

For the reduction of carbon dioxide emissions deriving from fossil fuel consumption, increased energy savings are the only real possibility. In Hungary, an average annual energy saving of 30 PJ was achieved between 1980 and 1985 within the framework of a centrally directed energy conservation programme with a 15 Billion HUF budget. This programme continued beyond 1985. It came to a halt, however, at the end of 1987 because of the economic difficulties of the country. Under the current conditions, the price system developed between 1990-1991 which reflects the real value relations is the best mechanism for effectively stimulating energy savings. However, beside the introduction of world market energy prices -- as it has been proven by experiences of the Western market economies -- such additional preferences are required that do not conflict with the market relations and yet stimulate energy saving investments of the enterprises and the population. In conformity with market relations, numerous financial and credit policy options can be proposed stimulating the entrepreneurs' initiative by providing allowances to promote energy savings, utilization of renewable energy resources, flexible responses to energy demands and production of energy efficient equipments and devices. Moderation of energy consumption by companies occurs by the evaluation of existing energy wastage and the discontinuance of such wastage, realization of the possibilities for recycling of waste materials and a better production organization. In order to moderate energy consumption by the population (residential sector), the general promotion of energy saving possibilities related to such goods as, for instance, the construction materials (building materials, doors and windows) or the electric appliances for households etc. and also the development of a deliberate attitude to energy saving is extremely important.

Transport sector

In consideration of the energy consumption related to public road transport and the future changes of greenhouse gas emissions deriving from that (carbon dioxide, methane, carbon monoxide), too, a lot of factors should be contemplated. This is also valid for the transport sector.

The decrease of the rail transport of goods will probably continue until the turn of the millennium before it starts to increase. The railway transport of passengers is expected to steadily increase, though at a low rate. The road transport for public use, parallel to the economic development, is going to increase, first of all in the field of transport of goods. A significant increase is expected up to the "saturation stage" in the field of municipal passenger transport and public transport of goods. Together with this, increasing standards are foreseen in the vehicles' technical state and their fuel consumption. In the case of railway transport, the use of diesel locomotives will decline, thanks to the expanding electrification of railway lines, consequently the specific towing capacity will further improve. Public road transport, with a share of 80 % of energy consumption of transport, is the determining factor in energy consumption in this sector. It particularly requires modernization, since the mean age of Hungarian passenger car fleet with about two million cars approaches 10 years and has a high average specific fuel consumption value (1.00 MJ/passenger kilometer in 1990). These are the principal causes of the very high average transport related fuel consumption. The situation is not much better in respect of freight cars. As regards the distant future, it is presumable that the technical characteristics of the public vehicular fleet will radically improve partly owing to modern production technologies, and partly because of the pressing strict rules of environmental protection.

The following possibilities can be considered for the sake of the expected decrease of the above-mentioned atmospheric emissions after 2000.

- a customs and taxation policy or tax allowances which stimulate the purchase of fuel saving and environmentally friendly vehicles;
- a tariff included in the petrol price and used for environmental protection purposes (which does not appear in case of lead-free petrol in order to promote its use);
- adjustment of the air quality criteria to the EC standards and their application to vehicles recently purchased;
- withdrawal of vehicles of two-stroke engine from the public road services by a relevant effective decree; and
- limitation of harmful emissions -- prominently on the municipal roads with heavy traffic -- can be achieved by the drastic decrease of passenger car traffic and supplements to the modern, comfortable and environmentally friendly public transport.

Renewable energy sources

Finally, the potential for generating renewable energy should also be taken into account.

The geographical position of Hungary is favourable for the utilization of geothermal energy or biomass. The significance of renewable energy resources may be very high in moderating the energy-related greenhouse gas emissions because with the exception of biomass they considerably reduce the overall anthropogenic carbon dioxide release.

The substitution of 1 GJ fossil fuel by wind or solar energy, thermal energy or hydropower reduces the carbon dioxide emission by 75-110 kg (the smaller value stands for the case of hydrocarbons, the greater one corresponds to coal burning). At present, the renewable energy resources in Hungary provide only 1.8 % of the overall energy consumption, this proportion, however, may reach 5 % by 2000 by properly elaborated solutions of environment and energy policy which may also moderate the annual carbon dioxide emission by 23 Mt.

The utilization of solar energy already has achieved results in our country. Rapid technical development, increasing demands for this energy source, its pollution-free characteristics, the price rise of fossil fuels, and proper financial stimulation mechanisms may make way for the extensive use of solar energy.

4.5. Conclusions and recommendations

In preparing for the negotiations of FCCC, the Government of Hungary reviewed its CO_2 and energy situation. During this period the medium-term energy policy document was just under substantial revision at the Ministry for Industry and Trade and at the same time a Climate Subcommittee of the Hungarian National Committee for UNCED was charged with the development of a Hungarian position on climate change and on a possible stabilization of CO_2 emissions at a national level and the corresponding position towards the FCCC. As a result, the government issued a national declaration on its position on the issue of climate change.

