ROMANIA

Ministry of Waters, Forests and Environmental Protection

2nd NATIONAL COMMUNICATION TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Bucharest
April 1998

Table of contents

1 Executive summary

1.1 National circumstances

National circumstances, Romania

The population of Romania amounts to nearly 22.7 million inhabitants. Total area is 238,390 square kilometers out of which, agricultural areas cover 62%, forest 27%, waters 3.7% and other areas represent 7.3%.

The Romanian climate is temperate-continental with local variations determined by season's succession and by relief forms.

Yearly average temperature decreases progressively, in latitudinal direction, from South (11°C) to North (8.5°C) and altitudinal, from field regions (10-11°C) to mountain ones (6°C at high of about 1000 m, 0°C to a high of about 1800 m and under -2°C at over 2500 m high).

Rainfall distribution represents a considerable decreasing from East to West but also altitudinal from mountain (1200-1400mm) to field (500-600mm).

The Romanian Gross Domestic Product amounted in 1994 to US$ 33061 million (converted in dollar 1995 by means of the exchange rate "leu-dollar"), corresponding to a per capita income of US$ 1454.

Agriculture account for 19.3% of the GDP, silviculture, forestry and hunting about 5%, manufacturing 35.6% and construction, trade and services 40.1%.

Energy

The main utilized primary energy type in Romania is natural gas. In 1994 the natural gas share in total primary energy reached 43.82% followed by crude oil and oil products with 27.12% and coal by 23.63%.

Primary energy consumption is supplied mainly from domestic production. Imported energy was about 26% in 1994.

Natural gas has the biggest share in the domestic production. The exhaustion of the resources determines the reduction of the production from 37.81Mtce in 1989 to 21.58Mtce in 1994. Also because of the resources diminution, the crude oil production recorded a decrease from 12.72×10^6 tce in 1989 to 9.34×10^6 tce in 1994.

The production of the domestic lignite and hard coal also decreases during the period 1989-1994 because of the high production costs and low productivity.

The final energy consumption decreased significantly during 1989-1994. In 1994 the level of consumption represented about 55% from that of the year 1989. Industry represents the most important energy consumer sector. Its share in total consumption decreases from 77% in 1989 to 58% in 1994.

The energy intensity of GDP related to primary energy consumption decreases from 2.4 tce/1000$ in 1989 to 1.86 tce/1000$ in 1994 that means 5% average rate per year and the energy intensity of GDP related to final energy consumption decreases in the same period with 7% per year.

Transportation

Due to the decreasing of the industry outputs during the period 1989-1994, the freight transportation recorded a reduction of the activity with about 40% in 1994 against 1989 (163458 mill.txkm in 1994 in comparison with 270929 mill.txkm in 1989).
Number of cars after 1989 up to now has increased by 30%. At the same time there has been a decrease of the both interurban and urban passengers traveling in 1994 against 1989; for interurban and international traveling from 62447 x 10^6 passengers x km in 1989 to 35913 x 10^6 passengers x km in 1994 and for urban public passengers transportation from 3.15 x 10^6 passengers in 1989 to 2.33 x 10^6 passengers in 1994.

1.2 Inventory of anthropogenic greenhouse gases and removals

Emission evaluated for period 1989-1991 has been calculated using methodologies that are consistent with IPCC.
Emission estimates for nitrogen oxides, carbon monoxide and non-methane volatile organic compounds for some source categories are based on CORINAIR methodology.
For the period 1992-1994 it was performed an evaluation of the GHG emissions using the quantities of fuels and productions resulting from the modeling of the economy development and energy sector.
In Table 1.1 a summary is shown for anthropogenic greenhouse gases emissions in the period 1989-1994.

Table 1.1 Total anthropogenic greenhouse gas emissions in Romania

[Gg/year]

	1989	**1990**	**1991**	**1992** estimate	**1993** estimate	**1994** estimate
CO_2	194826	172509	135660	130160	127086	125597
CH_4	2357	1976.2	1734.2	1603.3	1522.8	1460.9
N_2O	66.3	48.7	24.8	26.9	26.2	25.0
NO_x	554.1	528	458.3	481.8	485.2	483.2
CO	2421.3	2440.8	1980.7	1704.7	1766.9	1800.1
NMVOC	529	491.9	400.8	372.4	405.7	413.2
SO_2	1516.0	1311.0	1041.0	1181.0	1181.0	1204.0

Note: Data for period 1992-1994 were estimated and must be updated according to the IPCC Methodology

CO_2 emissions

Approximately 96% of primary energy used in Romania in 1989 were from fossil fuels (95% in 1994). Therefore the fossil fuel combustion is the dominant source of CO_2 emissions in Romania reaching 95% of total anthropogenic CO_2 emissions in 1989 and 96.6% in 1994.
In the period 1989-1994 CO_2 emissions dropped about 35.5%.

CO_2 removals

The Romanian's forests covers about 6.5 mill hectares, which represents about 27% of the total area of the country. Forests represent a significant CO_2 sink. The annual CO_2 net removal increase in 1991 to 6590 Gg against 2950 Gg in 1989 due to the reduction of the cutting standing timber.

CH_4 emissions

The major sources for CH_4 emissions are the fugitive emissions from natural gas production / processing, transmission / distribution and agriculture.

Between 1989-1994 methane emissions in Romania decreased by about 34%.

N_2O emissions

N_2O emissions in 1994 recorded a significant decreasing since 1989 (about 1.7 times). Important reduction of N_2O emissions up to 1994 recorded all sources: agriculture, industrial processes, fossil fuel combustion. In 1989 the share of fossil fuel combustion in total N_2O emission was 25%, of industrial processes 36.8% and agriculture 38.2% and in 1994 fossil fuel reached 50% of total N_2O emissions, industrial processes 22% and agriculture 28%.

Other gases

In 1994 emissions of secondary substances such as nitrogen oxides (NO_x), carbon monoxide (CO), non-volatile organic substances (NMVOC) and sulfur dioxide (SO_2) recorded low values against 1989. Emissions of NO_x and NMVOC are regulated within the Geneva Convention.

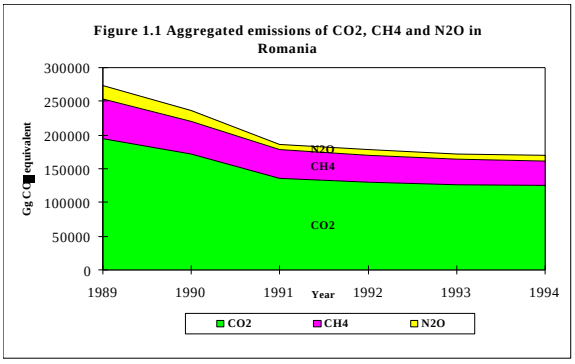
Aggregated GHG emissions

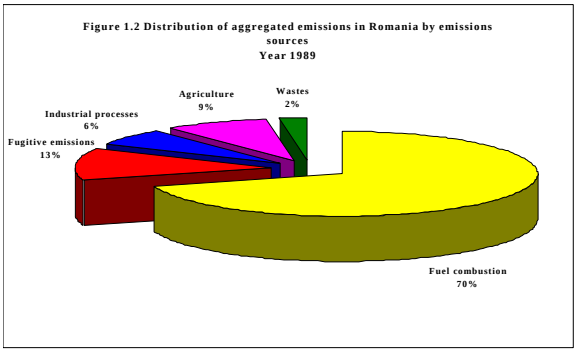
Aggregated GHG emissions are expressed as CO_2 equivalent by means of Global Warming Potential (GWP) value for the time horizon of 100 years.

In 1989 the CO_2 emission contribute to 71.2% of the total missions, CH_4 emissions 21.1% and N_2O emissions 7.7% (Figure 1.1).

In 1989 fuel combustion contribute with 70% to the total aggregated GHG emissions followed by fugitive emissions with 12.7% and agriculture with 8.6% (Figure 1.2).

Removals of CO_2 by forest ecosystem accounts for 1% of the total aggregated GHG emissions in 1989.





1.3 Policies and measures to reduce greenhouse gas missions

A greenhouse gas (GHG) mitigation strategy has not yet been adopted in Romania, but there are same measures accepted after year 1990 with important impact on the GHG mitigation and sinks.
Very important is Environmental Protection Strategy and Programme of Action which outlines the short and medium term target and measures for the accomplishment.
A national strategy of the energy sector was not yet approved. According with the sectorial strategies for coal, natural gas, crude oil, electricity and heat, national energy strategy should contents programs and measures to restructure, modernize, increase of the efficiency and reduce the environmental impacts in activities from the supply side, transformation and demand side.

1.3.1 Legislative framework

After 1989 special efforts were made to create in Romania the adequate regulation framework for environmental protection.

- The Environmental Protection Law no.137/1995 through which are settled norms correlated with European Union (E.U) for each branches of the economy, industry energy sector: within this frame, there are compulsory the environment impact studies for the performance of the new power objectives and also maximum conditions of admissible noxes that results during the operation of different power equipment.
- Waters Law follows the creation of the juridical frame for identifying turning to account, conservation and protection of the water resources in condition of keeping of the ecological balance.

Other regulation adopted are:

- Order 462/1.09.1993 amended by act no.12797/1994 Atmospheric protection. Technical conditions. Methodology for the determination of the pollutant emitted by stationary sources.
- Order 756/3.11.1997, regulation concerning the environmental pollution assessment.

Other regulation and measures with the effects on the GHG emissions reduction are:

- Special Fund for the Energy System Development to finance works for power conservation.
- Draft Bill for rational utilization of energy resources and promotion of new energy sources.
- National Programs of introducing of energy labeling system and of minimum admissible energy efficiency standardization at power receivers.
- Competition Law no.21/1996, contains, several provisions including the ones against some monopoly incorrect practices, available for the energy sector, also.
- Energy Chart Protocol, regarding Energy Efficiency and tasks related the environment and energy sectors.

1.3.2 Climate changes strategy and policy

The Romanian Government's target is to stabilize carbon dioxide emissions after 2000 at the year 1989 level.
A national policy to climate changes in Romania focused on the climate change issues and reduction of GHG has not been yet finalized.
Many ongoing activities, such as economy sectors restructuring and modernization, increasing of the energy efficiency, energy conservation and decrease of negative environmental impacts of energy system and economical sectors have as effect mitigation of the GHG.
The First National Communication on Climate Changes determined a survey of relevant activities. It was approved by the Government and became an effective instrument for the implementation of the Framework Convention on Climate Change until the national policy relevant to GHG will be adopted.
The evaluation of mitigation solutions is based on the results of "Country Study on the Climate Change".

1.3.3 Strategy and measures to mitigate CO_2 emissions

Electricity and heat generation

To complete the electricity demand:

- ongoing of the hydroelectric potential arrangements ,
- ongoing of new units of Cernavoda NPP achievement;
- achievement of new power plants running on imported natural gas and hard coal;
- development of the cogeneration plants.

Heat distribution and transport sectors

Energy saving by:

- hot water transport network modernization and rehabilitation;
- thermal point modernization;
- secondary thermal networks modernization and rehabilitation;
- heat supply control, metering and dispatching.

Household and services

Energy saving by:

- improvement of the thermal insulation

Industry

Industry is one of the sector with the highest potential for energy saving and conservation by:

- structural changes (reduction of energy intensive industries share);
- modernization and rehabilitation of the existing technologies;
- improvement of the energy management.

Agriculture

Modernization of Romania agriculture by:

- increase efficiency of the agricultural machines;
- modernizing of the livestock farms.

Transportation

The restructuring of the industry will determine the reduction of the industry requirements for freight transportation. Policies for CO_2 emissions in transportation sector are based on :

- increasing of road vehicle performances;
- development of public urban and interurban transport.

1.3.4 Emissions of CH_4

Gas industry

Gas industry reduction of the CH_4 fugitive by:

- improvement of the drilling technology;
- rehabilitation of the transportation and distribution gas network.

Wastes

Better wastes management:

- hygienized depositing stations;
- diminishing the quantities of the deposited organic wastes.

Agriculture non-energy

Improvement of the technology for animal breeding by:

- nourishing quality improvement;
- increase animal performances.

1.3.5 Emissions of Nitrous Oxide

Agriculture

Improved technology using nitrogen fertilizer.

1.3.6 Other gases

Romania adhered to the Geneva Convention on the long distance air transfrontier pollution. Environmental Protection Strategy and Programme of Action content the necessary measures.

1.3.7 Measures focused on the GHG sink

GHG mitigation measures in the forest ecosystems are:

- extending of the forest areas:
- improvement of the tree species and forms;
- achievement of the entire volume of wood protection.

The emission projections are based on the energy and non-energy sector development carried out in the framework of the US Country Study.

The assumptions for the analysis were in accordance with the economy situation in 1996 and the Government strategy for the implementation of the reform.

The new Government elected in October 1996 has as main objective the deeply reform in the Romania economy which will be reflected in the increase of the energy efficiency and energy conservation, in the restructuring of the energy sector to implement the competition, a higher increase of the activities to reduce the environmental impacts, etc, on a higher manner against the prognoses performed up to 1997.

After defining, the priorities in the economy sector restructuring it is necessary to update the projections of the GHG and the effects of proposed measures to observe the commitments under the Climate Convention.

1.4 Projection of anthropogenic CO_2 emission

1.4.1 Projection of energy related CO_2 emission

Assessment of measures

The assessment of the development up to 2010, is based on the following main considerations:

- structural change and modernization of the economy sector;
- different options for energy import supply and development of the electricity generation capacity;
- development of the cogeneration;
- losses reduction in heat networks;
- increase of building isolations;
- penetration of the performance vehicles for freight and passengers transportations.

Computer models

The projections are based on calculations carried out using ENPEP. Romania obtained from Argonne National Laboratory training and guidance to assess GHG emissions from energy sector and to develop a national strategy. The projections of GHG and assessment of reduction effects were performed within the 25 alternative scenarios against the reference scenario. All the reductions measures were integrated for energy sector into 25 alternative scenarios and for non-energy sector in two alternative scenarios.

The results will be provided for reference scenario and for two alternative scenarios : low scenario with low restructuring and modernization of the economy and high scenario with high implementation of all mitigation measures. The CO_2 emission level of the year 1989 will not be exceeded in the year 2000 in the case of all scenarios. At the level of 2010 it is possible to achieve the National Target by restructuring and modernize the economy sector as in low scenario. High implementation of the CO_2 reduction measures (high scenario) will determined a reduction of the CO_2 emission in 2010 with 14% against the reference year 2010. In all scenarios the biggest emission share will has energy sector, followed by industry. Transportation and agriculture are expected to remain sectors with low CO_2 emissions. The new Government elected in the fall 1996 has as main objective the deeply reform in the Romanian economy which will be reflected in higher reduction of environmental impact against the prognoses performed.

1.4.2 Projection of CO_2 sinks in forestry

Projections of CO_2 sinks in forestry were determined for reference scenario and for low and high scenarios considering the impact of tree species composition change, afforestation of non-forest lands and especially the increasing of the existing carbon stock.. The results are presented in Table 1.2.

Table 1.2 Amount of sequestered CO_2 by forest

[Gg CO_2/Year]

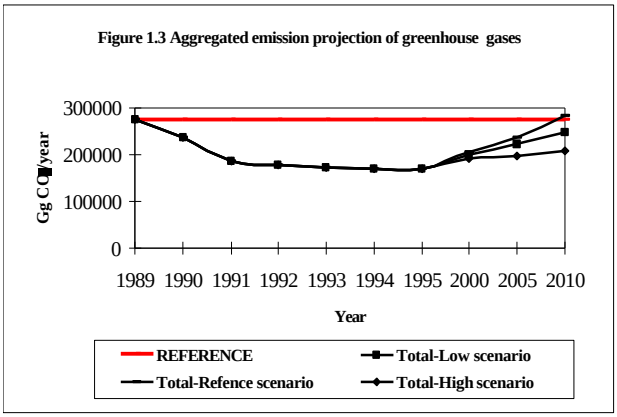
	1995	**2000**	**2005**	**2010**
Reference scenario	18488	18488	18488	18488
Low scenario	18488	20906	22600	24296
High scenario	18488	23041	25000	26953

1.4.3 Aggregated emission projection of greenhouse gases

The aggregated emission projection of GHG (CO_2 equivalent according to GWP) have been presented in Table 1.3 and illustrated in Figure 1.3 (GWP $_{CO2}$ =1, GWP $_{CH4}$=24.5, GWP $_{N2O}$=320). It is obvious, comparing the total GHG emission level in the year 1989 with the period until 2010, that this level will not be exceeded with low implementation of the CO_2 reduction measures. On the other hand, all projections show an increasing trend, when energy related CO_2 emissions play the most significant role. The trend of high scenario is the closest to stabilization. The GHG emission projections are influenced by GDP growth rate, the acceleration of energy conservation measures and economy sector restructuring. Due to these elements, the projections of GHG emissions for the countries with economy in transition should be updated every year up to the macro and micro stabilization.

Table 1.3 Aggregated emission projection of greenhouse gases
[Gg CO_2 equivalent /Year]

	1995	2000	2005	2010
Reference scenario				
Total CO_2 emissions	130823.3	162334.8	187794.0	228535.7
Total CH_4 emissions	30880	33531	36740	43125
Total N_2O emissions	7008	8480	10240	12704
Aggregated emissions	**168711.3**	**204345.8**	**234774.0**	**284364.7**
Low Scenario				
Total CO_2 emissions	130823.3	158445.9	178926.0	201447.5
Total CH_4 emissions	30880	33445	33712	36368
Total N_2O emissions	7008	8128	9024	10112
Aggregated emissions	**168711.3**	**200019.0**	**221662.0**	**247927.5**
High Scenario				
Total CO_2 emissions	130823.3	150807.9	156432.0	167655.5
Total CH_4 emissions	30880	32879	32164	33227
Total N_2O emissions	7008	7744	7904	8256
Aggregated emissions	**168711.3**	**191430.9**	**196500.0**	**209138.5**



1.5 Expected impacts of climate changes, Vulnerability assessment and adaptation measures

1.5.1 Climate changes scenarios

The global warming impact on Romanian climate was evaluated using models for general circulation of the air (GCM), equilibrium and transit models. Within the "Country Study on Climate Change. Element 2", all the GCM outputs were supplied by National Center for Atmospheric Research (NCAR) of US. To assess the vulnerability and adaptation of agriculture, forests and water resources to the climate change it was tested to the Romanian condition four equilibrium models (CCC, GISS, GFD3, UK89) and one "transient" model (GFD1) provided by NCAR.
CCC model shows a slightly decreasing of the precipitation during the hot months and an increasing during the cold months. CCC model reflects the best the present Romanian climate and gives the most realist results for 2x CO_2 scenario.

1.5.2 Agricultural plant

To evaluate the impact of climate changes on the agricultural harvest in the south part of Romania, a few simulation models were tested. CERES model can be used for the soil and climate condition from Romania. CERES model provides the forecast of the characteristic elements for harvest consistent with the outputs of the models in place in Romania. The most important harvest for Romania wheat, maize and soy were analysed.

Adaptation strategies

The preventive measures for risk reduction resulting from climate change impacts upon agriculture are as follows:

- re-evaluation of agricultural crop growing technologies to develop a sustainable agriculture with natural fertilizer of soil;
- re-evaluation of the agroclimatic regionalisation and structure of growing crops;
- development of the irrigation.

As a general remarque the rotation of the harvest increase the benefits. The short rotation is recommended. In the condition of the twofold of CO_2 the fertilizer demand will increase with 15-20%.

1.5.3 Forestry

In 1994, the afforested area covered 6,368 thousand hectares, i.e. 27% of the total area of this country.
The evaluation of climate changes on the forests in Romania was performed using Holdrige model (static model of vegetation associations). The climate changes scenarios correspond CCC and GISS models.

The Holdrige diagram shows the transition of the vegetation area in Romania due to the transition from the climate corresponding to cool temperate latitude area and boreal to warm temperate to first area and to cool temperate for the second area. This evolution of the climate will determine the reduction of areas covered by some species and the extension of the others with the influence on the biomass production. So, the area of the Fagus sylvicol will reduce with about 10% due to the reduction of the rainfall quantity. Among the oak species, Quercus cerres and Quercus frainetto will extend their area in the south side of the country due to their resistance to the high temperature.

In the baseline scenario, in optimal conditions, the Quercus frainetto realizes more stand production (4.5 m^3 / ha / year for 100 years and 6 m^3 / ha / year for 120 years) than Quercus cerres.

It is expected that the stand production to decrease in the conditions of the CCC and GISS scenarios.

Using the Holdrige model for baseline scenario and for climate changes scenarios provided by CCC and GISS models, it was obtained the specific maps with the determination of the impact area. This area should be analyzed using the Gap model.

Adaptation strategy

- Ending strategic study with respect to the potential impacts of global change on the forests in Romania and adaptation measures to minimize the negative impacts
- Development of scientific and technical projects aimed at forestry bioclimatology, ecophysiology, forestry dendroclimatology, forest protection, genetics and breeding of forest tree species.

