CHAPTER 1

INTRODUCTION

The climate of our planet has been changing continuously but while in the past these changes had been natural, now the scientists believe that the industrial and agricultural emissions of carbon dioxide and other gases may cause irreversible change of global climate. The drastic increase of concentration of these gases known as "greenhouse gases" may lead not only to a substantial temperature rise but also to a new climate pattern in the future.

The United Nations Framework Convention on Climate Change (UN FCCC), thereon referred to as Convention, is the first and major international legal instrument to address climate change issues at a global scale. It was signed in June 1992 at the Rio de Janeiro Earth Summit by more than 150 countries. The Convention entered in force on 21st March 1994. The ultimate goal of the Convention is to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level has to be achieved within a time frame sufficient to allow ecosystems to adopt naturally to climate change, that will ensure sufficient food production and will enable sustainable economic development. The goal of the Convention could be achieved by implement a global strategy to conserve the climate system for present and future generations.

Bulgaria signed UN FCCC in Rio de Janeiro in June 1992 and the Parliament ratified it in March 1995. In compliance with Article 4.6 and 4.2(b) of the FCCC, Bulgaria as a country in transition has adopted as a base year for the implementation of the Convention 1988 instead of 1990. As an Annex I Party of the UN FCCC the Republic of Bulgaria adopted the target to stabilize emissions of greenhouse gases by 2000 at a level not exceeded that in 1988. The same year was used as a base for comparison, evaluation and projection of the greenhouse gas emissions.

Within the frame of FCCC Bulgaria was obliged to present First National Communication with an inventory and projections on the greenhouse gas emissions, detailed description of adopted national policies and measures to mitigate climate change within a six months period after its entering into force.

The First National Communication of Bulgaria was elaborated by the Interministerial Committee supported by independent organizations and experts. The work was coordinated by the Ministry of Environment and Energoproekt PLC. It was submitted to the UN FCCC Secretariat in February 1996.

The Second National Communication is a further step in elaborating and implementing of the national climate change policy. It has been delivered after the Kyoto Conference of the Parties and after the new commitments agreed by the Parties to the Convention. This puts new targets in front of the country and stresses on the need of a consistent policy to reduce the anthropogenic emissions of GHG. According to Annex B of the Kyoto Protocol the quantified emission reduction commitment of Bulgaria for the first commitment period (2008-2012) is 8 % of the base year (1988) emissions. Currently this commitment is being discussed by the Governmental institutions. The preliminary studies show that it would be extremely difficult to achieve this target. It will require to pursue consistent policy and apply measures to reduce GHG emissions once the transition period is over and the recovery of the economy starts. Major problems to achieve the target are associated with the lack of enough investment opportunities to finance mitigation measures and projects. International collaboration and partnership will be essential for meeting the reduction target.

The Second Communication is elaborated following the Guidelines adopted by the Second Conference of the Parties of the Convention. It lays on the basis of the findings presented in the First Communication, supplemented and refined during the development of the National Action Plan on Climate Change in the frame of the US Country Study Program - Support for National Action Plans.

The Second National Communication of Bulgaria was elaborated by the Interministerial Committee supported by independent organizations and experts. The work is coordinated by the Ministry of Environment and Waters and Energoproekt PLC.

Evdokia Maneva
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CHAPTER 2

NATIONAL CIRCUMSTANCES

This chapter contains a brief description of Bulgaria natural and economic conditions that are related to the subject of the UN FCCC. The basic information on geography, hydrology, climate and demographic profile of the country. Information on the economy and sectoral development is also included.

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GEOGRAPHY AND CLIMATE PROFILE

Established in 681, the Bulgarian State lies in the Southeast of Europe on the Balkan Peninsular, at the cross-road between Europe, Asia and Africa.

The Republic of Bulgaria (the capital - Sofia) is a middle-size country with surface area of 110 993.6 km^2 (Figure 2.1.)

Figure 2.1. Map of Bulgaria

The land boundary to the North with Romania is 609 km long and it mainly runs alongside the Danube river. Bulgaria has land boundary with Turkey - 259 km, with Greece - 493 km and with the Republic of Macedonia and Union Republic of Yugoslavia (506 km). In the East Bulgaria borders the Black sea. The shore is predominantly flat with cliffs concentrated to the North (Kaliakra). The geographical coordinates of the country are given in Table 2.1.

Geographical coordinates

Table 2.1.

Directions	North latitude	East longitude
North	44°13’	22°40’
South	41°14’	25°17’
East	43°32’	28°37’
West	42°19’	22°22’

Source: Statistical Yearbook 1997

The connecting line between the northernmost and southernmost points is 396 km long, and between the westernmost and easternmost points 522 km.

31.45% of Bulgaria's surface is below 200 m above sea level. Hills within the range of 200-600 m above sea level cover 40.90% of the area. The highlands' (600-1600 m a.s.l.) percent is 25.13% and mountains over 1600 m a.s.l. account for 2.52% of the country area. Bulgaria is located alongside the 600 km long chain of Stara Planina (the Balkan) with the highest point of 2376 m a.s.l. (the Botev peak). In the south there are several mountains belonging to the Thrakian-Macedonian System: Vitosha, Pirin, Rodopy, Strandga, and Rila. The highest point of the Balkan peninsular is situated in Bulgaria. It is the Musala peak - 2925 m a.s.l. (the Rila mountain)

The geography profile of Bulgaria determines its climate as belonging to the mild continental zone with regular rotation of four seasons. In the eastern and southern parts of the country the climate demonstrates Mediterranean features related to the impact of large water basins. The diversity of terrain altitudes affects the temperature and precipitation patterns and provokes further weather variability.

Absolute temperature extremes are characteristic about the temperature status of the country. The highest temperature was measured on August 5, 1916 in Sadovo (45.2°C), and the coldest day was January 25, 1947 in Thrun (-38.3°C). The average temperatures during the 1983-1996 period were about 10-12°C within the range of maximum 42.2°C to minimum - 27.3°C. The average number of sunny days was between 259 (the city of Lom) and 319 (the region of Sandansky), Sofia - 301 days, Varna - 300 days, the Musala peak - 279 days. The daily maximum intensity of sunshine in the summer occurs between 11 and 14 o'clock. The annual number of hours of sunshine ranges between 1848 (peak of Botev) and 2506 (the city of Sandanski) hours annually.

Most of the rivers in the Republic of Bulgaria have a limited flow. The necessity of water storage has promoted construction of reservoirs. For example, there exist series of dams on the Arda River . There are six large natural water reservoirs, with the water volume that amounts to 211.8 million m^3 and twenty one large artificial water reservoirs with total water volume of 5335 million m^3.

The average annual precipitation is 511.1 mm. The precipitation figures for the country's regions are as follows:

- 500-550 mm in some parts of the Danube valley and in Trakia;
- to 1000-1400 mm in the highest mountain areas.

The lowest precipitation (below 500 mm annually) can be found in the most northern and eastern parts of the Danube valley. The average relative humidity is within the range of 60-84%. The precipitation is unevenly distributed during the year. It has its maximum in May-June and its minimum in February-March.

In the continental zones the maximal sum of day and night precipitation can be defined at the north and north-west slopes of the mountains. It is in the range of 35-40 mm during the summer months in the Stara Planina regions below 1000 m. For the Mediterranean zone the maximum is observable in November and December, and the minimum - during the spring and summer months - 15-22 mm. The maximum daily figure for Bulgaria was 342 mm precipitation measured in August, 1951. 1945 and 1985 are considered the driest years.

DEMOGRAPHIC PROFILE

The population of Bulgaria during the last several years is constantly decreasing (Figure 2.2). The social and economic problems in Bulgaria during the transition period caused this negative development of the natural increase since 1988. The downward trend is also related to events such as the recent emigration waves. In the period 1989-1997 about 702 thousand people left Bulgaria. The average population decreases within the recent years was of about 55 thousand people per year. The projections of the National Statistical Institute (NSI) and Eurostat predict a further decrease of the population and it is expected to become 7.4 mln by 2020.

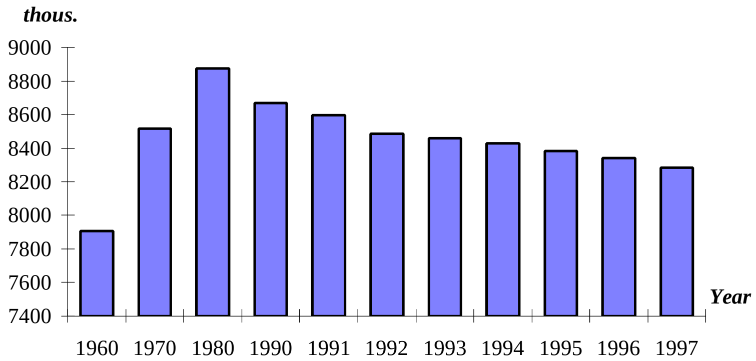

Figure 2.2. Population growth rates in Bulgaria

Some other parameters that characterize the demographic profile of the country are provided in Table 2.2. and the graphical presentation of the trends is provided in Figure 2.3.

General population data

Table 2.2.

	1960	1970	1980	1990	1991	1992	1993	1994	1995	1996	1997
Birth rate ‰	17.8	16.3	14.5	12.1	11.1	10.4	10.0	9.4	8.6	8.6	7.7
Natural increase ‰	9.7	6.0	3.4	-0.4	-1.7	-2.2	-2.9	-3.8	-5.0	-5.4	-7.0
Marriage rate ‰	8.8	8.6	7.9	6.9	5.6	5.2	4.7	4.5	4.4	4.3	4.2
Average age of population	32.4	34.4	35.8	37.5	37.8	38.1	38.4	38.5	38.9	38.8	39.2

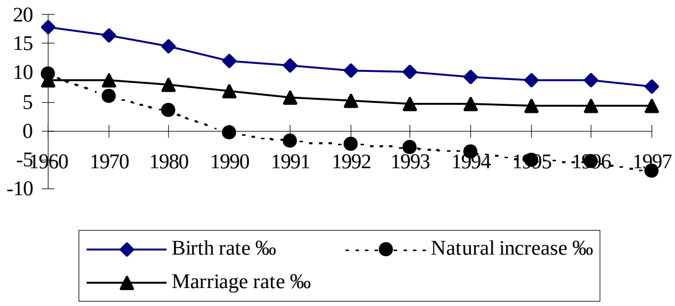

Figure 2.3. Trends of some demographic indicators

Most of the population is concentrated in the urban areas. Sofia - the largest city and the capital of the country - had a population of 1190547 inhabitants in 1997. The next largest cities - Plovdiv and Varna - have population in excess of 300 thousand people.

Despite the positive natural rate for the urban population the emigration waves led to a decrease.

Since 1994 the number of the population in the cities started to decrease. Tentatively the allocation of the population is 68:32 urban to rural. The average population density in the country is 74.6 inhabitants per km^2 (in 1997) that makes Bulgaria a moderate populated country.

Another negative tendency is the aging of population due to the decline in birth rates. The average population age in 1997 was 39.2 years while the birth rate dropped to 7.7 new-born per 1000 people. The relative share of the population in working age decreases. Currently every forth person in Bulgaria is a pensioner. The current structure of the population will lead to further development of the above listed tendencies.

ECONOMY

As stated in the First National Communication, Bulgaria is among the countries with economies in transition (EIT) and this specifies the similarities to the rest of the ex-socialist countries supplemented by some peculiarities in the Bulgarian development model related to the lower pace of the changes.

Until 1991 Bulgaria had centrally planned economy isolated from direct international competition through subsidies, taxes and currency exchange rationing. Since 1989 Bulgaria entered a situation of grave economic recession caused by political and economic collapse of the socialist system; unfavorable external factors, including world recession, some political events, ex-Yugoslavia embargo etc.; losses of major external markets. This recession is not yet overcome. Bulgaria was the only country with economy in transition that had a decrease in the GDP in 1996 (see Table 2.3). In 1997 the GDP rate was again negative. The GDP and GDP/capita indicators can not reach the levels in 1989 (Table 2.4.)

GDP growth for some countries with economies in transition [%]

Table 2.3.

Country	1991	1992	1993	1994	1995	1996	1997
Bulgaria	-11.7	-7.3	-1.5	1.8	2.1	-10.9	-6.9
Hungary	-11.9	-3.1	-0.6	2.9	1.4	1.3	4.0
Czech Republic	-11.5	-3.3	0.6	2.7	6.0	4.1	1.2
Poland	-7.0	2.6	3.8	5.2	7.0	6.1	6.9
Slovakia	-14.5	-6.5	-3.9	4.9	7.4	6.9	6.5
Romania	-12.9	-8.8	1.5	3.9	7.1	4.1	-6.6
Slovenia	-8.9	-5.5	2.9	5.3	4.9	3.0	3.3

Source: Economic Survey of Europe, 1998, No.1, UN, 199 pp.

GDP indices [%]

Table 2.4.

	1989	1990	1991	1992	1993	1994	1995	1996	1997
GDP	100.0	90.9	80.3	74.4	73.3	74.6	76.2	67.9	63.2
GDP/capita	100.0	92.6	82.5	77.3	76.8	78.4	80.4	72.1	67.4

Some other general economic indicators representative for the country development in the last few years are given in Table 2.5.

Key macroeconomic indicators

Table 2.5.

Indicator	Unit	1990	1991	1992	1993	1994	1995	1996	1997
Inflation (annual)	%	23.8	338.5	79.4	56.1	87.1	62.1	123.0	1082.8
Industrial Production	%	-16.8	-22.2	-15.9	-10.9	8.5	9.1	-8.4	-7.0
Unemployment	%	1.5	11.1	15.3	16.4	12.8	11.1	12.5	13.7
Exports	$US million	6113	3737	3956	3727	3935	5345	4890	4914
Imports	$US million	7427	3769	4169	4612	3952	5224	4703	4518
Current Account balance	$US million	-1710	-77	-360	-1098	-32	-26	82	446
General Government balance	% GDP	-4.9	-5.8	-5.2	-11.2	-5.8	-6.4	-13.4	-2.6
Gross debt	$ billion	10.9	12.3	13.9	13.9	11.4	10.2	9.6	9.8

It is evident that the negative tendencies outlined in the First National Communication are still valid.

The inflation rate has continued to be very high. The inflation covered all types of goods and it had an unstable trend (see Table 2.6).

Some of the reasons for this tendency were as follows: increased exchange rates, reduced consumption, unstable financial system, low yield and lack of some of the basic agricultural products, increased indirect duties, inefficient price monitoring, deficit, speculations and still existing monopolies. The inflation was several times greater than the values in the other European countries (3-5%).

Consumer price indices, 1991-1997

Table 2.6.

December of preceding year=100

	1991	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
TOTAL	**573.7**	**179.5**	**163.9**	**221.9**	**132.9**	**410.9**	**678.5**
Food	579.5	182.5	160.4	218.9	123.6	414.9	713.5
Other goods	537.6	171.6	155.9	218.0	158.3	447.3	590.7
Services	664.6	185.7	193.7	160.6	135.5	380.6	732.2

The investments were scarce and they have unfavorable structure. They even decreased in 1996 by 15% compared to the previous year. Mainly this was due to the lower investment activity of the public sector as far as the private sector investment kept their level. The investments in the agricultural sector decrease drastically (10% in 1990 to 1.2% in 1996). This fact had as a consequence a collapse in the agricultural production and agricultural products deficit. In 1991-1996 some US $830.9 millions entered the country as foreign investments. They keep increasing but their contribution still remains negligible and lower than the investments in some other countries in transition[1].

Major structural changes in economy and as consequence in the GDP structure took place during the transition period (Figure 2.4). Before the crisis the economic production structure was characterized by strong development of processing industry, mining and quarrying as a result of industrialization performed in the past several decades.

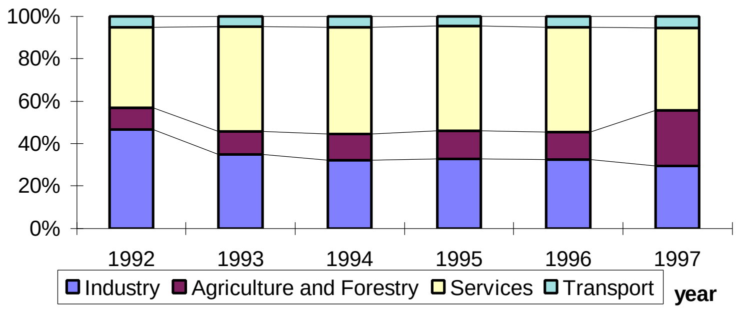

Figure 2.4. Structure of GDP

Note: In 1997 the NSI adopted a new sectoral split for GDP reporting by sectors. The new sectoral classification is based on the Statistical split of the economic sectors in the EU (NACE Rev.1). This is the reason, the shares in Figure 2.4 for 1997 to be hardly comparable to those for the previous years.

During the transition period the share of industry tends to decline and its production level is much lower compared to its capacity. It reduced its share from 61% in 1987 to less than 30%. At the same time service sector has passed through a real boom resulting in an increase of its share in the GDP from 22% in 1987 to about 40% in 1997.

The structural changes of economy and the drastic decrease in industrial production have resulted in negative social consequences such as increasing unemployment. The level of unemployment is relatively stable about 11-13% and is among the highest in Europe (Table 2.4).

The rate of privatization is still unsatisfactory although a real progress in that direction could be observed (Table 2.7).

1 Statistical Survey of recent trends in foreign investment in East European countries, 3 Dec. 1996 TRADE/R.647

Relative share of private sector in GDP (%)

Table 2.7.

	1994	1995	1996	1997
Private sector (total)	41.6	48.3	51.9	58.8
Agriculture and forestry	10.2	11.1	9.5	22.7
Industry	7.1	9.4	9.1	11.2
Services	24.3	27.8	33.2	24.9

But still when compared to the rest of the EIT countries, Bulgarian private sector share is comparatively low and Bulgaria is far behind the Central European countries with regard to this indicator.

In the Check Republic, Hungary and Poland the private sector is in charge of more than half of the GDP. In Bulgaria privatization is the greatest in the commercial field. Approximately 62% of trade in 1994 was due to it.

After the adoption of the Law on Reconstruction and Privatization of State and Municipal Enterprises in May 1992 lots of acts for the privatization have been signed (e.g. 4810 acts till 31 December 1996). The tendency (Figure 2.5) continues in 1997 when some big deals were signed.

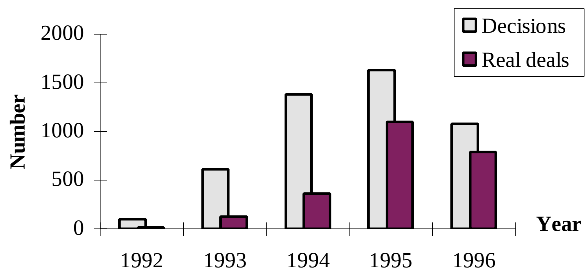

Figure 2.5. Privatization deals in the period 1992-1996

Alongside with the cash privatization the process of bonus privatization, with the participation of the entire population of the country above 18, also took place.

But still when compared to the rest of the EIT countries, Bulgarian private sector share is comparatively low.

It is expected the private sector to continue to increase as a consequence of the legislation improvements and the decline of the interest rate which stimulates the economic activity.

In 1996 Bulgaria recorded the second most serious decline since the beginning of the nineties. The GDP decreased by 10.9%, the consumer price index reached 311% (December to December), the annual average exchange rate rose more than 9 times, more than one third of the commercial banks were shut down. The country was overtaken by a total crisis of confidence. Logically, a Government crisis was reached in the end of the year. Bulgaria met 1997 with a full and crushing crisis, both economic and political.

As early as in the autumn of 1996 the International Monetary Fund suggested that a currency board should be established in the country. In the beginning of 1997 it was already clear that the currency board was the best and, maybe, the only solution for normalisation and stabilisation of the situation in the country. Actually, with the appointment of a functionary government a style of behaviour was established in compliance with the currency board requirements. The Central Bank gradually withdrew from participation in the interbank and currency markets, stopped financing of the state budget and refinancing of the commercial banks. Closing down of the losing banks proved beneficial to the rest of them and they strengthened their assets.

The currency board was introduced in the country by an Act from 1 July 1997, according to which the local currency, BGL (Bulgarian Lev), was pegged to the DM at a rate 1000:1. As of the pegging date, the market rate was 10% lower, so with that pegging the local currency was officially devaluated by 10%. The public's confidence in the official state and financial institutions has been gradually returning. In the end of the spring the country concluded another (the fifth) stand-by agreement with the International Monetary Fund (IMF) the parameters of which were specified later on under the new regular Government. The provisions of the Agreement are strictly observed, as a result of which the country receives the scheduled tranches.

The inertia of the negative downward trend could not be overcome in such a short time. In 1997 the GDP recorded another significant decrease (about 7.5%), the consumer price index hit the top 578.5% (December to December) out of which 450% - within the first three months of the year only. The interest rates fell amazingly quickly to normal levels (on loans, for example, within the limits of 10-12% with 15 to 20 times higher levels in the beginning of the year). Throughout 1996 physical persons and business agents drew about DM 1800 mln. from the banking system, while over the second half of 1997 only the Central Bank bought back (net) DM 1150 mln. at the fixed rate of exchange. In parallel to that, currency deposits began to increase. Dollarization of the economy had reached 75% in February 1997, and went down to 45% at the end of the year. Reduced demand in the domestic market combined with the undervalued local currency contributed to accumulation of a significant surplus on the current balance-of-payments account which, together with the grants from international financial institutions, helped to increase the gross currency reserve of the country to about DM 4.5 billion in the end of 1997 (by way of example, 6 times higher than it was in the beginning of the year).

In spite of the GDP structure unreasonably encumbered with energy costs, the energy intensity of the production continued to grow (Figure 2.6). A large part of that increase can be accounted for by the growing activity of unregulated business which is estimated as 45% of GDP in 1997. The lack of a clearly enunciated and adequately backed with arguments strategy on energy production and demand contributed to the asymmetry observed (Table 2.8). 1995, in which the growth of GDP was achieved with a significantly faster development of energy consumption, stands out particularly vividly in that respect not without the distorted assistance of some official government institutions. Such asymmetry is obviously futureless in the longer term.

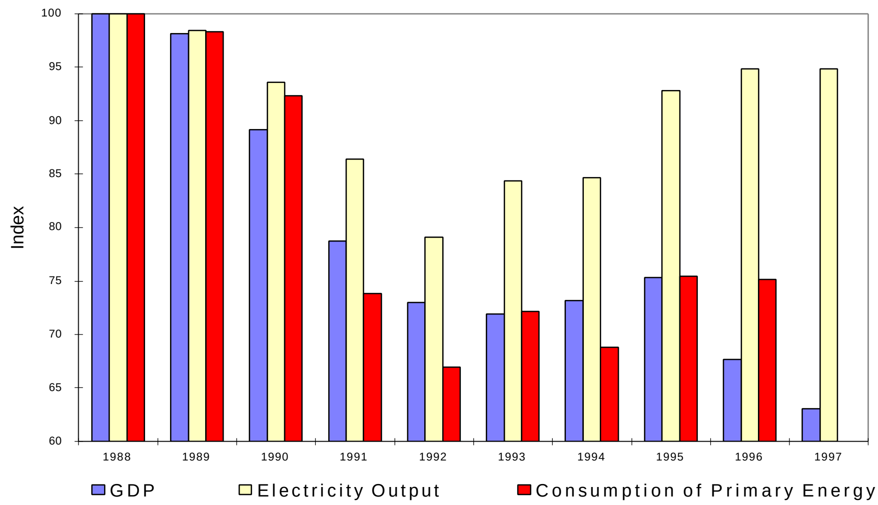

Figure 2.6. Energy intensity of production

GDP, Primary Energy and Electricity Supply Annual Growth Rates (%)

Table 2.8.

	1989	1990	1991	1992	1993	1994	1995	1996	1997*
GDP	-1.9	-9.1	-11.7	-7.3	-1.5	1.8	2.9	-10.1	-6.9
Electricity Supply	-1.6	-4.9	-7.7	-8.5	6.7	0.4	9.6	2.2	0.0
Primary Energy Demand	-1.7	-6.1	-20.0	-9.3	7.8	-4.6	9.6	-0.4	

* Preliminary data

The Government demonstrated its firm determination to adhere to a policy of stricter financial discipline. The budget is relieved in servicing of its colossal internal debt (due to the low interest rates) and manages to stay within the limits prescribed by the Parliament. The National Bank Act expressly prohibits financing of the budget expenditures, and the Government has only to cope with the difficulties in the expenditure part of the budget. Subsidising of losing production, as an option, becomes increasingly unacceptable, energy generation included.

The commercial banks adhere to a considerably more reasonable crediting policy. The Central Bank follows strictly the firm requirements of the currency board. One problem of the country is ensuring investment activity on an adequate scale. The commercial banks abstain from granting long-term credits, and the internal resources are scarce. Certain reviving of the foreign investors' interest is observed, but the process is still contradictory. The market imperatives would not allow maintenance of any inefficient structures, especially through wasteful utilisation of investments.

INDUSTRY

Bulgaria is an industrial country with exploration of natural resources (mainly coal industry), heavy industry (ferrous and non-ferrous metallurgy, mechanical engineering, chemical and oil processing industry, electrical and electronic engineering industries and light industry (i.e. food processing industry, textile, clothing industry)).