The Hungarian emissions scenarios discussed in detail in this declaration have been discussed in this report, and suggestions have been made for alternative assumptions that could be taken into consideration.

The Hungarian position is strongly influenced by the current economic situation in Hungary. Because of the present economic recession -- and the strongly felt differences with the countries of the European Community -- the foremost objective of all government departments is economic growth. All departments, including the Ministry for the Environment, are reluctant to take any decision that may be construed as an obstacle to economic growth.

In addition, the energy supply policy for Hungary is a very sensitive problem for various reasons. The Hungarian government is therefore understandably reluctant to take any decisions on a climate change policy that may have unforeseen consequences for its energy policy.

Energy efficiency is an important element in addressing the problem of climate change while at the same time promoting economic growth. The best incentive for energy saving and the increase of efficiency is a price which reflects real values and "... consumer prices will include research, production, transformation, storage, distribution, recultivations and environmental protection costs." (MIT, 1992).

The focus of these "complementary" investigations was to consider the emission levels in the context of:

- the possibility for structural change in the Hungarian economy, i.e., faster growth of less energy-intensive economic sectors; and
- the potential for increased energy efficiency, not necessarily in absolute terms, but in terms of energy use per unit of GDP.

The CO_2 emission scenarios prepared for both the energy- and climate-policy formulation (MIT, 1992, HNC, 1992) show that for the "worst case" assumptions of fast, homogeneous economic growth (4-5 % annually, without structural change) and moderate increases in energy efficiency (1.5-2.5 % annually) it is not possible to stabilize the emissions of CO_2. That is, the emissions of CO_2 in the year 2000 are probably lower than in 1985-1987 (before the recession), but they will be sharply increasing, and can be expected to pass the 85-87 level in the period 2000-2010.

Assumptions of structural change or increased energy efficiency, however, which account explicitly for the current structure of the Hungarian economy -- with its very high use of energy per unit of GDP -- change this picture quite drastically. It is also important to realize that increased energy efficiency -- at realistic energy prices -- is likely to be economic in many instances. This means that the private sector is likely to follow this direction partly without any government intervention. In other words, this is a case where environmental measures -- that save energy -- are not necessarily costly. These issues are discussed in more detail in this report.

Finally, as a recommendation and lately as a basis of the government declaration, an average of the emissions in the period 1985-1987 has been selected as the reference level because this was before the current recession. Emissions in the year 2000 will almost certainly be lower than those in 85-87 (87.6 Mton of CO_2), but the problem is what will happen thereafter if the desired economic growth materializes.

The analysis of the Hungarian data and further assumptions could lead to the following conclusions and recommendations.

- Based on the analysis of the available data and assumptions it is concluded that private sector investments supported by a well-directed government policy can, through a combination of structural change and increased energy efficiency, produce the desired economic growth for Hungary with emission levels for CO_2 in the years 2000 and 2010 that are not greater than those in 1985-1987 (before the recession).
- For a more informed assessment of the potential for increased energy efficiency -- and selection of priorities for action in Hungary, it is recommended that an "energy and environment review" or a country study should be carried out. Such a study should analyze:
    - a) current energy use in all sectors of the economy as well as non-commercial energy use such as residential lighting and heating;
    - b) technological potential for increased energy efficiency per sector -- including noncommercial uses such as residential lighting and heating, and energy use by government agencies etc.;
    - c) corresponding environmental effects including the greenhouse gas emission stabilization/reduction effects;
    - d) economic and financial perspective on increased energy efficiency per sector; and
    - e) possible government measures to promote energy efficiency with an estimate of their cost and impact.
- The main steps in such a systems analysis, or policy analysis, study could be:
    - (a) identification of energy use and emissions of the most relevant pollutants per unit of (material) production and per unit of GDP for the most relevant energy uses (disaggregated to possibly 30-40 subsectors and noncommercial uses);
    - (b) compare with energy use and emissions with similar activities in other countries for reference;
    - (c) identify best technologies and best management practices for each use, with costs, to establish energy conservation or rationalization potential from a technological point of view;
    - (d) identify (sub)sectors of the economy which have a potential for improved quality of production, industries that have the best chance of being economic (have private investment capital available), are considered of prime importance to the economy (possibly have public investment capital available), and those which are likely to decrease in relative economic importance;

(e) estimate possible savings in energy use and related emissions per activity, and cost-effectiveness / investment costs etc.;
(f) identify options (individual measures) for a government energy efficiency or energy conservation policy that are compatible with a freemarket system, i.e., not central planning but policy measures that are also used in countries of the European Community, and give rough estimates of costs and potential impacts;
(g) recommend priority actions for government policy.