1.5.4 Water resources and water management

Theoretical potential of the inside river's water resources was evaluated at 39.6 billion m^3 for average hydrological year. The share of Romania from the Danube water potential was estimated at 53.2 billion m^3.

The available potential is evaluated at 42.5 billion m^3 as an average multiyear. The water consumption increased ten times during the period 1960 - 1982, reaching in 1989, 20 - 22 billion m^3.

Due to the industrial production falling in the period 1990 - 1994, the water consumption decrease to 10.2 billion m^3. The forecast of the water demand estimated for 2075 is 40.4 billion m^3. Up to now it were not elaborated studies to analyze the correlation between the water consumption and the temperature and precipitation conditions.

In the baseline scenario if we compare the water demand and the available water resources of the inside rivers and Danube, results a global vulnerability during the period 2060 - 2075 which can be associated to marginal vulnerability.

By hydrographic basins, the water consumers supply can reach some difficulties such as:

- the high pollution of some water resources make them unusable for a part of the consumers
- irregular distribution of the water sources over the regions determines the remaining of some areas with important water deficits

- limited imposed by the Danube river position (in the south side of the country and evaluated with 50% of the total water resources).

To determine the vulnerability at the national level in the Romania's conditions, it is necessary to perform analyses for each hydrographic basin. For this purpose the following hydrographic basins were analyzed in detail: Siret, Arges and Târnava. For these three areas results the following conclusions:

- there are insufficient data to establish the vulnerability for the considered climatic scenarios
- considering only the maize irrigation there is no vulnerability, only for Siret and Târnava basins
- if it will be considered other hydrological year and irrigation for other harvests, it is possible to appear deficit in all basins.

Adaptations:

- to reach the water demand of all consumers in the dry period and the water for irrigation of other harvest it is necessary to reorganize the operation of the existing storage lakes and to build new storage lakes
- further research to reduce the losses in the water networks and to modernize the technologies used for irrigation and industrial processes
- continuation of the systematic observation of water balance in water basins especially during the dry periods. This will help in the early identification of potential decline in water resources
- several strategic decisions must be accepted and new priorities of water management must be set
- systematic implementation of the water economy balance.

1.6 Climate changes research

The Ministry of Waters, Forests and Environment Protection coordinate the research projects related to climate change, possible climate change impacts, mitigation options and adaptation strategies.

The main goals of the research are:

- detailed inventory of emissions and sinks of greenhouse gases and the assessment of technical measures to mitigate greenhouse gases emission or to enhance GHG sinks;
- development of activities in accordance with the aims of the World Climate Program;
- development of background information for state authorities and other institutions with respect to meeting international common treats related to climate change issues;
- studies to develop an action plan for GHG's emission abatement and implementation of climate change adaptation strategies;

  The following research and studies belong to the National Action Program and have as secondary effect the mitigation of the GHG:
- diminution of the causes determining rain acidity by reduction of SO_2, NO_x and Cl emissions;

- improvement of the used water treatment technologies for their re-utilization;
- solutions for the treatment and turning into account of the solid residues;
- improvement of management of the soil, industrial and household waste;
- improvement of life quality and the securing environment protection;
- lessening of the drought effects, desert limitation by specific measures, forest belts, soil erosion control, flood protection.
- growth of the forest role in the environment rehabilitation and protection, enlargement of the forest fund, sylvicultural management, exploitation of the wooden mass to the full rehabilitation capacity of the forests;
- Danube Delta Biosphere Reservation;
- preservation of the Black Sea ecosystem;
- rural planning, actions of soil and agricultural fund preservation;
- setting up of a complex educational program on the environment on all levels.

1.7 Educational public awareness

The Ministry of Water, Forests and Environment Protection (MWFEP) as well participating institutions in the US Country Studies Program have paid particular attention to the improvement of education and public awareness concerning climate change issues.

The main initiative in Romania in the last years included:

- distribution of the National Communication to members of state administration, research institutes, industries, NGO's and other interested parties;
- officials of the MWFEP several times informed representatives of the public mediums concerning FCCC commitments and national climate change strategies and policies;
- research reports and special articles were published and presented in national conferences and seminars.

2 Introduction

Romania signed the United Nations Framework Convention on Climate Changes on the 5th of June 1992 and ratified it on the 6th of May 1994.

According to decisions of the Convention, each country Party shall communicate to the Convention secretariat its second national report presenting inventories of emissions by sources and removals by sinks of all greenhouse related gases, a general description of steps taken or envisaged by the Parties to implement the Convention and other information that the Parties consider relevant to the achievement of the objective of the Convention.
This report presents a proposal of measures to observe the commitments under the Climate Convention. The projection of greenhouse gases emissions and the proposal of the mitigation options were evaluated mainly within the "Country Study on the Climate Change". Element 3: Mitigation Options" ended in 1996. Background material and data underlying the calculations, of the mitigation options in the report are available upon request to the Ministry of Waters, Forest and Environmental Protection of Romania.

The new Government elected in 1996 has as main objective the deeply reform in the Romanian economy which will be reflected in the increase of the energy efficiency and energy conservation, in the restructuring of the energy sector to implement the competition, a higher increase of the activities to reduce the environmental impact, etc., on a higher manner against the prognoses performed up to 1997. After defining the priorities in the economy sector restructuring, it is necessary to update the projections of the greenhouse gases and the effect of proposed measures to observe the commitments under the Climate Convention.

Chapter 3 of the report contains a large number of reference data on Romania such as: geography, population, climate and the consumption of primary energy, both for energy and for transport purposes.

Chapter 4 presents an inventory of emissions of greenhouse gases and describes the scope for increasing sinks within the forest and agricultural sectors.

Chapter 5 and 6 give an account of the measures which have been selected for the energy and transport sectors and which will contribute significantly to reduce emissions of greenhouse gases.

Chapter 7 presents the expected impacts of climate change and vulnerability assessment and adaptation measures.

Chapter 8 of the report describes the Romanian research activities carried out in support of climate research at national level for socio-economic assessment of climate change.

Chapter 9 deals with aspects of education, training and public awareness.

The following institutions have made contributions to the national report:

- ***Ministry of Industries and Trade;***
- ***Ministry of Transportation ;***
- ***Ministry of Agriculture and Food Industry.***

3 National Circumstances

Geography

3.1 Geography and land use

Romania is situated in Europe at half distance between Ecuator and North Pole (45° lat N) and also about half distance between Atlantic Ocean and Urali Mountains (25° long E). Its relief forms are in respect with the rules of equilibrium and harmony, including in almost equal proportions mountains (31%), hills and plateaus (36%), fields and river meadows (33%).

Land use

Out of the country's total area of 238,390 km^2 , 62% is covered by agricultural areas, 27% represents the forest, 3.7% the waters and 7.3% is represented by other areas.

The following modifications were registered on the 31st of December 1994, as against the 31st of December 1989, regarding the main uses of the land fund.

- the diminution of the agricultural area by 322,383 ha;
- the diminution of the arable area by 769,903 ha
- the increase of the pasture area by 378,783 ha
- the increase of the hay-area by 92,173 ha
- the increase of the vineyard area by 30,320 ha
- the diminution of the orchard area by 42,845 ha

The non-agricultural lands enlarged their areas by 400,543 ha, of which 246,126 ha are covered with buildings, roads or represents non productive lands.

Agriculture

The agricultural land productivity diminished by 20 - 30%, due to the action of certain factors having a limiting character, such as: erosion, compactness, acidity, the poor contents of nourishing elements, the growth of the salt contents, but most of all this can be accounted for by the chemical pollution due to the unreasonable utilization of fertilizers and pesticides or to the imissions of heavy metals, fluorides, oil, a.s.o. During droughty periods, agricultural production diminishes severely in the affected areas. The studies performed so far have shown that 6-7 million hectares suffer from drought, while only some 3.2 million hectares have been reclaimed for irrigation. However, agriculture still participate in the national income with a contribution of some 20%.

Privatization in agriculture led to the crumbling of the agricultural area, due to its being divided to a great number of owners. The average area of agricultural land per owner is about 1.8 ha. The growth of the agricultural production depends upon the settting up of efficient family farms, upon the gathering of the landowners in associations, on the use of adequate machinery and modern equipment, upon the application of irrigations and
upon the execution of drainage and soil erosion control works, as well as

upon the use of the natural fertilizers, which mean performing a long-lasting agricultural activity. The performing of such an agricultural activity and the proper use of this actual wealth - the soil are the means to secure the population's necessary food and also the necessary export products, which should, by all means, be competitive. The curbing down of the chemical fertilizers, the use of natural ones, the performing of land reclamation works and the application of adequate technologies under privatization conditions will only lead to the disappearance of poverty, which has also been brought about by the curbing down by some 40% of the agricultural production during the last couple of years. 1993 and, especially 1994 are years that mark the start of the agriculture rehabilitation. The wheat resources created in Romania in 1994 secure the home consumption for two years.

Forest areas

In 1994, the afforested area covered 6,368 thousand hectares, i.e. 27% of the total area of this country. The structure of forest in Romania, according to species, is:

- 1,930 thousand hectares resinous forest
- 1,902 thousand hectares beech tree forest
- 1,142 thousand hectares oak tree forest
- 1,278 thousand hectares other deciduous species

The weight of deciduous species is 69.2% , while that of the resinous ones is 30.8%.

The forest distribution on the large vegetation zones is:

- mountainous (above 700 m altitude) 58.5%
- hills (150 - 700 m) 32.7%
- plain (below 150 m) 8.8%

As against 1989, the area which has been registered with the forest fund grew by 107,395 hectares. However, the actual growth is small due to the unjustified cuttings practised mainly during the period 1991 - 1992.

3.2 Climate

Because of geographical position - in Central Eurasia - and its relief, Romania has a temperate climate, being under the influence of wet air masses, coming from Atlantic Ocean and of continental dry air masses, coming from the East side of the continent and, also, of the mediteranean air, coming from South.From this results a temperate-continental climate with local variations determined by seasons succession, by relief forms,by the position of Carpathians main branches, by largeness and orientation of valleys.

Temperature

Yearly average temperature decreases progressively, in latitudinal direction, from South (11°C) to North (8.5°C) and altitudinal, from field regions (10 - 11°C) to mountain ones (6°C at a heigh of about 1000 m, 0°C to a heigh about 1800 m and under -2°C at over 2500 m heigh).

Precipitation

Rainfalls distribution represents a considerable decreasing from East to West but also altitudinal, from moutain (1200 - 1400 mm) to field (500 - 600 mm). West side slopes of Western Carpathians and Eastern ones that stand before wet air masses, oceanic, get the most important qunatities of rainfalls. An important part of rainfalls is represented by snowfalls, within mountain area, where snow layer lasts 120 - 150 days.

Wind

Direction and intensity of wind are different on Romania area.

The Carpathians represents an obstacle in air masses traveling. At their outside prevails dry winds from Northen and Western side their direction being parallel with outside part of the mountains. In Western and Central part of the country prevails Western wet winds. Heigh winds velocity can reach sometimes 30 m/s, while in low regions it decreases intensely, the wind direction being substantially modified by the relief.

The wind regim is influenced by the position of the country: as frequency prevails West-East winds, the others being more weakly . As intensity Crivatz can be felt in Moldavia, Romanian field and Dobrogea; Cosava in Banat, Nemira in Barsa depression.

Hours of sunshine

Time of sun shining has an high value in field (2100-2200 hours yearly) and a lower one in mountains area (1800 hours). The highest values are registred on Black Sea Coast (2300 hours) in Danube Delta (2400 - 2500 hours) .

3.3 Population

The population of Romania amounts to 22.731 million inhabitants in 1994 out of which 54.7% in urban area. The population of the Bucharest area amounts to 8.8 % coresponding to 2.054 million in 1995.

Population decrease

Between 1989 and 1994 the population deacrease with 0.471 million inhabitants. (Table 3.1)

Projection

The projections indicate the maintaining of the decreasing tendence reaching about 22.0 million inhabitants in 2010.

Table 3.1 Population 1989 - 1994

[**millions]**

Year	1989	1990	1991	1992	1993	1994
Population	23.152	23.207	23.185	22.789	22.775	22.731

Unemployment has been registered in Romania starting from February 1991. The unemployment rate at the end of 1991 was about 3% (337.4 thousand persons). In 1994, the unemployment rate increase to 11.1% of the active population (1.22 million persons).

3.4 Gross Domestic Product

During the transition period, Romania chose a gradual economic liberalization policy, an option motivated by the necessity to reduce social pressure. However, this policy was not supported by other measures of the economic reform.

The gross domestic product (GDP) sharply declined between 1990 and 1992 . The GDP in 1992 represented less than 75% of the GDP in 1989. The severe decrease of the utilization of domestic energy resources occurred mainly because of the general decline of the economy, but also because of the low technological efficiency.

Table 3.2 Gross domestic product by categories of resources

bill. lei current prices

	1989	1990	1991	1992	1993	1994
Gross domestic product	**800**	**857.9**	**2203.9**	**6029.2**	**20035.7**	**49767.6**
Agriculture	109.8	181.6	404.3	1119.9	4124.3	9620.6
Silviculture, forestry and hunting	5.4	5.4	11.6	28	81.5	243.7
Industry[1]	369.3	347.6	834.6	2311	6781.4	17733.4
Constructions	43.9	46	96.1	290.1	1040	3171.8
Trade[2]	46	53.2	296.5	859.5	2057.7	4907.7
Transport	46.2	42.2	125.2	457.2	1759.3	3304.3
Post and communications	7.6	7.2	21.9	57.1	255.3	636.4
Gross domestic product per capita	**34556**	**36966**	**95057**	**264565**	**880487**	**2189450**

Source: National Commision for Statistics;

NOTE:: *1) Including electric and thermal energy, gas and water*

2) Including hotels and restaurants

Table 3.3 Indices of gross domestic product by categories of resources

1989 = 100

	1990	1991	1992	1993	1994
Gross domestic product	**94.4**	**82.2**	**75**	**76.1**	**79.1**
Agriculture	139.4	122.8	106.7	121.9	125.4
Silviculture, forestry and hunting	93.7	68.9	64.8	59.3	61.1
Industry	83.3	72.6	62.6	63.3	65.1
Constructions	101.1	81.5	76.9	95.9	121.6
Trade	109.3	81.4	73.9	67.2	69.1
Transport	78.2	65.1	61.1	61.4	61.5
Post and communications	81.2	112.3	121.6	147.2	161.6
Gross domestic product per capita	**94.2**	**82.1**	**76.2**	**77.5**	**80.6**

Source: National Commision for Statistics

Inflation

In 1994, the beginning of the economic recovery and macrostabilization was indicated by the increase of the production efficiency (labor productivity increased for the first time after 1989). In addition, the economic system underwent certain important changes, the most notable being the implementation of the value added tax (VAT). The macrostabilization process continued in the following years so that in 1994 the GDP represented about 79% of the GDP in 1989.

As shown in Table 3.4, the inflation has been increased since November 1990. This development was determined by factors such as price liberalization and the elimination of direct and indirect subsidies for certain products. Inflation was further induced by the poor economic performance, the increase of interest rates for circulating loans, high energy consumption per product unit, low productivity and the increase of wages under social and union pressure.

Table 3.4 Inflation Rate

[%]

	1991	1992	1993	1994
Inflation rate at the end of the year (December in the current year/December previous year):				
Total	222.8	199.2	295.5	61.7
Food Products	287.7	219.7	271.2	64.3
Non-Food Products	181.0	189.5	328.6	55.1
Services	185.4	162.7	282.8	74.1
Monthly average inflation rate:				
Total	10.3	9.6	12.1	4.1
Food Products	12.0	10.2	11.6	4.2
Non-Food Products	8.9	9.3	12.9	3.7

Employment

In 1994 the total active population was 10.011 million persons of which 35.57% were employed in agriculture, 28.79% in industry and 35.64% in other sectors.

3.5 Energy

3.5.1 Energy Consumption

The evolution of the energy indices during 1989 - 1994, presented in Table 3.5, corresponded to the general development of our economy, which was on decline during the first period, followed by an increase during the second one.

During the period 1989-1994, GDP decreases with an average annual growth rate at 9.5% in comparison with primary energy consumption which decreases yearly with about 9.4% and final energy consumption with about 11.1%. That means important reductions of the activity of the high energy intensive and uneconomic sectors.

Table 3.5 Evolution of the Energy Indices in the Period 1989 - 1994

Specification	M.U.	1989	1990	1991	1992	1993	1994
Population	10^6inh.	23.15	23.21	23.19	22.79	22.76	22.73
Primary energy consumption	10^6 tce	100.46	87.92	72.61	64.71	65.33	61.44
Final energy consumption	10^6 tce	69.904	61.012	44.911	43.533	40.402	38.733
Energy sector	10^6 tce	10.078	8.092	7.868	6.328	6.238	5.128
Final energy consumption(1	10^6 tce	79.982	69.104	52.779	49.861	46.640	43.861
Primary energy consumption/population	tce/inh.	4.34	3.79	3.13	2.84	2.87	2.70
Final energy consumption(1/population	tce/inh.	3.45	2.98	2.28	2.19	2.05	1.93
GDP/inh.	$/inh.	1805.60	1699.72	1481.39	1375.20	1397.66	1454.51
Primary energy consumption/GDP	tce/1000$	2.40	2.23	2.11	2.06	2.05	1.86
Final energy consumption*)/GDP	tce/1000$	1.91	1.75	1.54	1.59	1.47	1.33
GDP [constant prices 1995]	$10^6$$	41799.70	39450.55	34353.54	31340.74	31810.85	33061.02

Source: National Commision for Statistics;
NOTE: 1) Included energy sector;
Primary energy consumption = Domestic production + Import - Export + Stock;
In the evaluation of the final energy consumption, electricity and heat were converted in tone coal equivalent using the following indices:
1 MWh = 0.123 tce and 1Gcal = 0.143 tce;
The GDP values were brought up-to date in constant prices corresponding to 1995 by means of the exchange rate "leu-dollar".

To the same conclusions drives the evolution of the energy intensity of GDP related to primary energy and to final energy consumption. The energy intensity of GDP related to primary energy consumption decreases from 2.4 tce/1000$ in 1989 to 1.86 tce/1000$ in 1994 that means 5.0% average rate per year and the energy intensity of GDP related to final energy consumption decreases in the same period with 7.0% per year.
Table 3.6 shows the evolution of the final energy consumption during 1989 - 1994 classified in main activity domains (industry, construction, transportation, services, agriculture and population) as well as in the main industrial branches.
The final energy consumption decreased significantly during 1989 - 1994. In 1994 the level of consumption represented about 55% from that of the year 1989.

Industry represents the most important energy cosumer; it share in total consumption decrease from about 77% in 1989 to about 58% in 1994.

Table 3.6 Evolution of the Final Energy Consumption

	1989		1990		1991		1992		1993		1994
	10^6tce	%	10^6tce	%	10^6tce	%	10^6tce	%	10^6tce	%	10^6tce
T O T A L	79.981	100	69.105	100	52.780	100	48.519	100	46.64	100	43.86
A. INDUSTRY	61.522	76.92	49.067	71.00	35.557	67.37	29.568	60.94	27.694	59.38	25.340
1. Metallurgy, iron ores extraction and processing	13.161	16.46	8.471	12.26	8.615	16.32	5.512	11.36	6.070	13.01	5.817
2. Food and Light Industry	3.693	4.62	3.456	5.00	3.351	6.35	2.633	5.43	2.078	4.46	2.093
3. Wood and Pulp	2.491	3.11	2.067	2.99	1.580	2.99	1.236	2.55	1.084	2.32	0.972
4. Chemical industry	19.741	24.68	16.206	23.45	8.401	15.92	8.363	17.24	7.410	15.89	6.673
5. Machinery and Equipment	4.647	5.81	4.299	6.22	3.235	6.13	2.805	5.78	2.605	5.59	2.359
6. Building materials	4.415	5.52	3.957	5.73	2.159	4.09	2.126	4.38	1.696	3.64	1.945
7. Other industries non specified above	3.297	4.12	2.519	3.65	0.347	0.66	0.565	1.16	0.513	1.10	0.354
8. Total energy sector	10.077	12.60	8.092	11.71	7.869	14.91	6.328	13.04	6.238	13.37	5.127
B. CONSTRUCTION	1.372	1.72	1.171	1.69	0.683	1.29	0.493	1.02	0.477	1.02	0.591
C. TRANSPORTATION	2.584	3.23	2.628	3.80	2.262	4.29	3.837	7.91	4.436	9.51	4.547
D. SERVICES*)	3.301	4.13	3.540	5.12	1.775	3.36	1.768	3.64	2.798	6.00	3.051
E. AGRICULTURE	3.179	3.97	2.864	4.14	2.953	5.59	2.083	4.29	1.696	3.64	1.173
F. POPULATION	8.023	10.03	9.835	14.23	9.550	18.09	10.77	22.20	9.539	20.45	9.158

Source: National Commision for Statistics;
*NOTE: *) Statistical differences are included at Services sector;*
Final electricity and heat consumption were converted in tone coal equivalent using the following indices:
1 MWh = 0.123 tce and 1Gcal = 0.143 tce;

On the second place is situated the households consumption with 10% in 1989 and about 21% in 1994 from the final energy consumption.