The beginning of the 1989-1997 period started with a decrease in the industrial output with the lowest production output registered in 1993. During 1994 and 1995 an upward trend was observed but it couldn't compensate previous drastic decrease. The production in 1996 was comparatively equal to that in 1995 but it was only 55.3% of the output in 1989 (Figure 2.7).

There is a new structure of the industrial sector that tends to be comparatively stable in the last few years. Chemical and oil processing industries have the greatest share of 27.2% followed by the food processing industry - 19.2%. Electricity and heat generation comprise for 10% of the industrial output. Machinery and metal processing follow with a share of 9.8%. The contribution of the subsectors in monetary values is given in Table 2.9.

The production in the state enterprises continues to decrease. 12 out of all 18 industrial brunches indicate decreased output. The most drastic decrease in 1996 was observed in paper and pulp industry, machine construction and black metallurgy.

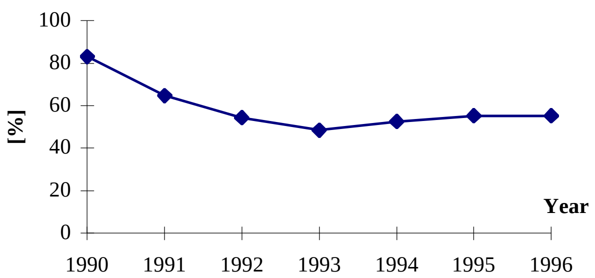

Figure 2.7. Production output (1989 = 100%)

The private sector increases its output and share. When compared to 1992 the private sector in industry has grown from 2.8% to 13.8% in 1996. Partially this is due to the privatization of some state enterprises.

Gross industrial output, million BGL

Table 2.9.

Year	1991	1992	1993	1994	1995	1996	1992	1993	1994	1995	1996
	Current prices						*Previous year prices*				
Gross output	172246	223174	253513	455676	767083	1726928	142944	196920	273332	500303	750766
Electrical and thermal power industry	15748	21128	25645	35131	58262	169074	12962	18669	24857	37134	59047
Coal industry	4020	6210	6807	8784	12823	39819	3857	6164	6575	9508	14364
Oil and gas extracting	90	223	371	638	1161	1814	89	337	409	989	716
Ferrous metallurgy	10831	8845	13618	28638	50963	103082	6100	11394	17005	33216	45587
Non-ferrous metallurgy	5799	9025	10282	24809	44765	95618	5712	10283	11416	25807	45083
Mechanical engineering and metal processing	20342	26428	30034	47370	82897	165361	15920	21111	28932	54205	66608
Electrical and electronic	13362	13832	14234	22808	38235	71852	9041	13074	13611	25808	36085
Chemical and oil processing	34472	43990	45689	107997	185178	473249	28752	38970	62624	131475	193519
Building materials	4052	4932	6449	12178	20201	43322	3266	4935	7448	13081	19849
Timber and wood processing	4511	6277	8192	13876	23423	45463	3972	5746	9125	13927	23520
Pulp and paper ind.	3154	2851	3279	6810	15566	25032	2851	2550	3685	8169	13263
Glass, china and earthenware	1770	2660	3265	6784	11272	24523	1461	2550	4020	7304	13168
Textile and knitwear	6656	9281	9872	17669	27808	55928	5836	7690	10160	17609	25158
Clothing industry	2407	3523	4445	8044	12682	24245	2149	3217	5005	7039	13993
Leather, fur and footwear industry	1973	3219	3757	7219	10519	21360	1779	2741	3857	6512	10743
Printing and publishing industry	1410	1758	3032	6557	10735	21306	1172	2273	3424	5593	8256
Food industry	39138	54232	57598	93040	151665	326990	34764	39793	56913	97028	153762
Other branches	2511	4760	6944	7324	8928	18890	3261	5423	4266	5899	8045
Intermediate consumption	126154	160151	178038	334777	557162	1298497	101507	137990	192646	389120	552479
Gross value added	46092	63023	75475	120899	209921	428431	41437	58880	80686	111183	198287

The overall conclusion is that the increased output in the last years is influenced by the good conditions for development of particular sectors but there is no a stable tendency of overcoming of the crisis in industry. Only the structural reform, successful privatization, financial stability and wider markets will guarantee increase of the industrial output.

ENERGY SECTOR

Before the World War II Bulgaria had the lowest electricity consumption in Europe (42 kWh/capita), 9 fold lower than the average in Europe. After the war and the access to the cheap Soviet market of energy resources a rapid electrification has began. In 1981 the mean European level of specific electricity consumption, i.e. 4500 kWh/capita, was achieved.

Bulgaria is relatively poor of indigenous energy resources. The only resource that is relatively abundant is lignite coal. Natural gas reserves have been discovered at Bulgaria Black Sea coast that could be an important source in future. About 70% of Bulgaria energy demand currently is met by imports.

The total primary energy consumption for the period 1990-1996 is given in Figure 2.8. It decreases at the beginning of the period and stays comparatively steady after 1992. The decrease in 1992 was by 38% compared to 1988.

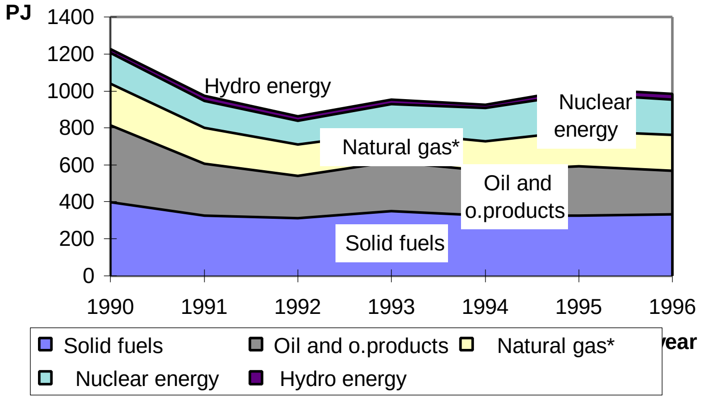

Figure 2.8. Total primary energy consumption

The total primary energy and final energy consumption follows the trend for primary energy consumption but it is diminished as a consequence of both GDP decline and the structural changes of some energy intensive industrial sectors such as ferrous metallurgy, machine manufacturing, building materials and others. A growing tendency had been observed in both primary and final energy demand in 1993, but in 1996 a new drop followed.

In Bulgaria electricity is produced out of coal, nuclear energy and in hydro power plants. The primary fuels used in electricity production are given in Figure 2.9 and data on the shares of primary energy resources input in the electricity production in 1996 is provided in Figure 2.10.

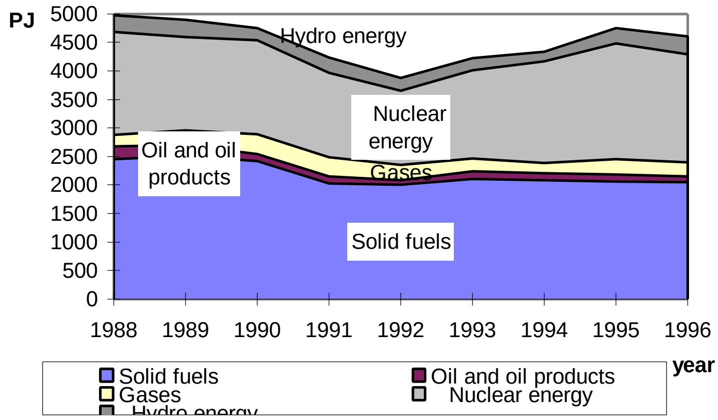

Figure 2.9. Primary energy carriers for electricity production

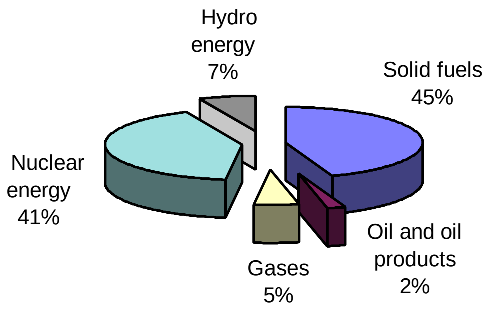

Figure 2.10. Structure of primary energy carriers for electricity production, 1996

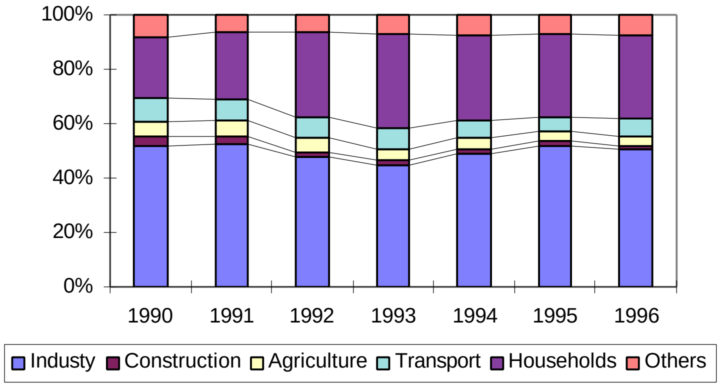

Figure 2.11. Sectors' shares in the final electricity consumption

Solid fuels, mainly indigenous lignite and nuclear energy prevailed in the structure of primary energy for electricity production with 45% and 41% in 1996 respectively. The portion of the utilised liquid fuels for electricity production was extremely small, i.e. 2% in 1996, and it gas decreased in the last years.

Oil processing industry in Bulgaria has a high priority since it allows not only to meet the demand for oil products on the internal market but for export as well.

The final energy consumption of Bulgaria is characterised by relatively stable share of solid fuels, oil and oil products and heat, while the electricity tends slightly to an increase and natural gas consumption has decreased strongly since 1992 due to the cut down of production output in chemical, rubber, glass, ceramic, iron and steel industries. The trend of the final energy consumption indicates that despite the industrial production decrease within the transition period, industry remains the major energy consumer. Thus in the final electricity consumption by economic sectors presented in Figure 2.11, industry accounted for 44% of the total electricity consumption in 1996.

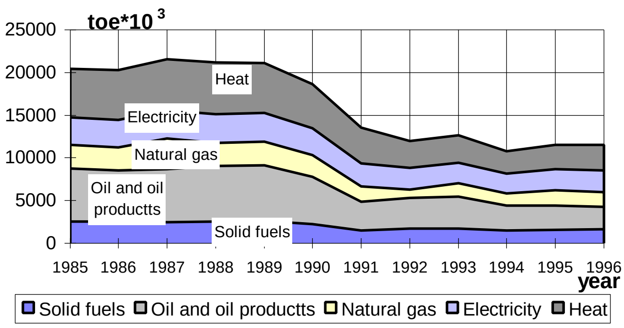

Figure 2.12. Final energy consumption

Electricity import and export [mln kWh]

Table 2.10.

Year	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Import	3289	1634	1173	1961	1803	785
Export	584	1518	1245	2121	2252	3308
Balance	-2705	-116	72	160	449	2523

(+) export; (-) import

Table 2.10 gives information on the import and export of electricity. There is a tendency of decreasing the import and increasing the export and since 1994 Bulgaria has become a stable net electricity exporter. The tendency is further developed and there is a possibility the electricity export to exceed 4 billion kWh annually. Thus from a net imported of electricity in 1988 (4146 mln kWh) Bulgaria became an electricity exporter.

The adequacy of the current energy policy is a factor to determine the future economic stability of the country, the national economic independence, and to ensure the population higher lifestyle. It is one of the key factors in the preparation of Bulgaria to integrate to the European Union. This is the reason energy sector to be set among the priorities of the Governmental policy till 2001.

ENERGY MARKET IN BULGARIA

The National Electric Company is a vertically integrated structure with 100% state participation, that produces 90% of the electricity in Bulgaria and is the only agent at transmission and distribution levels. The electricity demand and supply activities are organized in separate generation plants and distribution utilities which are not juridical self-standing and do not have separate accounting.

The current average trade price of electricity that allows the power sector to operate without subsidies is a tentatively good basis for improvement of the price and tariff policy and an important prerequisite for establishment of electricity market.

The coal mining subsection could be characterized by a developed market for coal and briquettes, existence of natural monopolies (“Matitza East” fields and a briquette factory that produce respectively 80% and 100% of the local energy coal and briquettes); low import dependence. The coal mining encompasses 16 state companies that could be categorized in 3 groups:

- the first group comprises of companies that have positive financial results and self-supported activities. They ensure 78% of the mined coal;
- the second group includes companies with underground mines that have higher expenses than the fixed or market prices for the respective coal quality. They account for 20% of the coal production.
- the third group includes 3 companies that are in process of liquidation.

The market principles are most widely introduced in the coal sector. The import coal has market prices. The domestic coal has partially liberalized prices. Six of the state companies and the briquette factory sell at state regulated price levels. The rest of the companies use contractual prices.

The use of natural gas is determined by its technological and environmental advantages. Despite the fact that in 1989-1992 period the consumption moved from 6.7 to 4.5 billion Nm^3 annually, the decrease is lower compared to the overall decrease of the energy consumption in the country and the share of the natural gas remains 19%. In terms of structure, the natural gas market in Bulgaria is characterized by a state monopoly “Bulgargas” that is the owner and operator of gas transmission system and the underground gas storage “Chiren”. The company controls the import, transmission and trade within Bulgaria mainly with industrial plants and district heating utilities. Since 1992 with the beginning of the gas supply to households the decentralization of the market has started. There are local gas distribution companies with private and municipal capitals that currently distribute about 0.5% of the natural gas consumed in the country. The natural gas used in Bulgaria is mainly imported. Over 99% of the import is from the Russians stock company “Gasprom”. Domestic extraction is negligible but it is expected its share to increase to about 7% in 2000 when the gas field “Galata” will be put in exploitation. Currently the natural gas prices are uniform for all consumers, that is an obstacle for the formation of a natural gas market. The prices are formed on the basis of the delivery prices plus transportation and pipeline exploitation expenses and a certain profitability rate for the state company.

In the heat supply market there are 21 district heating companies formed at a regional basis. 20 of them are state owned. “Sofia” district heating plant is a municipal property. In general, there are 1.5 million people, i.e. 19.8% of the population, connected to centralized district heating. In the consumption structure the heat energy for households comprises 70%. The most widely used fuel types are natural gas and residual, and in few cases - domestic coal. In 1997 the district heating companies had negative financial results due to the low fixed prices for the heat supply to households that do not cover the production and delivery expenses. Currently the prices are dependent on the type of the consumers:

- marginal prices for heat energy delivered to industrial plants based on the individual costs of each generation plant and profitability rate;
- fixed prices for the heat supply to households that are subsidized and substantially lower compared to the costs.

This situation combined with the lack of feasible alternatives for heating and the low incomes of the population hinder the introduction of economically reasonable prices.

The Committee of Energy has developed and submitted to the Government a project for a new Energy Strategy of the Republic of Bulgaria consistent with the national priorities and the principles of the market economy. The strategy matches the new positive political and economic tendencies in the country, as well as to the requirements of the European directives and is in compliance with the natural and geographical circumstances of the country.

For the development of energy market in the country the following prerequisites are to be ensured in the near future:

1. Adoption of legislative basis, harmonized with the legislation of the European Union. The draft Energy Act sets the normative framework for transition from centrally planed to market-based operation and development of the sector.
2. Structural reform towards market based energy sector; encouragement of the competition and privatization in the energy sector.
3. Market price policy to energy products that will also guarantee the interests of the society and the consumers. The goal of the price policy is to cover the costs of delivery to the end users where it is not yet done and gradually to attach the prices to the long-term marginal costs, and thus to ensure enough funds for energy systems operation and to guarantee investment recurrence.

TRANSPORTATION

As stated in the First National Communication, Bulgaria has a central position in the traffic connecting Europe with Asia and Africa. This fact turns the transport system into an important sector of the national economy. The transit flows go by rail and auto routes, pipelines, river and sea cruises. Therefore, with regard to the GHG emissions the automobile and pipeline transportation are to be taken into consideration.

The automobiles annually crossing the territory of Bulgaria are about 500 thousand cars and about 400 thousand freight vehicles. 85% of the transits are following the transeuropean routes, the most important of which are:

- Route No 4 (Berlin - Prague - Bratislava - Budapest - Sofia - Tessaloniki/Plovdiv - Istanbul). The distance on Bulgarian territory is 894 km.
- Route No 8 (Duras - Tirana - Scopie - Sofia - Plovdiv - Burgas/Varna) with 639 km in Bulgaria.
- Route No 9 (Helsinki - St. Peterbourg - Pskov - Kiev - Kishinew - Rousse - Dimitrovgrad - Alexandropolous) with 400 km on Bulgarian territory.
- Route No 10 that will have a fork from Nis to Sofia and thus it will be connected to route No 4.

The density of the networks can be considered appropriate but their quality is much lower than required. The entire Bulgarian infrastructure needs urgent measures for reconstruction and innovation of the existing networks.

Basic data on transportation sector are given in Table 2.10, and the classification of the vehicles by type is given in Table 2.11. It can be seen that the transportation infrastructure is not developed and the stock in Bulgaria reduces its potential every next year.

Basic data transport development

Table 2.10.

Year	**1960**	**1970**	**1980**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**
Length of railway lines [km]	5620	6040	6419	6604	6607	6560	6556	6508	6507	6490	6484
Roads [thous. km]	33	36.1	36.4	36.9	36.9	36.9	36.9	36.9	37.3	37.3	37.3
Airlines [thous. km]	5.4	28.1	77.5	153.1	136.2	134.4	175.4	282.5	210.9	149.4	152.4
Towns with trolleys lines [N]	2	2	2	13	14	15	16	16	16	16	16

Vehicles by type

Table 2.11.

Year	1990	1991	1992	1993	1994	1995	1996	1997
Locomotives	1111	965	943	939	878	872	813	773
Rail motor vehicle	94	93	90	90	88	88	87	86
Passenger carriages	1932	2009	1905	1797	1736	1753	1740	1737
Wagons	40918	40451	38347	37045	32199	29790	28236	27598
Lorries	37830	35062	27014	20667	16387	11958	10309	7749
Buses	13232	12716	11360	10287	9521	8537	8060	7293
Trolleys	863	844	845	836	822	820	807	780
Trams	444	459	449	431	423	416	397	368
Passenger cars	1317437	135876	1411278					
Sea cargo ships	13	13	10	9	9	6	3	3
Passenger liners	59	73	75	69	58	46	45	44

The gross production of the transportation companies in 1996 dropped by 12% compared to 1995. The decrease in the public sector was 9% and it was 17.4% in the private sector. The share of private sector in the final output was 37.4%.

As a whole the trends of the freight and passenger transportation are decreasing during the years of economy transition. The breakdown between different transportation modes for passengers and freight shows that the reduction is most peculiar in the auto transportation (both in public and private sector). It is important to note that the automobiles in Bulgaria are very old and highly polluting. Most of the existing private cars do not meet the environmental requirements. The current state of the transport sector directly related to the fuel and energy consumption and exhaust gases emissions in Bulgaria could be characterized as follows:

- very old equipment (particularly in terms of fuel use per km);
- low technical performance of the transportation vehicles due to bad maintenance and lack of spare parts;
- low quality of the materials used (fuels, oil, tiers, etc.);
- bad exploitation conditions (roads, driving modes, etc.);
- use of vehicle for inadequate transportation purposes;
- disturbed organization (lack of dispatching);
- reduced labour efficiency, due to the lower carrying capacity and speed.

Transportation sector currently consumes nearly 20% of the energy end use in the energy system of Bulgaria. This determines its place as an important source of pollution now and in the future.

AGRICULTURE

Before 1944 Bulgaria used to be an agricultural country with established foreign markets and traditions. The changed priorities in the country policy and the changed ownership during the period 1944-1989 distorted the existing infrastructure, but still the new organization established in the agricultural sector used to meet the demand for agricultural products not only of the domestic market, but also at the huge former USSR market.

The transitional period after 1989 is characterized with a process of land restitution. It is given back to its previous owners. Thus land becomes property of private farmers or joint companies. But the process is very complicated and lots of problems should be solved. The output levels before the transitional period are not yet reached.

The situation regarding the agricultural output is unstable (Figure 2.13). The decrease of the agricultural output was the greatest in 1993 (25.7% compared to the level in 1990). After a short revival in 1994 and 1995 the output was again decreasing in 1996. In 1997 the output was 20.2% higher compared to the 1996 with increase mainly in the plant growing.

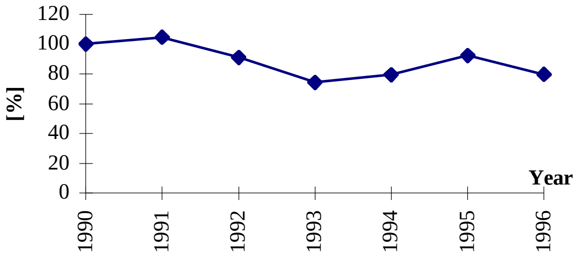

Figure 2.13. Agricultural output index (1990=100)

The main factors that contribute for the negative trend of the agricultural output are: the slow privatization process; the lack of funds and the adverse credit conditions; the high prices of input materials; worsened soil-climate conditions and droughts; distorted ratio between plant growing and livestock breeding; lack of market structures, appropriate legislation, and market studies.

In 1990-1996 period the main characteristics of the agricultural sector were as follows:

- General decrease of the arable land;
- Reduced share of the meadows, pasture and perennial plants;
- Increased share of the deserted and eroded land
- Increased share of the low yield areas in the semi-mountain regions;
- General decrease in the agricultural production;
- Random drainage of wet lands.

During the transitional period different size and performance private agricultural enterprises were established. They quickly responded to the technological and market conditions. Since 1994 there has been a tendency for large farms to be formed mainly through land leasing. If in 1993 the average area of the farms had been 12,7 ha, in January 1995 it was 31 ha. The private ownership was more explicit in livestock breeding subsector. There is a tendency producers' cooperations to become one of the main organizational forms in agriculture by 2000. They would grow bigger and it is expected to cover more than half of the arable areas and to organize highly efficient production.

Plant growing has been substantially reduced since 1990. The areas with cereals decreased by 12%. The areas with green crops, perennial plants and vineyards drastically dropped. The same is true for the areas planted with rice. The decrease is smaller in case of vegetables. The share of the arable land not used increased especially in hilly regions. The production efficiency of the plants is reduced. Since 1985 the use of inorganic fertilizers and pesticides has decreased. If in 1985 about 186 kg nitrogen had been applied to 100 ha land, in 1994 this quantity was reduced to 61.8 kg.

The total arable land in Bulgaria is 48047 thousand dka (31 December 1996). 45583 thousand dka of this land is privately owned. The increase in private owned land compared to 1990 is more than 5 folds. The land reform is responsible for this change. Unfortunately there is also an increase of the land not planted. Factors hindering the development of agricultural sector are the old technologies that exist in the country and the bad allocation of land.

A negative tendency is also evident in livestock breeding. The number of animals decreases, as well as the output products of the livestock breeding. There are two main tendencies in the subsector distinguished in the period 1989-1996, i.e. a sharp decrease of the animal stock and animal production and a shift towards private sector. The bulls decreased by 58.7%, cattle - by 42.5%, sheep - by 55.7%, swine - by 50.4%; poultry - by 31.2 %. The decrease in 1995 to 1993 as meat was by 51.2%. At the same time 77% of the bulls and 82% of the cattle, 92.6% of the sheep, 51% of the swine and 71% of the poultry in 1994 were breaded in private farms.

In general livestock breeding is the more stable subsection in agriculture. In the 1989-1996 period the agricultural sector contributes for about 11-15% of the GDP. The relative number of the population occupied in the agricultural sector is 24 - 25%.

FORESTRY

The total forest area in Bulgaria in 1995 was about 3.77 million ha, i.e. 34% of the country territory. The territory of forests with national importance is 97.4% of the total forest area. The review of the forest land in the 1955-1995 period indicates increment due to the annual afforestations of 9165 to 89660 ha. Thus about 1.2 million ha new forest appeared, i.e. within 40 year period, forests had been established to one third of the current forest areas. The creative policy in the field of forestry resulted in a quick increase of the total volume of above-ground mass of wood in the forest of Bulgaria for the 1955-1995 from 244.7 to 456.7 million m^3, i.e. by 86.6% for the 40 years period.

Another direction of forestry policy is the increase of the share of protected forests. In 1955 they were 8.4% and in 1995 - 39.8% of the total forest area. Some of the largest European national parks are located in Bulgaria, e.g. Rila - over 100 000 ha, the Central Balkan - over 72 000 ha. This is of great importance for conserving biological diversity and for development of tourism.

Basic statistical data on the Bulgarian forests for the 1955-1995 period are given in Table 2.13.

Basic data on the Bulgarian forests for 1955 - 1995

Table 2.13.

Characteristics	1955	1960	1965	1970	1975	1980	1985	1990	1995
1. Total area, mln ha	3.67	3.64	3.51	3.60	3.69	3.74	3.77	3.77	3.77
2. Afforested area, mln ha	3.15	3.19	3.05	3.07	3.13	3.20	3.24	3.26	3.26
3. Percentage of conifers	14.00	16.70	23.50	26.50	29.70	33.10	36.10	37.00	32.70
4. Protected forests, %	8.40	10.30	12.20	15.60	19.00	25.90	29.20	30.90	39.80
5. Mean increment, mln m^3	6.10	6.15	5.90	6.47	6.83	7.62	9.11	10.97	12.35
6. Total volume, mln m^3	244.7	243.5	248.1	257.6	268.5	296.8	336.7	396	456.7
7. Cut (planned), mln m^3	6.82	6.68	6.84	6.92	6.86	6.54	6.45	6.37	6.24
8. Cut (actual), mln m^3	7.45	8.57	8.16	7.14	6.32	5.91	5.53	4.68	4.76
9. Produced seedlings, mln (n)	414.3	1.357.7	598	766.7	637.2	385.9	351	347	156
10. Afforestation , x 1 000 ha	34.34	89.66	40.28	50.82	48.97	41.54	29.62	28.04	9.165

The changes in the annual increment, foreseen and the actual cut in Bulgaria for the 1955-1995 are given in Figure 2.14. It indicates that the mean annual increment of wood in the Bulgarian forest has increased from 6.1 to 12.35 million m^3/year, i.e. twice.