- It is highly recommended to identify possible government measures to implement a possible decision to stabilize CO_2 emissions, with their estimated costs and impacts. In addition it would then be useful to take into account also the emissions of greenhouse gases other than CO_2.
- An important issue for the effectiveness of environmental management in Hungary is to improve the communication, cooperation and negotiation between the relevant departments (ministries), experts of the various sectors and disciplines, and between the decision-makers and researchers in this field.

References

Arrhenius, S., 1896: On the influence of carbonic acid upon temperature at the ground. Phil. Mag., 41, 237

Born, G.J.v.d., A.F. Bouwman, J.G.J. Olivier and R.J. Swart, 1991: The Emission of Greenhouse Gases in the Netherlands. Report No. 222901003, National Institute of Public Health and Environmental Protection, Bilthoven, the Netherlands

Climate Sub-committee, 1992: Investigation of CO_2 Emission and its Stabilization in 2000 and 2010: with costs and international comparisons. Interdepartmental background paper prepared for the Climate Sub-committee of the Hungarian National Committee for UNCED, Hungary (draft of February 1992)

Chandler, W.U., A.A. Makarov and Z. Dadi, 1990: Energy for the Soviet Union, Eastern Europe and China. Scientific American, Sept 1990, 121-127

Economist Intelligence Unit, 1990: Hungary Country Profile 1990-1991. Annual Survey of Political and Economic Background. The Economist Publications. London

Faragó T., Iványi Zs. and Szalai S. (eds.), 1990: Climate variability and change: causes, processes, regional impacts with special emphasis on the socio-economic impacts and the tasks related to the international cooperation. Ministry for Environment, Hungarian Meteorological Service, 100 p. Budapest, Hungary

Faragó T., Iványi Zs. and Szalai S. (eds.), 1991: Climate variability and change, II. Changes in composition of atmosphere and in the climatic characteristics, detection, modelling, scenarios and impacts of the regional changes. Ministry for Environment, Hungarian Meteorological Service, 218 p. Budapest, Hungary

Faragó, T., 1992: Climatic Variability, Impacts and Sustainability: Generalization From Regional Climate Impact Studies. Paper presented at the conference on "Impacts of Climatic Variations and Sustainable Development in Semi-Arid Regions, Fortaleza, Brazil

FCCC, 1992. The United Nations Framework Convention on Climate Change 1992, A/AC.237/18 (part II)/Add.1

Hernaus, R., 1991: Climate Negotiations: Commitments to CO_2 emission cuts. Change. 8(1991):14-15. The Netherlands

Hinrichsen, D. and G. Enyedi (eds.), 1990: State of the Hungarian Environment. Statistical Publishing House, Budapest

HNC, 1991: Preliminary Hungarian Position on the Framework Convention on Climate Change - the basic principles. Hungarian National Committee for the UNCED, Climate Subcommittee, Budapest

HNC, 1992: The anthropogenic greenhouse gas emissions, their potential global environmental consequences, the possibility of stabilization of the Hungarian energy-related carbon-dioxide emissions and other issues related to the Framework Convention on Climate Change. Hungarian National Committee for the UNCED, Climate Subcommittee, Budapest

Houghton, J.T., Jenkins, G.J. and Ephraaums, J.J., 1990: Climate change, The IPCC Scientific Assessment. Cambridge University Press

Hungary, 1992: General Features of Energy Economy in Hungary, National Energy Data Profile. World Energy Council, 15th W.E.C. Congress, 7 p. Madrid

IEA/OECD, 1992a: Energy Statistics and Balances of non-OECD countries. 1989/1990

IEA/OECD, 1992b: Energy Balances of OECD countries 1989/1990

Jászay T., 1989: CO_2 emission study, Hungary. Preprint, University of Technology, Budapest

Koppert, P.C., A.A. Olsthoorn, and O. J. Kuik, 1988: Emission reduction through clean technology (in Dutch). IVM, Amsterdam

Krause, F., W. Bach and J. Koomey, 1991: Energy Policy in the Greenhouse, From Warming Fate to Warming Limit: Benchmarks for a Global Climate Convention. El Cerrito, IPSEP, California

MAP, 1990. Environmental Action Plan of the Energy Distribution Sector in the Netherlands, VEEN/VEGIN/VESTIN. The Netherlands

MEC, 1990. Memorandum on Energy Conservation, Ministry of Economic Affairs, The Netherlands

MERP, 1991a: The Short and Medium Term Environment Protection Action Plan of the Government. Ministry of Environment and Regional Policy, Budapest

MERP, 1991b: A Glance at the Environmental Protection and Regional Development in Hungary. Ministry of Environment and Regional Policy, Budapest