While consumption in industry decreased significantly - about 59% in 1994 compared to 1989 - and its share in the total consumption of 1994 also decreased (as mentioned above), the households consumption increased slightly in 1994 as compared to 1989, to about 14%, its share in the total consumption of 1994 being characterized by a significant increase (it was about double - in per cent - as compared to 1989).

The increase of the final energy consumption was recorded not only in the case of the households consumption, but also in transports - by more than 76% in 1994 as compared to 1989.

As far as industry is concerned, the main branches characterized by significant energy consumption are: chemical industry and metallurgy, iron ores extraction and processing. Both branches, with products requiring significant energy consumption, diminished their production and of course their final energy consumption during 1989 - 1994.

For example, the chemical industry decreased its final energy consumption by 60% in 1994 as compared to 1989 and metallurgy, iron ores extraction and processing diminished their consumption by about 55% in 1994 as compared to 1989. As a matter of fact, all the industrial branches as well as construction, services and agriculture diminished their final energy consumption in 1994 as compared to 1989, due to their production limitation for uneconomic products.

3.5.2 Energy supply

The main utilized primary energy types in Romania during 1989 - 1994 were natural gas, then oil products and coal. In 1989 the natural gas consumption represented about 46% from the total primary energy consumption, the oil products and coal about 25% each.

The consumption of all the energy types decreased in the period 1989 - 1994 (excepting wood and others), as follows: by 41.8% in the case of natural gas, by 34.8% for oil products and by 41.1% for coal.

The Table 3.7 shows the evolution of primary energy consumption during 1989-1994, for different energy forms.

Table 3.7 Evolution of Primary Energy Consumption by Energy Forms

Year	TOTAL	Coal		Oil prod.		Natural gas		Electricity		Wood and others	
	10^6tce	10^6tce	%	10^6tce	%	10^6tce	%	10^6tce	%	10^6tce	%
1989	100.46	24.78	24.67	25.55	25.43	46.19	45.98	2.51	2.50	1.43	1.42
1990	87.92	16.64	18.93	26.67	30.33	40.96	46.59	2.52	2.87	1.13	1.28
1991	72.61	13.41	18.47	21.13	29.10	34.30	47.24	2.62	3.61	1.15	1.58
1992	64.71	14.92	23.06	16.86	26.05	30.12	46.55	1.98	3.06	0.83	1.28
1993	65.33	14.47	22.15	18.15	27.78	29.11	44.56	2.07	3.17	1.53	2.34
1994	61.44	14.52	23.63	16.66	27.12	26.92	43.82	1.96	3.19	1.38	2.24

Source: National Commission for Statistics

Note: Total Primary Energy Consumption = Production + Import - Export + Stock; Electricity was converted in tone coal equivalent using the following index: 1MWh = 0.123 tce.

Primary energy consumption is supplied mainly from domestic production. The imported energy represents between 26% (year 1994) and 36.3% (year 1990) from the primary energy consumption.

The evolution between 1989 - 1994 of the domestic production (Table 3.8) shows a decrease from 70.82×10^6 tce to 45.02×10^6 tce that means an yearly reduction with 8.7%.

Natural gas has the biggest share in the domestic production. The exhaustion of the resources determine the reduction of the production from 37.81 Mtce in 1989 to 21.58 Mtce in 1994. Also because of the resources diminuation, the production of the crude oil recorded a decrease from 12.72 $\times 10^6$ tce in 1989 to 9.34 $\times 10^6$ tce in 1994.

Table 3.8 Evolution of the Domestic Primary Energy Production

Year	TOTAL	Coal		Crude oil		Natural gas (including petro-leum gas)		Hydro electricity		Wood and others	
	10^6tce	10^6tce	%	10^6tce	%	10^6tce	%	10^6tce	%	10^6tce	%
1989	70.82	17.74	25.05	12.72	17.96	37.81	53.39	1.55	2.19	1.00	1.41
1990	56.76	10.74	18.92	11.00	19.38	32.63	57.49	1.35	2.38	1.04	1.83
1991	49.70	9.12	18.35	9.42	18.95	28.25	56.84	1.75	3.52	1.16	2.33
1992	47.19	10.5	22.25	9.18	19.45	25.18	53.36	1.44	3.05	0.89	1.89
1993	47.13	10.85	23.02	9.26	19.65	23.94	50.80	1.57	3.33	1.51	3.20
1994	45.02	11.11	24.68	9.34	20.75	21.58	47.93	1.61	3.58	1.38	3.07

Source: National Commission for Statistics
NOTE: Hydroelectricity was converted in tone coal equivalent using the following index:
1 MWh = 0.123 tce.

The production of the domestic lignite and hard coal also decreases during the period 1989 - 1994 because of the high production costs and low productivity. The evolution of Romania's energy import during 1989 - 1994 is shown in Table 3.9**.**

As for the consumption rhythms of the years 1989 - 1990, Romania's reserves are estimated at some 20 - 30 years for crude oil and natural gas and about 75 - 100 years for coal. Even as uranium is concerned, the present reserves are estimated at a 20 years consumption duration for the five units which belongs to the Nuclear Power Plant in Cernavoda.

Table 3.9 Evolution of the Energy Import of Romania

Year	TOTAL	Coal and coke		Crude and oil products		Natural gas		Electricity	
	10^6tce	10^6tce	%	10^6tce	%	10^6tce	%	10^6tce	%
1989	47.13	7.008	14.87	30.776	65.30	8.384	17.79	0.961	2.04
1990	39.33	6.508	16.55	23.327	59.32	8.326	21.17	1.165	2.96
1991	25.17	4.100	16.29	14.100	56.03	6.100	24.24	0.867	3.44
1992	22.67	5.733	25.29	11.453	50.52	4.942	21.80	0.544	2.40
1993	21.80	3.077	14.11	13.192	60.50	5.167	23.70	0.368	1.69
1994	23.49	4.000	17.03	13.931	59.31	5.338	22.73	0.220	0.94

Source: National Commission for Statistics
NOTE: Electricity was converted in tone coal equivalent using the following index:
1 MWh = 0.123 tce.

The imported energy decreases between the period 1989-1994 from 47.13x10^6tce to 23.49 x10^6 tce, that means about 50%. The largest quantities imported are represented by the crude oil and oil products. Because Romania has refineries with a total processing capacity at 34 millions tons/year imported crude oil, processed it and the excess products were exported. The exported quantities reach the highest value at 19.17 x10^6 tce in 1989. After 1989 the exported oil products decreased between 3.16 x10^6 tce (in 1992) and 7.2 x10^6 tce (in 1990 and 1994).

3.5.3 Electric Generating System

Table 3.10 shows the installed capacity in power plants of Romania which, in 1994, summed up to 22,045 MW, out of which 16,107 MW in thermal power plants and 5,938 MW in hydro power plants. Out of these, CONEL has 14,914 MW in thermal power plants and 5,977 MW in hydro power plants, the rest belongs to the self producers.

One characteristic of the Romania electric system is the large number of cogeneration plants supplying the heat and hot water to residential and industrial consumers. The total installed capacity in cogeneration plants was 6,164 MW.

Many of thermal units have, or will have, till 2000 year, an over 30 year lifetime. As a consequence, 78 units with a total power of 5,000 MW with unit power between 3 MW and 315 MW will reach their designed lifetime and will need to be retrofitted or replaced. In order to increase both technical and economical efficiency, some rehabilitation works were considered for units of both condensing and cogeneration plants. CONEL, which owns about 94% of the electricity generating capacities has projects to rehabilitate in the long-term period a total of 9,514 MW, of which 6,200 MW in thermal power plants and 3,314 MW in hydro power plants. A total of 1,267 MW in obsolete, low performance units will be retired by the year 2000.

Table 3.10 Installed Capacity in Romania by Fuel Type

[MW]

	1989	**1990**	**1991**	**1992**	**1993**	**1994**
TOTAL ROMANIA	**22904**	**22479**	**22268**	**22177**	**22262**	**22045**
1. Hydro power plants	5584	5657	5687	5735	5872	5938
2. Thermal power plants	17320	16822	16581	16442	16390	16107
- coal	8708	8747	8669	8548	8597	8588
- hydrocarbons	8612	8075	7912	7894	7793	7519

Source: National Commission for Statistics

Table 3.11 shows final electricity consumption by economy sectors. Final electricity consumption decreases from 71.401 TWh in 1989 to 44.841 TWh in 1994, that means a reduction with 37%. The biggest fall was between 1989 - 1992, after that, the consumption begun to stabilize. In 1989 the structure by branches, of the electricity consumption, was as follows: 77.9% in industry, 2.1% in constructions, 4.1% in transport and telecommunications, 5.8% in agriculture and forestry, 4.1% in services and 6% for households consumption.

Table 3.11 Final Electricity Consumption by Categories of Consumers

[TWh]

	1989	1990	1991	1992	1993	1994
TOTAL	**71.401**	**60.216**	**51.531**	**46736**	**45.613**	**44.841**
Industry*	55.73	44.533	35.088	30.147	29.191	27.857
Construction	1.511	1.342	0.927	0.664	0.593	0.771
Transportation & telecomms.	2.921	2.614	1.786	2.827	2.207	1.904
Agriculture and forestry	4.169	3.180	4.191	2.182	1.959	1.834
Services	2.932	3.193	2.92	3.320	1.714	1.937
Households	4.296	5.354	6.747	7.596	7.023	6.646
Statistical differences	-1	0	0	0	2926	3892

Source: National Commission for Statistics
*Note: * Includes transformation industries (refinery, coke etc.).*

Table 3.12 shows the evolution of the fuel consumption for electricity generation during 1989 - 1994.

Table 3.12 Fuel Consumption for Electricity

[10^6tce]

	1989	1990	1991	1992	1993	1994
TOTAL ROMANIA	**22.594**	**19.517**	**15.615**	**15.601**	**15.854**	**15.449**
• coal:	10.180	7.030	6.028	7.834	8.214	8.240
- lignite	8.335	5.490	4.747	6.119	6.565	6.517
• fuel oil and Diesel	2.544	3.995	2.046	1.252	1.627	1.735
• natural gas	9.348	8.222	7.322	6.288	5.858	5.342
• other fuels	0.522	0.270	0.219	0.227	0.155	0.132

Source: National Commission for Statistics

3.5.4 Heat Generating System

In Romania, the heat supply (steam and hot water) from centralized systems represents important share of the final energy consumption, about 30%.

From the total amount of heat provided from centralized supply systems, CONEL supplies from its own cogeneration and heat plants about 42%, out of which from over 94% is from the cogeneration plants (combined heat and power generation). The rest of 58% is produced in the cogeneration and heat plants owned by industrial enterprises or autonomous companies of municipalities (self producers).
The technological level of thermal units from CONEL plants can be compared with the level of the 60's - 70's, their origin being of a various type (Russian, French, Czech or Romanian brands).

Because the industrial cogeneration plants have been designed for big heat consumption, to supply industrial branches (chemical, petrochemical, metallurgy) whose development have not reached the projected level or have diminished after 1990. In these conditions some industrial cogeneration plants operate at partial loads or have been partially decommissioned.

The evolution of heat production structure in the period 1989 - 1994, on plants types for CONEL and self producers is presented in Table 3.13.

Table 3.13 The Evolution of Heat Production from Cogeneration and Heat Plants

[PJ]

	1989	1990	1991	1992	1993	1994
A. Net Heat Production						
TOTAL ROMANIA	**704.622**	**648.950**	**545.628**	**459.187**	**463.923**	**384.486**
- Cogeneration plants	418.450	375.100	303.355	273.695	271.861	231.580
- Heat plants	286.172	273.850	242.273	185.492	192.061	152.906
A.1. CONEL	269.998	258.112	221.444	191.169	192.522	172.953
- Cogeneration plants	248.943	235.315	202.478	178.852	181.113	163.989
- Heat plants	21.051	22.797	18.966	12.318	11.409	8.964
A.2. SELF PRODUCERS	434.623	390.838	324.184	268.018	271.401	211.534
- Cogeneration plants	169.507	139.785	100.877	94.844	90.749	67.592
- Heat plants	265.121	251.053	223.307	173.174	180.652	143.942

In the Table 3.14 is presented the evolution in period 1989 - 1994 of the fuel used for the heat production.

Table 3.14 Fuel Consumption used for Production of Heat Supplied from Cogeneration and Heat Plants

[10^6 tce]

	1989	1990	1991	1992	1993	1994
TOTAL ROMANIA	**28.719**	**26.749**	**22.247**	**19.654**	**18.796**	**16.981**
- coal:	3.627	2.843	2.407	2.034	2.243	2.118
. lignite	3.12	2.285	1.815	1.51	1.782	1.728
- oil products	5.065	5.876	4.832	4.335	4.545	3.973
- natural gas	16.388	15.478	13.511	12.223	10.802	9.69
- RES + NES + other fuels	3.639	2.552	1.497	1.062	1.206	1.2
CONEL	10.627	10.3	8.923	7.833	8.026	7.045
- coal:	2.978	2.334	1.939	1.874	2.056	1.898
. lignite	2.707	1.956	1.577	1.416	1.674	1.626
- oil products	2.858	3.281	2.419	1.99	2.356	2.085
- natural gas	4.703	4.613	4.53	3.943	3.585	2.999
- RES + NES + other fuels	0.088	0.072	0.035	0.026	0.029	0.063

NOTE: RES = Renewable Energy Sources;NES = New Energy Sources.

For the heat production the natural gas represents the main fuel used, over 50%, followed by oil products. Because of this all the disturbances in the gas supply, especially when the temperature is below 5°C leads to the major problem in the heat supply.
The lack of hard currency led to an import of natural gas lower than needed and the reduced storage capacities for gas, of only $700x10^6$ m^3 determine also the limitation of the gas consumption during the winter period.
The evolution of the final heat consumption by total and economy sectors is presented in Table 3.15.

Table 3.15 The Evolution of Main Types of Heat Consumers

[PJ]

	1989	**1990**	**1991**	**1992**	**1993**	**1994**
A. Heat Consumption TOTAL	**682.068**	**626.777**	**523.312**	**435.557**	**437.600**	**363.343**
A.1. Industry	517.068	441.414	343.769	280.076	259.645	222.851
A.2. Construction	5.790	5.405	3.123	2.169	1.784	2.947
A.3. Agriculture & Silviculture	22.868	20.243	16.513	11.916	9.667	5.744
A.4. Services&Transportation	35.605	43.255	...	...	25.699	18.706
A.5. Population	96.698	109.673	107.387	118.461	129.347	126.429

During 1989 - 1994, the heat consumption decreases from 682.068 PJ in 1989 to 363.343 PJ in 1994 that means a reduction with over 46%.
We can see the severe regression of the industry heat consumption (mainly steam) which is because of the adjustments performed during the transition period in the Romanian economy. The amount of heat provided for population and services, for space heating and hot water preparation increases yearly, this sector being yet the most safe and stable consumer for heat.

3.5.5 Transport

The evolution of transport activity during 1989-1994 is presented in table 3.16.
The road network of Romania includes 72,820 km of public roads out of which 17,100 km modernized roads and 14,680 km national roads. The length of railroads was by the end of 1994 of 11,374 km out of which 3,866 km electrified.
Goods transport is performed by trucks, by rail, by pipes, by river. The transported goods route decreased by about 60% during 1989-1992, then it increased reaching by the year 1994 a value of about 50% higher than that of the year 1992.
The passengers interurban and international transport also decreased as compared to 1989, the transport performed in 1994 was below 60% of that performed in 1989.

The passengers urban transport oscillated during 1989-1994, by the year 1992 it exceeded the value of 1989 by abt. 10% and then it severely decreased so that in 1994 was 75% of 1989.
Number of cars after 1989 up to now increased by 30%.
For good and passengers transport, by the year 1993 was spent an equivalent amount of about 4.5 mill. tce representing abt.11% of the total final energy consumption.

Table 3.16 Evolution of transport during 1989-1994

A. Goods route

[mill. t×km]

	1989	**1990**	**1991**	**1992**	**1993**	**1994**
Railway transport	81131	57253	37853	28170	25170	24704
Road transport	30028	28993	20692	15744	15354	18321
Naval transport	3666	2090	2030	1890	1592	1586
Marine transport	1498372	110766	108089	62076	96305	115939
Air transport	78	57	26	136	108	107
Oil pipe line transport	6654	5062	3180	2558	2471	2801
TOTAL	**270929**	**204221**	**171870**	**110574**	**141000**	**163458**

B. Passengers interurban and international transport route

[10^6 passengers x km]

	1989	**1990**	**1991**	**1992**	**1993**	**1994**
Railway transport	35456	30582	25429	24269	19402	18313
Road transport	23007	24007	20835	25649	20512	14058
Naval transport	72	58	33	26	25	21
Air transport	3842	3418	2694	2732	2748	3521
TOTAL	**62447**	**58065**	**48991**	**52676**	**42687**	**35913**

C. Passengers urban transport

[passengers]

	1989	**1990**	**1991**	**1992**	**1993**	**1994**
Trams	942321	691602	843652	1117448	766409	653121
Buses	1541227	1309061	1496960	1706529	1371574	1189866
Trolley-buses	368715	264101	356382	473139	331211	300308
Maxi-taxi	28712	18591	14202	10483	10716	12304
Underground	271843	246966	244356	207454	172039	172605
TOTAL	**3152818**	**2530681**	**2955552**	**3515053**	**2651949**	**2328204**

Source: Romanian Commission for Statistics - Yearbook 1995

4.Inventory of greenhouse gas emissions

4.1 Introduction

This chapter presents the results of greenhouse gas emission inventory within the period 1989-1991 and the estimated data for the period 1992-1994. The inventory was developed in compliance with the IPCC Guidelines.
Aggregated emissions of all greenhouse gas emissions into CO_2 equivalent were evaluated using the global warming potential (GWP).
The emission inventory includes the following gases: CO_2, CH_4, N_2O, NO_x, CO, NMVOC's.

4.2 CO_2 emissions

In Romania the main CO_2 emission sources are fossil fuel combustion, industrial processes and waste waters.
The results of inventory of CO_2 emissions are presented in Table 4.1. The division of fossil fuel combustion CO_2emission is made only in transportation sector and stationary sources.

Table 4.1 Total CO_2 emissions and removals in Romania

	1989	**1990**	**1991**	**1992** estimate	**1993** estimate	**1994** estimate
CO_2 anthropogenic emissions [Gg]						
Fossil fuel combustion out of which:	185575	165382	130465	125498	122644	121327
- stationary sources	177682	155965	122944	118664	115146	113583
- transportation	7893	9417	7521	6834	7498	7744
Industrial processes	9244	7120	5188	4655	4435	4263
Waste	7	7	7	7	7	7
Total	**194826**	**172509**	**135660**	**130160**	**127086**	**125597**
CO_2 removals [Gg]						
Forest ecosystems	2925	5646	6590	6590	6590	6590
CO_2 net emissions [Gg]						
Total	**191901**	**166863**	**129070**	**123570**	**120469**	**119007**

Note: Data for period 1992-1994 were estimated and must be updated according to the IPCC methodology

4.2.1 CO_2 emissions from the energy sector

CO_2 emissions for the period 1989-1991 were calculated by means of IPCC methodology base on the primary resources availability and consumption. Besides, the exported and imported fuels have been taken into account. Traditional biomass has been excluded from the CO_2 emissions estimate.
For the period 1992-1994 it was performed an evaluation of the GHG emissions using the same quantities of fuels resulting from the modeling of the economy and energy sector.
There are some difficulties to report the fossil fuel consumption according to selected Nomenclature for Air Pollutants (SNAP):

- The National Commission for Statistics use to report all the data according to CAEN classification (which is an adaptation of the former CAER to ISIC classification)
- The National Authority for Electricity has started reporting the fuel consumption by each power plant beginning with 1991;
- In Romania there are many industrial companies which are energy self-producers. They use to produce energy for themselves but also for district heating or for other purposes. That is why to divide fuel consumption per source categories, as it is requited by IPCC Methodology , is a difficult task. Moreover, national statistics use to report fuel consumption by users of primary resources.

4.2.2 CO_2 emissions from industrial processes

The most important industrial sources of CO_2 emissions in Romania are cement and lime production.
The CO_2 emissions was calculated from the production of cement, lime, ferrous and non ferrous metals, some inorganic chemicals (hydrochloric acid, sulfuric acid, sodium carbonate, sodium hydroxide) some organic chemicals (ethylene, propylene, dichlorethane, vinylchloride, polyethylene, PVC, polystyrene, SBR, ABS, resins, formaldehyde, ethylbenzene) and wood, pulp and other products.
All activity data are conveyed by NCS.

4.2.3 CO_2 removals

The Romania's forest covers about 6.5 mill. hectares. In 1989-1991 period, storage of carbon in the forest ecosystems of Romania was estimated considering only the balance of carbon in trees.
For the period 1992-1994 it was assumed the maintaining of the storage of carbon in the forest ecosystems at the level of year 1991.
Land conversion is almost negligible.