The planned cut has been relatively constant within the range of 6.37-6.92 million m^3/year. The actual cut was seriously changed: till 1970-1975 it exceeded the mean increment and since then it dropped below the annual increment of the aboveground mass.

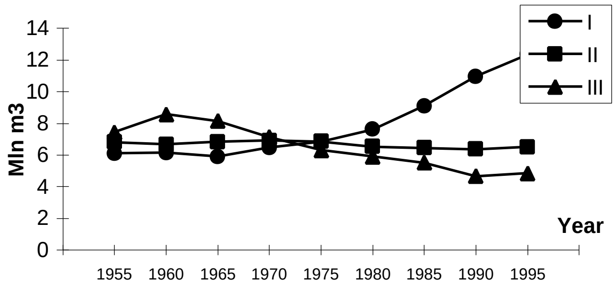

Figure 2.14. Mean increment (I), foreseen cut (II), and actual cut (III) in the forests of Bulgaria for the period 1955-1995

Carbon balance of the epigeaus biomass of the Bulgaria forests for the 1955-1995 period

Table 2.14.

Year	Increment	Yield	Balance	ODM K=0.6	Carbon accumulation	CO_2 offset
	mln. m3				mln. t	
1955	6.10	7.45	-1.35	-0.81	-0.36	-1.33
1960	6.15	8.57	-2.42	-1.45	-0.65	-2.40
1965	5.90	8.16	-2.26	-1.36	-0.61	-2.23
1970	6.47	7.14	-0.67	-0.40	-0.18	-0.66
1975	6.83	6.32	0.51	0.31	0.14	0.50
1980	7.62	5.91	1.71	1.03	0.46	1.70
1985	9.11	5.53	3.58	2.15	0.97	3.54
1990	10.97	4.68	6.29	3.77	1.70	6.22
1995	12.35	4.76	7.59	4.55	2.05	7.50

The consequences of the forestry long-term policy in Bulgaria are positive. As shown in Table 2.14 the carbon sink in Bulgaria changed from -0.36 Mt in 1955 to 2.05 Mt in 1995 and the CO_2 sequestered changed from -1.33 Mt to 7.5 Mt in 1995. The tendency is well represented in Figure 2.15 that provides information on the carbon balance of the forests in Bulgaria for the last 40 years.

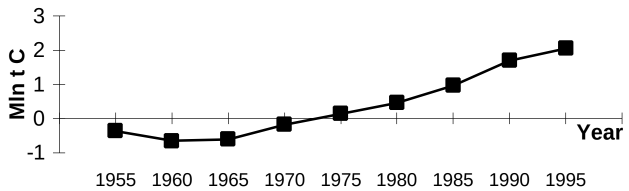

Figure 2.14. Changes of the amounts of carbon accumulated in the forests of Bulgaria in the period 1955-1995

The distribution of the forest in Bulgaria according to the three species, area, wood volume and annual increments in 1995 is given in Table 2.15.

Distribution of the forests of Bulgaria according to the tree species, areas and volumes of timber, 1995

Table 2.15.

No	Tree species	Areas thousand ha	Volumes	Increments
			thousand m^3	
1.	*Pinups sylvestris L.*	562.73	84508.7	3246.5
2.	*Pinus nigra Arn.*	313.64	21934.9	997.2
3.	*Picea abies (L.) Karst.*	153.87	34583.2	545.0
4.	*Abies alba Mill.*	30.53	9984.0	125.7
5.	Other conifers	38.30	5649.1	162.1
	Total conifers	**1099.08**	**156659.9**	**5076.5**
6.	*Quercus sp.*	1286.04	99029.1	2676.8
7.	*Fagus sylvatica L.*	477.66	101977.3	1610.7
8.	*Robinia pseudoacacia L.*	90.28	4918.7	411.2
9.	*Carpinus betulus L.*	86.82	15015.7	416.9
10.	*Tilia sp.*	41.77	5676.4	208.2
11.	*Populus sp.*	22.32	1771.4	186.1
12.	Other broad-lived	155.11	12350.7	519.6
	Total broad-leaved	**2159.99**	**240379.3**	**6029.5**

¾ ¾

CHAPTER 3

INVENTORY OF GREENHOUSE GAS EMISSIONS IN BULGARIA

This chapter presents the results of the GHG emission inventory for Bulgaria within the period 1990-1995. The inventory starts with 1988 which is the base year for the implementation of UN FCCC in Bulgaria. In most of the cases the IPCC Guidelines (IPCC, 1995) are followed. Trends of the emission levels of the main GHG and precursors are given, as well as the structure and their contribution to the aggregated CO_2 equivalent emissions.

¾ ¾

INTRODUCTION

This section provides data on the emissions of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and GHG precursors (NO_X, CO and NMVOCs) for the period 1990-1995. The emissions of Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6) are not addressed in the studies for Bulgaria up to now and there is no a calculation methodology adjusted for Bulgaria and no emission estimated yet. Those gases will be included in the next inventory of GHG emissions, together with the recalculated GHG emissions in accordance with the Revised 1996 IPCC Guidelines for National GHG Inventories.

The Global Warming Potential (GWP) values used to estimate CO_2, CH_4 and N_2O emissions contribution in the aggregated GHG emissions of the country are given in Table 3.1, as required by IPCC (IPCC, 1996). Estimates on NOx, CO, NMVOC, CFCs and Halons are not included at this stage because of their small contribution to the total emissions of GHG in Bulgaria.

GWP for a 100 years time horizon

Table 3.1.

GAS	CO2	CH4	N2O
GWP	1	21	310

METHODS OF ESTIMATION

In general, the GHG estimation methods follow the IPCC Guidelines for National Greenhouse Gas Inventory (IPCC, 1995). Other estimation methods have been used whereas appropriate in order to achieve better estimates for particular cases, e.g. GHG emissions from transport sector.

GHG emissions are computed using data for each category and each economic sector further multiplied by the specific emission factors. The key data sources are the statistics of the Bulgarian National Statistical Institute.

The estimation of the GHG emissions from fuel combustion is based on the “bottom-up” approach and emission factors’ values determined by experimental measurement, expert judgments or are the default emission factors recommended by the IPCC Guidelines. The emissions from mobile sources are calculated according to the IPCC structure for vehicle categorizing but with additional split of the vehicles according to their weight and engine volume in compliance with the guidelines in CORINAIR90. Thus a list of emission factors is coined which corresponds to the Bulgarian conditions.

The inventory starts with 1988 which is the base year for implementation of UN FCCC in Bulgaria. The relevant emission information for this year is given in the First National Communication. The current Communication develops the inventory by adding information on the emissions in 1994 and 1995, as well as by updating the information for the previous years of the period 1990-1995.

The main differences in comparison to the First National Communication are as follows:

Energy sector

- Revised emission factors for the combustion processes in the power plants and plant boilers due to precision of the information on the solid fuel combustion technologies;
- Changes in the categorization of the vehicles in road transport;

Industrial processes

- Revised activity data on pig iron as source of CO_2 emissions;
- Adjusted amounts for the steel production in electric ovens;

Waste

- Changes in the methodology of the National Statistical Institute for solid waste estimates in landfills;
- Precision of the industrial wastewater flows in compliance with the IPCC Guidelines;

The inventory results are obtained within the frame of the Bulgaria Country Study Project and the follow-up stage Support for National Action Plan (SNAP).

The overall emissions for 1988 and for the 1990-1995 period are given in Table 3.2.

Total anthropogenic GHG emissions in Bulgaria [Gg]

Table 3.2.

	1988	1990	1991	1992	1993	1994	1995
CO_2	96878	85278	67020	61037	63257	60390	63109
CH_4	1412.7	1420	1358	1250	1117	826	901
N_2O	30.8	29.6	23.2	19.1	17.5	17.7	20.6
NOx	486.35	250.8	191.4	179.4	183.7	162.8	161.3
CO	826.59	951.8	738	755	767.7	707.3	760.6
NMVOC	132.3	104.9	58.3	62.4	67.9	65.6	73.4

The analysis of Table 3.2 indicates a decrease in the fluctuations of the GHG emissions since 1992. In the period 1992-1995 the emissions stayed comparatively similar and lower compared to the previous few years.

A necessary remark concerning the GHG emissions from the energy sectors is related to the changes in the power sector in Bulgaria. In the past Bulgaria electric power system has had electricity exchange with neighboring countries and the former Soviet Union. The total electricity exchange balance (import 4450 GWh, export 304 GWh) resulted in import of 4146 GWh in 1988. In the past few years the electricity import has been reduced that resulted in the exchange balance near to zero.

In order to produce the same quantity of electricity that was imported in 1988 in its own plants the Bulgaria Electric Power System would have to consume more fossil fuel. The least-cost production schedule of the electricity generating units to produce in addition the insufficient electricity shows that an additional CO_2 amount of 6321 Gg CO_2 would have to be emitted. The real 1988 operation conditions of the electricity generation units and additional electricity consumption for auxiliaries have been considered when the emission quantity was calculated.

EMISSIONS and SINKS of CO_2

Fossil fuel combustion and change in land use are the two primary reasons for the observed increase of the atmospheric CO_2. Cement, lime, glass, steel, pig iron, ammonia and soda production/consumption are other important sources. The activities in the forestry and the changes in land use are two-sided, i.e. they are CO_2 emitters and sinks simultaneously.

The emissions of CO_2 are estimated using both methods recommended in the IPCC Guidelines. In the CO_2 inventory the "top-down" (reference) approach is widely used. In contrast to the "bottom-up" approach which specifies the emissions by sector and source-technology, this method starts from the total fuel quantities used in the combustion and transformation processes.

Table 3.3 gives information on the total CO_2 emissions according to the two stated approaches. The deviation of the results received by application of both methods is within the range of 0.4-7.97%.

CO_2 emissions from fuel combustion, Gg

Table 3.3

N	Approach/Year	1988	1990	1991	1992	1993	1994	1995
1	"Top-down"	90730	78715.63	61286.41	56570.01	61771.86	58040.58	61098.17
2	"Bottom-up"	90327	76483.6	60626.2	55416.46	57650.49	54321.90	56255.1
	Difference, %	0.44	2.84	1.08	2.04	6.67	6.41	7.97

The enumerated differences are due to:

- different operation modes of the processing technologies (oil refineries, coke batteries, etc.);
- different operation modes of the fuel stores;
- different emission factors at the input and output of the transformation processes;
- statistical difference in the energy balance sheets, due to problems related to the accurate accounting of the export and changes in the ownership, because of the privatization process.

The overall estimates of CO_2 emissions and sinks in Bulgaria in 1988 and in the period 1990-1995 allocated by sectors are given in Table 3.4.

Total CO_2 emissions and sinks in Bulgaria by sectors

Table 3.4

	1988	1990	1991	1992	1993	1994	1995
National CO_2 emission (Gg)							
Energy (stationary combustion)	79574	64727.6	53782	48416	49468	47143	48830.9
Transport (mobile combustion)	10753	11756	6845	7000	8183	7179	7394.2
Industry (process emissions)	5890	7200	475.1	4023	4103	4812	5601.8
Others	661	1594.4	1642	1598	1503	1256	1282.1
National CO_2 sinks (Gg)							
Managed forests	-4657	-5801	-7880	-7636	-7022	-6974	-7520

As the data in the First National Communication indicates, the fossil fuels prevail in the structure of primary energy resources used in Bulgaria. As a consequence fossil fuel combustion is the most important source of CO_2 in Bulgaria that accounts for more than 90% of the total CO_2 emissions (Figure 3.1). At the same time energy production and transformation activities are the most important sources among the energy-related CO_2 emitting activities with share of about 65-70%. This exceeds the total contribution of all other energy related emissions.

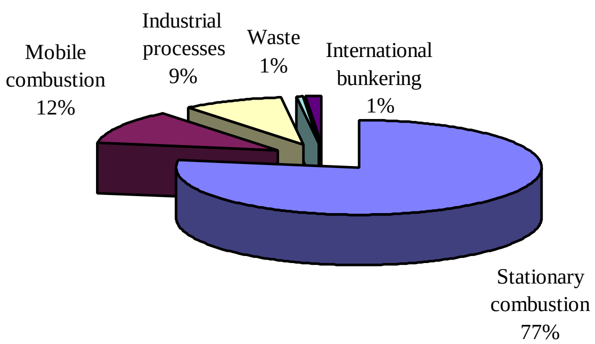

Figure 3.1. CO_2 emissions by sectors in 1995

Among the fossil fuel combustion sources of CO_2, the energy transformation industry is the major one. The second important source is the transportation sector. Its share of 11.1-14% is smaller compared to the developed countries. Sector *industrial processes* is ranked third.

The historical trends of CO_2 emissions and their allocation among stationary combustion, mobile combustion, industrial processes, agriculture and waste management in the period 198 8-1995 are shown on Figure 3.2.

Stabilisation of CO_2 emissions level was achieved in 1987 and 1988 due to the commitment of a 1000 MW nuclear unit. In 1989 the first signs of an economic recession appeared, and a decrease in CO_2

emission occurred. It lasted till 1992, although the lowest level of GDP was achieved in 1994. In 1993 and later on the CO_2 emission level was increasing due to the recovery of the national economy.

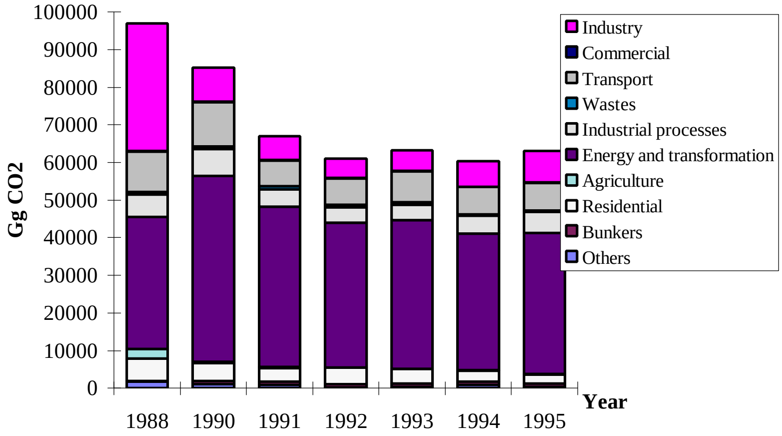

Figure 3.2. Historical trends of CO_2 emissions by sectors in Bulgaria

CO_2 Sinks

The territory of Bulgaria is about 110 994 sq. km. including approximately 30% of forests.

Forest clearing and land use changes are not observed in Bulgaria and therefore only managed forests are considered as an emission/source category. Due to the intensive process of afforestation after 1950 and the normalisation of wood harvesting since 1985, the annual increment of Bulgarian forest exceeds substantially the annual cut. Therefore, managed forest acts as a net sink.

Data for calculation of a forest sink capacity are based on the forests inventories carried out every five years, as well as on statistics for annual forest harvesting.

The historical trend of the forest CO_2 sinks capacity within the period 1987-1995 is shown on Figure 3.3. Since 1990 a positive tendency of increase in CO_2 absorption by forest can be observed due to the lower actual cut compared to the projected cut.

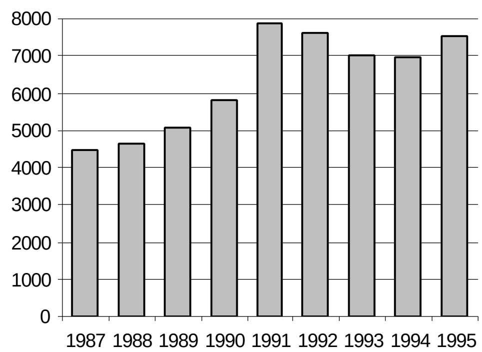

Figure 3.3. Historical trends of forest CO_2 sinks in Bulgaria

METHANE EMISSIONS

Methane emissions in Bulgaria by sectors in 1988 and the changes in the subsequent period are displayed in Figures 3.4 and 3.5, respectively. Wastes are the major source of methane and the major portion is emitted by landfills. There are serious change when compared to the First National Communication in the emissions from this sector. The results are due to the changed methodology for waste estimates in the National Statistical Institute and respectively to the drastic drop in the solid wastes per capita.

The second important source is the coal mining and the production of oil and natural gas. More than 77.7% of the coal in Bulgaria is extracted through open-cast mining. The fugitive methane emissions per unit production in open coal mines is 15 times less than in underground mines. Therefore the overall emissions from coal production are comparatively small - 5-8% from the total emissions.

The emissions from natural gas and oil systems are also low - 14 .3-16.3%, due to the fact that the natural gas and oil systems are not quite developed yet.

The livestock breeding in the agricultural sector is the third important methane source.

In general, a stable decrease of the CH_4 emission is observed during the entire study period.

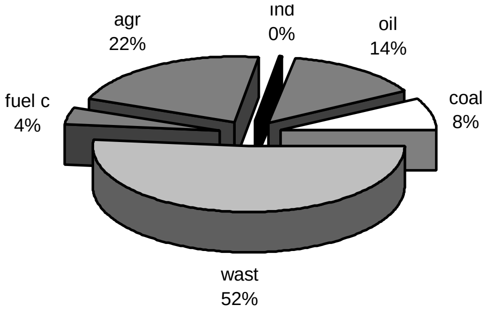

Figure 3.4. CH_4 emissions in Bulgaria in 1988 by sectors

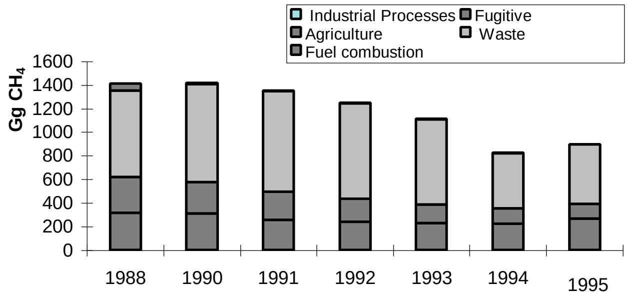

Figure 3.5. CH_4 emission trends in Bulgaria by sectors

N_2O EMISSIONS

Figure 3.6 shows the N_2O emissions by sources in the base year (1988). Three major sources of N_2O emissions are identified in Bulgaria. The application of mineral fertilizers is the main source. Production of nitric acid is the second important source of N_2O emissions and the stationary combustion is the third one.

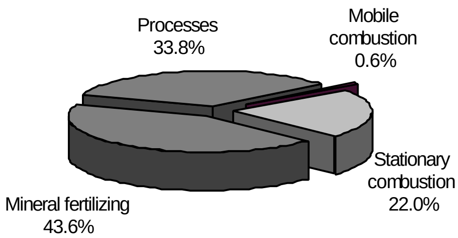

Figure 3.6. N_2O emissions in Bulgaria in 1988

Figure 3.7 shows the N_2O emissions trends. A significant decrease of the emissions due to application of mineral fertilizers is observed entailed by the economic crisis and to the structural changes in agriculture. Therefore, from 1990 till the end of the period the stationary combustion became the most important N_2O emission source.

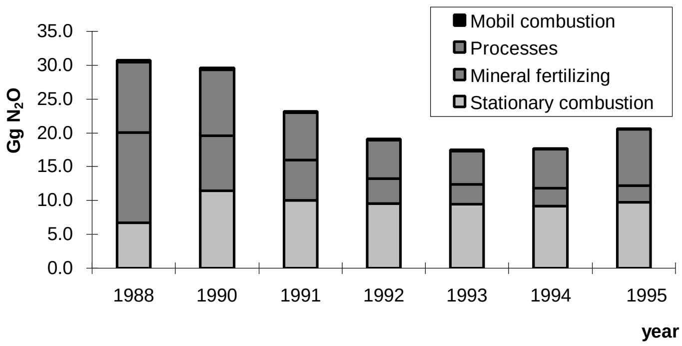

Figure 3.7. N_2O emission trend in Bulgaria

PRECURSORS EMISSIONS: NO_x , CO AND NMVOC

The greenhouse gases precursors are also addressed in the national GHG inventory. The main NO_X emission sources identified in Bulgaria are the stationary and mobile combustion, plus the emissions from international bunkering. Figure 3.8. shows the NO_X emission trends.

It reveals steady decrease till 1992, followed by a slight increase in 1993 and once again drop of NOx emissions in 1994. The second important NOx emitter (transportation sector) takes the first position only in 1990. This is due to the drastic increase in travels and transportation activities in the changed situation of the East Europe.

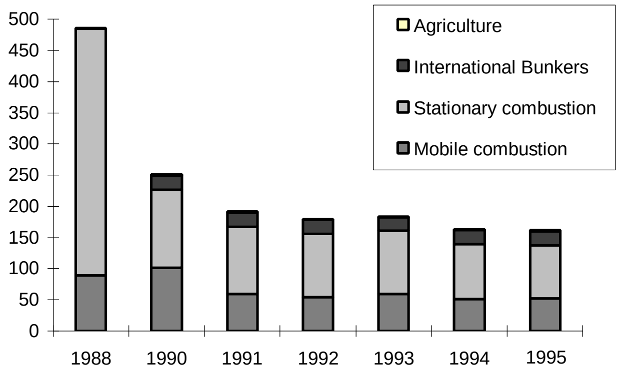

Figure 3.8. NO_X emission trends in Bulgaria

There are three main CO emitters in Bulgaria - transport, stationary combustion, agricultural wastes and biomass burning. In 1988 and 1990 the shares of these sources in the total CO emissions were estimated as follows:

- 53.9% and 46.7% - transport;
- 29% and 15.1% - stationary combustion;
- 4.5% and 6% - agricultural waste burning;
- 12.7% and 32.2% - biomass burning.

Figure 3.9 shows the CO emission trends. The different shares of sectors' contribution to the CO emissions in 1988 and 1990 could find explanation in the start up of the economic reforms in the Eastern Europe. In general, the period 1988-1994 is characterised by uneven decrease in the emission level. The variations in the emission levels is related with the diversity of sectors, as type and dynamics, and combustion technologies contributing to the CO emissions.

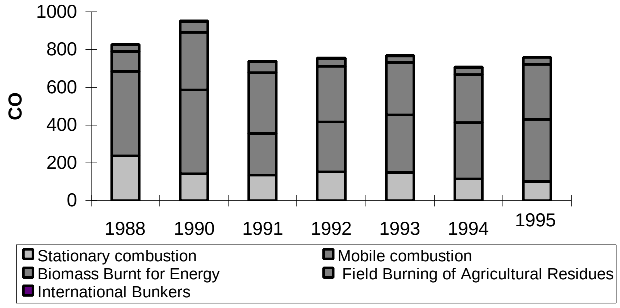

Figure 3.9. CO emission trends in Bulgaria

The anthropogenic emissions of NMVOCs in 1988 and 1990 were estimated for two major sources - transportation and solvent use. As there is no available data on solvents import, only the local production is considered. Figure 3.10 shows the NMVOCs emission trends.

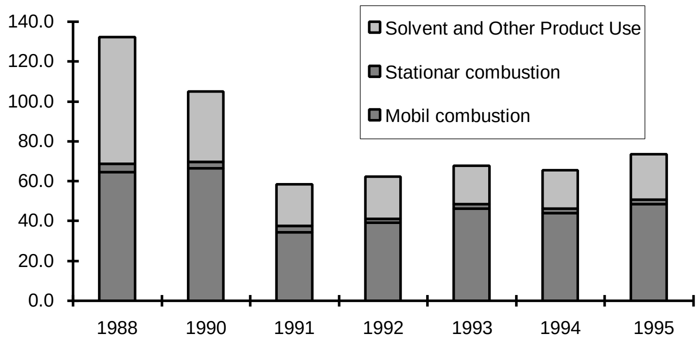

Figure 3.10. NMVOCs trends in Bulgaria

The emissions from mobile sources despite the drop of 48% in 1991 compared to 1990, as a whole are steadily increasing in the period till 1995. The second greatest NMVOC emitter, i.e. solvent use, fixes at 19-20 kt levels after the sharp drop in 1991.

The Summary Tables for the inventory period 1990-1995 are provided at the end of the Chapter. The Standard Tables for 1995 are given in Annex A in compliance to the recommended format in the IPCC Guidelines (IPCC, 1995).

CO_2 EMISSIONS PER GDP AND PER CAPITA

The share of Bulgaria in the global anthropogenic emissions is about 0.3-0.4%. If this indicator is analyzed Bulgaria is far behind the world's largest CO_2 emitters. But when comparing in terms of emissions per capita and emission per GDP, Bulgaria is ranked in the front.

The analysis of the total GHG levels by type of emissions reveals a general tendency for emission decrease. The comparison of the emissions per capita and per unit GDP shows the same tendency. The total emissions, emissions per capita and emissions per unit of GDP for the 1990-1995 period are given in Table 3.5.

CO_2 emissions per capita and per GDP

Table 3.5.