MERP, 1991c: Air Pollution Abatement Policy in Hungary. Ministry of Environment and Regional Policy, Budapest

Mészáros E., Major Gy. and Horváth L., 1984: The impact of use of fossil fuels on the composition of atmosphere, its acidification and the heat release. Idôjárás, 88, 339-342. Hungary

MIT, 1992: The Hungarian energy policy. Ministry of Industry and Trade, Budapest

MVMT, 1990: Technical Data, 1990. Hungarian Electric Power Trust, Budapest

Okken, P. A., R. J. Swart and S. Zwerver, 1989: Climate and Energy: The feasibility of controlling CO_2 emissions. Kluwer Academic Publishers, Dordrecht, The Netherlands

Okken, P. A. and T. Kram, 1990: Calculation of Actual CO_2 Emissions from Fossil Fuels. ECNRX90048. Paper presented at the IPCC Preparatory Workshop, Paris, 22-23 May

Rijsberman, F.R. and R.J. Swart (eds.), 1990: Targets and Indicators of Climatic Change. Stockholm Environment Institute, Stockholm

Rijsberman, F.R, 1992: Energy use and carbon-dioxide emissions in Hungary. Report prepared under the project "Support for the development of a Hungarian position on climate change". The Netherlands

Statement by the Meteorological Scientific Committee of the Hungarian Academy of Sciences on the future of our climate, 1991. Hungarian Academy of Sciences, Dept. X, Budapest

Swager, J., F.v.d. Meer and J. Gupta, 1990: Regulations as an instrument to control, limit or reduce emissions of greenhouse gases. Paper prepared for the IPCC Seminar on Financial and Economic Measures as a Response to Climate Change, Paris, 26-27 April

SWCC, 1990: Second World Climate Conference, Ministerial Declaration. Geneva

UNGA, 1988, 1989, 1990, 1991: Protection of global climate for present and future generations of mankind. UN General Assembly Resolution 43/53 (6 December 1988); 44/207 (22 December 1989), 45/212 (21 December 1990), 46/169 (19 December 1991)

VROM, CCP, 1990: Climate Change Policy in the Netherlands and Supporting Measures. Netherlands Ministry of Housing, Physical Planning and the Environment, The Netherlands

VROM, MCC, 1992. The Netherlands' Memorandum on Climate Change, Executive Summary. Netherlands Ministry of Housing, Physical Planning and the Environment, The Netherlands

VROM, CCD/Paper 3, April 1992. Measures taken within The Netherlands' National Programme on Climate Change. Netherlands Ministry of Housing, Physical Planning and the Environment, The Netherlands

VROM, 1992: CFC Annual Report 1991. Netherlands Ministry of Housing, Physical Planning and the Environment, The Netherlands

VROM, 1991a: Developing a Climate Change Policy. Netherlands Ministry of Housing, Physical Planning and the Environment, Leidschendam, the Netherlands

VROM, 1991b: Fiscal and Nonfiscal Measures with Respect to CO2 Reduction Plans in the Netherlands. Netherlands Ministry of Housing, Physical Planning and the Environment, Leidschendam, the Netherlands.

Weenink, J.B., J. Gupta and L.H. Janssen, 1992: Addressing Non-CO_2/CFC Greenhouse Gases. World Resources Review, USA

Williams, J., 1978: The effects of climate on energy policy. Electronics & Power, 261-268

Wolters, G., J. Swager and J. Gupta, 1991: Climate change: a brief history of global, regional and national policy measures. Paper prepared for the International Global Warming Symposium organized by the Japan Society for Air Pollution, Tokyo, November 15

World Bank, 1990: Hungary: Environmental issues. Background paper prepared by the Technical Department of the Environment Division of the World Bank. Draft version of November 1990, World Bank, Washington D.C.

World Bank, 1992: World Development Report 1992, Development and the Environment. Oxford Univ. Press, United Kingdom

ENERGY USE AND CARBON-DIOXIDE EMISSIONS IN HUNGARY AND IN THE NETHERLANDS: ESTIMATES, COMPARISONS, SCENARIOS

ENERGIAFELHASZNÁLÁS ÉS SZÉN-DIOXID KIBOCSÁTÁS MAGYARORSZÁGON ÉS HOLLANDIÁBAN BECSLÉSEK, ÖSSZEHASONLÍTÁSOK, JÖVŐKÉPEK

Kiadja:

Fenntartható Fejlődés Bizottság
(tárcaközi állandó bizottság)

Felelős szerkesztő:

dr. Faragó Tibor
Környezetvédelmi és Területfejlesztési Minisztérium

ISBN 963 03 3678 2

Készült:

MTESZ Házinyomda
Felelős vezető:
Boncza Gábor