4.2.4 CH_4 emissions

Table 4.2 presents the CH_4 emissions in Romania. The major sources are the fugitive emissions from natural gas production/processing, transmission/distribution and agriculture. Less important are waste treatment and fuel combustion.
CH_4 emissions – as fugitive emissions from fuels (natural gas and oil) have been estimated using IPCC Guide emission factors. National Commission for Statistics has conveyed the fuel quantity data.

Table 4.2 CH_4 emissions in Romania

[Gg]

	1989	**1990**	**1991**	**1992** estimate	**1993** estimate	**1994** estimate
Fossil fuel combustion	49.5	44.8	33.9	23.8	23.9	23.7
Fugitive emissions	1416.3	1130.3	975.4	916.8	897.4	847.2
Industrial processes	15.8	11.1	7.8	4.7	4.7	5.0
Agriculture	634.8	560.3	488.5	431.3	369.6	357.3
Waste	240.6	229.7	228.6	226.7	227.2	227.7
Total	**2357**	**1976.2**	**1734.2**	**1603.3**	**1522.8**	**1460.9**

Note: Data for period 1992-1994 were estimated and must be updated according to the IPCC methodology

Regarding the solid waste disposal, landfilling is almost unique technology applied in Romania, for the time being. The CH_4 emission from this source category is about 9.5% of the whole national emission in 1989. No large variation of emission has been accounted for 1989-1991 period of time.
Waste incineration is not usually applied on a large scale in Romania. Only six incineration plants are working. The capacity of each plant is 25 tones of waste per day. That is why emission coming from waste incineration plants is not significant in Romania.
The emission from waste water has been estimated taking into account the amount of Biochemical Oxygen Demand load of the population connected to the sewage systems, as well as the possible efficiency of the existing waste water treatment plants.
It must be pointed out that the situation of industrial waste water has been preferred not to be taken into consideration due to the same uncertainties in information. That is why the emission of this type of activity is underestimated and this field of activity should be regarded as a gap information.
According to the data conveyed by NCS and the Ministry of Housing and Territorial Planning out of 90 m^3 per second waste water discharged into the natural systems, only 42 m^3 per second is biologically treated, generally by activated sludge process with the excess sludge digestion. 0.22 kg of CH4 of Biochemical Oxygen Demand (BOD)

digested has been considered.
The discharge via waste water of 54 grams BOD per inhabitant, per day is a general figure used for waste water treatment plants according to the Romanian standards.
For domestic refuse in Romania there are no reliable information about the real weight of waste produced, especially from industry. Due to the existing uncertainties it has been preferred to consider the emission from industrial waste water and industrial solid waste as a gap in information, further research being necessary.
Methane emissions from fossil fuel combustion are of little significance. Methane from industrial technologies contributes to the total emission by only 2%.

4.3 N_2O emissions

N_2O emissions from fuels combustion are the biggest source in 1994. Due to the decreasing of industrial activity the N_2O emissions were reduced in 1994 with 24% in comparison with 1989. Big reduction recorded also the N_2O emissions from industrial processes. The emission of 1994 represents only 23% of the 1989 level.
N_2O emissions from agriculture are mainly coming from fertilized lands. The privatization process after 1989 has put the landowners in the position of not using fertilizers on their lands, primary due to the low of funds. This is the main reason of significant decreasing of N_2O emissions since 1989 (about 2.7 times).
In Table 4.3 are shown the N_2O emissions by total and by sources.

Table 4.3 N_2O emissions in Romania

[Gg]

	1989	**1990**	**1991**	**1992** estimate	**1993** estimate	**1994** estimate
Fossil fuel combustion	16.6	15.0	11.6	13.3	12.9	12.6
Industrial processes	24.4	13.0	6.4	6.8	6.5	5.6
Agriculture	25.3	20.7	6.8	6.8	6.8	6.8
Total	**66.3**	**48.7**	**24.8**	**26.9**	**26.2**	**25.0**

Note: Data for period 1992-1994 were estimated and must be updated according to the IPCC methodology

4.4 Other gases

Table 4.4 shows the NO_x, CO, NMVOC's, SO_2. The CFC, HCFC and CF emissions are not known. The SO2, NO_x and CO emissions were estimated based upon the data on fuel consumption from NCS. It is necessary to note that the sector splits here do not correspond exactly to those in IPCC Methodology.
Power and heat generation is the major source of SO2, NO_x and CO emissions.

For NMVOC emission the most important sources are the solvent and other product use for paint application, degreasing and cleaning of metals, chemical products manufacturing and processing and the other use of solvents.

Table 4.4 Anthropogenic emissions of NO_x, CO, NMVOC and SO_2

[Gg]

	1989	**1990**	**1991**	**1992** estimate	**1993** estimate	**1994** estimate
NO_x						
Fuel combustion:	513.7	502.0	439.8	463.0	467.4	465.8
- stationary sources	299.9	266.1	213.1	239.8	234.4	229.2
- transportation	213.8	235.9	226.7	223.2	233.0	236.6
Industrial processes	31.9	18.1	10.2	10.5	9.5	9.1
Agriculture	8.5	7.9	8.3	8.3	8.3	8.3
Total	**554.1**	**528.0**	**458.3**	**481.8**	**485.2**	**483.2**
CO						
Fuel combustion:	2011.8	2107.8	1687.5	1436	1497	1525
- stationary sources	1703.6	1539.4	1230.3	958.7	941.1	945.8
- transportation	308.2	568.4	457.2	477.3	555.9	579.2
Industrial processes	185.0	127.1	91.9	67.4	68.6	73.8
Agriculture	224.5	205.9	201.3	201.3	201.3	201.3
Total	**2421.3**	**2440.8**	**1980.7**	**1704.7**	**1766.9**	**1800.1**
NMVOC						
Fuel combustion:	92.7	128.0	105.1	96.5	107.8	110.2
Fugitive emissions	126.6	107.7	90.0	66.7	71.9	80.0
Industrial processes	80.8	64.7	46.0	46.0	46.0	46.0
Solvent and other product use	228.9	191.5	159.7	163.2	180.0	177.0
Total	**529.0**	**491.9**	**400.8**	**372.4**	**405.7**	**413.2**
SO_2						
Fuel combustion:	1516.0	1311.0	1041.0	1181.0	1181.0	1204.0

Note: Data for period 1992-1994 were estimated and must be updated according to the IPCC Methodology

4.5 Aggregated emissions

The emissions aggregated by means of GWP values for 100 years span and expressed as CO_2 equivalent are presented in Table 4.5. The CO_2 emissions contribute with 71-74% in the total emissions, CH_4 emissions by 21.1-21.11% and N_2O emissions by 7.7-4.72%.

4.6 Conclusions

The main gaps of the inventory presented are the emission from the industrial waste water and industrial solid waste. Due to the existing uncertainties it has been preferred to consider these emission as a gap in knowledge, further researches being necessary.

Table 4.5 Aggregated emissions of CO_2, CH_4 and N_2O in Romania

[Gg]

	1989	**1990**	**1991**	**1992** estimate	**1993** estimate	**1994** estimate
CO_2						
Fuel combustion:	185575	165382	130465	125498	122644	121327
- stationary sources	177682	155965	122944	118664	115146	113583
- transportation	7893	9417	7521	6834	7498	7744
Fugitive emissions	-	-	-	-	-	-
Industrial processes	9244	7120	5188	4655	4435	4263
Forestry systems	-2925	-5646	-6590	-6590	-6590	-6590
Wastes	7	7	7	7	7	7
Total emissions	**194826**	**172509**	**135660**	**130160**	**127086**	**125597**
Net emissions	**191901**	**166863**	**129070**	**123570**	**120496**	**119007**
CH_4 [Gg CO_2 equivalent]						
Fuel combustion:	1213	1097	830	583	585	580
Fugitive emissions	34699	27629	23897	22461	21986	20756
Industrial processes	387	272	191	115	115	122
Agriculture	15552	13727	11968	10566	9055	8753
Wastes	5894	5627	5600	5554	5566	5578
Total emissions	**57745**	**48415**	**42486**	**39279**	**37307**	**35789**
N_2O [Gg CO_2 equivalent]						
Fuel combustion:	5312	4800	3712	4256	4128	4032
Industrial processes	7808	4160	2048	2176	2080	1792
Agriculture	8096	6624	2176	2176	2176	2176
Total emissions	**21216**	**15584**	**7936**	**8608**	**8384**	**8000**
Aggregated [Gg CO_2 equivalent]						
Fuel combustion:	192100	171279	135007	130337	127357	125939
Fugitive emissions	34699	27692	23897	22461	21986	20756
Industrial processes	17439	11552	7427	6946	6630	6177
Agriculture	23648	20351	14144	12742	11231	10929
Wastes	5901	5634	5607	5561	5573	5585
Total emissions	**273787**	**236508**	**186082**	**178047**	**172777**	**169386**
Forestry systems	-2925	-5646	-6590	-6590	-6590	-6590
Net emissions	**270862**	**230862**	**179492**	**171457**	**166187**	**162796**

Note: Data for period 1992-1994 were estimated and must be updated according to the IPCC Methodology

5 Policy and Measures to Mitigate Greenhouse Gas Emissions

A greenhouse gases (GHG) mitigation strategy has not yet been adopted in Romania.
This chapter outlines measures accepted in Romania after year 1990 with important impact on the GHG mitigation and sinks.

5.1.Policies

The environmental protection is an integral part of Romania's governing program. In its meeting of the 22'nd of December 1995, the Government of Romania approved the Environment Protection Strategy and the Programme of Action.

Environmental Protection Strategy

From Environmental Protection Strategy specific principles will be integrated into sectorial strategies elaborated by each economic area. The main targets for short and medium term are:

Short term targets until 2000

Targets with an immediate result are being considered, with relatively low expenses and having important short term positive results (until 2000). These refer to:

- the cutting of the polluting agents emission by at least 10%, at low costs, by the existing gas treatment installations and used waters treatment plants functioning at designed parameters;
- the cutting of the sulfur dioxide and nitrogen emissions by some 20% and of the chlorine and H_2Cl ones by some 40% until 2000 as compared to 1989)
- the re-utilization of the waste exhausted with the gas and discharged as used waters in proportion of 10-15% until 2000 with efforts meant to carry on this activity in the future;
- the increase of the solid waste turning into account by some 20%, until 2000;
- the soil reconditioning were there are deposits of solid residues with an exhausted capacity;
- the controlled storing of the household solid wastes and the turning into account of part of them, to an extent of 20%;
- the application of irrigation on 1.5 million hectares until 2000, and the planting of forest belts on some 50 thousand hectares;
- soil erosion control works on the approximately 1.5 million hectares, that have already been managed;
- the growth of the forest fund by about 200 thousand hectares until 2000 and the improvement of its structure.

Medium term targets until 2010

Targets the results of which are seen in a more remote prospect are to be considered, for the accomplishment of which certain actions should be started as early as the first stage (until 2005). The medium term targets (until 2005 or 2010, for some of them) are:

- the diminution of the air pollution by 20-30% for the SO_2, CO, NH_3, CH_4, under such circumstances as an industrial output in 2000 amounting to 80% out of the 1989 level and to 100% in 2005;
- the emissions of substances which destroy the ozon layer will be cut to zero in 2005 (2008, in the case of certain substances) which will bring them in line with the provisions of the elaborated national study and other studies made in various countries within the United Nations Programme for the Environment Protection. These actions are conditioned by the possibility to finance certain initiatives from the Environment Global Fund;
- the sylvicultural fund will improve in the areas where it was affected and will develop both intensively and extensively, so as to cover 30% of this country's area in 2005 (2010), including the forest belts areas;
- an ecological recovery of about 70-78% of the Danube Delta Biosphere Reservation.

Energy sector

A national strategy of the energy sector was not yet approved. With the technical support of PHARE and World Bank started studies to define the sectorial strategies for lignite, hard coal, natural gas, crude oil, new energy sources, wastes management, electricity and heat sectors and to develop a fuel policy for Romania. Based on the results of these studies, the national energy strategy should contents the following programs and measures:

Primary energy resources

- The development of the speciality international connections.
- The diversification of import resources for the increase of the safety in supplying oil and natural gas.
- The increase of transport, producing and extraction activity capacities for oil and natural gas through:

- the intensification of geological researches;
- the modernization of existing operating and extraction technologies;
- the promotion and stimulation of operating in common with firms of financial, economic and technical potential;
- the reconsideration on economic efficiency criteria of transport systems.

- The increase of coal extraction, processing and transport activity.
- The performance of a long-term policy of coal sectors.
- The reconsideration based on economic efficiency criteria of the uranium extraction, processing and operating capacities.
- The utilization based on economic efficiency criteria of the hydropower potential.
- Researches promotion of demo equipment that use new energy sources.
- The increase of new energy sources installation efficiency by identifying the available location, endowing with performant and reliable equipment.

Heat and electricity generation

- The planning of producing sector within the larger frame of integrated planning of the resources under the actual specific conditions of producing capacity i.e. excess of production capacity and its low availability.
- The reconsideration of power plants operation as to cover of the load curve economically based on minimal costs performing at the level of economy.
- The rehabilitation of some existing equipment in power plants (according to economic analysis).
- Stopping from operation and retirement of some unperformant equipment or which operate uneconomically.
- Commissioning at nuclear power plant Cernavoda, depending of identification of financial source.
- The increase of activity efficiency of thermal and electric power producing in the plants belonging to State Electricity Company (CONEL).
- The development of some predictive and preventive maintenance work programs which should lead to the increase of power equipment availability.

Heat and electric power distribution and transport

- The increase of operating efficiency by reconsidering the network operation based on economic efficiency criteria.

The rehabilitation of existing electrical networks (works at about 6700 km transport lines, 51000 km distribution lines, over 19000 substations).

- The interconnection of Romanian electricity network with the Western European Systems (UCPTE).
- The finalizing of rural electrification.
- Modernization of the measuring, monitoring and control systems for electrical and heating system networks.
- The development of some predictive and preventive maintenance work programs which should lead to the increase of power equipment availability.

Energy consumption

- The increase of energy efficiency at all consumers categories by reconsideration, on economical efficiency criteria, of the way of energy or fuels utilization in industry, agriculture, services, domestic consumption.
- Increase of insulation for commercial and industrial buildings and houses.
- The rehabilitation of existing heat networks.
- The reconsideration based on economic efficiency criteria of presently practiced solutions for heating and hot water supplying of houses and commercial spaces.
- The redirectioning of industry for:

-producing of building materials with high thermal resistance;
-performing of domestic devices and heating equipment with -performance of international standards.

- The introducing of some modern and high performance systems for energy consumption management, controlling of the industrial processes which are energy and fuel consumers.

- The reconsideration and adjusting of power performance standards for equipment, installations etc. in order to be lined up with the standards of the European Union.
- The creation of consulting services which should offer proper solutions of fuels and energy consumption.
- The development of some financial incentive mechanism for energy efficiency increasing and energy conservation actions, as advantageous loans to reduce energy losses at consumers, equipment manufacturers and suppliers involved in such programs.
- The development of some energy education programs of consumers which should show and promote efficiency consumption ways and technologies.
- The creation of some consulting services which should offer to consumers the performance of energy analysis, solutions for energy efficiency increasing, choosing of proper tariff options.

Environment protection

- For atmosphere protection:

- reducing of SO_2 and NO_2 emissions by using of low sulfur content fuels (1 - 2 %) and by controlling the firing process;
- reducing of particles emissions by improving of restraining degree of electrostatic filters;
- endowing of power installations with polluting emissions monitoring equipment, desulphuring equipment.

- For waters protection:

- the rehabilitation of waste water purging and treatment equipment;

- For soil protection

- avoiding of polluting substances loss and of infiltration in soil and subsoil;
- reducing of coal dumps and their recultivation;

- In case of electrical networks resystematization, introducing of more compact equipment, which should frame within environment landscape.
- The evaluation and taking into consideration, within the energy solution analysis of their impact cost on environment.
- The promotion and stimulation of energy producing from new energy sources.

Energy costs

- The reconsideration of energy tariff policy, keeping into account the transparency of practiced tariffs and economical efficiency ensurance, correctness against the consumers and financial viability of energy system.
- The subsidy elimination (still practiced for coal and for heat and electricity consumption of the population) these being in contradiction with energy rational utilization principle and long-term economical development concept.
- The taking into consideration of all cost categories at tariffs' calculation, including external costs (such as impact costs on environment).
- The introducing of some tariff options which should reflect the general tendency of power conservation.

- The endowing of consumers with modern systems of energy measuring, of consumption management which must allow the using of stimulate tariff options which should ensure operating efficiency of the energy system and the reducing of consumers energy expenses.

Institutional frame

- Energy sector represents a strategical economic sector in which the government should be strongly involved.
- The main purposes of the government actions within energy sector are the following:

- the performance of a safety energy supply at low price within the national economy;
- interval primary resources adequate using for maximizing the national advantage;
- the ensurance of environment protection, social and local protection within the energy system development and operating;
-the adequate correlation between energy policy, external policy and national defense policy;
- the supervising of monopoly characteristics of some of the energy system industries;
- using as efficient as passible of all energy carriers and forms.

- The reorganization, modernization and ensurance of energy system efficiency should successively cross the following stages:

- the introducing of a legislative and institutional frame specific to market economy in parallel with promotion of a high performance management system;
- challenging promotion in energy industry;
- the privatization of energy system.

5.2. Legislative framework

After 1989 special efforts were made to create in Romania the adequate regulation framework for environmental protection.

On the December 30th. 1995, the Law on Environmental (Law 137) was voted and promulgated by the Parliament and on the September 25th. 1996 the Law of Water. Both render compulsory the adaptation of effective environment protection measures.

- The Environment Protection Law no.137/1995 through which are settled norms correlated with EU, for each branches of the economy, including energy sector: within this frame, there are compulsory the environment impact studies for the performance of the new power objectives and also maximum conditions of admissible noxes that results during the operation of different power equipment.

- Waters Law follows the creation of the juridical frame for identifying, turning to account, conservation and protection of the water resources in condition of keeping of the ecological balance. As compare to Law no.8/1974, completed with Law no.5/1989, in the present Law there were included and approved new elements such as:

-the settlement of public property of national interest related waters, taking into account the social characters of water management works;
-the performance of the info system hydrometeorological phenomena and water resources in order to be performed some optimized decisions;
-the introduction of economical mechanism for water resources rational use and protection of waters quality in all activity sectors.

Other regulation adopted are:

- Order 462/1.09.1993 amended by act no.12797/1994, Atmospheric protection. Technical conditions. Methodology for the determination of the pollutant emitted by stationary sources.

- Order 756/3.11.1997, regulation concerning the environmental pollution assessment.

In the prospective of the considerable development of the legislation the Environmental Law itself includes it specific laws, while within the framework of the legislative alignment of the EU environment institutions are more then 200 such instructions which are to be adopted by the national legislation.

Other regulation and measures with the effects on the GHG emissions reductions are:

Energy efficiency promotion

According to Governmental Decision (G.D.) no.794/1993 and G.D no.451/1991, the Romanian Agency for Energy Conservation, within the Ministry of Trade and Industry (established in 1991) is the responsible institution for the promotion of energy efficiency policy within all sectors of national economy.

- Starting from 1994, according to Law no.136/1994, was established the Special Fund for the Energy System Development on purpose of financing, together with the own resources of industrial companies of some investments objectives within the sector of producing, transport, distribution and using of thermal and electrical energy. Also, from this fund are provided to be financed works for power conservation .
- There was performed a Draft Bill for rational utilization of energy resources, in stage of approval at Ministry of Trade and Industry which, in present, includes also provisions regarding the promotion of energy regenerable sources (for which there is the alternative of performing of a distinct law). The Draft Bill also settles the management activities of energy use.

Regarding the harmonization of Romanian legislation with EU one, in 1993 a National Programs of introducing of energy labeling system and of minimum admissible energy efficiency standardization at power receivers, was initialed by Ministry of Industry in cooperation with Technology and Research Ministry of Standardization Romanian Institute.

Up to present, there were performed six analysis studies, of some industrial and domestic equipment performances, and also the standard for refrigerating devices (S.R.13339/1996) harmonized with E.U. There was adopted G.D. regarding energy labeling at refrigerators, freezers, and refrigerating combines, harmonized with European Community Council Direction no.750/1992 and Committee Direction 2/1994. For 1997-1998, the programme provides the performing of standards and norms related the following types of devices: wash machines, cook machines, radio and TV set, small boilers for hot water, vacuum cleaners, lighting sets, asynchronous motors with normal power under 50kW.

Crude oil

- Regarding the subsector of crude oil products, it can be mentioned that there were performed European norms type EN-228 (motor oil leadless gasoline) Romanian Standard STR-13386-92, but there are not finalized get norms type EN-589 (Diesel motor oil).

It is considered that equivalents provides of these norms, can be settled to come in force in first of January 1998.
There was performed a programme for ensure the quality of existing motor oils at E.U standards, program that should be fulfilled by the recent established Romanian Oil Company.