Indicator/ Year	1990	1991	1992	1993	1994	1995
Total emissions [Gg]	85278	67020	61037	63257	60390	63109
Population - million	8669.3	8595.5	8484.9	8459.8	8427.4	8384.7
Emissions [kg/capita]	9837	7797	7194	7477	7166	7527
GDP [billion $ US]	20.73	17.93	16.84	16.05	16.13	16.40
Emissions [kg/US $1000]	4114	3738	3625	3941	3744	3848

The results show that in 1995 there were decreases of 6.5% of the CO_2 emission per GDP and 23.5% of the CO_2 emissions per capita, respectively, compared to the values in 1990. Figure 3.11 represents the trends in those indicators. As seen the emissions per GDP are comparatively constant through the period. After the initial drop (1990-1992) the CO_2 emissions per capita also stabilize within the range of 7-8 t/capita which is comparatively high values when compared to the rest of the Parties. It should be noted that the constant values are due to the economic rises and do not rely on implementation of mitigation measures.

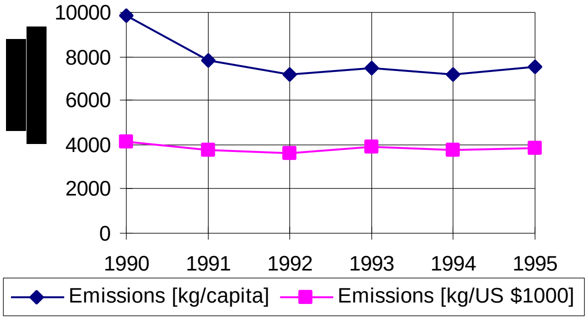

Figure 3.11. CO_2 emissions per capita and per 1000 $US GDP for the period 1990-1995

RECALCULATION OF GHG EMISSIONS AS CO_2 EQUIVALENT

In contrast to the First National Communication, the aggregated GHG emissions in the Second National Communication are estimated with the Global Warming Potential values from IPCC, 1996. The corresponding recalculated GHG emissions for the period are given in Tables 3.6.

Aggregated GHG emissions [Gg CO_2 equivalent]

Table 3.6.

Emissions	1988	1990	1991	1992	1993	1994	1995
CO_2 [Gg]	96878	85278	67020	61037	63257	60390	63109
CH_4 [Gg]	29667	29820	28518	26250	23457	17346	18921
N_2O [Gg]	9548	9176	7192	5921	5425	5487	6386
TOTAL [Gg CO_2 eq]	***136093***	***124274***	***102730***	***93208***	***92139***	***83223***	***88416***
Percent to 1988.	***100***	***91.32***	***75.49***	***68.49***	***67.70***	***61.15***	***64.97***

The results indicate a downward trend in the aggregated GHG emissions that was broken in 1995, when a slight increase can be observed.

Table 3.7 provides information on the shares of the main greenhouse gases in the aggregated emissions. As seen the emissions of CO_2 take the lead with percent share of 65 to 73%. Methane emissions that are ranked second tend to decrease their share in the last few year. The emissions of N_2O keep a stable 6-7% contribution in the national GHG emission totals.

Contribution of main gases to the aggregated GHG emissions in Bulgaria

Table 3.7.

Emissions	1988	1990	1991	1992	1993	1994	1995
CO_2 [%]	71	69	65	65	69	73	71
CH_4 [%]	22	24	28	28	25	21	21
N_2O [%]	7	7	7	6	6	7	7

QUALITY ASSESSMENT OF THE EMISSION ESTIMATES

The data on greenhouse gas emissions presented in this study can not be considered as final. In Bulgaria pilot studies on this problem were initialized in 1992 on the base of the IPCC methodology. With regard to the limited financial resources, the national statistics shortcomings and the specific fuels characteristics, further information on sources and emissions can be obtained only step by step. The next inventory would be developed following the Revised 1996 IPCC Guidelines as required. The activity data according to the JSIC is ready, as well as there are some preliminary estimations for the SO_2 emissions.

In accordance with the Overview table provided in IPCC Guidelines there is a self-assessment of the quality of the results obtained. It is given in Table 3.8. The assessment provides just a tentative assessment of the inventory quality, since it is difficult to evaluate the accuracy of estimates using a single, uniform standard applied to the activity data and emission/removal factors that provide the basis of the inventory and have widely varying characteristics.

1990

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS EMISSIONS (Gg)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	HFCs	PFCs	SF_6
Total National Emissions and Removals	85278	5801	1420	29.7	250.8	951.7	104.9			
1 All Energy (Fuel Combustion + Fugitive)	76484	0	318.6	11.8	226.4	892.3	69.6			
A Fuel Combustion	76484	0	7.5	11.8	226.4	892.3	69.6			
1 Energy & Transformation Industries	49249		2.9	11.3	99.6	13.5	2.8			
2 Industry	9086		0.2	0.0	11.5	6.5	0.0			
3 Transport	11756		2.9	0.3	101.3	442.3	66.6			
4 Small Combustion	5378		0.2	0.2	8.4	121.1	0.0			
5 Other	1015		0.0	0.1	2.4	2.5	0.1			
6 Traditional Biomass Burnt for Energy	0		1.2	0.0	3.3	306.5	0.0			
B Fugitive Emissions from Fuels	0	0	311.0	0.0	0.0	0.0	0.0			
1 Solid Fuels			79.0							
2 Oil and Natural Gas			232.1							
2 Industrial Processes	7200		2.8	9.7	0.0	0.0	0.0			
3 Solvent and Other Product Use							34.9			
4 Agriculture	0	0	264.5	8.2	2.0	57.7	0.0			
A Enteric Fermentation			179.8							
B Manure Management			77.4							
C Rice Cultivation			4.5							
D Agricultural Soils	0			8.2						
E Prescribed Burning of Savannas										
F Field Burning of Agricultural Residues			2.7	0.1	2.0	57.7	0.0			
G Other										
5 Land Use Change & Forestry	0	5801	0.0	0.0	0.0	0.0	0.0			
A Changes in Forest and Other Woody Biomass Stocks		5801								
B Forest and Grassland Conversion										
C Abandonment of Managed Lands										
D Other										
6 Waste	721	0	833.7	0.0	0.0	0.0	0.0			
A Solid Waste Disposal on Land	721		720.6	0.0	0.0	0.0	0.0			
B Wastewater Treatment			113.0							
C Waste Incineration			0.0							
D Other Waste			0.0							
7 Other										
International Bunkers	874		0.0	0.0	22.4	1.8	0.3			

1991

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS EMISSIONS (Gg)										
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	HFCs	PFCs	SF_6
Total National Emissions and Removals	67020	7880	1358	23.2	191.4	737.7	58.3			
1 All Energy (Fuel Combustion + Fugitive)	60626	0	263.6	10.2	166.8	678.3	37.5			
A Fuel Combustion	60626	0	6.0	10.2	166.8	678.3	37.5			
1 Energy & Transformation Industries	42449		2.9	9.8	87.6	12.3	3.1			
2 Industry	6363		0.1	0.0	7.8	2.8	0.0			
3 Transport	6845		1.4	0.2	58.9	218.6	34.4			
4 Small Combustion	4085		0.1	0.2	7.1	120.1	0.0			
5 Other	884		0.0	0.1	2.0	1.0	0.0			
6 Traditional Biomass Burnt for Energy	0		1.3	0.0	3.5	323.5	0.0			
B Fugitive Emissions from Fuels	0	0	257.6	0.0	0.0	0.0	0.0			
1 Solid Fuels			65.5							
2 Oil and Natural Gas			192.1							
2 Industrial Processes	4751		2.1	7.0	0.0	0.0	0.0			
3 Solvent and Other Product Use							20.5			
4 Agriculture		0	0	239.9	6.0	2.0	57.7	0.0		
A Enteric Fermentation			165.7							
B Manure Management			68.0							
C Rice Cultivation			3.5							
D Agricultural Soils	0			5.9						
E Prescribed Burning of Savannas										
F Field Burning of Agricultural Residues			2.7	0.1	2.0	57.7	0.0			
G Other										
5 Land Use Change & Forestry	0	7880	0.0	0.0	0.0	0.0	0.0			
A Changes in Forest and Other Woody Biomass Stocks		7880								
B Forest and Grassland Conversion										
C Abandonment of Managed Lands										
D Other										
6 Waste	764	0	852.3	0.0	0.0	0.0	0.0			
A Solid Waste Disposal on Land	764		763.9	0.0	0.0	0.0	0.0			
B Wastewater Treatment			88.4							
C Waste Incineration			0.0							
D Other Waste			0.0							
7 Other										
International Bunkers	878		0.0	0.0	22.6	1.7	0.3			

1992

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS EMISSIONS (Gg)										
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	HFCs	PFCs	SF_6
Total National Emissions and Removals	61037	7636	1250.4	19.1	179.4	755.0	62.5			
1 All Energy (Fuel Combustion + Fugitive)	55416	0	246.3	9.8	155.7	713.0	41.3			
A Fuel Combustion	55416	0	4.9	9.8	155.7	713.0	41.3			
1 Energy & Transformation Industries	38470		1.7	9.5	82.9	9.9	2.0			
2 Industry	5141		0.1	0.0	6.5	2.9	0.0			
3 Transport	7000		1.7	0.1	54.0	262.1	39.3			
4 Small Combustion	4609		0.1	0.1	8.4	141.2	0.0			
5 Other	196		0.0	0.1	0.6	0.4	0.0			
6 Traditional Biomass Burnt for Energy	0		1.2	0.0	3.2	296.5	0.0			
B Fugitive Emissions from Fuels	0	0	241.4	0.0	0.0	0.0	0.0			
1 Solid Fuels			67.9							
2 Oil and Natural Gas			173.5							
2 Industrial Processes	4023		2.0	5.7	0.0	0.0	0.0			
3 Solvent and Other Product Use							20.9			
4 Agriculture	0	0.0	0.0	196.6	3.6	1.3	40.2	0.0		
A Enteric Fermentation			137.2							
B Manure Management			55.4							
C Rice Cultivation			2.13							
D Agricultural Soils	0.0			3.5						
E Prescribed Burning of Savannas										
F Field Burning of Agricultural Residues			1.9	0.0	1.3	40.2	0.0			
G Other										
5 Land Use Change & Forestry	0.0	7636	0.0	0.0	0.0	0.0	0.0			
A Changes in Forest and Other Woody Biomass Stocks		7636								
B Forest and Grassland Conversion										
C Abandonment of Managed Lands										
D Other										
6 Waste	725	0	805.5	0.0	0.0	0.0	0.0			
A Solid Waste Disposal on Land	725		724.7	0.0	0.0	0.0	0.0			
B Wastewater Treatment			80.8							
C Waste Incineration			0.0							
D Other Waste			0.0							
7 Other										
International Bunkers	873		0.0	0.0	22.4	1.8	0.3			

1993

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS EMISSIONS (Gg)										
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	HFCs	PFCs	SF_6
Total National Emissions and Removals	63256	7022	1116.7	17.4	183.7	767.7	67.9			
1 All Energy (Fuel Combustion + Fugitive)	57650	0	237.2	9.7	160.8	731.0	48.6			
A Fuel Combustion	57650	0	5.6	9.7	160.8	731.0	48.6			
1 Energy & Transformation Industries	39451		2.3	9.3	83.7	10.4	2.5			
2 Industry	5511		0.1	0.0	6.2	2.0	0.0			
3 Transport	8183		2.0	0.2	59.0	306.0	46.1			
4 Small Combustion	4117		0.1	0.1	7.7	136.6	0.0			
5 Other	389		0.0	0.1	1.2	0.7	0.0			
6 Traditional Biomass Burnt for Energy	0		1.1	0.0	3.0	275.3	0.0			
B Fugitive Emissions from Fuels	0	0	231.6	0.0	0.0	0.0	0.0			
1 Solid Fuels			70.1							
2 Oil and Natural Gas			161.5							
2 Industrial Processes	4103		2.3	4.9	0.0	0.0	0.0			
3 Solvent and Other Product Use							19.1			
4 Agriculture	0	0.0	0.0	154.4	2.9	1.1	35.1	0.0		
A Enteric Fermentation			107.0							
B Manure Management			44.5							
C Rice Cultivation			1.28							
D Agricultural Soils	0.0			2.8						
E Prescribed Burning of Savannas										
F Field Burning of Agricultural Residues			1.7	0.0	1.1	35.1	0.0			
G Other										
5 Land Use Change & Forestry	0.0	7022	0.0	0.0	0.0	0.0	0.0			
A Changes in Forest and Other Woody Biomass Stocks		7022								
B Forest and Grassland Conversion										
C Abandonment of Managed Lands										
D Other										
6 Waste	659	0	722.8	0.0	0.0	0.0	0.0			
A Solid Waste Disposal on Land	659		658.8	0.0	0.0	0.0	0.0			
B Wastewater Treatment			64.0							
C Waste Incineration			0.0							
D Other Waste			0.0							
7 Other										
International Bunkers	844		0.0	0.0	21.8	1.6	0.3			

1994

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS EMISSIONS (Gg)										
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	HFCs	PFCs	SF_6
Total National Emissions and Removals	60390	6974	826.1	17.7	162.8	707.3	65.6			
1 All Energy (Fuel Combustion + Fugitive)	54322	0	229.8	9.4	139.6	669.0	46.2			
A Fuel Combustion	54322	0	5.1	9.4	139.6	669.0	46.2			
1 Energy & Transformation Industries	36170		1.9	9.0	69.7	9.6	2.0			
2 Industry	6837		0.1	0.0	7.8	2.0	0.0			
3 Transport	7179		1.9	0.1	51.4	299.4	44.2			
4 Small Combustion	3325		0.1	0.2	6.2	103.6	0.0			
5 Other	811		0.0	0.0	1.8	0.7	0.0			
6 Traditional Biomass Burnt for Energy	0		1.0	0.0	2.7	253.7	0.0			
B Fugitive Emissions from Fuels	0	0	224.7	0.0	0.0	0.0	0.0			
1 Solid Fuels			64.9							
2 Oil and Natural Gas			159.8							
2 Industrial Processes	4812		3.1	5.8	0.0	0.0	0.0			
3 Solvent and Other Product Use							19.2			
4 Agriculture	0	0.0	0.0	129.9	2.6	1.1	36.8	0.0		
A Enteric Fermentation			90.0							
B Manure Management			37.8							
C Rice Cultivation			0.43							
D Agricultural Soils	0.0			2.6						
E Prescribed Burning of Savannas										
F Field Burning of Agricultural Residues			1.8	0.0	1.1	36.8	0.0			
G Other										
5 Land Use Change & Forestry	0.0	6974	0.0	0.0	0.0	0.0	0.0			
A Changes in Forest and Other Woody Biomass Stocks		6974								
B Forest and Grassland Conversion										
C Abandonment of Managed Lands										
D Other										
6 Waste	406	0	463.3	0.0	0.0	0.0	0.0			
A Solid Waste Disposal on Land	406		405.8	0.0	0.0	0.0	0.0			
B Wastewater Treatment			57.6							
C Waste Incineration			0.0							
D Other Waste			0.0							
7 Other										
International Bunkers	850		0.0	0.0	22.0	1.5	0.3			

1995

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS EMISSIONS (Gg)										
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	HFCs	PFCs	SF_6
Total National Emissions and Removals	63109	7520	901.4	20.6	161.3	760.6	73.4			
1 All Energy (Fuel Combustion + Fugitive)	56225	0	269.9	9.7	137.5	722.2	50.3			
A Fuel Combustion	56225	0	5.3	9.7	137.5	722.2	50.3			
1 Energy & Transformation Industries	37479		1.8	9.4	68.1	9.8	1.9			
2 Industry	8414		0.2	0.0	8.8	2.3	0.0			
3 Transport	7394		2.0	0.1	51.6	329.7	48.4			
4 Small Combustion	2625		0.1	0.1	5.0	88.5	0.0			
5 Other	314		0.0	0.0	1.0	0.6	0.0			
6 Traditional Biomass Burnt for Energy	0		1.2	0.0	3.1	291.4	0.0			
B Fugitive Emissions from Fuels	0	0	264.7	0.0	0.0	0.0	0.0			
1 Solid Fuels			69.8							
2 Oil and Natural Gas			194.9							
2 Industrial Processes	5602		3.4	8.3	0.0	0.0	0.0			
3 Solvent and Other Product Use							22.8			
4 Agriculture	0	0.0	0.0	125.0	2.5	1.1	36.6	0.0		
A Enteric Fermentation			85.1							
B Manure Management			37.6							
C Rice Cultivation			0.59							
D Agricultural Soils	0.0			2.5						
E Prescribed Burning of Savannas										
F Field Burning of Agricultural Residues			1.7	0.0	1.1	36.6	0.0			
G Other										
5 Land Use Change & Forestry	0.0	7520	0.0	0.0	0.0	0.0	0.0			
A Changes in Forest and Other Woody Biomass Stocks		7520								
B Forest and Grassland Conversion										
C Abandonment of Managed Lands										
D Other										
6 Waste	400	0	503.2	0.0	0.0	0.0	0.0			
A Solid Waste Disposal on Land	400		399.7	0.0	0.0	0.0	0.0			
B Wastewater Treatment			103.5							
C Waste Incineration			0.0							
D Other Waste			0.0							
7 Other										
International Bunkers	882		0.0	0.0	22.7	1.7	0.3			

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CHAPTER 4

POLICIES AND MEASURES TO MITIGATE GHG EMISSIONS

This chapter provides a general survey of strategies, legislation and economic instruments and measures to mitigate GHG emissions considered in Bulgaria. Basic information on programs and major projects which are relevant to the climate change policies and measures is presented. Due to the fact that in the past decades Bulgaria has followed a high energy intensive development pattern of economy, the primary objective of the current climate change policies and measures is to improve energy efficiency. Most of the important measures resulting in energy savings are directly related to the CO_2 and other greenhouse gases reduction since the fossil fuels prevail within the structure of primary energy consumption.

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OVERALL POLICY CONTEXT

The UN FCCC and the scientific understanding of the greenhouse effect serve to formulate the basic principles of the Bulgarian policy to address climate change. The underlying principles of the national climate change policy lay on the basis of Bulgaria joining the international efforts towards solving climate change problems to the extent that is adequate to both the possibilities of national economy and the options to attract foreign investments that might promote implementation process. In compliance with these principles and because of the grave economic crisis in the county, the measures to be implemented at national level should be as cost-effective as possible.

In signing the UN FCCC and its ratifying by the Parliament, Bulgaria has demonstrated its concern to climate change problems and its political will to fulfil the commitment of the Convention. At the moment the Kyoto Protocol ratification is under discussion. Its ratification will put further requirements in front of the country that invokes the necessity of more comprehensive mitigation measures to be developed, studies and implemented in the country.

The chapter starts with enumerating the legal and economic instruments already implemented that have positive impact on GHG mitigation. They have complex effect reducing GHG and other pollutant emissions.

Logically since the main share of the GHG emissions in Bulgaria are the energy related CO_2 emissions and their share is projected to increase further if the energy intensive production pattern is not replaced by energy-efficient options, the next extensive group of GHG mitigation policies and measures in Bulgaria are the organisational and institutional measures, initiatives, policies, instruments and strategies to improve energy efficiency and thus to mitigate GHG emissions (mainly CO_2 emissions) in the energy sector and in energy related activities in the rest of the sectors of the Bulgarian economy. These measures will contribute to the complex reduction of the three main GHG, as represented in a table for each of the sectors where options for reduction of the energy related emission are searched for. A separate section is devoted to the options available in forestry sector for increase of the carbon sequestration potential of Bulgarian forests.

The last two sections provide measures for reduction of CH_4 and N_2O emissions in agriculture and waste management and other sectors which are significant sources of those emissions in Bulgaria. It has to be noted that all enumerated measures should be considered as a supplement to the policies and measures already discussed in the First National Communication.

LEGISLATIVE FRAMEWORK, ECONOMIC INSTRUMENTS AND ENVIRONMENTAL STRATEGY

Legislative framework

The principles and legislative instruments to achieve the objectives of the National Ecology Strategy are formulated in the **Environmental Protection Act** adopted in 1991 (State Gazette No. 86/1991) and amended in 1992 (State Gazette No. 84/1992). This is a comprehensive act that specifies the responsibilities of executive bodies at both national and local level toward environmental protection problems and points out the increased power of the municipal authority in this regard.

The Environment Protection Act sets the right of each citizen of clean environment and access to information concerning both the environmental issues and assessments about the environmental impact in construction, reconstruction or expansion of a wide range of projects, including energy project as well.

The **Clean Air Act** was drafted in 1992-94 and it was adopted by the Parliament at the end of January 1996. In linkage with this act a series of subordinate legislation ordinances have to be elaborated including Ordinance on licensing, Ordinance to regulate the emissions from large stationary installations, Ordinance on the level of critical concentrations, Ordinance for the best techniques to specify the stack height, Ordinance for organisation of National air quality control system, etc.

Although the environmental regulations address only the concentrations of particulate matter, sulphur dioxide (SO_2) and nitrogen oxides (NOx), and do not concern directly the major greenhouse gases - carbon dioxide (CO_2) and methane (CH_4) and their precursors, it is expected the regulations to have positive impact in suppressing the greenhouse gas emissions as far as the regulation requirements can be met by increasing overall efficiency of stationary combustion processes and by implementing new environmentally friendly technologies. Since 1995 the emission control regulations have become more stringent since Bulgaria has moved toward market-driven economy.

In general, the instruments and incentives for environmentally friendly development are adopted by Governmental decisions after proposal of the Ministry of Environment and Waters. They are published and available to the society.

Regulations that substantially contribute in greenhouse gas emission mitigation are also those related to the ozone depleting substances. Bulgaria has ratified the Vienna Convention to preserve ozone layer and Montreal Protocol to phase out ozone depleting substances (ODS). A **National program for gradual reduction of ODS** mainly Chlorofluorocarbons (CFCs) and Halons that account to 93% of ODS consumption in Bulgaria has been developed and is under implementation. Global Environmental Facility ensures the financial support for the program of about 10.5 million $ US. The program is to be accomplished in two phases. During the first phase by 1998 the reduction of the total consumption of ODS has to be 87%.

Since January 1, 1996 the ozone depleting substances, as well as refrigerators, freezers, air conditioners using or produced by using ozone depleting substances (ODS) has been included in the import prohibited articles list.

The program addresses the following sectors:

- *Aerosols*. The use of ODS was reduced by manufacture restructuring to the minimal extent possible in medical and cosmetic goods production in 1992.
- *Solvents*. Several steps towards manufacture restructuring to substitute ODS by other substances are already made. One of the GEF supported projects is in this sector.
- *Fire extinguishers*. The ODS consumption in this sector is diminished up to 2 tons annually and further reduction is impossible due to the lack of substitutes.

- *Refrigeration and foams*. The ultimate goal of the projects in these sectors supported by GEF is to phase out by the end of 1998 all CFCs used but CFC-22.

<u>Economic incentives and instruments</u>

The Environmental Protection Act arranges the financial mechanisms meant to support environmental projects by the assistance of the **National Environmental Fund** and the **Municipal Environmental Protection Funds** (State Gazette No. 5/1993). Governmental decree No.194/5.08.96 (State Gazette No. 72/1996) regulates the ways to collect and manage the money in the Funds.

The sources to form the National Environmental Protection Fund are: 70% of the charges for pollution and violation of the environmental standards enforced by the Ministry of Environment and Waters and its subdivisions; import duties for cars older than 10 years; revenues from privatization of state enterprises; charges on the prices of the producers and importers of gasoline, diesel and residual fuel; other sources.

The Municipal Environmental Protection Funds function at the municipality level. The sources are taken from sanctions for pollution above the set standards; fees for use of the natural resources on the territory of the municipality; charges; etc.

Another fund that is active in the environmental protection field is the **Environment Trust Fund**. The fund uses the money get as debt-for-environment and debt-for-nature swap, e.g. with Switzerland for 20 million Swiss francs (State Gazette No. 74/1975), as target funds from the national budget.

The **tax system** is changing now in order to promote energy efficient technologies and technologies aimed to reduce GHG. In order to harmonise Bulgarian tax and import duty system with the Member States in the European Union, a Regulation No. 237 was issued on 12 December 1995 for adoption of Custom tariff of Republic of Bulgaria (State Gazette 109/15.12.1995) and the **Governmental Decree on Export and Import** from No 493 from 23 December 1997 (State Gazette 126/28.12.1997).It repeats the prohibition on the import of ozone depleting substances, as well as refrigerators, freezers, air conditioners using or produced by using Freon 11 or Freon 12, including also the installations built-in to vehicles to be used in Bulgaria. An addition to the prohibition list on the import is Halon 1211.

The same Governmental decree enumerates among the duty free goods the import of:

- equipment, spare parts, software and reagents for monitoring, analysis, assessment, reporting and control of the state of the environment, and for emission control;
- installations, equipment and machinery for reduction of the adverse substances in the wastewater flows and emissions, as well as for recultivation of contaminated soils;
- substances, materials and investment equipment for replacement of technologies using ODS;
- new installations and equipment for treatment and storage of wastes (mainly wastes from meat processing); for waste collection and transportation and keeping the clean environment in the villages and cities;
- installations and equipment for energy production from renewables (solar, wind, geothermal energy and biomass);
- materials and equipment for improvement of nuclear safety;
- materials and elements for production of energy saving bulbs.