Heat and electricity

- It is in stage of approval the project of heat and electricity. Law whose main purposes are the following:

-the performing of feeding with heat and electricity in quantity and quality which should contribute to a long-term economic development;
-the ensuring of environment protection;
-the ensuring of the possibility of participation of private sector and foreign investors;
-the stimulation of challenge in activity, settlement of monopoly characters elements;
-the efficient power use, including through power use management activities;
-the ensuring of heat and electricity consumers.

There are under performance more detailed settlements that in order to be applied the Law provides.

- The Competition Law no.21/1996, contains several provisions including the ones against some monopoly incorrect practices, available for the energy sector, also.

- The Ordinance Law no.19/1992 settles the standardization activity in Romania.

Regarding the ratification of Energy Chart Agreement, it is to be mentioned the fact that there was transmitted to the Parliament the Draft Bill for the ratification of Chart and up to now this was discussed within the Specialists Committee of the both Chambers and agreed by the Senate.
Energy Efficiency Protocol

The Energy European Chart was agreed through the Chart Conference Protocol concluded in Haga on the 17th. of December 1991. The Energy Chart Agreement was discussed for approval between 17.12.1994 and 16.06.1995.

The Constructions and the Environment

The Energy Chart Protocol, regarding Energy Efficiency and tasks related the environment, ensure that all the specific activities, belonging to energy sectors, from production to consumption, will be run so that to reduce, as much as possible, the negative effects on the environment.

Measures regarding the ensurance of the connection between the building activity and environment.

For the ensurance of the harmony between the building inside climate and the environment there were performed some norms available both on national and international field.

There were created two important categories of norms, that contains restrictions, for the performance of an agreement of concepts of EEC member states that is: Community norms and guidelines with possibilities to be extended abroad, in the participant countries.

The main task, for the performance of the norms and guidelines, regarding the harmonization of the connection between the construction and the environment pollution, as a consequence of thermal power producing, and the nature of the materials used for constructions and installations. These norms and settlements, although already performed, are in a continuous improvement keeping into account as main measures: the power save, reduction of the pollution under the admissible norms, increasing of fire safety, operating security, etc.

Transports

These measures are imposed, in Romania, by the Law 10/1995 regarding construction quality.

Among the useful measures related to pollution limitation the most importance are the followings:

- the use, as much as possible, of public transport and the promotion of electric public transport;
- settlement of commercial supplying transport as to avoid high traffic hours and peak hours;
- exigency regarding urban traffic authorization for each vehicle depending on its emission level and periodical control;
- the settlement, as correct as possible, of urban traffic for the ensurance of fluency and minimum stationary duration without overthrows;
- the obligation to limit “no-load” operation of motors on the urban roads and on the building sites especially of Diesel motors;
- the monitoring of the nitrogen oxides and volatile organ matters concentration in critical points especially at crossings and the signaling of admissible limits exceeding correlated with measures meant to restrain circulation during the critical moments as well as population warning;
- the creation of procedures for population warning in case of critical limits exceeding.

5.3 Climate changes strategy and policy

Romanian Government target

The Romanian Government's target is to stabilize carbon dioxide emissions after 2000 at the year 1989 level.
A national policy to climate changes in Romania focused on the climate change issues and reduction of GHG has not been yet finalized.
Many ongoing activities, such as economy sectors restructuring and modernization, increasing of the energy efficiency, energy conservation and decrease of negative environmental impacts of energy system and economical sectors have an effect mitigation of the GHG.
The First National Communication on Climate Changes determined a survey of relevant activities. It was approved by the Government and became an effective instrument for the implementation of the Framework Convention on Climate Change until the national policy relevant to GHG will be adopted.
The evaluation of mitigation solutions is based on the results of "Country Study on the Climate Change".

5.3.1 Carbon Dioxide, CO_2

5.3.1.1 Energy and transformation processes

Electricity and heat generation

A large fossil fuels consumer characterizes the system of public electricity generation. The essential issue with important impacts on GHG emissions consists in the efficiency of using these fuels. In the year 1994 the gross average efficiency to produce electricity was 33%.

In order to increase both technical and economic efficiency and secondary to reduce the GHG emissions it is envisaged to carry out the rehabilitation works for units belonging both to condensation plants and to cogeneration plants.
To complete the electricity demand we assumed the following options:

- ongoing of the hydroelectric potential arrangements;
- ongoing of the units 2 and 3 of Cernavoda NPP achievement;
- achievement of new standard power plants running on imported natural gas and hard coal.

The development of industrial and urban cogeneration plants it was envisaged to cover the electric and heat demand. It was evaluated a potential at about 450 MW in cogeneration plants equipped with gas turbine with heat recover and combined gas turbine cycle and cogeneration.

Heat distribution and transport sector

Energy saving through efficient heat distribution and transport to consumer might lead to the significant increase of the global efficiency of heat centralized supply systems and implicitly to the adequate reduction of fuel total consumption and emissions.
Among the possible solutions for this purpose accomplishment, the following ones were considered:

- hot water transport networks modernization and rehabilitation;
- thermal point modernization;

- secondary thermal networks modernization and rehabilitation;
- rehabilitation and modernization of the transport thermal networks, thermal point and secondary thermal networks;
- heat supply control, metering and dispatching.

It was evaluated the reduction of losses by modernization of transport, distribution, thermal point and heat supply control, metering and dispatching by 5% in 2005 and by 20% in 2010.

Household and services

For the reduction of the heat and fuel consumption of residential sector it was considered the effect of following solutions:

- the improvement of thermal insulation for all new flats to be supplied with heat from centralized sources leading to the reduction of demand by 11.1 GJ / year and dwelling ;
- increasing of the lightness by windows tripling for the existing building saving 3.35 GJ / year and flat;
- increasing of the thermal insulation degree for the existing building by using a 4.8 cm thickness polystyrene layer, saving 8.36 GJ / year and flat.

Industry

The industry is one of the sector with the highest potential for energy saving and conservation. The energy consumption reduction strategies have two components:

- the performance of structural changes having in view the reduction of energy-intensive industries share (chemistry, cast iron, steel, cement, aluminum);
- the modernization of the existing technologies;
- the improvement of the energy management.

It has to be mentioned that the Romanian industry is under a complex process of adjustment and restructuring as to meet the requirements of the market economy. Due to the fact that is not available a national development strategy of industry on long, mid and short term, for evaluation of the industry potential for GHG reduction by modernization and restructuring there were worked-out three evolution scenarios, namely:

- a reference scenario considering that the present share of the industrial branches within the added value will be constant up to 2010 (variant I of GDP structure). Considering the removal of both recent difficult operation conditions of installations and disturbance factors as well as the improvement of the management activity and same modernization works will lead to the performance of the design indices of each technology. On the basis of these elements it was evaluated a reduction of energy intensity in industry from 3.303 kgce / $ in 1993 to 2.97 kgce / $ in 2010 that means an yearly average rate of 0.6%.
- Alternative I considering the modification of the share of industrial branches within the added value by reducing mainly the share of chemistry and metallurgy and increase of light and food industry share (variant II of GDP structure). It was considered that the structural adjustment process includes also modernization and rehabilitation of technologies. The average energy intensity will decrease during the period 1993-2010 from 3.303 kgce / $ to 2.69 kgce / $ that means an yearly average reduction rate of 1.2%.

Agriculture

- Alternative II based on the same hypotheses as Alternative I except it considered a higher level of energy conservation for each industrial branch. The energy intensity of industry will decrease in 2010 to 2.453 kgce / $ with an average yearly rate of 1.7%.

The transition period including its difficulties is expected to be ending by the year 2000 when the new private property forms as well as their administrating method are consolidated.
The modernization of the Romanian agriculture will conduct to:

- reduction of the motor fuels demand per hectare by agricultural machines as the effect of land concentration and the increase of the efficiency of the agricultural machines of 11% in 2005 and 15% in 2010;
- reduction of the energy demand by modernizing the livestock farms reaching in 2010 up to 8% for electricity and heat and 10% for fuel.

5.3.1.2 Transportation

The Romanian transportation sector contributes with about 7% of the total CO_2 emission from the energy consuming sectors.
The policy for reduction in CO_2 emissions in transportation sector is based on:

- increasing of road vehicle performances;
- development of public urban and interurban transport.

The restructuring of the industry will determine the reduction of the industry requirement for freight transportation.

For energy sector to quantify the potential of reduction measures it was used an integrated approach. The reduction measures were included in different scenarios such as:

Reference scenario - without structural change of the economy, with low reduction of the energy intensity in all sectors, no implementation of new measures;

Alternative scenarios - with different degree of structural changes of the economy and implementation of the energy efficiency measures at the level of the energy supply side, energy transformation sectors, development of the electricity generation capacities and cogeneration, heat transportation networks, increase of the building insulation.

The potential of GHG reduction measures was evaluated by differences between alternative scenario and reference scenario, and the results of this analysis is presented in Table 5.1.

Forestry

5.3.1.3 Land use change and forestry

The storage of carbon in the forest ecosystems of Romania was estimated by the balance of carbon in the part of forest above ground trees, plant cover and including the estimate of wood cutting. The researches carried out by the Romanian specialists yielded the following average value concerning carbon requestration in forests, namely:

- in the leafage: 0.9 tC / year / ha
- in the tree wood: 1.27 tC / year / ha
- shrubs and forest grass plants: 0.11 tC / year / ha

The measures focused on the GHG mitigation in this sector can be summarised as follows:

- Extending of the forest areas by plantation of heavily degraded agricultural areas, the setting up of "forestry curtains" to protect fields of plantations in areas lacking forests and the extention of rural and urban "green" areas.
- Increasing of carbon fixing by means of special measures using the most productive tree species and forms able to accumulate a larger amount of wood per time unit, the increase of the wood reserve inside forests by maintaining the cutting below the annual growth rate and
- the achievement of the entire volume of wood protection with a view to increase wood accumulation.

5.3.2 Emissions of CH_4

In Romania one of the most important emission source is the fugitive CH_4 . The development of fugitive CH_4 emissions level will be determined by the demand for natural gas drilling, transportation and distribution, the demand for crude oil processing and drilling and the demand for domestic lignite and hard coal production. In the fossil fuel combustion case the CH_4 emission decline will be due to the implementation of some measures as to the CO_2 emission reduction.
Other important sources are agriculture, urban waste and urban waste waters.

5.3.2.1 Solid urban wastes and urban waste waters

It is foreseen to develop hygienized depositing stations with a beneficial environmental impact and to extend the town water treatment in order to reduce GHG emissions that resulted from town wastes.

The methan emissions reduction in the present day depositing stations can be performed by diminishing the quantities of the deposited organic wastes. Waste waters will be treated aerobically in oxidation tanks.

5.3.2.2 Agriculture - non-energy sector

To reduce the methan emission resulting in the digestion process, the impact of the following techniques will be considered:
- nourishing quality improvement that may lead to a 5% increase of feeding due to the growth of proteins percentage. It is appraised that this improved technology of animal breeding may bring about the methan emission decrease with 10% up to the year 2005 and up to 15% in the year 2010;
- meat additional weight raising per 1 kg fodder as well as milk additional amount per 1 kg fodder are meant to increase animal performances. It is estimated a 5% reduction of the methan in the year 2010.

5.3.3 Nitrous Oxide Emissions

Agriculture is only one sector where the effective measures for N_2O emissions mitigation can be applied.

In 1989 the consumption of chemical fertilizers has been reached at 160kg/ha and after that time a fast decline in consumption has been observed (in 1994 there were used only 41kg/ha). The decline in consumption of fertilizers is not due to changes in the behaviour by formers but rather due to the economic recession. Increase in consumption may be expected in the future.

The improved technology using nitrogene fertilizers can increase the nutritive elements usage rate and diminish losses by leaching. It is envisaged, in this respect, to the increase the chemical fertilizers diversity, apply them in agreement with the nitrogene demand of the culture, raise the nutritive elements usage rate by applying them under stages, extend foliage fertilizing, improve the range of agricultural machines for evenly distributing chemical fertilizers and balance the ratio between different nutritive elements (nitrogene, phosphorus, potassium, micro-elements, etc.).

Different methods to distribute chemical fertilizers on agricultural lands will be studied in compliance with the extent of land plots to be fertilized. As long as agricultural areas are concentrated and farms are economically reinforced one may take into account the use of liquid fertilizers. Therefore, as an option in the future that may be considered in order to handle such liquid fertilizers would be the unique existing technology making use of sealed metallic tanks.

Another technology gaining ground at present on a would-wide scale is the fertirrigation, meaning the introduction of chemical fertilizer through dosing devices in the irrigating water of the terminal columns (arials).

5.3.4 Other gases

The greenhouse effect is indirectly influenced by non-methan volatile organic compounds (NMVOC), NO_x , CO (ozone precusors) and SO_2 (sulphate precusors). Emissions of these gases will be gradually reduced consistent with environmental legislation and international agreements.

The Geneva Convention on the long distance air transfrontier pollution

Romania adhered to the Geneva Convention on the long distance air transfrontier pollution on 25 January 1991, Law No 8/1991 ratified it, so that the following tasks are incumbent upon the country by virtue of the document:

- the emissions calculation, in relation with the basic year: 1980 for the SO_2, 1987 for the NO_x , 1988 for the VOC (volatile organic compounds).

As part signatory of this Convention, Romania will apply the specific measures as regards re-technologization, the operation at certain capacity and any other resulting in: the curbing down of the SO_2 by 30% until 1995, the maintenance of the NO_x consistent on the level of the basic year (1987) and the curbing down of the VOC by 30% until 1999.

For non-energy sectors the evaluation of the effect of measures it was estimated for the following scenarios:

Reference scenario - without structural change of the economy and no implementation of new measures

Low scenario - with low economy sector restructuring and modernization (Reduction scenario I)

High scenario - with high economy sector restructuring and modernization (Reduction scenario II)

6 Projections and Assessment of Measures Effects

The emission projections are based on the energy and non-energy sector development carried out in the framework of the US Country Study.
The assumptions for the analysis were in accordance with the economy situation in 1996 and the Government strategy for the implementation of the reform.

The new Government elected in October 1996 has as main objective the deeply reform in the Romania economy which will be reflected in the increase of the energy efficiency and energy conservation, in the restructuring of the energy sector to implement the competition, a higher increase of the activities to reduce the environmental impacts, etc, on a higher manner against the prognoses performed up to 1997.

After defining, the priorities in the economy sector restructuring it is necessary to update the projections of the GHG and the effects of proposed measures to observe the commitments under the Climate Convention.

6.1 Projection of anthropogenic CO_2 emission

6.1.1 Projection of energy related CO_2 emission

Assessment of measures

The assessment of the development up to 2010, is based on the following main considerations:

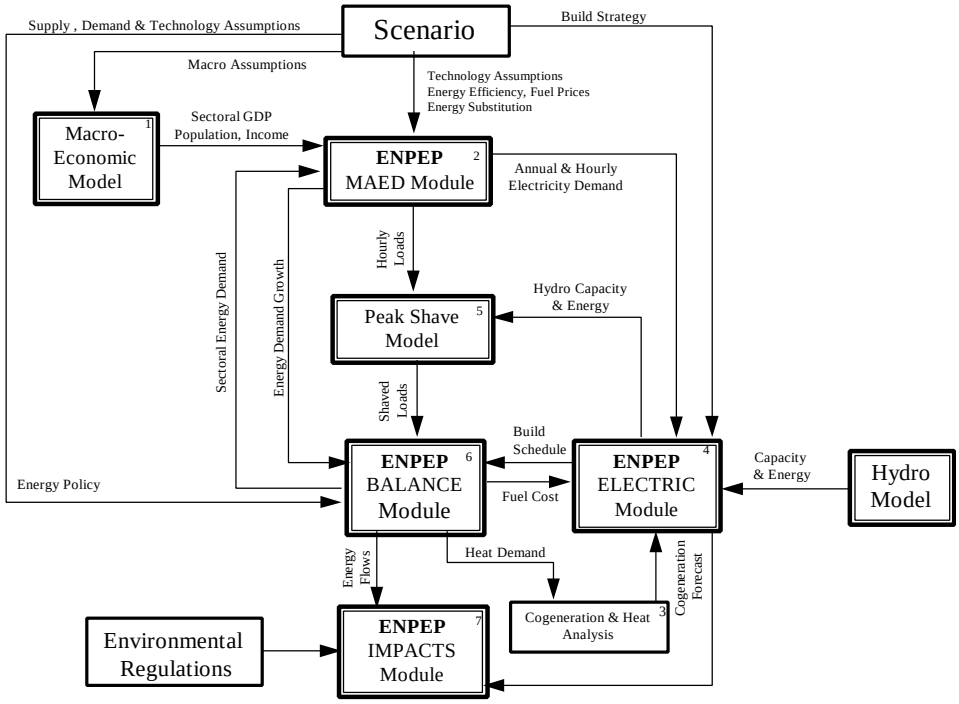
- structural change and modernization of the economy sector;
- different options for energy import supply and development of the electricity generation capacity;
- development of the cogeneration;
- losses reduction in heat networks;
- increase of building insolations;
- penetration of the performance vehicles for freight and passengers transportations.

Computer models

The calculation method used for the projections is described in the report "Country Study on the Climate Change. Element 3: Mitigation Options"

The projections are based on calculations carried out using ENPEP, as illustrated in Figure 6.1.

Figure 6.1 Integrated Modeling Framework for the Analysis of Romania's Energy Supply and Demand System



The main models as MAED (Model for Analyses of Energy Demand), WASP (Wienner Automatic Simulation Program), BALANCE, IMPACTS Models belongs to ENPEP (Energy and Power Evaluation Programs) developed by Argonne National Laboratory of U.S. Department of Energy (DOE) and distributed by International Atomic Energy Agency (IAEA) to Romania as member state. In the framework of the U.S. Country Studies Programme, Romania obtained from Argonne National Laboratory training and guidance to assess GHG emissions from energy sector and to develop a national strategy.

As mention in Chapter 5.3.1.2, the projections of GHG and assessment of reduction effects were performed within the 25 alternative scenarios against the reference scenario.
For reference scenario, the key assumptions used have been summarized in Table 6.1.

Table 6.1. Key assumption used for reference scenario

Parameter	Unit	1995	2000	2005	2010
Fuel and energy carrier prices:					
domestic lignite	$1993/GJ	1.76	1.97	2.02	2.11
domestic hard coal	$1993/GJ	1.86	2.13	2.24	2.32
domestic crude oil	$1993/GJ	2.17	2.39	2.45	2.48
domestic natural gas	$1993/GJ	1.78	1.97	1.93	1.9
imported crude oil	$1993/bbl	16.26	14.06	14.06	14.06
imported natural gas	$1993/bbl	15.43	13.4	12.87	12.87
imported hard coal	$1993/bbl	11.45	10.34	10.34	10.34
GDP	10^3 bill.lei	21.96	28	36.59	47.1
	bill.US.$1993*	74.91	95.52	124.9	160.7
	bill.US.$1993**	28.95	36.79	48.06	62.05
GDP growth rate	%		5.0	5.5	5.2
Population	mill.	22.76	22.57	22.35	21.97
Population growth rate			-0.167	-0.196	-0.342
GDP structure	%	100	100	100	100
-industry	%	32.1	32.1	32.1	32.1
-agriculture & forestry	%	20.9	20.9	20.9	20.9
-construction	%	6.6	6.6	6.6	6.6
-transportation	%	9.7	9.7	9.7	9.7
-services	%	30.4	30.4	30.4	30.4

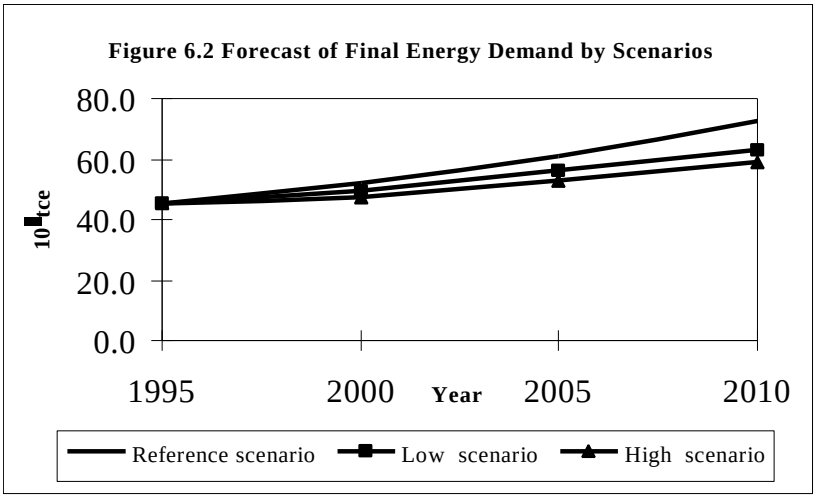
*Note: *) GDP expressed in US $ using the purchase power of lei*
***) GDP expressed in US $ using the exchange rate leu/dollar of year 1993*

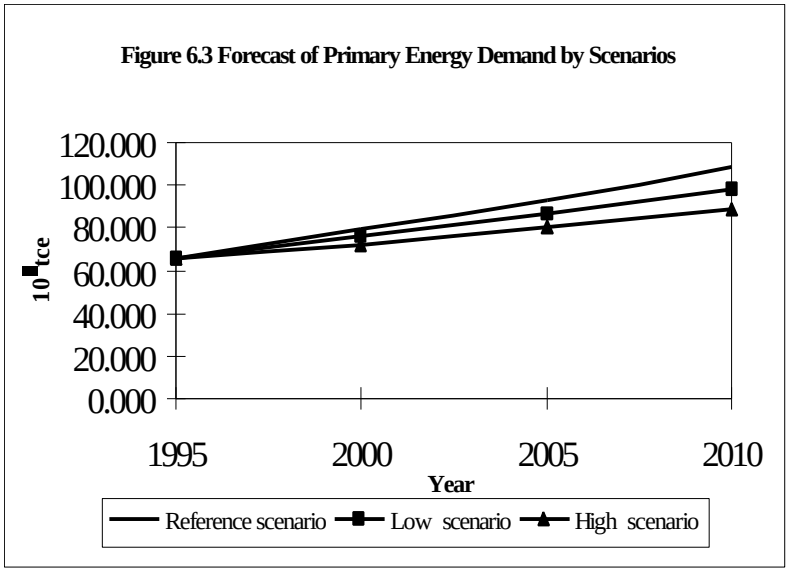
All the reductions measures were integrated for energy sector into 25 alternative scenarios and for non-energy sector in two alternative scenarios.
In Appendix 2 are presented the assumptions for reference scenario and for alternatives.