By the **Law on Liquid Fuels Taxation for the Republic Road Network Fund and for the National Environmental Protection Fund** adopted on 14 February 1996, the level of taxes levied on the production and import of gasoline, diesel and residual with sulphur content over 1% is updated. The new tax levels are as follows:

- For car gasoline: 19% of the producer price or of the custom taxable value increased by import duties and taxes. 14% of the sum is accumulated in the Republic Road Network Fund and 5% in the National Environmental Protection Fund.

- For diesel fuel: 15% allocated as follows: 11% in the Republic Road Network Fund and 4% - in the National Environmental Protection Fund.

Lower level of excise on unleaded gasoline introduced in 1994 by Act on Excise. There is a Governmental Decision from 27 April 1998 for the adoption of a **National Program on the gradual phase out of the production and consumption of leaded gasoline in the Republic of Bulgaria** that will also contribute in the field of emission reduction.

Additional import duties on used cars was introduced in 1995. At the beginning of 1998 those duties were removed for the cars imported from EU and countries members of the European Free Trade Association. New regulations aiming at better environmental indicators of the import cars are under discussion.

The **Law on Corporative Income Taxation** in force since 1 January 1998 article 23, para. 3, item 1 projects duty levies as an incentive for the environmental friendly development of economy, as well for environmental protection and climate change issues: The Law states that the financial result before it having been adjusted for tax purposes shall be reduced with donations in favour of environmental organizations amounting to 5% of the positive financial result before adjustment for tax purposes in case the donations are from the capital reserves at the expense of the owner.

POLICY, LEGISLATION AND REGULATIONS IN THE ENERGY SECTOR

National Energy Strategy

As in many countries, in Bulgaria climate change policy and strategies are largely based on the national energy policy due to the high energy intensity of GDP and to the substantial share of the greenhouse gas emissions that originate from the energy sector.

The underlying principles of the energy policy of Bulgaria are stated in the **Energy Charter** adopted by the Committee of Energy in 1993. A draft **National Energy Strategy by 2020** was adopted by the Committee of Energy and is currently under discussion by the Government.

NATIONAL ENERGY STRATEGY

The target of the National Energy Strategy is to ensure continuous and high quality energy supply to the economy and households based on the rational use of indigenous and imported energy resources, existing energy units and national scientific potential and labour force. This target can be achieved by:

- Reduced energy intensity of GDP through efficient energy production, transmission, distribution and consumption;
- Optimal use of indigenous energy resources, such as coal, hydro and renewables to guarantee highest possible level of country energy independence;
- Optimal use of existing energy capacities, extension of technical life-time, improvement of their technical, economic and environmental performance by in time rehabilitation and refurbishment;
- Guaranteed nuclear safety by means of reconstruction and refurbishment of the nuclear units;
- Retirement of old units and their replacement by new state-of-the-art technologies;
- Emission mitigation and maximal abatement of the adverse environmental impacts caused by energy facilities;
- Improving population lifestyle through wide application of centralized heating system optimization, penetration of natural gas supply to the households and better quality of fuel supply;
- Improvement of legislative and regulatory framework;
- Establishing of market orientated energy policy controlled by the Government that will ensure gradual transition to real market driven energy prices and limitation of the natural monopoly;
- Attracting of foreign investments as well as municipal and private capital for rehabilitation of old plants and commissioning of new generation units.

The Governmental policy toward integration to EU, as well as the necessity to attract foreign investments in the energy sector require restructuring of the sector in compliance with the energy policy of EU. As recommended in the White Paper of the European Commissions, the energy strategy is part of the economic policy for market integration, towards restricted state participation in the sector, protection of the consumers, economic and social liaison. The main objective of the energy policy of EU, i.e. the market integration, determines the development of the Bulgarian energy sector in the next 10-15 years.

The restructuring of the sector has to create environment for competition and to replace the state monopoly in the energy sector and to be in compliance with the EU directives. For the initial period the most appropriate model for the Bulgarian power sector is the Single Buyer model. The characteristics of the model create opportunities for smooth transition towards a free electricity market. Two stages are envisaged in the transition period:

First stage: Restructuring of the vertically integrated National Electrical Company (NEC). At this stage the prerequisites are:

1. Complete differentiation of the accounting for the production, transmission, distribution, as if they are carried out by separate companies.
2. Generation of separate prices for power production, transmission and distribution that will be used as a basis for introduction of a system of internal contracts for production, transmission and distribution.
3. Development and introduction, along with the Energy Act, of a series of normative, organisational, technological, financial, tariff and personnel principles and elements consistent with the Single Buyer model (power producers, transmission system operator, single buyer, distribution system operators, etc.). Simultaneously, the conditions for buying from the NEC's generation plants and power producers outside NEC will be equalized on the basis of the uniform status of independent producers (as referred in the EU Directives).

Second stage: Free power market and privatization of the distribution and sales of electricity to the end users. The number of the end users that have the right to negotiate directly with a chosen producer will increase. Within the period of 2000-2005 there will be a process of restructuring of the generation plants into joint-stock companies that will be privatized by shares sold to investors, including municipalities.

The beginning of the accelerated privatization in the sector has started by the Governmental decision from January 1998 for pool privatization of 22 micro Hydro Power Plant (HPP). Other 40 micro HPP have been chosen to be sold in the next 2-3 years. The privatization of TPP Maritza 3 and TPP Rousse is discussed. It is planed NEC to continue to be the owner only of the transmission system, the main hydro generation facilities, pump storage plants and the Nuclear Power Plant (NPP) Kozloduy.

The restructuring of the coal mining is part of the overall reform in the energy sector. The process could be as swift and as acceptable in social and economic terms as possible if following the next two stages:

First stage (till 2001): Stabilisation and preparation for market development, close down of inefficient mining units; investments and privatization in the sector;

Second stage (after 2001): Specification, stabilisation and privatization of market oriented energy facilities producing electricity, heat, briquettes, etc.

The structural reform in the gas supply system has to be in compliance with the requirements of the draft EU directive for the general rules of the internal natural gas markets. It is envisaged the model with a national company for extraction, import, transmission, storage, distribution and natural gas trade and separate companies for gas supply to the households to be kept and further developed. This model allows gradual transition to a free market of natural gas and is based on the experience in the western countries. Since 2001 the privatization of the national gas company is expected to start through sales of shares at the stock exchange or to a partner, while the state will continue to keep its supervision.

The expansion of the natural gas market goes into two directions:

1. Development of gas supply and new tariff methodology, and

2. Adoption and realisation of the program for diversification of the natural gas sources.

The goal of the structural reform is the integration of the national market to the natural gas markets in Europe and in the Middle East.

The district heating will continue to have significant share in the energy market. The introduction of new options for heating (gas supply to households, efficient individual heating installations, etc.) that require lower investments and are economically feasible will constrain the development of the district heating within the cities and in the regions where they already exist. It is considered not rational to replace installed heat supply systems with new ones before their amortisation.

The district heating will keep its share and competitiveness if considering the following requirements:

- modernisation of the existing heating facilities with increased share of the combined heat and electricity generation;
- rehabilitation and modernisation of the heat transmission networks and users stations that will allow transmission loss reduction from about 20% to 10%;
- installation of equipment and measurement devices for individual monitoring and control of the heat consumption;
- structural and price reform that will allow district heating utilities to be competitive at the energy market;
- shift of the state subsidies from the utilities to the consumers with low incomes;
- adoption of the legislative framework for control and market-based development of the sector.

Energy legislation

Several legislation tools are available or under consideration to achieve the goals of the National Energy Strategy.

In December 1994 Bulgaria joined the **European Energy Chart** and the **Energy Efficiency Protocol**. For their implementation the Government has had to establish the legal and regulatory framework that will ensure efficient performance of the market mechanisms in the field of energy production and consumption; overcoming of the barriers for energy efficiency improvement and promotion of investment incentives for energy efficiency projects; and will facilitate energy efficiency financing.

The adoption of an **Energy Act** and the corresponding regulations, as well as establishment of the necessary administrative structures are among the priorities in the National Program for harmonisation with the EU legislation. Currently the draft Energy Act is prepared and submitted to the Government. The regulations that are currently in force are issued in the 1970s and they hinder the market-based development of the sector. There are still no regulations on the heat and gas supply and on energy efficiency.

The draft Energy Act discusses the necessity of complete set up of the interrelations under state supervision and control of the sector, as well as the rights and duties of the companies when producing, transmitting, distributing and selling electricity and heat energy, and when transmitting, storing, distributing and selling natural gas. The Act aims to introduce market instruments in the energy sector and to harmonise Bulgarian legislation with the EU directives. It is expected the Act to create a legislative basis and opportunities for ensuring of save, rational and reliable energy services at appropriate prices, for efficient and environmentally friendly least-cost energy supply, sustainable developments, promotion of energy efficiency and private ownership, opportunities for competition among energy producers, increase of the investments, modernisation of the infrastructure, access to the international markets and introduction of options to the consumers.

Some of the regulations that are expected to support the Energy Act are as follows:

- Regulation on the permits and licenses (to regulate the procedure for the issuing of construction permits for power plants and licenses for energy activities).
- Regulation on the additional requirements for social services (concerning the additional requirements that could be claimed to the energy plants related to the safety, continuity, quality and prices of the electricity, heat, natural gas supply, as well as to environmental issues).
- Regulation for introduction of constrains for the use of electricity and heat, natural gas and oil products (concerning the type and ways to put constrains to the electricity, heat and natural gas or oil products producers and consumers).
- Regulation on the procedure and prerequisites for access to the transmission and/or distribution systems. It is meant to regulate the level and stages of electricity market opening and prerequisites for signing of direct contract between consumers and independent producers for electricity supply through the transmission or distribution systems.
- Regulation on the obligatory requirements to the contract articles for sells ofrenewables based or combined cycle based electricity.
- Regulation on the connection of consumers to the power transmission and distribution systems.
- Regulation on the heat supply, delivery and distribution. Operational control and connection of consumers to the heating systems.
- Regulation on the energy efficiency audits.
- Regulations on the procedures for collection, use and control of the funds in the Energy Development Fund, Energy Efficiency Fund, Safe Storage of Radioactive Wastes Fund, and Nuclear Unit Decommissioning Fund.

Together with the all supporting regulations to the Energy Act, a State Agency for Energy Control is planned to be established in 1999. It would be a state financed organisation to regulate the prices in the energy sector.

As stated in the First National Communication a draft of **Energy Efficiency Act** was elaborated in 1995 by the Government. It was not adopted by the Parliament because of the Pre-term Elections. Another version of the law has been finalised in 1998. The Act, after its co-ordination with all ministries and authorities, was offered to the attention of the Legislation Board and the Government.

The Energy Efficiency Act has to regulate the actions related to energy efficiency improvement and to encourage the use of renewable energy sources. The aim of that Act is to reduce the energy intensity of the products and services, to mitigate the environmental impact of energy transformation processes, and to improve the quality of the energy services. The Act will impetus the development of energy efficiency projects, and will increase the overall energy efficiency of economy through:

- Setting standards for energy efficiency of technologies and equipment, introduction of obligatory energy efficiency labelling of equipment;
- Mandatory energy audits that should be accomplish for each new large industrial project with high energy consumption, including new energy units;
- Establishment of a **State Energy Efficiency Fund** that should serve as a financial mechanism to promote national energy efficient policy, projects and activities. Main fund sources are state budget subsidies, free instalments, local and foreign financial assistance, restored sums, etc.

Energy and fuel prices

Changes of structure and the level of energy prices are fundamental to promote energy efficiency, to conserve energy, to reduce GHG emissions emitted at the end-use energy consumption, as well as for restructuring of Bulgaria energy sector. At present, when the process of price liberalisation affects all economy, some of the energy prices are still controlled by the Government.

The electricity tariffs are characterised by a structure that went into effect in 1992. For households the electricity is priced on time-of-day basis. Industry was charged on a more complex tariff considering the season of the year and the day zone. The seasonal tariff for industrial consumers was cancelled in 1998.

The new tariff levels (VAT included) for business and households in force since 1 September 1997 are given in Table 4.1 (exchange rate 1 USD = 1719 BGL).

Electricity prices

Table 4.1.

Zone	Industry						Households	
	supply voltage							
	high		medium		low			
	BGL/kWh	**$/kWh**	**BGL/kWh**	**$/kWh**	**BGL/kWh**	**$/kWh**	**BGL/kWh**	**$/kWh**
Peak	139.36	0.0811	144.61	0.0841	151.11	0.0879		
Day	75.59	0.0440	78.01	0.0454	81.24	0.0473	63.42	0.0369
Night	37.31	0.0217	38.58	0.0224	40.07	0.0233	33.9	0.0197

The compulsory energy prices liberalisation is related to the establishment of international energy prices in the domestic market. The analysis of the current state indicates that Bulgaria fell behind the European price levels. Level of 3-4 cents/kWh were very low at the beginning of 90s and they are even lower at the end of the decade and afterwards. Currently the average electricity price is 3.2 cents/kWh (VAT excluded) which is relatively lower compared to the 1991-1993 period. The indispensable price adjustment to the real production and distribution costs will influence the electricity demand and will focus on the energy efficiency and the national energy consumption.

A steep increase of the liquid fuel prices was observed in 1994 when VAT was introduced and in 1995 when the excise duties went upward from 35% to 70% for gasoline up to A93 and 110% for gasoline over A93 and from 25% to 30% for diesel fuel. Since 1996 the excise for the unleaded gasoline is set to be 10 points lower compared to the ordinary gasoline to encourage the use of more environmentally friendly fuel. There is an additional 19% tax for the liquid fuels.

Natural gas prices are formed based on the cost of the import and delivery of the fuel to the final consumers through the high, medium and low pressure pipelines to the final consumers. The domestic trade prices are limited. They depend on the demand volume and on the average international prices for the previous one month period, as well as on the average exchange rate for the same time period. The duties - 5%, taxes - 22% and trade surplus charge - up to 11% are added to form the end user price. The prices are calculated by the supplier, i.e. “Bulgargas” state owned company, agreed with the price commission and proposed for approval by the State Public Energy Price Commission that is consulting body to the Government. It consists of members of Ministries and institutions, unions and consumer organizations and its activities are announced to the society. The low pressure natural gas distributors can add a surplus charge but not more than 4%. Differentiated prices for industrial and residential consumers are planned for the future that will take into consideration the gas consumption mode, consumed volumes, safety requirements to the deliverer and requirements for continuous supply, necessary investments.

According to the methodology approved by the Government, the prices for electricity, heat and local coal production are fixed. The electricity prices depend on the share of imported fuels (incl. natural gas, coal and nuclear fuel), share of local coal, and shares of the other costs that depend on the inflation and exchange rate, as well as on the indices of the prices of the imported fuels, local fuels and consumer and producer prices. According to the same methodology the limited prices for the heat in the industry are calculated by the producers based on the cost and a 20% (7% before May 1997) profit rate. For the households, fixed prices for heat are applied. The level of prices accounts for the population purchasing power and the ability of the budget to subsidise the difference to the actual costs.

Since June 1996, there were some changes in the methodology for electricity, heat and coal prices generation that required monthly update of the prices, for setting decisions on the procedure for methodology changes, compulsory monitoring of the methodology efficiency, monthly calculation of the index for average trade price of the electricity based on new calculation methods, changes in the prices of the heat, coal and briquettes for households.

At the same time, the price policy in the power sector will try to cover the expenses for the expanded reproduction in compliance with the economic development of the country. Some changes in the tariff structure could be expected. By 2001 the prices have to mirror the long-term marginal costs, including the cost for system maintenance and development, for storage of the nuclear wastes and for decommissioning of the nuclear equipment. The tendency is towards prices that are closely related to the competition in the power production and distribution. The deregulation of the power market and the penetration of the market price mechanisms will replace the state control by 2000. Since 2000 the heat prices will be regionally determined depending on the specific competitiveness with other heating sources. They will be such as to cover the production costs and to ensure necessary funds for system maintenance, modernisation and development. The price liberalisation will include also the coal sector.

Since 1 May 1997, the prices of local coal are formed month by month on the basis of the latest inflation rate, the average exchange rate for the last 15 days period, share of the cost dependent on the inflation and official exchange rate.

The latest changes in the price methodology since June 1997 allow the Commission to formulate prices different than the prices calculated following the methodology, and since October 1997 the compulsory monthly discussion and update of the prices has been removed.

Imported coal prices for households and industry completely correspond to the international market prices. It could be expected the Government to continue subsidising part of indigenous coal prices because of the national strategic interests and employment issues. Therefore, the introduction of carbon tax is not relevant to the conditions of Bulgaria energy market where the fuels with high carbon content such as coal are subsidised.

MEASURES, POLICIES AND PROJECTS TO MITIGATE GHG EMISSIONS

Institutional Setting

Alongside with the legislative measures, regulations and economic instruments that promote introduction of energy efficiency and GHG mitigation measures, the actions in that direction are managed by specialised organizations and structures. The Ministry of Environment and Waters is responsible for the current climate change policy in Bulgaria as well as for the future Climate Change Policy formulation.

The State Committee of Energy takes care of the policy development in the energy supply and energy efficiency of the energy transformation, transmission and distribution systems, penetration of policy decisions. The National Energy Efficiency Agency to the Government is taking overall responsibility for the policy formulation in the field of energy efficiency and renewable energy sources.

The Ministry of Agriculture, Forestry and Rural Reform takes the responsibility for the measures undertaken in the agricultural and forestry sectors, and the Ministry of Industry manages the processes in this sector.

Climate change implications of all these governmental institutions are co-ordinated by an interministerial expert team supervised by the Minister of Environment and Waters. The team was established in the early 1997 when work on the National Climate Change Action Plan was started under the US CSP - SNAP agreement between the USA and Bulgaria.

Recently a National Co-ordination Centre on Global Change has been also established to the Bulgarian Academy of Sciences.

Some other organizations active in the field, their goals and activities are presented hereafter[1].

The **Energy Efficiency Centre** was established in 1995 in co-operation of the Japanese International Co-operation Agency - JICA. It's activities, performed by a team of Bulgarian and Japanese experts are based on the latest Japanese technologies and modern measuring equipment provided by JICA. The proposed measures for energy consumption are by optimising the management, improving the production process, and modernising the production facilities the leading idea being *Energy efficiency at minimum cost*. The Centre provides consultations on energy consumption control, management and organisation and performs the necessary energy audits.

The **National Energy Efficiency Agency** was established in 1997 with a Governmental decree as a legal person at the Council of Ministers for the development and implementation of the state policy in the field of the efficient utilisation of energy resources and the expansion of the use of renewable energy sources with the purpose of reducing the cost for energy needs and the negative impact on the environment.

The Agency performs the following functions in the development of the state policy in the field of the energy efficiency: participates in the development of the state strategy and policy of the energy sector in its part for efficient utilisation of the energy resources and the renewable energy sources, as well as in development of legislation in the field of energy efficiency; proposes improvement of the structure of the energy balance of the country through adoption of energy-saving solutions and wider utilisation of renewable energy sources; in collaboration with the Ministers and the local authorities develops long-term programs and projects for the implementation of energy saving and renewable energy; develops and co-ordinates ways to stimulate the energy efficiency and wider utilisation of renewable energy; creates, supports and updates information database and organises training and happening in the field, etc.

The Agency performs the following functions to pursue the state policy in the field of energy efficiency: co-ordinates the energy efficiency activities of the units and the experts to ministers and the regional administrative structures; assists in creating regional energy efficiency units; promotes and consults on the efficient energy consumption and the utilisation of renewable energy sources; co-operates for training of experts in energy efficiency and renewable energy in Bulgarian and foreign institutions; organises and implements demonstration projects in the field of energy saving and renewables; promote contacts of consumers with Bulgarian and foreign financial institutions to facilitate financing energy efficiency projects; co-operates for the implementation of the international obligations of the Republic of Bulgaria in the field of energy efficiency and the negative impact on the environment; organises and carries out audits and studies for efficient energy use, etc.

The Agency administerates the National Energy Efficiency Fund established with a Governmental decree.

In June 1992 the EC **Energy Centre Sofia** was established by the EC (DG XVII) and financed through the Associated Measures of the THERMIE program. The objectives of the Centre have been:

- to establish a communication channel for the flow of information concerning efficient and environmental friendly energy technologies between Bulgaria and EU Member States and to facilitate the market penetration of these technologies in Bulgaria;
- to co-ordinate or contribute to a wide range of activities aiming at disseminating EU expertise and know-how concerning modern energy technologies and practices;
- to facilitate and support the execution of measures under other EU energy programs in Bulgaria.

[1] The list is not exhaustive giving just few examples of organizations active in the energy efficiency policy in the country and few of the projects and programs developed in Bulgaria

Most of the measures of the Centre have had a clear orientation towards promotion, dissemination and demonstration of technology in all sectors. Alongside the Centre supports market orientated measures such as market assessment studies, energy audits, facilitates business contacts, etc.

Other projects closely conducted within the frame of the THERMIE related to the environmental performance of different technologies and sectors in Bulgaria are: Energy auditing and technology assessment of energy conservation in buildings; Market assessment of clean coal technology, Potential for wind energy technologies in Bulgaria; Potential for biomass waste energy technologies in Bulgaria; Energy audits of district heating boilers; Potential of small hydro technologies in Bulgaria; Implementation of solar collectors and heat pumps in buildings; etc.

Recently a Centre **FEMOPET** (Follow Member of the Network of Organizations for Promotion of Energy Technologies) was established in Bulgaria. It is a part of 44 organizations from EU Member-States, joint in the Network of Organisation for Promotion of Energy Technologies (OPET), and 13 Centres of Central and Eastern European Countries, joint in FEMOPET.

The activities of FEMOPET Bulgaria are being performed by a Consortium of Sofia Energy Centre as Co-ordinator and Energoproekt as Partner. Its activities cover the territory of Bulgaria by means of collaboration with the National Energy Efficiency Agency and with the Regional Energy Centres of Haskovo and Lovetch.

The main objectives of FEMOPET Bulgaria are:

- to facilitate the implementation in Bulgaria of new European energy technologies;
- to promote and assist the co-operation with European partners in the field of energy technology research and development and in their implementation;
- to support the establishment of joint-ventures and technology and know-how transfer.

Another example of an organisation active in the field of energy efficiency and in particular in the GHG emission reduction issues is the Energy Efficiency Centre **EnEffect**. It is an NGO established in 1992 that supports the efforts of the Government and the municipalities for sustainable development of the country. The main goals of the organisation are: to facilitate the development of energy efficiency policy at all levels of Bulgarian economy and thus to promote economic and environmental benefits; to support the capacity building in the country; to stimulate the development of domestic production, and market of energy efficiency products and services; to assist in the technology transfer in the field of energy efficiency.

<u>Implemented measures and measures under development. Demonstration projects.</u>

During its first (1992-1995) operation period the EC Energy Centre Sofia organised and co-ordinated tow major large scale energy efficiency initiatives:

- **Special Electricity Program for Bulgaria**, consisting of 21 demonstration projects carried out by several EU consulting firms, aiming at exhibiting in practice the large potential for electricity saving in the country. The key objective of the Program was to demonstrate how this large potential can be exploited by using low investment equipment and applying effective energy management practices.
- **Internal Energy Assessment and Advice Program**, which was launched and co-ordinated by the Centre, and executed in collaboration with local energy experts. The program covered twenty major local industrial units and aimed to provide energy consultancy to the companies, to assess their energy efficiency, to identify the most promising and feasible measures in order to improve effectiveness, as well as to identify the economically feasible projects. The major objective of the program was the opening of local market for energy consulting services and involvement of Bulgarian experts in this type of activities.

Some **programs** in development in Bulgaria **to promote the energy efficiency** that are conducted by EnEffect with the consultancy of the US companies, are as follows:

- Program for introduction of energy efficiency requirements in the state purchases The program should start with a list of energy efficiency devices to be recommended to the army, state institutions, public education and health services, budget companies, municipalities.
- Program for up-to-date lightning (compact fluorescent bulbs) A win-win option that requires big consumers from the public sector to combine, and thus an economy due to the great quantities (traded at lower prices) traded to be achieved.
- Energy efficiency program in the low income households. The program is developed as a social support to low income households. It will start with low cost measures with gradual introduction of complex measures.
- Energy efficiency program for the budget social services institutions
- Program for standards and labelling of the household refrigerators. The program will start by harmonisation of the standards wit those in the EU and will be followed by an information program to make society aware of the labels and their meanings.
- Energy efficient office equipment program for Bulgaria that is to be based on the internationally accepted Energy Star program.
- Program for establishment of energy audit centres for the public and residential buildings to the Technical Universities. Such centres could be organised by 4-12 students to perform the audits.
- Program for accomplishment of educational materials. The program is meant to create energy saving behaviour. It is adapted to the age peculiarities in pre-school and school education.

Insulation and standards for buildings. Regulation No.1 from July 28, 1992 (State Gazette 104/1992) sets forth the requirements concerning heat insulation efficiency of the buildings. The construction of new building has to be in compliance with the heat related constructions and physical criteria in order to reduce energy cost for heating. In 1993 a supplementary material was issued as Guidelines for elaboration of the heat efficiency part to the investigation and design works (BSA, 6/1993).

The Standards for Designing of Building Heat Insulation edited in 1987 and amended in 1991 are now in force in Bulgaria. They set a heat resistance Ro (m^2 $^0C/W$) of the wall construction of a building to be higher or equal to the economically expedient heat resistance Ro_{EC} (m^2 $^0C/W$). The Ro_{EC} values are given in the First National Communication. In general, Bulgaria heat insulation standards correspond to the standards in the EU countries and no major changes are needed. Problems arise, however, because the existing building stocks and the greater part of buildings under construction do not meet the heat insulation standards.

There are regulations for accepting the hydro, steam and heat insulation in construction, special standards for state technical control and other regulations in force. Currently a regulation on the heat insulation of buildings, regulations for design and a regulation for heat insulation designing are under discussion. Since there is no unification in these standards throughout the European countries, the German standards DIN 4108 for heat insulation of high floor buildings with all subsequent amendments are taken as a model.

The new regulations require a new Pr EN 12086/1995 standard to be adopted. There are a series of transitional and new standard elaborated. Due to the limited funds there are no a definite dead line for the enforcement of the standards. An important standard that is omitted in the program is PrEN 832 (Thermal Performance of Buildings - Calculation of energy use for heating - Residential buildings). Its acceptation by CEN/CENELEC has to provoke its uniform introduction in Bulgaria together with standards on the Heating ventilation, air conditioning and purification equipment.

Construction control, specific programs for energy efficiency in buildings and new building technologies are foreseen as the most promising measures to conserve energy and therefore to reduce GHG originating from the sector.

The **demonstration projects** are an approach that facilitates the introduction of up-to-date energy efficient technologies and precise the policy decisions. The successful demonstration is the best option for public awareness and prove of the benefits of energy efficiency. Demonstration project exist in all sectors of the economy. Thus the Demonstration energy efficiency zone in Gabrovo within the frame of GHG Mitigation Strategy Through Energy Efficiency Project (financed by GEF) encompasses projects in three main areas:

- Energy efficiency in construction. There are measures undertaken for the residential, public and industrial buildings. Demonstration projects for reconstruction of the "D-rT.Venkova" hospital was accomplished in 1996-1997. The registered energy savings were about 20%. The pay-back period is expected to be 2.5 years. After energy audits, energy efficiency measures have been recommended for a sample school building and for a trolley depot in Gabrovo and now the measures are under implementation.
- Reconstruction of the district heating network. District heating is supplied to 18% of Bulgarian population in 20 towns in the country. The demonstration project included energy audit of the district heating plant, of the transmission system and end users. Feasibility studies were conducted and lists of measures were recommended. To implement part of the measures some additional funds are stilled searched for.
- Reconstruction of street lighting. The street lighting is an important electricity consumer and comprises a serious share in the municipal budgets. The measures recommended for the reconstruction of the inefficient street lighting are: harmonisation with the European norms of street lighting; use of efficient light sources, street lighting management and control.

Within the frame of the Dutch program for co-operation with the Ministry of Environment and Waters in heat supply companies the following project are to be developed:

- **District heating unit Plovdiv South**

Control system for management of the heat demand of 62 end stations that should lead to reduction of the specific heat consumption, reduction of the transmission heat losses; reduced heat generation. The expected results of the project are: 70 000 $ US annually saved due to 700 000 Nm^3 natural gas savings; and the corresponding CO_2 and NOx emission mitigation. In addition to the above results, the project includes delivery of the monitoring and upgrading equipment for fuel processes, and replacement of the obsolete and unreliable equipment with up-to-date equipment for monitoring and upgrading of the fuel processes in order to ensure environmentally-friendly operation that will lead to extra savings of 200 000 Nm^3 natural gas and CO_2 and NOx emissions.

- **District heating unit Samokov**

Shift in the fuel base from residual to natural gas with expected economic effect of 50 000 $ US annually as saving of fuel and as difference in the prises due to the shift in the fuel base. There will be mitigation of the adverse emissions of SOx, CO_2 and NOx due to the replacement of the with sulphur content 3.5%, improvement of the combustion process efficiency and reduced amount of combusted fuel.

- **Gas supply Lovech**

Construction of installation for water purification to obtain water quality required in the normative requirements of the Bulgarian State Standard aiming at improving the operational mode of the water heating boiler and the heat transmission network. The expected results of the projects are: 8 000 $ US saved (i.e. 80 000 Nm^3 natural gas saved annually) and CO_2 and NOx emission mitigation.

- **Heat supply Varna**

Construction of micro-processing information control system for steam boilers type PKM 12 and connection to the existing control system of the major water heating boilers type VK 100 /116 MW/ in the heating plant with expected results of 22 000 $ US annually saved and CO_2 and NOx emission mitigation from the avoided combustion of 220 000 Nm^3 natural gas.

- **Heat supply Sofia**

Systems for heat demand control in Ovcha kupel complex that have to reduce the specific heat consumption, the transmission heat losses and heat generation through transfer of know-how from Netherlands for 400 user stations. It is possible the implementation to have 2 stages 2000 stations each. At the end of the project 3 600 000 Nm^3 natural gas will be saved annually, i.e. annual economic effect of 360 000 $ US and the environmental benefits.

On the basis of Bulgaria Climate Change Country Study Program and PHARE some demonstration projects were proposed to be developed in the field of renewable energy as follows:

- **Comparative assessment of old hot water solar collectors produced in Bulgaria**

The basic aim of this project is to elaborate national strategy to select appropriate solar collectors comparable to European standards. There is available some experience in Bulgaria in design, assembling and exploitation of solar hot water collectors. Built solar collectors are over 50000 m^2. They are produced mainly from steel, the basic part from which being amortized due to expired lifetime. These collectors are mount on different hotels and administrative buildings mainly at Black Sea Coast and south-east of Bulgaria. Other solar collectors are built with financial support of different programs: PHARE, TEMPUS and others, or imported by different private companies. Such collectors are produced by different technologies with unknown efficiency, so it is necessary to analyse and summarise results on efficiency and performance of installed collectors (both small household and big ones).

The project includes two types of collectors: small type modules for households; and solar installations for municipal buildings, hotels, hospitals.

- **Wind master for electricity generation - installed capacity up to 100 kW; connected to the distribution network**

Besides some small wind aggregates, there is no experience in Bulgaria in using modern equipment producing electricity from wind. The aim of the project is to demonstrate possibilities for utilisation of wind energy for electricity production on a large scale; gaining experience in construction and exploitation of such equipment.

- **Wind pumps for water pumping for irrigation purposes and supplying animals with fresh water**

The basic aim of the project is to demonstrate possibilities for utilisation of wind energy for agricultural purposes. It must include assembling, monitoring and use of a Bulgarian type wind pump, as well as such produced abroad (England) in order to define the basic characteristics of the equipment, which can be recommended to the Bulgarian producers, and to demonstrate to farmers remote from the grid, the possibilities of the system.

- **Installation for efficient burning of wood residues for domestic purposes**

The biomass, especially burning of wood and agricultural wastes is the traditional energy source in Bulgaria. Unfortunately some old combustion systems are used - stoves, boilers. Due to the increased heating and electricity prices, the share of biomass consumption for cooking and heating increased and reached 0.5% of the energy consumption in the country. Gaining of experience, know-how, for producing of energy effective equipment for burning of biomass residues is the aim of the project.

Such an installation will be used for production of hot water and heating of a building using a boiler installation with capacity up to 20 kW, which will satisfy one family power demand.

- **Cultivation of energy crops in regions with land polluted by heavy metals**

The aim of the project is gaining experience in cultivation of energy crops and their further utilisation for energy production.

- **Geothermal Installations**. There are some geothermal installations built with total capacity of 95 MW, used for heating of hotels, administrative buildings and others. These installations are constructed in different periods, following different schemes and by different organizations. It is necessary to summarise the experience from exploitation of these installations, to make recommendations for choice and retrofit the old systems.

Some demonstration project are developed in the rest of the sectors, as for example in the forestry:

- **Biological and technical stabilisation of 'Racovitza' river watershed in the Rila mountain**

The expected effect of the project includes: protections of soils against erosion; regulation of the water balance in the watershed area; improvement of the river water quality in the watershed area; planting forest vegetation (producing from 45 000 to 70 000 m^3 wood boimass for 50 years); improvement of the biodiversity; accumulation of CO_2 (37 000 t for 50 years); improvement of the microclimate; use of the pilot project results for solving ecological problems in other country's regions and others.

- **Forest biological recultivation of spoil banks in open-cast mining in the region of the Maritza-East coal mines**

The project aims a pilot project to be accomplished for utilisation a number of forest tree and shrub species, resistant to the unfavourable climate and soil conditions in the largest complex of open-cast coal mines in Bulgaria. The expected effect of the project are as follows: recultivated terrain wealth restoration; acceleration of the soil formation process; anti-erosion effect; recreational utilisation of the terrain; establishment of forest plantations, resistant to the climate change and poor soil conditions; microclimate improvement; creation of producing forest vegetation (6 900 to 10 000 m^3 wood biomass for 50 years); CO_2 accumulation (6 000 t for 50 years); the pilot project results utilisation for the other country's regions.

GHG Mitigation Measures

The main part of the measures enumerated in the Second National Communication are developed within the framework of the SNAP project for development of the National Climate Change Action Plan and are included in the draft for the National Energy Efficiency Program currently discussed by the Government.

All mitigation measures are assessed with regard to the necessary investments for their implementation, as well as with regard to their economic and environmental feasibility. The measures have multidimensional effects: on the one hand they reduce the GHG emissions (mainly CO_2, but also the emissions of CH_4 and N_2O), improve the environmental situation in general, increase the economic competitiveness of the technologies and improve the population lifestyle.

NATIONAL ENERGY EFFICIENCY PROGRAM

A draft National Energy Efficiency Program (NEEP) is developed that aims to reduce the energy intensity of the gross national product, and to offer better, socially acceptable energy services to the society. The proposed National Program is an important component of the sustainable development of the country. It is an indispensable part of the energy reform. It requires directing of the efforts to a non-energy intensive and competitive development of the national economy.

Aimed at demand-side energy efficiency and encouragement of the utilisation of renewable energy sources, the Program forms the basis for integrated energy planning and provision of socially acceptable energy service. To Bulgaria which imports 75% of the energy resources used by it, the Program is a priority objective for increasing the energy independence of the country.

The Program is a component of the policy for performance of the international obligations with respect to reduction of the noxious emissions, the greenhouse gases and the related climate changes.

The high economic and environmental attractiveness of the Program provides grounds of offering it to national and international institutions and funds for financial support and implementation.

When the GHG emission reduction potential of the measures is evaluated, the following assumptions are laid down:

- the reduced electricity consumption leads to reduced power generation in the fossil fuel based power plants. The production in hydro, nuclear and cogeneration plants stays constant. When the emission factors for the electricity are estimated the auxiliarities and the transmission/distribution losses are also taken into account. The losses are assumed to be 8% for the electricity delivered to the most energy intensive industrial brunches, and 14% for the electricity consumed by the light industry, in services, households and street lighting.
- the reduced heat consumption provokes a corresponding decrease in the heat generation by cogeneration district heating and industrial plants. The heat distribution losses are considered to be 3% for the main industrial sectors, and 12% for the light industry, services, and households.
- the GHG mitigation potential due to reduced fuel consumption (natural gas, coal, residual, etc.) is estimated using average emission factors as in the GHG inventory.

The cost of energy and carbon saved is estimated on the bases of discounted investment cost for the live cycle of the individual measure. The assumed discount rate is 10%.

CO_2

The most significant contributors to the CO_2 emissions in Bulgaria are the energy transformation industry and the energy intensive sectors of the economy. Therefore the main efforts in the mitigation measures developed are focused on these sectors. Along with that some measures are also developed for some sectors with moderate energy intensity as households and services.

Energy-related emissions in Industry

A total of 76 measures, envisaged in the plans of the works to some extent, have been analysed for the industry in general. The measures are for the following subsectors of the economy:Ferrous metallurgy, Non-ferrous metallurgy, Chemical production, Light industry, Food processing industry, Machine building and metalworks, electrical and electronic industry, Construction, Building material industry. Most of the options are energy efficiency measures, as far as energy efficiency improvement is the main stream in the technology policy and market competitiveness of the industrial sector.

The summarized results of the measures by individual subsectors are presented in Table 4.2.

Mitigation potential in industrial sector

Table 4.2.

	Subsector	Investments mln $	Annual energy savings (total) kToe/year	Annual electricity savings GWh/yr
1	Ferrous metallurgy	285	372.7	430
2	Non-ferrous metallurgy	0.882	28.8	0.9
3	Chemical production	145.5	648.7	38
4	Light industry	28.4	74.1	304.2
5	Food processing industry	0.188	0.4	3.3
6	Machine building and metalworking, electrical and electronic industry	37.9	319.7	1181.2
7	Construction	69.8	26.8	0
8	Building material industry	132.9	383.8	0
	TOTAL	**700.57**	**1855**	**1958**

Annual emission reduction due to saved:	*Electricity*	*Heat energy*	*Fuels*	*TOTAL energy*
CO_2 emissions [Gg]	3112.6	2951	2650	8713.6
CH_4 emissions [Mg]	39.2	118.4	54.2	211.8
N_2O emissions [Mg]	969	650.2	0	1619.2

The results show that the annual fuel and energy savings resulting from implementation of the measures amount to 1855 thousand toe/year. With investment ofUS$700 mln. the annual economies of funds are US$335 mln.

Implementation of the individual measures or sets of measures involves significant investment and is directly related to the political and economic stability in the country as well as the market opportunities for sale of the product.

Ownership restructuring in the industry after completion of the privatization and finalisation of the privatization transactions will determine the performance of investment projects during the period till 2005 and the actual technological and hardware renovation of the companies.

Hereafter some of the measures included in each of the subsectors are described. Estimates on the GHG reduction potential of each measure in the industrial subsectors, as well as information on the cost of the saved CO_2 emissions is provided in Annex B.

<u>Ferrous metallurgy</u>

Large-scale technical and technological measures as listed below are to be implemented in the subsector:

- In the Kremikovtsi Integrated Works - shutdown of two sintering furnaces and upgrading of the remaining four; shutdown of one blast furnace and process intensification at the other two; shutdown of one arc furnace (one 100-ton furnace remaining); switching over to 100% continuous steel casting and phasing out of some blending shops, stripping department, bloomingslabbing (Mill 1250, a 950/700/500 continuous billet mill); switching over of two heating furnaces of the sheet mill to 1700 hot rolling.
- Stomana J.S.C. - shutdown of one arc furnace (two 100-ton furnaces remaining); reengineering and refurbishment of the continuous-pouring blooming mill; decommissioning of the small-size shape mill 250;
- Promet Co. Ltd. - reengineering and refurbishment through fitting of new general-purpose cooler cells, and of the finishing section;

- Other companies - implementation of a set of measures for expansion of the product range, quality improvement and cost reduction.

The main mitigation measures related to the energy efficiency improvement in the industry are shown in Table B-1, Annex B.

Non-Ferrous metallurgy

Copper Extraction:

- Reaching the design load of the smelting unit (flash furnace) with a view to a normal course of the autogenous processes (Union Miniere - Copper Extraction Integrated Works - Pirdop) which provide the required heat for the charge smelting process and enable normal purification of the furnace gases.
- Erection of a new sulphuric acid plant (at the Non-Ferrous Metal Integrated Works - Plovdiv) to trap the increased quantity of sulphurous gases and, in that manner, to minimise the noxious emissions causing the "acid rain" phenomenon. The rate of power consumption will be of the order of 140 kWh/ton;
- Construction of a new electrolytic shop (Union Miniere - Copper Extraction Integrated Works - Pirdop) operating with a higher power utilisation rate - 95%, and optimal power consumption - 350 kWh/ton thus significantly reducing the power consumption per unit of product.

Lead Extraction:

- Introduction of new technological processes (at the Non-Ferrous Processing Works - Kardjali) where roasting and smelting of the lead concentrates take place in the same highly air-tight unit. The shaft furnace is eliminated which results in reduced coke consumption.

Zinc Extraction:

- Construction of new works for autoclave zinc extraction and replacement of the sulphuric acid production by sulphur production which leads to electricity saving (Non-Ferrous Processing Works - Kardjali);
- Construction of a new roasting shop and sulphuric acid facility. Complete desulphurisation is achieved thus resulting in increased output of sulphuric acid. The heat released from the autogenous processes will be used for steam generation - 17 t/hour at 40Atm. pressure;
- Construction of Larox systems (at the Non-Ferrous Metal Integrated Works - Plovdiv) whereby an environmental effect will be achieved through heavy metal removal from the coke and electricity saving;
- Switching from heavy fuel oil to natural gas (Union Miniere - Copper Extraction Integrated Works - Pirdop, Non-Ferrous Metal Integrated Works - Plovdiv, Non-Ferrous Processing Works - Kardjali, Non-Ferrous Metal Processing Works - Sofia). Reduction of SO_2 emissions and atmospheric gas releases will be achieved. Fuel consumption will be reduced - there will be no need to reheat the heavy fuel oil. Fuel oil itself is economised. Transport costs for heavy fuel oil supply will be reduced;
- Refurbishment of the steam pipe network (Non-Ferrous Metal Integrated Works - Plovdiv) for the purpose of loss reduction and adequate heat supply to the work places, the residential sector, and for the technological processes;
- Use of a new type of filters in the extraction of non-ferrous metals. The effect is environmental - dust concentration in the atmospheric releases is minimised. Power consumption increases;
- Power consumption metering is introduced in the processing of non-ferrous metals and alloys (Non-Ferrous Metal Processing Works - Sofia);

- Weighing of incoming railway tank cars on a calibrated railway weighing platform (Non-Ferrous Metal Integrated Works - Plovdiv);
- Replacement of the flow gauges downstream of the tanks to the internal consumers with more reliable ones which will be used for energy consumption assessment and control in certain sectors (Non-Ferrous Metal Integrated Works - Plovdiv);
- Regular checks of heavy fuel oil quality using the services of an independent laboratory the results of which will be used in payment arbitration (Non-Ferrous Metal Integrated Works - Plovdiv).

Particular data on the results from implementation and the mitigation potential of each individual measure are shown in Table B-2, Annex B.

Chemical Industry

The measures were selected in conformity with the main trends towards replacement of the outdated technologies by new, up-to-date and advanced technologies as well as re-engineering of some key production processes. The measures and sites indicated underlie the long-term programs of the enterprises. Projects have been elaborated, new technologies and engineering have been defined for some of them:

1. Update of the urea production capacities in Chimco - Vratza is the second stage of the urea production reengineering and updating whereby reduced consumption of basic raw materials, heat and power is achieved.
2. Redesign of the ammonia production at Agrobiochim - Stara Zagora. The plant has the largest energy consumption of the four ammonia facilities in the country (13.8 Gcal/t ammonia). Construction of a new 300 000 t/year ammonia capacity with energy consumption 8.2-8.5 Gcal/t is envisaged.
3. Redesign of the ammonia production at Agropolichim - Devnya. The plant was commissioned in 1973 and was designed to burn gasoline. Later on it switched over to natural gas. The equipment used does not allow reduction of the energy consumption below 10.5 Gcal/t ammonia.
4. Production of lime-ammonium nitrate at Agrobiochim - Stara Zagora. Switching over to lime-ammonium nitrate from the ammonium nitrate produced currently was dictated by agricultural demand for that type of fertilizer (related to the high acidification of the soil) in the country and in the international market. Construction of about 360 000 t/year capacity is envisaged. The new owner shall undertake Measure No. 2 and the related Measure No. 4 if willing to enter the domestic and international nitric fertilizer markets.
5. Rehabilitation of the catalytic reforming plant at Neftochim - Bourgas. The plant is outdated and worn-out, with high consumption of basic raw materials, heat and electricity . The technology shall be re-designed for an up-to-date layout and equipment guaranteeing reliability of the plant. The annual economies are conditioned by the reduced heat and power consumption and have been calculated on the basis of the current load of the plant. With full load the annual economies will be increased by 30-35%.
6. Rehabilitation of the catalytic cracking plant at Neftochim - Bourgas. The envisaged rehabilitation will guarantee process safety and up-to-date energy consumption which is of great significance for the cost value of the product.
7. Production of ammonium nitrate at Agropolichim - Devnya. The nitric fertilizer produced at Devnya currently - stabilised ammonium nitrate has low quality indicators with high energy consumption. Production of pure ammonium nitrate will increase the demand for that product and will result in energy saving. Annually a construction of installations with 360 000 t/year capacity is scheduled using ammonia by a new technology described in Measure No. 3.

8. Heat loss reduction through rehabilitation and updating of the heat exchangers and through improved thermal insulation are regularly performed at the industrial companies.

Further data on the measures are summarized in Table B-3, Annex BI.

Light industry

The light industry in Bulgaria consists of 5 subsectors (Textile and knitwear; Clothing; Glass, porcelain and glazed earthenware; Tanning and footwear; Woodwork and furniture) with a total of 385 companies and 136829 employees.

The following groups of mitigation measures are envisaged aimed at energy efficiency improvement in the subsectors:

1. Non-investment measures and low-cost projects (organisational/technical and managerial): full loading of the capacities of enterprises; production concentration in separate shops and buildings and isolation of the remaining buildings and rooms in order to reduce energy consumption; regular checks and prevention maintenance of energy-intensive machines and equipment; use of electricity in the lower-tariff zones and times of the day; improvement of the thermal insulation of pipelines, taps, user stations and water heaters; improved power supply management, training of operators and managing staff; development of energy consumption and product energy intensity rates and standards. These measures will be determining in the shorter term till 2000.

2. Medium-cost measures with 1 to 3 years payback period: updating of the lighting and conditioning installations: economy of about 6% of the total electricity consumption costs;optimization of the steam boiler facilities - up to 7% reduction of the energy resource costs; energy recuperation, new energy sources, adoption of new technologies - up to 3% economy of energy costs. These measures are scheduled within the middle term till 2010.

3. High-cost investment projects with 5 to 10 years payback period: Import of new equipment, process lines, adoption of new products, gas supply to the industry, energy loss reduction through space heating and conditioning of the process shops - up to 30% heat saving; highly automated, unattended, automated shops and machines, energy efficient electric drives in large quantities - 5 to 10 thousand electric motors.

Table B-4 in Annex B presents these measures allocated in 6 groups, with pilot sites assigned to each of them and mitigation potential assessment.

Food processing industry

The subsector includes dairy, meat processing, fish processing, wine production, brewery, sugar extraction and processing, vegetable-oil and canning. The subsector encompasses 260 companies employing 39 050 people or 8.62 % of the employees of the industrial sector. Beside the public sector enterprises, numerous small private businesses have been established. The output of the industry in 1996 constituted 20.8 % of the total industrial output for the country. The food industry products are a major part of the country’s exports. The measures selected in the subsection are of a demonstration nature and matched to the main trends in that area, aiming at replacement of the outdated technologies by new, more advanced and more efficient ones. A major obstacle to the implementation of these measures is raising of the required funds on terms beneficial for the enterprises.

Some of the measures discussed in the subsection resulting in electricity saving are gas supply to the steam boiler plant at the Maritsa Canning Works - Pazardgik; Construction of a local water supply system for the refrigerator, Maritsa Canning Works - Pazardgik; Supply and installation of 20 pcs high-efficiency condensate separators, Maritsa Canning Works - Pazardgik; Supply and installation of 6 pcs Curtis regulators for electric truck control, Maritsa Canning Works - Pazardgik; Design and building of local heating systems with water as heating medium; Supply and installation of automatic doors for refrigerating chambers, FRUCTO - Sliven; Sectionalization of the main building lighting, YAGODA Canning Works - Yambol; Installation of local lighting of four process lines, YAGODA Canning Works - Yambol; Building of a system for selection and automatic return of the process condensate, MALINA

Co. Ltd. - Dupnitsa; Introduction of a chemical additive for heavy fuel oil doping, SERDIKA AD - Stara Zagora; Building of a system for steam boiler plant preparation with automatic temperature monitoring T = 95-98^{o}C, MELTA-90 AD; Capital repair of the thermal insulation of the main steam line and condensate line, Maritza Canning Works - Pazardgik. The measures are summarized in Table B-5, Annex B.

Machine building and metalworks, electrical and electronic industry

The measures selected in this subsector were matched to the main goals and trends of the industrial policy and will contribute to the competitiveness of the products.

The evaluations of the proposed measures have been made on an expert level and are of a tentative character. The measures should be regularly re-evaluated depending on the results and development trends. At the initial stage that should take place after the introduction of an overall energy audit up the chain: enterprise - business activity - subsector - industry.

Table B-6 in Annex B presents technical measures in a typical enterprise. On that basis, proceeding from the total number of enterprises in both subsectors, and the saving of energy for the period, the following expert assumption was made for the potential for energy saving as referred to a typical enterprise:

- 150% potential - 50 companies;
- 100% potential - 100 companies;
- 80% potential - 210 companies;
- 60% potential - 200 companies.

If a consistent energy efficient policy is carried out, in 2020 the reduction of energy consumption can be expected to amount to 30%.

Construction

In order to improve energy efficiency in the construction industry, a system of measures (Table B-7, Annex B) and regulatory framework for their enforcement are needed. A primary significance is attached to measures for economy of oil products and electricity contributing 75,5 % and 19.2 % respectively to the final energy demand in the sector. Second in significance are coal and heat saving measures. In connection with the pending gas supply to the country, it would be technically and economically justified to increase the demand natural gas as an energy source for the industry.