The results will be provided for reference scenario and for two alternative scenarios : low scenario with low restructuring and modernization of the industry and high scenario with high implementation of all mitigation measures.

Figures 6.2 - 6.4, and Tables 6.2 - 6.4 provide the results of modeling obtained in selected scenarios.

Figure 6.2 Forecast of Final Energy Demand by Scenarios





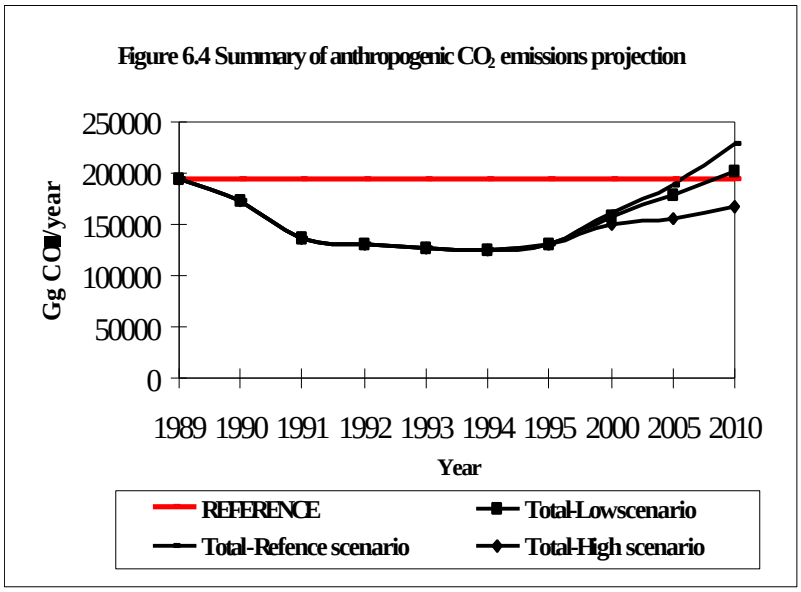


Table 6.2 Summary of anthropogenic CO_2 emissions projection Reference Scenario

[$GgCO_2$/Year]

	1995	2000	2005	2010
Fuel combustion-Total	126212.0	155637.9	178767.0	216795.2
-Energy	63620.1	77550.0	87716.2	109331.6
-Industry & constr.	34625.2	48087.5	58843.9	71631.4
-Population & serv.	17892.0	17792.6	17614.3	18440.2
-Agriculture	2066.3	3172.2	4131.0	5261.5
-Transportation	8008.4	9045.6	10461.7	12130.5
Industry processes	4604.0	6689.0	9018.0	11730.0
Wastes	7.3	7.9	9.0	10.5
Total	**130823.3**	**162334.8**	**187794.0**	**228535.7**

Table 6.3 Summary of anthropogenic CO_2 emissions projection Low Scenario

[$GgCO_2$/Year]

	1995	2000	2005	2010
Fuel combustion-Total	126212.0	152091.0	170788.0	191533.0
-Energy	63620.1	78028.0	88965.0	101146.0
-Industry & constr.	34625.2	44395.0	50429.0	55757.0
-Population & serv.	17892.0	17762.0	17636.0	18526.0
-Agriculture	2066.3	3026.0	3716.0	4729.0
-Transportation	8008.4	8879.0	10042.0	11375.0
Industry processes	4604.0	6347.0	8129.0	9904.0
Wastes	7.3	7.9	9.0	10.5
Total	**130823.3**	**158445.9**	**178926.0**	**201447.5**

Table 6.4 Summary of anthropogenic CO_2 emissions projection High Scenario

[$GgCO_2$/Year]

	1995	2000	2005	2010
Fuel combustion-Total	126212.0	144707.0	149005.0	159227.0
-Energy	63620.1	69679.0	72084.0	74966.0
-Industry & constr.	34625.2	41131.0	46248.0	51533.0
-Population & serv.	17892.0	18051.0	17939.0	18268.0
-Agriculture	2066.3	3025.0	3707.0	4668.0
-Transportation	8008.4	8752.0	9026.0	9796.0
Industry processes	4604.0	6093.0	7418.0	8418.0
Wastes	7.3	7.9	9.0	10.5
Total	**130823.3**	**150807.0**	**156432.0**	**167655.5**

The CO_2 emission level of the year 1989 will not be exceeded in the year 2000 in the case of all scenarios. At the level of 2010 it is possible to achieve the National Target by restructuring and modernize the economy sector as in low scenario. High implementation of the CO_2 reduction measures (high scenario) will determined a reduction of the CO_2 emission in 2010 with 14% against the reference year.

In all scenarios the biggest emission share at 2010 will has energy sector, followed by industry.
Transportation and agriculture are expected to remain sectors with low CO_2 emissions.

The new Government elected in the fall 1996 has as main objective the deeply reform in the Romanian economy which will be reflected in higher reduction of environmental impact against the prognoses performed.

6.1.2 Non-energy related CO_2 emissions

Emissions of CO_2 in industry processes were calculated in correllation with the industrial production development. In the reference scenario it was considered the same emission factors in inventory and in low and high scenario it was assumed a low and high reduction of the emission factors according with the modernization of the industrial technologies and the increasing of the efficiency in the using of the raw materials. Tables 6.2 - 6.4 presents the CO_2 emissions from industry processes. CO_2 emissions from urban wastes are shown also in Tables 6.2 - 6.4.

6.1.3 Total anthropogenic CO_2 emission projection

Total anthropogenic CO_2 emission, summarizing the energy related emissions and the non-energy related emissions are presented in Tables 6.2 - 6.4.

6.1.4 Projection of CO_2 sinks in forestry and land use

Projections of CO_2 sinks in forestry were determined for reference scenario and for low and high scenarios considering the impact of tree species composition change, afforestation of non-forest lands and especially the increasing of the existing carbon stock.. The results are presented in Table 6.5.

Table 6.5 Amount of sequestered CO_2 by forest

[Gg CO_2/Year]

	1995	**2000**	**2005**	**2010**
Reference scenario	18488	18488	18488	18488
Low scenario	18488	20906	22600	24296
High scenario	18488	23041	25000	26953

6.2 CH_4 Emission projection

6.2.1 Projection of CH_4 emission from fossil fuel combustion

The projection of CH_4 emission from fossil fuel combustion has been determined together with CO_2 emissions within the reference and all alternative scenarios. Tables 6.6 - 6.8 illustrates the values for reference, low and high scenarios.

Table 6.6 CH4 emissions from fossil fuel combustion Reference Scenario

[Gg CH_4/Year]

	1995	2000	2005	2010
Total	**24.2**	**27.1**	**28.2**	**30.3**
-Energy	3.5	4.0	4.5	5.0
-Industry & constr.	3.2	5.3	6.4	7.9
-Population & serv.	16.0	16.0	15.1	14.8
-Agriculture	0.3	0.5	0.6	0.8
-Transportation	1.2	1.3	1.6	1.8

Table 6.7 CH4 emissions from fossil fuel combustion Low Scenario

[Gg CH_4/Year]

	1995	2000	2005	2010
Total	**24.2**	**26.3**	**26.7**	**27.5**
-Energy	3.5	3.9	4.4	4.6
-Industry & constr.	3.2	4.6	5.1	5.6
-Population & serv.	16.0	16.0	15.1	14.8
-Agriculture	0.3	0.5	0.6	0.7
-Transportation	1.2	1.3	1.5	1.7

Table 6.8 CH4 emissions from fossil fuel combustion High Scenario

[Gg CH_4/Year]

	1995	2000	2005	2010
Total	**24.2**	**25.1**	**24.9**	**25.3**
-Energy	3.5	3.6	3.7	3.8
-Industry & constr.	3.2	3.8	4.2	4.6
-Population & serv.	16.0	16.0	15.1	14.8
-Agriculture	0.3	0.5	0.6	0.7
-Transportation	1.2	1.2	1.3	1.4

6.2.2 Fugitive emissions of CH_4 from fuels

The yearly emissions have been calculated for the following activities:

- natural gas drilling, transportation and distribution;
- crude oil drilling and processing;
- underground coal mining.

The most substantial differences between scenarios were obtained from natural gas transportation and distribution, where the CH_4 emissions is determined by the volume of natural gas consumption. Tables 6.9 - 6.11 presents the values projected for reference, low and high scenarios.

Table 6.9. Fugitive emissions of CH4
Reference scenario

[Gg CH_4/Year]

	1995	2000	2005	2010
Total	**850.3**	**934.8**	**1017.9**	**1224.9**
Coal	262.8	299.0	310.0	309.0
Oil	0.7	0.8	0.9	0.9
Natural gas	586.8	635.0	707.0	915.0

Table 6.10. Fugitive emissions of CH4
Low scenario

[Gg CH_4/Year]

	1995	2000	2005	2010
Total	**850.3**	**932.7**	**896.7**	**953.8**
Coal	262.8	286.0	224.0	198.0
Oil	0.7	0.7	0.7	0.8
Natural gas	586.8	646.0	672.0	755.0

Table 6.11. Fugitive emissions of CH_4
High scenario

[Gg CH_4/Year]

	1995	2000	2005	2010
Total	**850.3**	**910.8**	**868.6**	**912.7**
Coal	262.8	286.0	224.0	198.0
Oil	0.7	0.6	0.6	0.7
Natural gas	586.8	624.0	644.0	714.0

6.2.3 Projection of non-energy related CH_4 emission in industry

Emission of CH_4 in industry processes were projected in the same manner as CO_2 (presented in Chapter 6.1.2) and are presented in Table 6.12

Table 6.12. CH4 emission from industry processes

[Gg CH_4/Year]

	1995	2000	2005	2010
Reference scenario	5.2	6.6	8.3	11.1
Low scenario	5.2	6.2	7.4	9.2
High scenario	5.2	6	6.6	8.3

6.2.4 Projection of CH_4 emission in agriculture

The projection of CH4 emission in agriculture it was performed within reference scenario and for alternative scenario with reduction measures.

The results are presented in Table 6.13 for reference and low scenarios and in Table 6.14 for high scenario.

Table 6.13. Projection of CH4 emission in agriculture Reference & Low Scenarios

[Gg CH_4/Year]

	1995	**2000**	**2005**	**2010**
Ruminant digestion	319	335	375.3	417.2
Dejection anaerobic fermentation	61.7	65.1	69.9	76.7
Total	**380.7**	**400.1**	**445.2**	**493.9**

Table 6.14. Projection of CH4 emission in agriculture High Scenario

[Gg CH_4/Year]

	1995	**2000**	**2005**	**2010**
Ruminant digestion	319	335	342.8	333.2
Dejection anaerobic fermentation	61.7	65.1	69.9	76.7
Total	**380.7**	**400.1**	**412.7**	**409.9**

6.2.5 Projection of CH_4 emission from waste management

CH_4 emission from waste management was projected for all scenarios (Table 6.15) taken into consideration the same measures: diminishing the quantities of the deposited organic wastes and the aerobically treated of waste waters in oxidation tanks.

Table 6.15. CH_4 From waste management (All Scenario)

[Gg CH_4/Year]

	1995	**2000**	**2005**	**2010**
Total	228.2	233.3	242	250.9

6.2.6 Summary of CH_4 emission projection

The CH_4 emission projection results are summarized in Tables 6.16 - 6.18.

Table 6.16 Summary of CH_4 emission projection Reference Scenario

[Gg CH_4/Year]

	1995	**2000**	**2005**	**2010**
Fuel combustion	24.2	27.1	28.2	30.3
Fugitive emissions	850.3	934.8	1017.9	1224.9
Industry processes	5.2	6.6	8.3	11.1
Agriculture	380.7	400.1	445.2	493.9
Total	**1260.4**	**1368.6**	**1499.6**	**1760.2**

Table 6.17 Summary of CH_4 emission projection
Low Scenario

[Gg CH_4/Year]

	1995	2000	2005	2010
Fuel combustion	24.2	26.3	26.7	27.5
Fugitive emissions	850.3	932.7	896.7	953.8
Industry processes	5.2	6.2	7.4	9.2
Agriculture	380.7	400.1	445.2	493.9
Total	**1260.4**	**1365.3**	**1376.0**	**1484.4**

Table 6.18 Summary of CH_4 emission projection
High Scenario

[Gg CH_4/Year]

	1995	2000	2005	2010
Fuel combustion	24.2	25.1	24.9	25.3
Fugitive emissions	850.3	910.8	868.6	912.7
Industry processes	5.2	6.0	6.6	8.3
Agriculture	380.7	400.1	412.7	409.9
Total	**1260.4**	**1342.0**	**1312.8**	**1356.2**

6.3 N_2O Emission Projection

6.3.1 Projection of N_2O emission from combustion

The projection of N_2O emission from fossil fuel combustion has been determined together with CO_2 emissions within the reference, and alternative scenarios. Table 6.19 - 6.21 illustrates the values for reference, low and high scenarios.

Table 6.19 N_2O emission from fossil fuel combustion
Reference Scenario

[Gg N_2O/Year]

	1995	2000	2005	2010
Total	**13.0**	**16.2**	**18.7**	**23.2**
Energy	7.9	9.9	11.4	14.6
Industry & construction	2.4	3.4	4.2	5.2
Population & services	2.0	1.9	1.9	2.0
Agriculture	0.4	0.6	0.8	1.0
Transportation	0.3	0.3	0.4	0.4

Table 6.20 N_2O emission from fossil fuel combustion
Low Scenario

[Gg N_2O/Year]

	1995	2000	2005	2010
Total	**13.0**	**16.2**	**18.3**	**20.9**
Energy	7.9	10.0	11.5	13.3
Industry & construction	2.4	3.3	3.8	4.3
Population & services	2.0	1.9	1.9	2.0
Agriculture	0.4	0.6	0.7	0.9
Transportation	0.3	0.3	0.3	0.4

Table 6.21 N_2O emission from fossil fuel combustion
High Scenario

[Gg N_2O/Year]

	1995	2000	2005	2010
Total	**13.0**	**12.5**	**15.5**	**16.3**
Energy	7.9	9.5	9.3	9.4
Industry & construction	2.4	2.8	3.3	3.7
Population & services	2.0	2.0	2.0	1.9
Agriculture	0.4	0.6	0.7	0.9
Transportation	0.3	0.3	0.3	0.3

6.3.2 N_2O emission projection from industrial processes

Emission of N_2O in industry processes were projected in the same manner as CO_2 (presented in Chapter 6.1.2) and are shown in Table 6.22

Table 6.22 N_2O emission from industry processes

[Gg N_2O/Year]

	1995	2000	2005	2010
Reference scenario	6.2	7.6	9.9	12.8
Low scenario	6.2	6.5	6.9	7.9
High scenario	6.2	6.3	6.2	6.7

6.3.3 Projection of N_2O emission in agriculture

Scenarios have been designed similarly to the case of methane emission, as follows:

- reference scenario without reduction measures;
- alternative scenarios with reduction measures.

Results are summarized in Table 6.23.

Table 6.23 N_2O emission from agriculture

[Gg N_2O/Year]

	1995	2000	2005	2010
Reference scenario	2.7	2.8	3.4	3.7
Low & High scenarios	2.7	2.7	3.0	2.8

6.3.4 Summary of N_2O emission projection

The summary of N_2O emission is provided for the all scenarios in Tables 6.24 - 6.26. The highest N_2O emission source is fuel combustion which is expected to contribute with over 60% to the total N_2O emissions

Table 6.24 Summary of N_2O emission
Reference Scenario

[Gg N_2O/Year]

	1995	2000	2005	2010
Fuel combustion	13.0	16.2	18.7	23.2
Industry processes	6.2	7.6	9.9	12.8
Agriculture	2.7	2.7	3.4	3.7
Total	**21.9**	**26.5**	**32.0**	**39.7**

Table 6.25 Summary of N_2O emission
Low Scenario

[Gg N_2O/Year]

	1995	2000	2005	2010
Fuel combustion	13.0	16.2	18.3	20.9
Industry processes	6.2	6.5	6.9	7.9
Agriculture	2.7	2.7	3.0	2.8
Total	**21.9**	**25.4**	**28.2**	**31.6**

Table 6.26 Summary of N_2O emission
High Scenario

[Gg N_2O/Year]

	1995	2000	2005	2010
Fuel combustion	13.0	15.2	15.5	16.3
Industry processes	6.2	6.3	6.2	6.7
Agriculture	2.7	2.7	3.0	2.8
Total	**21.9**	**24.2**	**24.7**	**25.8**

6.4 Aggregated emission projection of greenhouse gases

The aggregated emission projection of GHG (CO_2 equivalent according to GWP) have been presented in Tables 6.27 - 6.29 and illustrated in Figure 6.5 (GWP $_{CO2}$ =1, GWP $_{CH4}$=24.5, GWP $_{N2O}$=320).

It is obvious, from comparing the total GHG emission level in the year 1989 with the period until 2010, that this level will not be exceeded with low implementation of the CO_2 reduction measures. On the other hand, all projections show an increasing trend, when energy related CO_2 emissions play the most significant role. The trend of high scenario is the closest to stabilization.

The GHG emission projections are influenced by GDP growth rate, the acceleration of energy conservation measures and economy sector restructuring. Due to these elements, the projections of GHG emissions for the countries with economy in transition should be updated every year up to the macro and micro stabilization.

Table 6.27 Aggregated emission projection of greenhouse gases Reference Scenario

[Gg CO_2/Year]

	1995	**2000**	**2005**	**2010**
Total CO_2 emissions	130823.3	162334.8	187794.0	228535.7
Total CH_4 emissions	30880	33531	36740	43125
Total N_2O emissions	7008	8480	10240	12704
Aggregated emissions	**168711.3**	**204345.8**	**234774.0**	**284364.7**

Table 6.28 Aggregated emission projection of greenhouse gases Low Scenario

[Gg CO_2/Year]

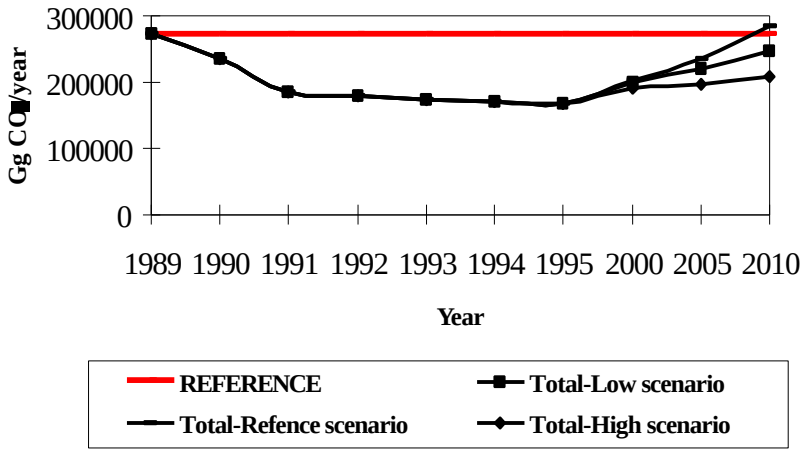
	1995	**2000**	**2005**	**2010**
Total CO_2 emissions	130823.3	158445.9	178926.0	201447.5
Total CH_4 emissions	30880	33445	33712	36368
Total N_2O emissions	7008	8128	9024	10112
Aggregated emissions	**168711.3**	**200019.0**	**221662.0**	**247927.5**

Table 6.29 Aggregated emission projection of greenhouse gases High Scenario

[Gg CO_2/Year]

	1995	**2000**	**2005**	**2010**
Total CO_2 emissions	130823.3	150807.9	156432.0	167655.5
Total CH_4 emissions	30880	32879	32164	33227
Total N_2O emissions	7008	7744	7904	8256
Aggregated emissions	**168711.3**	**191430.9**	**196500.0**	**209138.5**

Figure 6.5 Aggregated emission projection of greenhouse gases



7 Expected Impacts of Climate Changes,Vulnerability Assessment and Adaptation Measures

7.1 Climate change scenarios in Romania

The global warming impact on Romanian climate was evaluated using models for general circulation of the air (GCM), equilibrium and transit models. Within the "Country Study on Climate Change. Element 2", all the GCM outputs were supplied by National Center for Atmospheric Research (NCAR) of US.

As input data were used temporal series of monthly average temperatures of air (from 100 meteorological stations of Romania and 4 hight limits: 0-500m, 500-1000m, 1000-1500m, >1500m) for the period 1961-1990 and monthly average temperatures, precipitation and solar radiation provided by NCAR.
The GCM outputs are monthly average data for temperature, precipitation and solar radiation for the present level of CO_2 (named 1x CO_2) and for twofold of the present level of CO_2 (named 2x CO_2).

To assess the vulnerability and adaptation of agriculture, forests and water resources to the climate change it was tested to the Romanian condition four equilibrium models (CCC, GISS, GFD3, UK89) and one "transient" model (GFD1) provided by NCAR.

There are detail difference between the fields obtain CLIM and from Romanian Observation Stations due too the big density of the observation stations and the CLIM grid point. Inside Romania is only one grid point.
Taken into consideration the modeling of the precipitation and temperature it was selected CCC model to assess vulnerability and to evaluate the adaptation measures.

For scenarios 2x CO_2 all models presents the same results: the increase of the air temperature in the condition of twofold of the CO_2.
The most moderate on temperature changes provides CCC model between 2.8°C in December and 4.9°C in March.

CCC model shows a slightly decreasing of the precipitation during the hot months and an increasing during the cold months. CCC model reflects the best the present Romanian climate and gives the most realist results for 2x CO_2 scenario.

Table 7.1 The differences between air temperature for GCM (1 x CO_2) and CLIM for Romania

Model	I	II	III	IV	V	VI	VII	VII	IX	X	XI	XII
CCC	1.7	1.4	0.3	-0.8	-0.9	0.2	2.0	2.4	0.8	-0.6	-0.8	1.4
GISS	1.4	1.3	1.0	-1.4	-3.8	-2.2	-0.3	0.0	-1.4	-2.5	-2.4	-0.5
GFD3	-8.2	-6.4	-4.3	-6.3	-3.3	-0.9	1.5	3.5	0.6	-4.1	-6.6	-7.7
UK89	-5.1	-7.1	-6.0	-6.3	-5.4	-4.7	-3.0	-2.6	-3.5	-4.5	-5.8	-6.3

Table 7.2 Ratio between precipitation for GCM (1 x CO_2) and CLIM for Romania

Model	I	II	III	IV	V	VI	VII	VII	IX	X	XI	XII
CCC	1.03	1.05	1.23	1.31	1.06	0.8	0.66	0.75	0.79	0.62	0.8	1.1
GISS	1.44	1.61	1.72	1.26	1.49	1.15	0.92	0.87	0.76	0.8	1.04	1.29
GFD3	0.76	.064	1.03	1.54	1.22	0.86	0.49	0.43	0.68	0.93	0.85	0.87
UK89	1.72	1.44	1.76	1.41	1.06	0.98	1.21	0.99	0.88	0.9	1.07	1.31

In the Tables 7.1 and 7.2 are presented differences for air temperature and precipitation between GCM (1 x CO_2) and CLIM for Romania.

Table 7.3 Differences between scenarios 1 x CO_2 and 2 x CO_2, for temperature in Romania

Model	I	II	III	IV	V	VI	VII	VII	IX	X	XI	XII
CCC	4.3	4.1	4.9	3.3	3.2	4.0	4.8	4.2	4.0	3.2	3.4	2.8
GISS	5.0	5.8	3.9	5.4	3.9	2.4	2.5	2.6	4.5	3.3	5.3	4.4
GFD3	2.4	6.1	3.9	4.5	3.8	5.1	5.8	4.1	3.4	3.6	4.3	5.0
UK89	3.2	6.6	6.0	5.4	4.1	6.7	7.1	7.4	6.6	6.0	5.2	4.2

Table 7.4 Differences between scenarios 1 x CO_2 and 2 x CO_2, for precipitation in Romania

Model	I	II	III	IV	V	VI	VII	VII	IX	X	XI	XII
CCC	1.2	1.0	1.1	1.0	0.9	0.9	1.0	0.9	0.8	1.2	1.1	1.2
GISS	1.2	1.1	1.3	1.2	1.2	1.1	1.1	1.2	0.7	1.4	1.3	1.1
GFD3	1.2	1.5	1.1	0.8	1.0	0.6	0.8	1.7	1.0	1.0	1.1	1.2
UK89	0.8	0.8	0.8	0.7	0.8	0.6	0.5	0.5	0.6	0.7	1.1	0.9

Table 7.5 Adjustment statistics for transient GFD1 model

Decade		I	II	III	IV	V	VI	VII	VII	IX	X	XI	XII
Fourth	Temp.	1.1	0.7	3.0	1.0	-0.1	1.4	-0.5	1.7	2.5	1.0	0.5	1.5
	Precip.	1.2	1.1	1.1	1.1	0.8	1.2	1.6	0.7	0.8	0.7	1.0	1.3
Seventh	Temp.	3.4	1.7	2.9	1.1	1.1	2.7	1.5	3.2	3.0	1.8	1.0	2.4
	Precip.	1.4	1.0	1.3	0.8	0.9	1.1	1.4	0.9	0.6	0.8	0.9	1.3
Tenth	Temp.	5.3	3.1	3.9	2.7	2.7	4.7	4.5	5.9	3.7	3.1	2.7	3.8
	Precip.	1.2	1.2	1.1	1.2	0.9	0.9	1.0	0.6	0.8	0.7	1.1	1.2

Tables 7.3 and 7.4 present for air temperature and precipitation the differences between scenarios 1 x CO_2 and 2 x CO_2 and Table 7.5 the average changes of the temperature and precipitation for the fourth, seventh and tenth decade.

7.2 Agricultural plant production in Romania

The analyses regarding the impact of climate changes on the agricultural plant production in Romania followed two goals:

- effects estimation of the probable climate changes on the harvest formation and the main elements of the water balance for the agriculture crops tiled in the south part of Romania – one of the most vulnerable country region to the climate changes;
- efficiency evaluation of different adaptation techniques for agricultural systems management against projected climate changes.

To evaluate the impact of climate changes on the agricultural harvest in the south part of Romania, following simulation models were tested:
ARFCWHEAT2 for winter wheat, CERES for winter wheat, maize and soy, EPIC for all harvest, MAIZE for maize, SOS for all harvest and ACCES for winter wheat and maize.
ARFCWHEAT2, MAIZE and SOS models are implemented in Romania and are used to forecast the wheat and maize national harvest.
CERES and EPIC models were tested only for a few Romanian conditions such as soil, climate and agricultural management.

As a conclusion of the test, CERES model can be used for the soil and climate condition from Romania. CERES model provides the forecast of the characteristic elements for harvest consistent with the outputs of the models in place in Romania.

The EPIC simulation model must be used with caution for wheat harvests forcast, probable it is necessary a review of physiological parameters of the model for Romanian conditions.

The effects of twofold of the CO_2 in air on the agricultural harvest were evaluated for the most important harvest for Romania such as: winter wheat, maize and soy.

Winter wheat harvest

The following conclusions resulted:

- the reduction of the vegetation period with 16-22 days;
- the increase of the production with 0.7t/ha for CCC climatic scenario and with 0.4t/ha for GISS. The increase f the harvest is higher for the regions with lower production in the actual condition due to the water stress;
- the wheat harvest will used more efficient the water in the 2x CO_2 scenario (45-57% against the present situation) due to the increase of the CO_2 uptake;
- economic risk analyses show that are indicated the non-irrigated technologies;
- changing of the sowing date with 30 days before and after the present situation do not produce important modifications of the production**.**

Maize harvest

Maize harvest is very much sensible to the technology used and genetics coefficients of the maize hybrids.

Main conditions for non-irrigated systems are:

- increase of the beans production with 1.4-2.1 t/ha for CCC scenario and 3.5-5.6 t/ha for GISS scenario;
- reduction of the vegetation period with 4-32 days in the conditions of the CCC scenario and 2-26 days for GISS scenario;
- against the baseline scenario the cumulated precipitation over the vegetation period will be diminished with 2-19% in the case of CCC scenario and will increase with 1–18% in the GISS alternative;
- cumulated evapo-transpiration on the vegetation period will reduce up to 19% in all alternatives.

For irrigated systems the main conclusions are:

- decreasing of the beans production with 4-15% depending of the region in the CCC scenario. For GISS alternative the production will increase up to 18%;
- water demand for irrigation increase from 17-52% in the CCC scenario and in GISS alternative will decrease with 14-29% against the baseline scenario.

Other conclusions for both irrigated and non-irrigated harvest are:

- cumulated evapotranspiration over the vegetation period will decrease;
- negative effect of the CCC scenario over the production can be diminution by using a special hybrids;
- economic risk analysis recommend the using of special hybrids and using of irrigation.

Soy harvest

Soy harvest is characterized by:

- increase of the production with 35%;
- vegetation period increase with 10%.

Adaptation strategies

The preventive measures for risk reduction resulting from climate change impacts upon agriculture are as follows:

- re-evaluation of agricultural crop growing technologies to develop a sustainable agriculture with natural fertilizer of soil;
- re-evaluation of the agroclimatic regionalisation and structure of growing crops;
- development of the irrigation.

As a general remarque the rotation of the harvest increase the benefits. The short rotation is recommended. In the condition of the twofold of CO_2 the fertilizer demand will increase with 15-20%.

7.3 Forestry

Forests have first a determining and very important role in the maintaining and adjustment of the ecological balance on the large areas. In 1994, the afforested area covered 6.368 thousand hectares, i.e. 27% of the total area of this country. The structure, according to species, of forests in Romania is:

- 1,930 thousand hectares resinous forest
- 1,902 thousand hectares beech tree forests
- 1,142 thousand hectares oak tree forests
- 1,278 thousand hectares other deciduous species.

The weight of the deciduous species is 69.2%, while that of the resinous ones is 30.8%.

The forest distribution on the large vegetation zones is:

- mountainous (above 700 m altitude) 58.5%
- hills (150 m - 700 m) 32.7%
- plain (below 150 m) 8.8%

The average production per hectare of wooden material is: 280 m^3 - resinous, 250 m^3 - beech shrubs, 151 m^3 - quercines. The average growth index is of about 5.4 m^3 / ha / year, the yearly felling capacity being of 14.5 million m^3.

7.3.1 The health condition of the forests

The forest supervision in Romania takes place on three levels:

- level 1, based on the 2 x 2 km and 2 x 4 km national networks and on the 16 x 16 km European one, with steady inspections so as to estimate every year the defoliation of the tree crowns;

- levels 2 and 3, based on an intensive supervision network of the main parameters of the forest ecological systems (soil parameters, physical and chemical air parameters, wood characteristics and the growth of the forest)

Moreover, the representative forest biocenoses are monitored, based on a network including 15 areas intensively observed.

The density of the sample taking for the determination of the forests health conditions is 1/400 ha in the forest districts in the plain zone and hills and 1/800 ha in the mountainous zone, 240000 trees being inventoried yearly in about 11800 locations.

The health conditions of the trees is characterized by their belonging to one of the following classes:

- class 0 - no defoliation (practically healthy trees)
- class 1 - slight defoliation (trees beginning to defoliate)
- class 2 - moderate defoliation
- class 3 - marked defoliation (trees in an advanced state of defoliation)
- class 4 - dead tree

Class	Defoliation degree	% of the losses
0	no defoliation at all	0 - 10
1	slight defoliation	11 - 25
2	moderate defoliation	26 - 60
3	marked defoliation	61 - 99
4	dead tree	-

In the 4-th class are included such trees which are practically dried. Classes 2-4 include medium and strongly damaged trees.

It has resulted, from the analyses of the data supplied by measurements and observations carried out in the period 1990 - 1994 that the forest undergoes a degradation process, especially set forth during the period 1992 - 1994, although the state of the forests in Romania is not worst than in most European countries.

The fir-tree is the most damaged specie of all the main resinous ones, the amount of the fir-trees included in classes 2-4 reaching 20%. From among the deciduous species, the silver oak-tree is the most damaged, with 45% in the classes 2-4. The beech-tree and the spruce fir are among the less damaged species, with up to 15% of the trees in classes 2-4.

The relatively poor health condition of the forests can be accounted for by the excessive drought occurring very frequently during the last decade to which one might also add local and transfrontier pollution, biotical and abiotical aggressive factors and sylvicultural measures which had been faulty applied in the past (full cuttings, inadequate planting, a.o.). As a matter of fact, the defoliation process up to the tree drying is interconditioned.

Within the drying process in progress for the time being in Romania, the highest defoliation percentage has been registered in the drought area, whereas the most intensive drought occurs in areas with very poor afforestation.

Is well known the fact that the ecological role of the forests was neglected in the past when their economic role was favored. During the period 1988 - 1989, the quantity of wood taken from the forests had reached 24 - 26 million m^3 / year, while the tree felling capacity was 15 - 15.8 million m^3 / year.

The evaluation of climate changes on the forests in Romania was performed using Holdrige model (static model of vegetation associations). The climate changes scenarios correspond CCC and GISS models.

The Holdrige diagram shows the transition of the vegetation area in Romania due to the transition from the climate corresponding to cool temperate latitude area and boreal to warm temperate to first area and to cool temperate for the second area. This evolution of the climate will determine the reduction of areas covered by some species and the extension of the others with the influence on the biomass production. So, the area of the Fagus sylvicol will reduce with about 10% due to the reduction of the rainfall quantity. Among the oak species, Quercus cerres and Quercus frainetto will extend their area in the south side of the country due to their resistance to the high temperature.

In the baseline scenario, in optimal conditions, the Quercus frainetto realizes more stand production (4.5 m^3 / ha / year for 100 years and 6 m^3 / ha / year for 120 years) than Quercus cerres.
It is expected that the stand production to decrease in the conditions of the CCC and GISS scenarios.

Using the Holdrige model for baseline scenario and for climate changes scenarios provided by CCC and GISS models, it was obtained the specific maps with the determination of the impact area. This area should be analyzed using the Gap model.

Adaptation strategy

- Ending strategic study with respect to the potential impacts of global change on the forests in Romania and adaptation measures to minimize the negative impacts
- Development of scientific and technical projects aimed at forestry bioclimatology, ecophysiology, forestry dendroclimatology, forest protection, genetics and breeding of forest tree species.
- Monitoring the health and production of the forest in the network of 4 x 4 km and investigating the changes of ecological on selected plants.

7.4 Water resources and water management

7.4.1 Water resources

The most important soft water resources are the rivers and the Danube which build a hydrographic network at 78905 km length, grouped in 12 basins such as: Banat, Mures, Crisuri, Somes - Tisa, Siret, Prut, Ialomita, Arges, Olt - Vedea, Cerna, Dunarea and Dobrogea. The Romanian hydrographic network is not uniform distributed within the country area. Theoretical potential of the inside river's water resources was evaluated at 39.6 billion m^3 for average hydrological year. The share of Romania from the Danube water potential was estimated at 53.2 billion m^3.

The most important hydrographic basins are: Somes - Tisa, Olt - Vega, Mures and Olt and the poorer basins are Dobrogea and Prut - Bârlad.

One characteristic of the romanian rivers is the flow variation during the seasons and from one year to another. The report between the maximum flow (in the wet period) and the multiyear average flow differ from one basin to another (12.5 for Mures river, 27 for Somes river, 79 for Buzau river and over 100 for small hydrographic basins).

The water resources of natural lakes were evaluated at 1 billion m^3 and the underground water to 9.6 billion m^3. Based on this estimation, the Romanian theoretical water potential is 107.4 billion m^3 for average hydrological year.

The available potential is evaluated at 42.5 billion m^3 as an average multiyear due to:

- characteristic of inside rivers flow determine the using only of 5 billion m^3 and from the existing storage lakes still 12 billion m^3
- as international navigable river, Danube offer only 20 billion m^3
- natural lakes are used in a small scale
- underground waters contribute with 5.5 billion m^3

The water consumption increased ten times during the period 1960 - 1982, reaching in 1989, 20 - 22 billion m^3. The structure of water consumption by users are: 13% as drinking water, 41% for industry, 33% for irrigation, 3% for animal breeder, 10% for piscicultural. The water sources were: 58% from inside rivers, 31% from Danube, 11% from underground waters.

Due to the industrial production falling in the period 1990 - 1994, the water consumption decrease to 10.2 billion m^3. The forecast of the water demand estimated for 2075 is 40.4 billion m^3. Up to now it were not elaborated studies to analyze the correlation between the water consumption and the temperature and precipitation conditions.

7.4.2 Evaluation of the global vulnerability

In the baseline scenario if we compare the water demand and the available water resources of the inside rivers and Danube, results a global vulnerability during the period 2060 - 2075 which can be associated to marginal vulnerability.

The analyses based on the overall water management of the underground water shows the absence of vulnerability for this category up to the end of the prognoses period. The reality confirms an advanced degree of use in some areas of the underground waters. The global vulnerability must be amended with the results of the water consumers supply analyses by hydrographic basins.

By hydrographic basins, the water consumers supply can reach some difficulties such as:

- the high pollution of some water resources make them unusable for a part of the consumers
- irregular distribution of the water sources over the regions determines the remaining of some areas with important water deficits
- limited imposed by the Danube river position (in the south side of the country and evaluated with 50% of the total water resources).

To determine the vulnerability at the national level in the Romania's conditions, it is necessary to perform analyses for each hydrographic basin. For this purpose the following hydrographic basins were analyzed in detail: Siret, Arges and Târnava. For these three areas results the following conclusions:

- there are insufficient data to establish the vulnerability for the considered climatic scenarios
- considering only the maize irrigation there is no vulnerability, only for Siret and Târnava basins
- if it will be considered other hydrological year and irrigation for other harvests, it is possible to appear deficit in all basins.

Adaptations:

- to reach the water demand of all consumers in the dry period and the water for irrigation of other harvest it is necessary to reorganize the operation of the existing storage lakes and to build new storage lakes
- further research to reduce the losses in the water networks and to modernize the technologies used for irrigation and industrial processes
- continuation of the systematic observation of water balance in water basins especially during the dry periods. This will help in the early identification of potential decline in water resources
- several strategic decisions must be accepted and new priorities of water management must be set
- systematic implementation of the water economy balance.

8 Climate change research

The Ministry of Water, Forests and Environment Protection coordinate the research projects related to climate change, possible climate change impacts, mitigation options and adaptation strategies.

The main goals of the research are:

- detailed inventory of emissions and sinks of greenhouse gases and the assessment of technical measures to mitigate greenhouse gases emission or to enhance GHG sinks;
- development of activities in accordance with the aims of the World Climate Program;
- development of background information for state authorities and other institutions with respect to meeting international common treats related to climate change issues;
- studies to develop an action plan for GHG's emission abatement and implementation of climate change adaptation strategies;

The following research and studies belong to the National Action Program and have as secondary effect the mitigation of the GHG:

- diminution of the causes determining rain acidity by reduction of SO_2, NO_x and Cl emissions;
- improvement of the used water treatment technologies for their re-utilization;
- solutions for the treatment and turning into account of the solid residues;
- improvement of management of the soil, industrial and household waste;
- improvement of life quality and the securing environment protection;
- lessening of the drought effects, desert limitation by specific measures, forest belts, soil erosion control, flood protection.
- growth of the forest role in the environment rehabilitation and protection, enlargement of the forest fund, sylvicultural management, exploitation of the wooden mass to the full rehabilitation capacity of the forests;
- Danube Delta Biosphere Reservation;
- preservation of the Black Sea ecosystem;
- rural planning, actions of soil and agricultural fund preservation;
- setting up of a complex educational program on the environment on all levels.

9 Education and public awareness

The Ministry of Water, Forests and Environment Protection (MWFEP) as well participating institutions in the US Country Studies Program have paid particular attention to the improvement of education and public awareness concerning climate change issues.

The main initiative in Romania in the last years included:

- distribution of the National Communication to members of state administration, research institutes, industries, NGO's and other interested parties;
- officials of the MWFEP several times informed representatives of the public mediums concerning UNFCCC commitments and national climate change strategies and policies;
- research reports and special articles were published and presented in national conferences and seminars.

8 Climate change research

The Ministry of Water, Forests and Environment Protection coordinate the research projects related to climate change, possible climate change impacts, mitigation options and adaptation strategies.