The set of energy efficiency measures includes the measures listed below:

- *Introduction of highly efficient construction machines and devices.* The existing machines with internal-combustion engines, owing to wear, have up to 30% overconsumption of fuel. The feasibility study on replacement of the machines shall be comprehensive and shall take into consideration not only the cost of saved fuel, but also the maintenance costs, the reduced working time fund due to low reliability and repair time.
- *In-operation inspection checks of fuel consumption.* Through installation of gasoline and fuel oil flowmeters, the actual consumption can be taken down and the information can be used for making correct management decisions and quantitative assessments of fuel overconsumption. Through inspection checks for the purpose of developing industry rates of consumption, 3% economy of fuel can be achieved. The Bulgarian standard BDS 87-50 for setting the specific fuel consumption is dated in 1971 and needs revision.
- *Update of the technical specifications* of liquid fuel consumption in machines with internal combustion engines and electricity consumption in the production process in the production technology base: Instruction No. 1 of the Ministry of Construction, Architecture and Urbanisation on the standardised fuel and lubricant consumption by the construction devices, and Instruction No.

3 on standardisation of fuel and lubricant consumption are in effect since 01.01.1990 and are already outdated.

- *Gas supply to the machines driven by internal-combustion engines:* equipping the machines with internal combustion engines with LPG systems. Currently there are obstacles owing to the lack of a developed gas station network; the measure, however, will have a definite economic and environmental effect.
- *Liquidation or restructuring of enterprises* with overconsumption of fuel. Implementation of that measure has partly started with the establishment of enterprises for production of grout and products for the construction with the optimum of production capacity and servicing defined consumer regions. Most often, the new plants have lower installed capacities and lower degree of mechanisation. Power consumption is twice lower. Their service areas are limited. Thus, in addition to energy saving, economy of liquid fuel is achieved.

Building materials industry

The measures that are envisaged are related to the increase of the energy efficiency and reduction of the fuel consumption in the different processes. Regulatory and legislative measures are also considered.

The objectives of the measures are reduction of the absolute in-process fuel consumption as well as replacement of the more expensive imported liquid and solid fuels by alternative fuels and fuel waste from the domestic market, as well as renewable energy sources (RES). The main measures are shown in Table B-8, Annex B.

In the cement industry, an accent is laid on the technical measures performance and adoption of which cannot be accurately predicted in time due to the change of cement plant owners and the new owners' views with respect to investments in energy-saving technologies. For example, the new owners of three plants have announced their investment policy for the next eight years, and the total sum amounts to about US$300 mln. However, the exact structural allocation of investments is not clear because it is a company secret. It is supposed that part of these funds will be invested in improving the environment around the plants (construction of new or refurbishment of the existing wastewater treatment plants). Another part will probably be invested in conversion of the process type into a dry process, and part of the funds will be invested in adapting the facilities to solid fuel. The planned heat savings are based on a process line of 100 000 t/year capacity equivalent which is 5 % of the annual output. The economy of secondary energy resource utilisation is envisaged subject to opportunities for continuous use of such resources, that is, existence of a permanent consumer of such "secondary" heat. Utilisation of other waste fuels such as motor-car tiers and combustible additives is planned as replacement for part of the main fuel (natural gas).

In the production of structural ceramics, the measures are mainly technical and concern a conditional process line for production of 30 mln. bricks per annum which is 4.6 % of the annual output. In that case privatization also introduces an element of uncertainty about measure implementation. Drying by means of solar energy would save up to 60 % of the total energy needed for the drying process. Economical methods of drying would result in 5 % economies of heat energy. Fuel consumption control would result in 5 % economy. The financial, regulatory and other measures proposed for the cement industry can be applied to this branch industry as well.

The energy saving measures for quicklime production concern a process line with capacity equivalent of 100 t/24 h which is 10 % of the annual output. In 80 % of the quicklime kilns in Bulgaria both technical measures, as well as investments, can be implemented. The average economies of 40 kg fuel (AC anthracite) per one kiln system would result in emission reduction.

Households and Services

The analysis encompasses residential and service subsectors, in 6 groups of settlements by different process types: heating, water warming and cooking, and specific power consumption (e.g. lighting). Sixty nine programs (measures) and demonstration projects structured as technical, financial leverage, investment, and legislative are given. The current status analysis and development forecasts for the household and public service sector show that the improvement of energy efficiency in the individual process types should be implemented along the following lines:

A) **Low-temperature heat processes (heating, hot-water supply and cooking):** improvement of the thermal characteristics of buildings by means of appropriate architectural and layout solutions, improvement of the thermal insulation indices of external enclosing structures and energy installation efficiency; competition among the different types of heat supply (centralised, individual, and gas supply) under the conditions of normalised market relations; improvement of the technical condition of distribution systems inside the buildings; creation of opportunities for individual control, metering and payment of heat consumption in centrally heated or gas-supplied buildings; technically and economically justified choice of energy carriers and of the respective combustion facilities for residential and public buildings with individual heating;

B) **In the electric lighting process**, it is envisaged to implement measures resulting in reduction of electricity consumption by more than 50% without reducing the illuminance level and without deterioration of illumination quality. These measures shall be implemented using compact luminescent lamps in the residential and public lighting, as well as replacement of the present incandescent lamps by high-pressure sodium-vapour lamps in street lighting. In that case electricity savings will be achieved with the minimum investments.

C) The high-priority areas and measures in the **electric appliance purposes process** in the household and public service subsector where electricity savings can be sought are: economical operation of the electric appliances and replacement of the inefficient refrigerators, TV sets, etc., introduction of energy-efficient motors, energy audits and consultancy for energy consumers, economic constraints by reaching the marginal price level of energy carriers, etc.

1. Financial measures

Setting up of district (municipal) energy efficiency funds, utilisation of the existing funds to reduce electricity consumption of low-income households, ownership change program, and adoption of a new tariff for payment of the electricity consumed for street lighting.

2. Investment measures

Demonstration projects: reconstruction of the district heating system inGabrovo; reconstruction of a panel residential building in Gabrovo; reconstruction of a school building in Gabrovo; reconstruction of an industrial building in Gabrovo; lighting reconstruction in the District Hospital of Kardjali; lighting reconstruction in the Technical College of Galabovo; street lighting reconstruction in a region of Gorna Oryahovitsa; automated control of the street lighting in Sofia; a program of energy efficiency measures for the budget-supported social establishments.

3. Regulatory measures

Harmonisation of the standards applying to electric appliances used in households and in the public service sectors; a new tariff of local heat energy prices on the basis of individual consumption metering and control; labelling of commodities and products in accordance with their energy efficiency; a program of applying the "energy efficiency" criterion to state purchases.

4. Legislative measures

An energy efficiency law including normative preferences for implementation of energy-saving measures; an energy law including provisions for regulation of the status of local gas-supply companies, and regulatory bodies; supplement and amendment of the Urban Development Act and tax laws.

5. Institutional measures

Development of a municipal energy efficiency network; setting up energy efficiency teams at the municipal and district administrations and establishment of district energy centres; programs for energy-saving training of energy consumers; inspection of the quality and energy efficiency of locally produced or imported household appliances.

As seen in Table 4.3. the effect of the measures is quite significant. On the average, the costs involved in the conservation of unit energy are about 25 times smaller than its market value which, in addition to that, shows an upward trend with a view to elimination of budget subsidies for some energy sources and to approaching the European levels. The regulatory, legislative and institutional measures cannot be quantified; however, they are absolutely indispensable for the implementation of technological and investment measures.

Mitigation potential of measures in the residential and public sector

Table 4.3.

No	Measure	Annual energy savings GJ (mln kWh)	Costs of project mln USD	Payback period years	Cost of unit energy saved USD/kWh(GJ)
1	District heating user stations retrofit	6.6 (0)	98	3.5	0.166 USD/ GJ
2	Individual control and metering of heat energy with centralised heat supply (600 thousand houses and 257 thousand reduced dwellings covered)	2.6 (0)	26	4.7	0.110 USD/ GJ
3	Thermal insulation of houses and public buildings (450 thousand houses and 150 thousand reduced dwellings covered)	21.4 (0)	373	2.1	0.185 USD/ GJ
4	Reconstruction and rehabilitation program of schools and panel houses with centralised heat supply	0.9 (8.9)	25.3	7	0.0069 USD/ kWh
5	Reconstruction and modernisation program of existing hospitals	0.2 (2.5)	1.8	2.17	0.0022 USD/ kWh
6	Efficient shower for the electric water heater program (1 000 000 households covered)	0 (500)	15	0.5-1	0.002 USD/ kWh
7	Program for efficient use of household electric appliances	0 (158.1)	0.463	0.01	0.003 USD/ kWh
	TOTAL	21.7 (669)	539.6		

Annual emission reduction due to saved:	***Electricity***	***Heat energy***	***Fuels***	***TOTAL energy***
CO_2 emissions [Gg]	**1124**	3043.1	1150.1	5317.2
CH_4 emissions [Mg]	**14**	121.9	28.7	164.6
N_2O emissions [Mg]	**350**	666.2	0	1016.2

<u>Transport</u>

In compliance with the national priorities in the transport policy, 48 mitigation measures are analysed, out of which 3 technical, 4 financial (with charges and incentives for environmental protection and improvement of the energy-technology characteristics of the transport vehicles); 29 investment measures for infrastructure development and replacement of the transport vehicle fleet; 5 regulatory ones for improvement of the organisation and management in the industry, and 7 legislative ones for harmonising of the current law and regulatory system with that of the Western countries, for stimulation of the public transport, legislative, customs and tax restrictions on the imports of second-hand cars, and regulatory systems for the fleets and airports.

Therefore the main directions for improvement of the energy and environmental performance of the transportation sector are:

1). Legislative background and institutional framework to set the functions and relationships in defining, development and implementation of continuous energy and transportation policy aiming energy savings, promotion of energy efficient technologies and decrease of the environmental externalities of the transport sector.

2). Building an infrastructure matched to the requirements for trans-continental transport corridors crossing the territory of the country;

3). Technical and technological measures directed to more efficient utilisation of the fuel and energy resources and improvement of the environmental characteristics of transport vehicles.

The choice of measures for energy and environmental efficiency improvement in the transport sector is limited by the conditions listed below:

- only recently since establishment of the currency board there are some signs of slowing down or cessation of the crisis processes;
- there is no legislative base which impedes the normal functioning of the market mechanisms;
- there is practically no investment market owing to lack of interest on the part of both local and foreign investors;
- the transport sector is in a process of transition from a strongly centralised management system to a disintegrated one containing various forms of ownership (state, municipal and private);
- the transport vehicles are almost totally imported. That circumstance limits the possibilities for carrying through a government policy of their manufacture;
- the small financial possibilities of state, municipal and private companies as well as the low purchasing capacity of the population necessitate the use or import of outdated machines and technologies;
- lack of incentives and penalties.

Due to the dominating share of the water and railway transport in the freight transportation and the automobile and railway transport in passenger transportation, the priorities in the energy efficiency improvements are facing these transportation types.

It can be assumed that with revival of the country's economy its requirements for transport services will grow, and the processes of getting closer to the economies of developed West European countries will set quite high requirements towards their quality. The limited possibilities of the country at the current stage determine the higher importance of and attention (at least in the short term till about 2005) to measures which do not require significant financial resources. That is why, in the first place, the problems of providing the legislative and normative framework shall be solved. Measures of a regulatory nature not requiring large investments are also of major importance. At the same time, keeping in mind the geographical situation of the country and the earliest possible integration with West European countries, the credits, loans, and aids granted by them shall be utilised in the best way possible for building an up-to-date infrastructure for the transport system. Keeping in mind the considerations above, three groups of measures in the sector could be introduced:

The first group encompasses cases the efficiency and effectiveness of which can be assessed (economies of fuels and energy, investments, costs per unit of energy saved, etc.) as a direct energy-saving effect. Some examples of such projects are given in Table 4.4.

Mitigation potential of measures in transportation sector

Table 4.4.

No	Measure	Annual energy savings toe	Costs of project mln USD	Payback period years	Cost of unit energy saved USD/kWh
1	Improvement of the physical condition, efficiency and effectiveness of the power systems of ships	2.6	0.0022	10	6
2	Replacement of existing ship refrigerating units by new, ecological refrigerating agents	1.8	0.0011	15	3
3	Fitting of catalyzer systems in buses	65.6	0.736	2	276
4	Development of a freight carriage dispatching system	2043	10	20	25
	TOTAL	2113	10.7		

Annual emission reduction due to saved:	*Electricity .*	*Heat energy*	*Fuels*	*TOTAL energy*
CO_2 emissions [Gg]	**41.3**	0.007	6.843	48.15
CH_4 emissions [Mg]	**0.52**	0.0003	0.256	0.776
N_2O emissions [Mg]	**12.8**	0.002	0	12.802

The second group includes measures with a direct or indirect effect which, however, cannot be quantified in economic terms at present. These are mainly measures of the regulatory, financial and legislative character (e.g. Introduction of legislative, custom and fiscal constrains for import of old cars that do not meet the European environmental standards: Improvement of the legislative basis for control of the fuel consumption and flue gases in the exhausts; Project development for a National environmental transport policy; Introduction of taxes for covering of expenses for environmental protection; Qualitative study on the adverse effects of the transport; Introduction of financial incentives for improvement of the energy-environment characteristics of the transportation means and charges in case of violation of the standard requirements, etc.).

The third group includes measures related to building the transport system infrastructure (large-scale transport projects) that will create favourable conditions for improving the energy efficiency of the transport sector. The total investments in such measures (construction of transport corridors, transport facilities, etc.) are estimated to 4.2 billion $ US, 3.7 billion of which are for projects directed to trans-European transport corridors.

Cross-sectoral measures - Efficient Lighting Program

In 1995 electric lighting consumed 12% of the total electricity consumed in the country. This fact indicates the significance of energy efficiency improvement on a national scale, encompassing the energy efficiency of residential and street lighting, lighting in the public and commercial sectors, as well as lighting in the industry.

- **Program for introduction of compact fluorescent lamps in residential lighting and other programs as** a program for marking the energy efficiency of light sources, lighting fittings, floodlights, and trigger control devices, as well as development of energy indices and standards for lighting installations which shall be observed in their design, manufacture and trading, or a joint action program with the European institution "Green Light" for energy efficiency of electric lighting, etc.
- **Program for improving the energy efficiency of street lighting** (e.g. replacement of the mercury-vapour lamps by sodium-vapour lamps);
- **Energy efficiency program in the public and commercial sector** (e.g. replacement of incandescent lamps by fluorescent lamps; replacement of the existing fluorescent lighting fittings with plastic grids by new lighting fittings with aluminium reflecting grids; proper design and make of commercial lighting installations; incentives for and training of the customers.

Summary indicators of the efficient lighting program

Table 4.5.

N	Sector	Annual electricity saved mln kWh/year	Cost of saved electricity mln $US/year	Capacity saved MW	Total investments needed mln $US	Payback period years	Implementation period years
1	Households	441	17.64	441	65	3.7	5-6
2	Street lights	480	32.64	120	40	1.7	4-5
3	Administrative and commercial buildings	270	18.36	160	60	3.3	5-6
4	Industry	375	25.5	200	50	2.2	5-6
	TOTAL	1566	94.14	921	215	2÷3.7	4-6

Annual savings:

Electricity [mln kWh]	**1566**
CO_2 emissions [Gg]	**2631**
CH_4 emissions [Mg]	**33**
N_2O emissions [Mg]	**819**

- **Industrial lighting energy efficiency improvement program** (e.g. replacement of the mercury-vapour lamps by high-pressure metal-halogen lamps and sodium-vapour lamps; replacement of the incandescent lamps by double-capped tubular fluorescent lamps; automated control of the general lighting in production shops; redesign of the present lighting installations laying the accent on local lighting.

Table 4.5 presents a summary of the indicators describing the potential for energy efficient lighting in different sectors of the economy.

Energy and transformation industries

The measures in the energy sector, related to emission reduction from electricity and heat generation systems are based on restructuring of production capacities and reduction of losses in electricity and heat transmission and distribution. The impact of some changes in the structure of energy transformation system is also pointed out.

Development of nuclear energy

The nuclear energy is considered as one of the most efficient technologies for electricity generation from the GHG-related point of view. It is expected some of the nuclear units at NPP Kozloduy to be decommissioned at the beginning of next century. Several major projects aimed to improve the safe operation of the rest units of NPP Kozloduy have been already implemented. In order to keep the share of nuclear energy a modified nuclear plan of energy system development is designed. It envisages to continue construction works on 1000 MW unit that has been stopped by the Governmental decision in 1990 and construction of new nuclear units at NPP Belene.

Accelerated development of hydro energy

As far as the GHG emissions are considered hydro energy can be evaluated as one of the most clean methods of electricity generation. Besides hydro energy is a renewable energy source. In order to assess the CO_2 reduction potential in case of accelerated development of hydro energy in Bulgaria, by 2020 there are 800 MW hydro energy units added to the baseline scenario at the following generating hydro energy sites and years of commitment:

- Gorna Arda cascade - 156 MW - 2007;
- Sredna Vucha cascade - 120 MW - 2008;
- Mesta cascade - 122 MW - 2014;
- Danube hydro complex - 400 MW - 2015;
- Micro-HPPs with total capacity of 200 MW, gradually constructed by the year 2020.

Upgrading of cogeneration plants and district heating boilers by natural gas turbines

The lately developed new steam-gas modules which include gas turbines, steam turbines and boilers-utilizers facilitate electricity production at very low level of fuel consumption. An option for energy system development is examined which envisages commitment of 530 MW units and production of 3 billion kWh in cogeneration plants and district heating plants (Table 4.6).

Natural gas combined cycle for electricity generation

Recently electricity generating units have been designed which combust natural gas in gas turbines and use exhausted gases for steam production to feed steam turbines for electricity generation.

The electricity unit commitment plan envisages implementation of natural gas combined cycle units with unit capacity 450 MW and 2250 MW total capacity and electricity production of approximately 12.5 billion kWh.

Upgrading of cogeneration plants (TPP) and district heating boilers (TP) by natural gas turbines - main technical and economical indices

Table 4.6.

Index	Unit	TPP Sofia	TP Zemliane	TPP Plovdiv	TP Plovdiv	TP Burgas	TP Edinstvo	TP Mladost	TP Varna
Installed capacity	MW	150	78	78	25	78	85.6	30	7.8
Load factor	h	5000	6000	5800	5760	6475	6000	5740	7217
Electricity production	10^6 kWh/a	750.0	468.0	452.4	144.0	505.0	513.6	172.2	56.3
Heat production	10^6 Gcal/a	265.0	1470.0	563.0	211.7	1269	221.2	359.0	78.0
Investments - total	10^6 USD	90.0	27.3	27.3	9.1	27.3	48.0	11.0	6.0
Incl. for electricity	10^6 USD	51.3	19.1	19.1	7.9	19.1	27.4	9.5	2.3
Incl. for heat	10^6 USD	38.7	8.2	8.2	1.2	8.2	20.6	1.5	3.7
Heat rate for electricity production	kg/kWh	180	161.5	161.4	161.4	157.0	183.1	166.7	167.0
Heat rate for heat production	kg/Gcal	163.5	162.1	158.7	158.7	165.4	163.5	163.2	163.0
Natural gas price	USD/10^3 nm^3	104	104	104	104	104	104	104	104
Electricity cost	USc/kWh	2.00	1.74	1.72	2.03	1.66	2.08	1.73	1.98
Heat cost	USD/Gcal	19.6	16.18	18.99	20.29	20.15	21.29	19.52	21.95

Increase of renewable energy sources in the country energy balance

Recently the interest in renewable energy sources (RES) has grown mainly in connection with the changes in the field of energy policy around the world and in particular in Bulgaria as a result of the air pollution and the climate change. The renewables are CO_2 emission free energy sources. The study on the energy potential of the renewable sources in Bulgaria shows that theoretically they can meet the overall energy demand of the country. Practically available potential, however, is considerably smaller.

The adoption of the laws on energy and energy efficiency would have primary importance to favour RES development. The wide utilisation of RES would contribute to energy independence of the country, development of technological base, creation of new jobs, conservation of the environment. It would involve local and foreign investments. According to the scenario of country integration to EC, RES may cover about 7-8% from total energy demand. It is necessary the state administration and National Electric Company (NEC) to treat RES with priority to the rest energy sources and especially imported energy sources. It is necessary a preferential financing scheme to be adopted for RES.

Currently the renewable energy sources (hydro-power stations with installed capacity up to 10 MW, wind farms, geothermal waters, solar collectors and photocells, biomass and biogas generators) are of about 135 MW installed capacity and generate about 1100 GWh per year which is 0.4 % of the total energy demand.

Without any incentives on the part of the state, in 2010 the RES installed capacity may reach 1090 MW, and the annual output - 3800 GWh, that is, about 1.5 % of the total energy demand.

The European “short-term energy” criteria require achievement of an 8÷10 % share of RES in the total energy demand. That can be done by means of purposeful state policy adopting special standards in the Energy Efficiency Act to encourage the utilisation of renewable energy sources, and on that basis - to encourage the entrepreneurship for wide utilisation of the RES potential.

Reduction of electricity and heat losses in transmission and distribution networks

The level of electricity and heat losses in transmission and distribution networks forms considerable potential for energy economy and therefore for CO_2 emissions reduction. At the ground of network studies and expert judgement a schedule has been designed for electricity losses and auxiliaries reduction by 6%, and by 8% for heat network for the period after 2000.

Rehabilitation of Thermal Power Plant

Comprehensive study of the rehabilitation of TPP that are in operation had been carried out last three years. Seven TPP are addressed in the study at average cost of rehabilitation 130 $US/kW. The rehabilitation will result in extension of unit life-time by 10-15 years, increasing plants availability by 3-5%, decreasing auxiliaries to 10% and CO_2 emission reduction by 3.75-4.75% for the plants on local lignite and 1.8% on the plants on imported coal. The total capacity to be rehabilitated is 4500 MW.

Natural gas supply to the households and public buildings

This option aims to replace electricity, residual and coal consumption with natural gas. The program for household natural gas supply is elaborated and it projects 400 000 households (i.e. about 1.2 million inhabitants) to be supplied by 2020. If the same lifestyle in the households is assumed the CO_2 emission reduction due to the fuel switching will be 3 million tons CO_2 annually at a cost of emission reduction of 7.3 $US/ton CO_2 saved. If some additional measures are undertaken for the increase of the scope of the program the gas supply could be ensured for 2 million inhabitants and public buildings equivalent in terms of consumption to 320 000 households at total investments in the distribution network construction of about 202 million $US.

In order to compare the effectiveness of different mitigation options, the annual emission reduction potential of the measures and the investment cost to reduce 1 ton of CO_2 per life cycle of a measure are estimated. Table 4.7 shows energy supply options ranked by specific investment cost per ton CO_2 emission reduction.

CO_2 reduction potential and investment cost per ton CO_2 emission reduction

Table 4.7.

No	Measure	Annual potential 10^6 t CO2	Investment		
			Total $10^6$$US	$US/t CO_2 life cycle	Life cycle
1	**Reduction of electrical losses**	2.1	91	2.9	15
2	**Reduction of thermal losses**	2.0	235	5.9	20
3	**Upgrading of heat production plants**	3.3	246	3.7	20
4	**Micro-hydro potential**	1.1	275	5.0	50
5	**Hydro power projects**	4.3	1335	6.2	50
6	**Natural gas combined cycle**	13	1267	6.5	15
7	**Belene NPP**	9	1300	8.5	30
8	**TPP rehabilitation**	1.3	585	28.0	15
9	**Gas supply to households**	6.8	1650	6.07	40

The above mentioned technical and economic assessments of the mitigation measures are based just on the investments required for their implementation. A series of important economic indicators are not taken into account, such as:

- The implementation of a measure entails reduction of the funds invested in other projects, postponed as a consequence of the option ranking.
- The operational costs of energy system change as a result of measures implementation for CO_2 reduction.
- The financial profit of measure implementation.

The financial assessment uses the discounted costs of 1 to CO_2 reduction for 2000-2020 period, calculated as ratio of total emission reduction for the period via the sum of discounted change of production cost of energy supply due to the mitigation measures within the same time period;

The best energy supplyoption with regard to the financial parameters is the losses reduction, followed by the upgrading of the cogeneration power plants and district heating boilers and the hydro option.

The analysis of the measures and comparison of the scenarios for energy system development shows that energy supply measures except for renewable energy and natural gas combined cycle are no-regret measures.

Forestry

In the end of 1997, the Law on Forests and the Law on the Forests and Forest Areas Restitution were adopted.

In these laws the main items of the forestry policy are as follows:

- conservation and increase whenever possible the forestry areas in the country;
- some restrictions imposed to the future forest owners for the benefit of the society;
- stress on the environmental and social significance of the Forrest, without neglecting their economic (wood production) role.

The policies may prove to be attractive if additional impacts such as recreational, microclimatic, hydrological and living condition improvements are taken into account. They are also pilot projects that should identify the adaptation and resistance rates of the tree species in Bulgaria to climate changes. The analysis of the results to be obtained will help to update the existing standards and governmental policy for sustainable development of the forestry sector.

Lowland forest creation. More than two thirds of Bulgarian territory (72.35%) is covered by plains, from 0 to 200 m a.s.l. and hills, from 200 to 600 m a.s.l. In the same time the percentage of forests in the lowlands is very low, between 3.9 and 9.5%. These forests are under critical minimum, which is in range of 12% for the plains and 24% for the hills. There are too many perspectives for the forest territories to be extended in these parts of the country.

Afforestation of lands, inappropriate for agricultural activities. At present, there are estimated approximately 250 000 ha waste lands - eroded, degraded, marshy, salted and other inappropriate for agricultural production territories. Lands along bigger and smaller rivers, appropriate for reclamation with poplar plantations could be added to this category.