The main goals of the research are:

- detailed inventory of emissions and sinks of greenhouse gases and the assessment of technical measures to mitigate greenhouse gases emission or to enhance GHG sinks;
- development of activities in accordance with the aims of the World Climate Program;
- development of background information for state authorities and other institutions with respect to meeting international common treats related to climate change issues;
- studies to develop an action plan for GHG's emission abatement and implementation of climate change adaptation strategies;

The following research and studies belong to the National Action Program and have as secondary effect the mitigation of the GHG:

- diminution of the causes determining rain acidity by reduction of SO_2, NO_x and Cl emissions;
- improvement of the used water treatment technologies for their re-utilization;
- solutions for the treatment and turning into account of the solid residues;
- improvement of management of the soil, industrial and household waste;
- improvement of life quality and the securing environment protection;
- lessening of the drought effects, desert limitation by specific measures, forest belts, soil erosion control, flood protection.
- growth of the forest role in the environment rehabilitation and protection, enlargement of the forest fund, sylvicultural management, exploitation of the wooden mass to the full rehabilitation capacity of the forests;
- Danube Delta Biosphere Reservation;
- preservation of the Black Sea ecosystem;
- rural planning, actions of soil and agricultural fund preservation;
- setting up of a complex educational program on the environment on all levels.

9 Education and public awareness

The Ministry of Water, Forests and Environment Protection (MWFEP) as well participating institutions in the US Country Studies Program have paid particular attention to the improvement of education and public awareness concerning climate change issues.

The main initiative in Romania in the last years included:

- distribution of the National Communication to members of state administration, research institutes, industries, NGO's and other interested parties;
- officials of the MWFEP several times informed representatives of the public mediums concerning UNFCCC commitments and national climate change strategies and policies;
- research reports and special articles were published and presented in national conferences and seminars.

Appendix 1

TABEL 5 NATIONAL INVENTORY OF GREENHOUSE GASES - SYNOPTIC TABEL - 1991

[Gg]

GREENHOUSE GASES SOURCES AND STOCKING CATEGORIES	CO2 Emissions	CO2 Reductions	CH_4	N_2O	NO_x	CO	NMVOC	HFCs	PFCs	SF_6
Total of national emissions and of reductions	135660,210	6590,100	1734,212	24,784	458,245	1980,707	400,802			
I. Total energy sector (fuels combustion + fugitive emissions)	130464,822	0,000	1009,297	11,607	439,777	1687,508	195,142			
A. Fuels combustion	130464,822		33,894	11,607	439,777	1687,508	105,152			
1. Energy and transforming sector	57878,721		4,464	6,477	152,885	14,745	4,464			
2. Industry	37173,945		2,563	1,430	31,945	760,237	4,947			
3. Transport	7520,942		1,117	0,276	226,743	457,188	71,162			
4. Small fuels sources	25605,679		8,451	2,635	21,328	94,566	8,262			
5. Other categories	2285,535		0,220	0,395	1,579	15,594	0,173			
6. Traditional combustion of biomass for energy production*	2519,836		17,079	0,394	5,297	345,178	16,144			
B. Fugitive emissions from extraction, processing, transport/distribution of fuels			975,403				89,990			
1. Solid fuels			198,048				0,000			
2. Crude oil and natural gas			777,355				89,999			
II. Industrial processes	5188,137	0,000	7,827	6,436	10,190	91,883	45,960			
III. Use of solvents and of other products	0,000	0,000	0,000	0,000	0,000	0,000	159,750			

* CO2 emissons from biomass are not included in TOTAL

Appendix 2

Appendix 2

Hypotheses for reference and alternative scenarios

The evolution of GHG emissions for the reference scenario has been determined in the following hypotheses:

Non-energy sector:

- Forest ecosystems
  - constant forest surface of about 6.4 mill. ha until 2010;
  - wood mass cutting quantity increases from 14.5 mill. m^3 as it was the in 1994 to 15.6 mill. m^3 in 2010;
  - all works necessary to regenerate, and clean the forests shall be made.
- Agriculture
  - essential changes as regards the agricultural surface will not happen;
  - vegetable wastes: 60% are soil incorporated; 24.99% represent the animal food; 15% is used in the paper industry and 0.01% is burnt;
  - the CH_4 emissions from the animal digestion process and from the anaerobic fermentation of dejection have been determined in correlation with the number of animals and it is not considered that reduction techniques are presently applied;
  - the N_2O emissions have been estimated only for the use of chemical nitrous fertilisers.
- Industrial processes
  - the emissions have been correlated with the cast iron, steel, aluminium and other non- ferrous metals, chemical fertilizers, cement, lime, etc that underlay the energy demand determination.
- Solid and liquid urban wastes
  - the waste quantity and quality have been determined in accordance with the increase of the living standard;
  - the incinerating substations shall no longer be extended.

Energy sector

- Energy supply
  - maximum use of domestic production;
  - the renewable sources will increase from 40 x 10^3tce in 2000 to 65 x 10^3tce in 2010;
  - the import of crude oil and natural gases will be achieved in order to cover the existing consumers demand and hard coal will be imported for new capacities of electricity generation;
  - the demand of oil products will be assured by refining both the Romanian and imported crude oil in the country;

- The electricity and heat generation
  - the Cernavoda nuclear power plant will be achieved only with two units;
  - the completion of hydroelectric plants with different execution stages;
  - modernisation of cogeneration plants mentioned in RENEL programme as well as the programmes of achieving new capacities;
  - the preponderant fuel for the heat generation will be the natural gas, too.

Consumption sectors

- Households
  - the evolution of the number of persons per residence from 2.951 in 1993 to 2.746 in 2010;
  - reduction of the energy demand for cooking by 2.5% until 2010;
  - increase of hot water consumption per residence by 8.7% until 2010;
  - fifty percent increase of the electricity consumption per residence until 2010;
  - improving the thermal insulation degree of residences by reducing the average energy demand by 3% on the forecast period.

- Services
  - increase of medium surface per employee by 18% until 2010 year;
  - specific consumption reduction of electricity by 15.5% for old buildings and by 3% for new buildings;
  - specific consumption reduction for thermal uses in new buildings, due to a good insulation by 21% in the forecast interval against in old buildings.

- Transports
  - <u>goods transport:</u> * the motor fuel consumption per ton x kilometres was considered to be reduced during 1996-2010 such as: by 3% for trucks used for the local transport and by 4% for long-distance transport, and 3% for Diesel trains, by 5% for electric trains and by 4% for ocean livers;
  - <u>interurban passenger transport:</u>
    * development of the activity correlated with the population evolution and the mobility degree increase;
    * the increase of car participation share to interurban transport in detriment of transport by bus and train.
    * the average motor fuel consumption of a car lowers from 9.4 l/100 km in 1995 to 9.1 l/100 km in 2010; in case of a bus the lowering is from 58.5 l/100 km in 1995 to 56.8 l/100 km in 2010;
  - <u>urban passengers transport;</u>
    * increase of car participation in urban traffic in detriment of passenger transport;
    * an average motor fuel consumption of a car in locality will lower from 10.8 l/100 km in 1995 to 10.6 l/100 km in 2010 and a bus consumption will lower from 61 l/100 km (1995) to 58.2 l/100 km (2010).

- Agriculture
  * harnessing for irrigation of about 1,300 thousands ha in 2000 year and

3,200 thousands ha in 2010; average specific consumption 800 Wh/ha;
* harnessed surface for greenhouses will be 700 ha in 2000 with a demand of $11.119x10^3$TJ;
* agricultural surfaces divided in small parcels; motor fuel demand increase from $1,284x10^3$t in 2000 to $2,120x10^3$ t in 2010;
* the energy demand for live-stock farms increase in the period 2000-2010 as follows: electricity increase from 1.4 TWh to about 2.2 TWh, heat from $5.3x10^3$ TJ to $5.6x10^3$TJ and the fuel demand from $164x10^3$ tce to $280x10^3$tce.

- Industry

* value added in industry increase from $6.528x10^9$ $ to $14.77x10^9$$ during1993 - 2010;
* the share of industrial branches in achieving the value added keep the present situation; important share of energy intensive branches;
* the increase of the industry energy demand from $21.56x10^6$ tce to $44.24x10^6$tce (a rhythm of 4.3%) during 1993 - 2010;
* average energy intensity lowers from 3.303 kg ce/$ in 1993 to 2.995 kg ce/$ in 2010 (annual average rhythm of 0.2%).

- Extraction, processing, transport/distribution fuel

* the emissions have been determined function of the energy balance evolution during 1993 - 2010; the losses percentage for crude oil and natural gases due to extraction, transport and distribution activity was considered to be constant during the studied period.

THE GHG EMISSIONS REDUCTION OPTIONS

The alternatives to reducing the GHG emissions have been analysed on each activity sector and for the options where technical and economic elements exist, there have been performed their selection and hierarchy according to cost-profit analyses.

Non - energy sector

Forestry: For the process of forest carbon sequestration, two basic options are taken into consideration, namely: increase of surfaces occupied by forest with 100 thousands ha up to190 thousands ha until 2010 and by special measures referring to forest management in order to create optimum structures

Agriculture: In order to reduce the methane emission from the animal digestion process, the following technique have been considered:

- the improving of the nutrition quality by increasing the protein percentage was considered to lead to methane emission decrease by 10% until 2005 and by 15% in 2010;
- the improvement of meat weight share on kg of fodder as well as the milk amount share on kg of fodder will lead to the increase of animal performances. The methane emission has been estimated to 5% at the level of 2010 year.

The alternatives to reducing the N_2O emissions are aimed at improving the technology of using nitrogen fertilisers. As the agricultural surfaces are concentrated and the farms are economically consolidated, the use of liquid fertilisers can be taken into consideration.
All measures can contribute to reducing the emissions at the level of 2010 year by up to 25%.

Industrial processes. The solution to reducing the GHG from the industrial processes have been correlated with the options taken into consideration for industry restructuring, namely: reducing the branches that are big consumers, an effective use of raw materials, using of new and modern installation (Alternative I and II).

Use of solvents and other products. It is estimated that by improving the technologies, investments in environmental protection field and some changes in the weight of the activities following the structural adjustment of the economy, will occure reductions of the total emissions ofNMVOC estimated in 2010 to be 80% from the emissions corresponding to 1989 reference year will occur (for high scenario).

The energy supply sector and the electricity generation

As alternatives to the imported energy supply there have been considered the natural gas and nuclear fuel import for the electricity generation.

The development of the industrial and urban cogeneration plants has been considered to be about 455 MW until 2010; a reduction at heat losses in the transport and distribution system and thermal points by about 20% at the level of 2010 year as well as the reduction by about 3% of heat delivered to urban consumers by metering, controlling and dispatching monitoring.

Consumption sectors

Households and services: In order to reduce the GHG emissions, the following alternatives have been considered:

- improving the thermal insulation to all new flats that will be supplied by heat from centralised sources (the reductions of the demand is 11.1 GJ/year and residence);
- the reduction of the maximum hourly heat demand by 8% for 100,000 existing residences and by 28% for other existing 100,000 residences.

Transports: The options for greenhouse gas emissions reduction in the transport sector take in consideration the following directions:

- reduction of goods transport activity as a result of industry restructuring. The evolution of the transport activity has been determined in correlation with the industrial development and the same shares of participation in goods transport, means of road transports, railway transport, and pipeline transport as in the reference scenario;
- improving the performances of the vehicle fleet used to goods and passengers transport:
- in case of long-distance goods transport the average motor fuel consumption has been considered to be reduced to 18 l/100km in 2005 and to 17.2 l/100km in 2010 and for local goods transport the reduction will be to 28 l/100 km in 2005 and 26.8 l/100 km in 2010 has been considered;
- in case of interurban passengers transport a reduction of the motor fuel consumption from 8.4 l/100 km in 2000 to 7.6 l/100 km in 2010 was considered and for buses from 52 l/100 km in 2000 to 47 l/100 km in 2010;
- in case of urban passengers transport, a reduction of the motor fuel consumption for cars from 10.2 l/100 km in 2000 to 9.1 l/100 km in 2010 and for buses from 56 l/100 km in 2000 to 51 l/100 km in 2010.
- share modifications of different means of transport in the passengers transport as a result of infrastructure modification and attracting a greater and greater, number of passengers to public transportation means. At the level 2000, a reduction of the numbers of passengers that use the cars to the place of transport by bus and electric transport has been estimated. At the level of 2010 year about 70% of the

number of passengers that used the car, would prefer the public transportation means.

Agriculture: The alternatives to reducing the GHG have been analysed for: greenhouses, motor fuels for agricultural machines and live-stock farms.

By the greenhouses modification and retrofitting, the energy consumption can be reduced by 3% in 2010. It has been estimated that by the unification of the agricultural fields and by re-organisation of the activity the use of the agricultural machines will be optimised which will lead to the motor fuel demand reduction as against the reference scenario by 11% in 2005 and 15% in 2010.

In order to modernise the live-stock farms the energy demand could be reduced as follows:

- the electricity by 1% in 2000 reaching 8% in 2010;
- the heat by 5% in 2005, reaching 8% in 2010;
- the fuel by 5% in 2005, reaching 10% in 2010.

Industry: The GHG emissions reduction has been determined within two energy demand reduction alternatives. Both of the alternatives have as a common element, the structural adjustment of industry and same share of industrial branches to the creation of value added .

The Reduction Alternative I the industry energy demand has supposed a modest modernisation process that leads to energy intensity lowering from 3.303 kg ce/$ that represents the achievement in 1993 year to 2.363 kg ce/$ in 2010. The industry energy demand reaches 36.8×10^6 tce at the level of 2010 year.

The Reduction Alternative II the industry energy demand where a vast retrofitting process has been supposed, the average energy intensity reaches 2.09 kg ce/$ in 2010 year. The energy demand in 2010 is almost 33.5×10^6 tce.

For Low Scenario it was considered the “Reduction Alternative I” for economy and the low level of reduction measures.

For High Scenario it was considered the “Reduction Alternative II” and the high level of reduction measures.

Bibliography

The Research and Engineering Institute for Environment (ICIM) - National Study on Climate Change Element 1: Inventory, Bucharest 1995 - 1996

National Institute for Meteorology and Hydrology (INMH) - National Study on Climate Change - Element 2: Expected Impacts of Climate Changes, Vulnerability Assessment and Adaptation Measures, Bucharest 1996 - 1997

Institute of Power Studies and Design (ISPE) - National Study on Climate Change - Element 3: Assessment of Mitigation Options for Greenhouse Gas Emissions, Bucharest 1996 - 1997

HUTTE - Manualul Inginerului, Editura AGIR, Bucuresti 1947

Ministry of Waters, Forests and Environmental Protection - The Research and Engineering Institute for Environment - National Review of Romania, Bucharest 1991

Central Institute for Research Designing and for Directives in Constructions (ICCPDC) - Hydraulic Research Institute - Prognosis of Water Supply and Waste Water Disposal in Romania, Contract 1053/89

AWWA Industrial Water Use, JAWWA, 45, 1953, p. 289

Green, R., JAWWA, 43, 1952, p. 591

Nemerow, N.L. - Theories and Practicies of Industrial Waste Treatment, Wesley Publishing Company Inc. Massachussets, 1963

Elkin, H.F. et al. - Biological Oxidation of Oil Refinery Wastes and Cooling Tower System; Sewage and Industrial Wastes, No. 12, Dec. 1956

Rensink, J.H. - L'influence de deversment d'eaux usees de laiterie sur les eaux de surface; La Tribune de Cebedeau No. 262 - 263, 1965 (p. 420)

Ministry of Waters, Forests and Environmental Protection - The State of Environment in Romania - First Draft - National Report for the Second Pan European Conference of the Ministers of Environment, Luzerne, 1993

The Research and Engineering Institute for Environment (ICIM) - CORINAIR 90 - Emission Inventory for Romania, 1993, Contract No. 94-0014 with CEC - DGXI - Brussels

European Topic Center on Air Emissions - Report to the European Environment Agency - CORINAIR 90 - Summary

CEC - CORINAIR INVENTORY - Default Emission Factors Handbook, Second Edition, January 1992
Ministry of Waters, Forests and Environmental Protection - National Strategy for Environmental Protection 1995

Ministry of Waters, Forests and Environmental Protection - National Environmental Action Program 1995

IPCC (Intergovernmental Panel on Climate Change) - Guidelines for National Greenhouse Gas Inventories. Volume 1 - 3, Sathaye, Jayant; Meyers, Stephen (1995)

Greenhouse Gas Mitigation Assessment - A Guidebook, Kluwer Academic Publishers

Forestry Research Institute - Alternatives of atmospheric carbon stocking by forest ecosystems 1995 - 1996

The Ministry of Industries - Restructuring and developing strategy, of the electric and thermal energy branch covering the perod 1995 - 2000 (1995)

The Strategy of restructuring the Romanian oil industry during 1995 - 2000 (1995)

KEMA, N. V., Netherlands, Environmental Impact Assessment Study for Power and Lignite Subsectors Rehabilitation and Modernization Project (1993)

IEA, Energy Policy of Romania, OECD, 1993

National Commission for Statistics - Romanian Statistical Yearbook, 1995

National Commission for Statistics, The Census of the Population and Residences of January 7, 1992 (1992)

Coopers&Lybrand Deloitte Management Consultants, Least Cost Capacity Development Study for Romania (1993)

Bechtel International, Inc., Bucharest District Heating System, Feasibility Study (1993)

KEMA - IEV, Study on Bucharest District Heating System (1993)

*** Improvement of RAL economic - Financial activity and providing lignite deliveries for the modernized power plants located in Rovinari and Turceni (1993)

World Bank, Power Sector Rehabilitation and Modernization Projects for Romania (1995)

Institute of Power Studies and Design (ISPE), The substantiation of RENEL (Romanian Electricity Authority) power plant development strategy until 2010 and the trends for 2010 - 2020 period - stages 1 - 7 (1995)

IAEA, ISPE - TEC DOC - 820 - Energy and Nuclear Power Planning Study for Romania (Covering the period 1989 - 2010), (1995)

Institute of Power Studies and Design (ISPE) - Alternative Strategies for Electricity Supply in Romania: Composition of Nuclear Power Plant and Combined Cycles Gas Fired Power Plants, DECADES case study project, 1995

Gaf - Deac, I. Rancea, Gh. etc. - Romania's Coal Extractive Sector's Strategy. Elements Concerning the Restructuration Towards the Market Economy, The Meeting of Experts on Coal Trade, Statistics and Transport, CEE - ONU, 20 - 23 May 1996, Constanta, Romania

World Bank, International Economics Department - Commodity Policy and Analysis Unit. Commodity Markets and the Developing Countries - February 1996

Mircescu, I. etc. - The Coking Coal Trade and its Transport to the Integrated Iron and Steel Works "SIDEX" S. A. Galati. The Meeting of Experts on Coal Trade, Statistics and Transport, CEE - ONU, 20 - 23 May 1996, Constanta, Romania

Lama, Ripu, D. 1991 - Methane Gas Emissions from Coal Mining in Australia: Estimates and Control Strategies in: Proceedings of International Conference on Coal, The Environment and Development: Technologies to Reduce Greenhouse Gas Emissions, Sydney, Australia, 18 - 21 November 1991

EPA 1990. Preliminary Technology Cost Estimates of Measures Available to Reduce Greenhouse Gas Emissions by 2010. Prepared by ICF Resources, Washington DC

Kuuskraa, Velo, et. al., 1989 - Steps to Assess Resource Economics Covered. Oil and Gas Journal, December 21, 1989, p. 121 - 125

Ghetan Vasile - From forecast to demographic policy in "The Economist" - Theoretical and Applied Economy Studies, no. 6/Nov. 1994

United Nations Framework Convention on Climate Change

Law on Environmental Protection no. 137/December 1995

Leca, Aureliu - Principii de Management Energetic, Editura Tehnica, Bucuresti 1997

Boer, G.J., McFarlane N. and Lazare, M. - "Greenhouse Gas - Induced Climatic Change Simulated with the CCC Second - Generation GCM", Journal of Climate 1991

Busuioc, A. and H. von Storch, 1995 - "The connection between summer precipitation anomalies in Romania and large-scale atmospheric circulation", Atmospheric Physics and Dynamics in the Analysis and Prognosis of Precipitation Fields, Rome, 15 - 16 November 1994

Busuioc, A. and H. von Storch, 1996 - "Changes in the winter precipitation in Romania and its relation to the large-scale circulation"

Addiscott, T.M., Heys, P.J. Whitemore, A.P., 1986 - Application of simple leaching models in heterogeneous soils, Geoderma

Addiscott, T.M., Heys, P.J. Whitemore, A.P., 1987 - Computer simulation of changes in soil mineral nitrogen and crop nitrogen during autum and spring, Journal of Agricultural Science

Marica, A. and Tanasescu, M., 1995 - The effect of climate change on water balance in the winter wheat crop, Studies and Meteorological Research of INMH, Bucharest

Stanescu, V. Al., Oancea, V., 1993 - Procedures for Hydrological Regionalisations Applied in Romania, International Conference of FRIEND

Stanescu, V., Adler, M.J., 1993 - Determinarea caracteristicilor scurgerii din perioadele secetoase in scopul exploatarii optime a resurselor de apa pentru lacurile de acumulare, Revista "Hidrotehnica", vol. 38, nr. 4, Bucuresti

Ministerul Apelor, Padurilor si Protectiei Mediului,1995 - Strategii de dezvoltare in domeniile apelor, padurilor si protectiei mediului