Afforestation in forest shelter belts (FSB). More than 10 000 ha FSB have been established in the last 35-60 years in Bulgaria, mainly in the north-east region of Bulgaria, the Danube plain and the Trakia plain. These FSB serve as effective protection on approximately 500 000 ha arable lands, which is about 10% of the total tillage land in our country. First of all, this protection is expressed in the wind velocity decrease, snow cover homogenous distribution, agricultural lands evaporation reduction, cultivated plants yield increase and others. The FSB are a mighty instrument for the microclimate improvement, biomass productivity and biodiversity improvement, as well as for an increase of forest adaptation to the changed climate conditions.

At present, there is a necessity for the new FSB establishment of nearly 50 000 ha as an effective protection of about 2 mln ha arable lands. The cost of FSB creation is about $ 8 mln for a 10-15 year period and the pay back period is 4-5 years. The cost of reconstruction of existing FSB is estimated to US $ 6 mln.

The FSB creation could have quite positive consequences, due to the great potential of setting of a network of forest corridors which will increase biodiversity in the plain territories, enhance adaptation of the vegetation species. It will lead to environment conditions improvement, CO_2 absorption increase, etc. The creation of the shelter belts should be co-ordinated with the interests of the private owners, municipalities and government consistent with the land reform and private forest restitution.

Linear afforestations are performed in the homogenous schemes along the agricultural property borders, along the roads and rivers. There is no need of special land for these afforestations. The cost of such kind of afforestation range from $35 to $40 per 1 km (distance between saplings = 1 m).

Urban afforestation might include shady trees in the residential areas both in the court yards and between the block houses as well as the line, fruit and ornamental trees. This vegetation helps the microclimate to be more favourable, dust and CO_2 to be absorbed, etc.

Concerning the practical application of new methods for creation of resistant to climate change conditions forest plantations and also with the purpose of the most appropriate choice of wood species and genetic forms, adapted to more dry and worm climate, the series of demonstration projects realisation in Bulgarian forests will be necessary. Some of these projects are given in the demonstration projects section.

These Model projects will serve as an education tool for Bulgarian specialists and students as well as from neighbouring countries for establishment, growing and monitoring of resistant forest ecosystems under the heaviest ecological conditions.

Agriculture

Decreasing the carbon emissions containing gasses and retaining the soil carbon

- Burning termination of stubble-fields and plant remainders.
- Introduction of methods for keeping and improving soil fertility under decreasing carbon dioxide emissions.
- Application of a system against soil water erosion, especially against irrigation erosion.

Waste Management

The CO_2 mitigation potential is presented under the complex mitigation measures for CH_4 emissions.

CH_4

Waste Management

With regard to the implementation of integrated management of municipal wastes a **National Policy for Municipal Solid Waste Management** was developed.

In 1997 a **Law on Reduction of the Adverse Environmental Effect of Wastes** was adopted (State Gazette, No 86/30.09.1997) that regulates the environmentally friendly waste management as a combination of rights, duties, decisions, actions and activities related to the waste generation and treatment. It offers different modes of monitoring of the waste flows. This Law sets the requirement to develop and update, if necessary, the national and municipal programs for waste management. Currently a set of regulations are under development to support the Law (e.g. Regulation on the construction and exploitation of equipment and installations for treatment and storage of municipal wastes). A concrete requirements are to be set, that will also contribute directly or indirectly to the reduction of CH_4 emission due to the fermentation of municipal wastes.

CH_4 mitigation measures The measures to limit the impact of CH_4 emissions from anaerobic decomposition of municipal wastes include:

⇒ Reduction of the total MSW - This measure is complex and its application will certainly lead to diverse impacts on the environment. Because of this, it forms the basis of the National Policy for MSW Management and will be priority in the National Action Plan to Address MSW, as well as in the guidelines of the Governments to the municipalities for development of municipal action plans to address MSW.

⇒ Choice of alternatives for waste treatment

- MSW sanitary landfills - a financially feasible measures for municipalities. The easiest to achieve among the measures related to climate change is the setting of an additional requirement to the companies using the landfills to incinerate theirbiogas. The enforcement of supplementing requirements aiming emission reduction could be done in the process of preparation and adoption of different regulations, including Regulation on the circumstances and requirements for construction and exploitation of facilities and installations for MSW treatment. The implementation of the measure will lead not only to CH4 emission reduction, but also to improvement of air and water quality, reduced risk to spread diseases.

- Reuse and recycling of useful components from wastes is beneficiary to the environment in terms of reduction of used raw materials and waste minimisation, and hence they lead to CH_4 emission reduction. It is environmentally and economically effective measure and it has positive impact not only to the environment and climate, but to the entire society, too.
- Composting is studied as an option for MSW treatment in some of the bigger villages and towns in Bulgaria. If the output compost has good characteristics, its application in agriculture to recultivate soils will lead to additional benefits.
- Incineration is an extreme measure in case other alternative waste treatment approaches are inapplicable. The construction and exploitation of MSW incineration facilities requires serious investments and substantial operational costs which doesn’t match the financial opportunities of the municipalities.
- Complex measures.

⇒ Collecting and incineration (flare) of biogas produced in MSW dumps and landfills The measure that combines the collection and gas removal system, wells and tubes, is the most easy to apply in terms of construction and investments. However, when applied to old landfills, it requires preliminary investigation to specify the composition of generated biogas. If there are hazard wastes together with the municipal wastes, there is a pollution risk frombiogas combustion.

⇒ Utilisation of the methane from MSW dumps and landfills. Biogas collection, removal and utilisation could be considered as a combination of potential measures for CH_4 reduction and development of clean energy sources. The benefits out of the application of this measure are increased security of the landfills, increased air and water quality, decrease of the disease spread risk, prevention of odour contamination and last but not least, economic benefits.

Table 4.8. gives information on the expected reduction of thebiogas due to the implementation of some of the measures discussed.

Expected reduction of biogas from MSW landfills due to planned collection and incineration (utilisation for energy and household needs is not included)

Table 4.8.

MSW landfill	CH_4 reduced emissions		CO_2 equivalent reduced emissions		CO_2 emissions reduced emissions	
	average for project’s life-time	total for project’s life-time	average for project’s life-time	total for project’s life-time	average for project’s life-time	total for project’s life-time
	kt/yr	kt	kt/yr	kt	kt/yr	kt
Sofia - Dolni Bogrov	1 173,74	17 606,04	24 648,46	369 726,88	37,97	569,61
Sofia - Suhindol	721,60	10 823,93	15 153,50	227 302,49	23,35	350,19
Varna	415,06	6 225,95	8 716,34	130 745,03	13,43	201,43
Veliko Turnovo	314,87	4 723,07	6 612,30	99 184,44	10,19	152,81
Rousse	266,58	3 998,66	5 598,12	83 971,85	8,62	129,37
Stara Zagora	263,23	3 948,46	5 527,85	82 917,76	8,52	127,74
Gabrovo - new landfill	232,67	3 490,06	4 886,08	73 291,27	7,53	112,91
Bourgas	217,19	3 257,83	4 560,96	68 414,34	7,03	105,40
Sliven	171,83	2 577,45	3 608,42	54 126,35	5,56	83,39
Dobrich	166,21	2 493,20	3 490,48	52 357,27	5,38	80,66
Pleven	160,93	2 413,88	3 379,44	50 691,58	5,21	78,10
Iambol	160,88	2 413,16	3 378,42	50 676,34	5,20	78,07
Plovdiv	144,53	2 167,99	3 035,19	45 527,83	4,68	70,14
Pernik	129,84	1 947,56	2 726,58	40 898,69	4,20	63,01
Shoumen	117,13	1 756,97	2 459,75	36 896,31	3,79	56,84
Targovishte-old landfill	109,59	1 643,89	2 301,44	34 521,63	3,55	53,18
Razgrad	107,34	1 610,14	2 254,20	33 812,95	3,47	52,09
Pazardjik	95,93	1 438,96	2 014,55	30 218,19	3,10	46,55
Montana	94,33	1 415,02	1 981,03	29 715,44	3,05	45,78
Vratza	92,16	1 382,35	1 935,29	29 029,40	2,98	44,72
Kardjali	90,53	1 358,00	1 901,20	28 517,98	2,93	43,94
Dimitrovgrad	90,11	1 351,68	1 891,35	28 385,30	2,92	43,73
Silistra	90,06	1 350,93	1 891,30	28 369,53	2,91	43,71
Targovishte- new	88,98	1 334,71	1 868,59	28 028,92	2,88	43,18

landfill						
Doupnitza	83,12	1 246,76	1 745,46	26 181,89	2,69	40,34
Haskovo	76,96	1 154,38	1 616,13	24 241,90	2,49	37,35
Petrich	74,81	1 122,15	1 571,02	23 565,25	2,42	36,31
Gorna Oriahovitza	73,46	1 101,83	1 542,56	23 138,41	2,38	35,65
Vidin	66,77	1 001,56	1 402,19	21 032,82	2,16	32,40
Sandanski	66,06	1 004,42	1 406,19	21 092,90	2,17	32,50
Velingrad	47,43	711,38	955,93	14 938,93	1,53	23,02
Lovech	45,48	682,24	955,13	14 326,94	1,47	22,07
Blagoevgrad	41,91	628,70	880,18	13 202,65	1,36	20,34
Gabrovo - old landfill	38,07	551,07	799,49	11 992,41	1,23	18,48
Lom	36,73	551,01	771,41	11 571,12	1,19	17,83
Sevlievo	36,39	545,84	764,17	11 462,55	1,18	17,66
Smolian	32,86	492,97	690,15	10 352,27	1,06	15,95
Svishtov	27,66	414,96	580,94	8 714,11	0,90	13,43
Popovo	25,12	376,86	527,61	7 914,16	0,81	12,19
Asenovgrad	24,45	366,78	513,49	7 702,35	0,79	11,87
Teteven	21,14	317,08	443,92	6 658,76	0,68	10,26
Gotze Delchev	16,67	250,12	350,17	5 252,58	0,54	8,09
Samokov	14,50	217,49	404,48	4 567,20	0,47	7,04
Troian	8,31	124,69	174,56	2 618,43	0,27	4,03
TOTAL:	6 376.22	95 596.18	133 921.02	2 007 861.4	213.24	3 101.36

Agriculture

The following measures are under consideration in the Ministry of Agriculture, Forests and Rural Reform:

Reduction of methane emissions by biological fermentation in stock-breading:

- Increasing the stock-breading production by means of improving the genetic characteristics and reproductive abilities of all kinds of animals.
- Improving the animal feeding and increasing the quality of animal production by reinforced supplements, specific substances, etc.
- Increasing animal productivity by mechanisation of the processes in all sectors of livestock breeding.
- Improving the meadow and pasture utilisation mode in stock-breeding.

Methane emissions reduction through effective utilisation of solid and liquid manure

- Improving the devices and equipment for collection and storing solid and liquid manure.
- Constructing and establishment of equipment for underground storage of manure, methane extraction and its utilisation.
- Composting manure by use of agricultural, industrial and municipal wastes at special sites.
- Improvement of organic fertilization with manure (rates, dates of application, machines for transport and spreading) of different agricultural crops.
- Development of qualitative characters of manure-based fertilizers and defining their prices.

Decreasing methane emissions under rice cultivation.

- Rice field construction including an improved system of water drainage.
- Improving the rice production technology.
- Cultivation of new high-productivity rice varieties with improved botanical qualities.

Industry, Energy and Transformation, Households and Services, Transport (energy-related)

There are no particular measures developed in those sectors addressing the CH_4 emissions. However the measures aiming to improve the energy efficiency and to mitigate the CO_2 emissions have complex impact and their CH_4 mitigation potential in each sector and for some concrete measures is presented in the corresponding tables in the body text and in the tables included in Annex B.

N_2O

Agriculture

Improving mineral fertilization

- Use of nitrogen fertilizers, especially urea, to be in a form, time schedules and qualities consistent with the soil profiles.
- The use of nitrogen mineral fertilizers to be combined with manure in order to decrease N-gasses.
- Incorporated fertilizers containing nitrogen to be immediately tilled and sowed.

Industry, Energy and Transformation, Households and Services, Transport (energy-related emissions)

At the current stage, the N_2O emissions are not separately addressed when developing GHG mitigation measures in Bulgaria, since their share in the aggregated GHG emissions is comparatively small (6-7%). However, the enumerated measures to reduce the CO_2 emissions contribute for the N_2O mitigation as well. The mitigation potential of the measures with regard to the N_2O emissions is provided in the tables for each sector and in the detailed tables for the measures in the industrial sector attached in Annex B.

All discussed measures are preliminary database that will be used to rank and select measures to be included in the aggregated National Action Plan to address climate change in Bulgaria.

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CHAPTER 5

GREENHOUSE GAS EMISSION PROJECTIONS AND ASSESSMENT OF POLICIES AND MEASURES

The chapter presents results of GHG emission projections based upon scenarios of future development of economy, energy demand and supply in Bulgaria. Different methods and approaches are used at different stages of the forecasting process and key mitigation options are identified and evaluated according to the data discussed in chapter 4. The results obtained indicate that the aim of Framework Convention of Climate Change (FCCC) to have year 2000 GHG emissions below the base year 1988 emissions will be achieved. The implementation of these options have to start now in order to prevent a rapid GHG emission increase in the decades immediately after 2000, and to meet the Kyoto Protocol reduction target.

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METHODOLOGY FOR GHG EMISSION PROJECTION AND SCENARIO DEFINITION

The most significant contributors to GHG emissions in Bulgaria are the energy production sector and the energy-intensive sectors of the national economy. Therefore, the main effort in the GHG emission forecasting are directed towards these sectors, while the studies that address non-energy sectors are more limited.

The GHG projections have two main targets:

- To identify whether Bulgaria will be able to meet its obligations in regard to the FCCC and the Kyoto Protocol;
- To identify the most efficient policies and measures at macroeconomic, sectoral, utility, enterprise and household level that may lead to GHG emission reduction.

In order to achieve these goals, a methodology is used, that allows to exhaust the interrelationships between macroeconomic development, sector development (including the energy sector), and GHG emissions. Therefore, according to these methodology forecasting procedures have been carried out in four major stages within the relevant institutions responsible for them:

- Macroeconomic and socio-economic analysis and projection - Institute of Economics to the Bulgarian Academy of Sciences (BAS). There are also sector by sector projections developed by the corresponding Ministries and Institutes;
- Final energy demand analysis and projections - Institute of Nuclear Research and Nuclear Energy to BAS;
- Energy sector long-term development - ENERGOPROEKT and the National Electric Company;
- GHG emission projection - ENERGOPROEKT.

Four scenarios are elaborated: *1) baseline scenario, 2) energy supply scenario, 3) energy efficiency scenario, and 4) mitigation scenario* with specific assumptions at each stage. The baseline scenario corresponds to the underlying assumptions and key results consistent with the Draft National Energy Strategy (see Chapter 4). The energy supply, energy efficiency and mitigation scenarios are elaborated in the way that allows to identify potential effects of policies and measures with special attention to the energy efficiency issues. The baseline scenario is a rather *likely-to-be* future scenario than a *frozen* efficiency scenario which means that it incorporates to a certain extent all policies and measures. The mitigation scenario shows the maximal GHG mitigation potential.

MACRO-ECONOMIC PROJECTIONS

The development of macroeconomic scenario is based on methodology and software designed at the Institute of Economy to BAS. This methodology that includes both modelling approach and expert judgements is implemented using simulation econometric model of neokeynesian-monetary type on macro and inter-branches level. Using this methodology the macroeconomic trends are obtained up to the year of 2020. Given the restrictions of the currency board introduced in the country only one scenario is considered.

In the First National Communication there were two macroeconomic scenarios developed in 1995:

- baseline scenario (BS)
- mitigation (energy efficiency) scenario (EES).

The comparison of the two previous scenarios with the currently proposed scenario under currency board is not appropriate due to the drastic economic recession in the country in 1996-1997 that brought to a drop of about 17% of the GDP. Some of the demographic and macro-economic indicators taken into account or projected in the three enumerated scenarios are given in Table 5.1. As seen the new scenario for the macroeconomic development of the country differs substantially from the previous ones and the values are quite lower. It accounts for the 6-8 year delay in the actual development rates.

Demographic and macroeconomic indicators

Table 5.1.

Indicator	Unit	Scenario	1995	2000	2005	2010	2015	2020
Population	thous. people	BS	8460	8417	8375	8333	8292	8250
		EES	8460	8417	8375	8333	8292	8250
		CBS	8385	8040	8020	8000	7980	7960
GDP	billion BGL (prices '92)	BS	187.7	232.5	320.0	436.4	575.8	741.9
		EES	187.7	211.3	276.3	376.7	507.3	713.6
		CBS	205.6	194.2	257.6	337	423.8	520.6
Production index:								
Industry	%	BS	100	118	155	204	263	336
Construction	%	BS	100	133	181	251	334	432
Agriculture and Forestry	%	BS	100	129	174	232	300	379
Transport	%	BS	100	141	206	302	422	580
Industry	%	EES	100	105	134	182	248	345
Construction	%	EES	100	106	136	183	244	338
Agriculture and Forestry	%	EES	100	118	156	214	291	413
Transport	%	EES	100	126	172	247	347	509
Industry	%	CBS	100	93	131	167	207	253
Construction	%	CBS	100	86	114	149	188	231
Agriculture and Forestry	%	CBS	100	91	123	165	211	263
Transport	%	CBS	100	102	138	183	230	286

Note: BS - baseline scenario; EES - energy efficiency scenario; CBS - currency board scenario

The following main **assumptions** were set down in the updated projection:

1. A comparatively smooth development during the period is assumed, without crisis shocks. The currency board will continue to function at the BGL/DM rate fixed in a Parliament Act, and later on - the BGL/EURO rate. No significant changes are expected after the introduction of the EURO. It is supposed that any possible changes for Bulgaria resulting from the introduction of the EURO would be solely of a technical nature.

2. It is estimated that the country has a real potential and capabilities to achieve positive economic growth in the mid-term. A gradual growth acceleration from 3.5% to 5% is expected. The dollar value of the GDP will grow faster than the dynamics at unchanging prices due to the valorisation of the local currency.

The prerequisites for growth are formed by means of:

- the healing effect of financial stabilisation;
- the laid down milestones of the structural reform;
- the unusually low basis level of production reached during the crises years both in industry and agriculture;
- the existing reserves in the utilisation of material and labour resources, production capacities included;
- the stimulating and growth-supporting international economic environment, investments included;

3. The price dynamics will progressively subside, settling down steadily at a single-digit level in the end of the period. The relatively higher inflation compared to Germany is explained with the existing significant lagging of the domestic price level behind the international prices, which is corroborated by some international comparisons. The interest rates will remain moderately negative, contributing to strengthening of the banking sector and state finances.

4. Foreign demand is expected to be the main drive of production. There are reserves for activation of the foreign trade both in agriculture and in some industries (such as textile, food processing, machine building).

5. Domestic demand during the period under consideration will be suppressed, that is, it will fall behind the GDP dynamics at the expense of investment. A major factor of the actual growth of the population's income will be the labour productivity dynamics, however, with partial compensation for the inflation component. The relatively high unemployment level will be also a factor of the delay of domestic demand.

6. Acceleration of money turnover is expected. The monetary multiplier will remain relatively stable with a slight upward trend. The net foreign assets of the Bulgarian National Bank will grow in parallel to its international currency reserves. In the beginning, an external (foreign) asset gain of the commercial banks is expected, that is, leakage of capital and shrinking (on equal other conditions) of the internal crediting possibilities. It is assumed that, as time goes, the commercial banks will be oriented to granting more credits for the domestic market. State budget financing is envisaged to be totally at the expense of revenues from privatisation and from external sources. The Government will not accumulate any new receivables and will reduce its internal debt through negative net emissions of state securities.

7. Bulgaria is obliged to service regularly its external debt. The latter will remain about the level already reached in absolute value, however, it will decrease with respect to the GDP. A prerequisite for such dynamics is the accelerating rate of GDP gain in hard currency compared to GDP at constant prices. The forecast of the macroeconomic and industry dynamics in conformity with that assumption is taken as basis for the expert assessments of the juxtapositions made among sectors and subsectors.

Figure 5.1 illustrates the GDP dynamics at 1992 prices. The industry dynamics used by the experts covers four indicators for each sector and subsector: product output, imports, exports, and investments. Table 5.2 presents the product output till 2020.

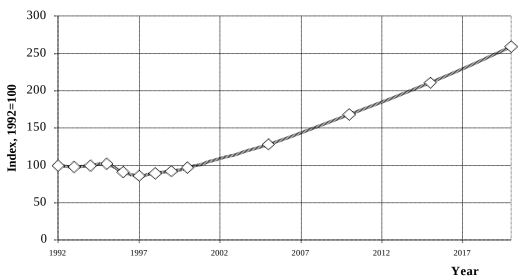

Figure 5.1. GDP growth rate in 1992 prices

Structure of production volumes by sectors (at 1992 prices)

Table 5.2

Years	Industry	Agriculture / forestry	Construction	Transport
1995	238452	36809	19181	27679
2000	225272	33597	16507	28159
2005	297528	45338	21896	38125
2010	387550	60660	28645	50550
2015	487370	77555	36023	63570
2020	596087	96832	44251	79131

SOCIO-DEMOGRAPHIC PROJECTIONS

A serious socio-economic problems that arose few years ago and the recent emigration waves have resulted in a substantial decrease of population. Using the demographic tendency analysis and the basic demographic indicators for 1995, a forecast is prepared for the period to 2020.

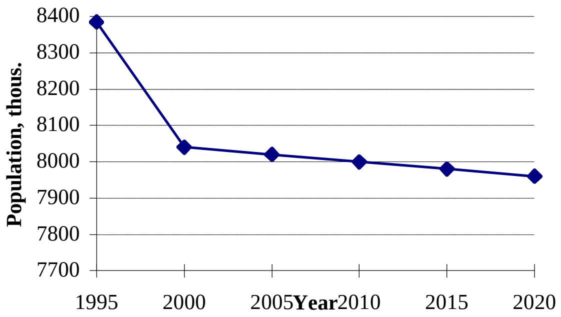

Figure 5.2. Socio-demographic forecast

It predicts a decrease of the Bulgarian population by about 5% from 1995 to 2020 with an average annual rate of -0.2%. The total employment, employment by economic sectors, unemployment, number of households are also considered in the forecast.

PROJECTED DEVELOPMENT IN SOME SECTORS OF BULGARIAN ECONOMY

Transport

The following main priorities are outlined in the new national transport policy:

- transition to market economy;
- integration of the national transport system into the transport systems of the EC countries, CEE, Central Asia and the Caucasian countries;
- establishment of a national transport market;
- transport services improvement ;
- technological and technical renovation;
- development of combined transport technologies.

Within the limits of these priorities, and pursuant to the new concepts of macroeconomic and industry development, the development trends in the transport sector described below are emerging: In freight carriage the hegemony of water transport is preserved although its relative share decreases from 84.9 % in 1995 to 79.5 % in the end of the forecast period. The share of railway transport increases from 9.1 % to 11.8 %, and of road transport - from 5.3 % to 9.7 %. In passenger conveyance road transport remains the main type of transport, its share decreasing from 59.5 % in 1995 to 53.1 % in 2020. The share of air transport also decreases respectively from 19.3 % to 16.5 %. That decrease is offset by the increased share of railway transport - from 17.4 % to 23.6 %, and urban transport - from 3.7 % to 6.7 %.

Significant changes are envisaged in the structure of ownership. The privatisation process affects the motor transport most of all, where the share of private companies of freight carriage is about 61 %, and after 2000 it will be almost totally taken over by private carriers. In passenger conveyance that process will be slower: the share of state and municipal companies will decrease from 72 % to 16 % in 2015 after which it will be probably wholly taken over by the private companies. Currently, the state airlines BALKAN cover about 60 % of the passenger conveyance, but it is also going to be privatised. There are similar trends in the water and railway transport.

The forecast in the transportation sector envisage domination of the water transport (mainly sea transport) in the freight transportation. The second important type, i.e. the railway transport that had 9% share in 1995 is expected to increase to 12% at the end of the projection period. The automobile freight transport will also increase.

The passenger transportation is dominated by the automobile transport. The share of the air transport is expected to decrease from 19% in 1995 to 17% at the end of the period. The decrease is compensated by increase in the railway transportation. The urban electric transport is also expected to grow.

The privatisation processes are active in the sector. It is expected by 2000 the automobile freight transport to shift completely to private companies. The state and municipal automobile companies gradually reduce their activity in the passenger transport as well and it would be expected after 2015 they would be replaced by private companies.

The perspectives for the transit auto transport are closely related to the development of the East-West trade. The political situation and stability in the region is also of primary importance. The capacity of the routes is also important factor. It is assumed that the transit traffic through Bulgaria will increase about 1.5 fold by 2010 and about two times in 2020. The liquid fuel consumption related to the transit traffic in 2010 will be about 5862 TJ diesel and about 586 TJ gasoline. In 2020 this consumption is projected as 7621 TJ for diesel and 879 TJ gasoline.

Agriculture

The main target in the agricultural sector is its stabilisation and sustainable development with competitive participation to the international market. This requires increased output and restructuring of the products shares, technical and technological improvement of the production; social attractiveness and market efficiency of the sector.

The increase of the agricultural output will have several dimensions: overcome of the grain and fodder crises; cereals and stock breading sectors development as priority fields in the rural reform; optimal production of fruits and vegetables for the inner market and for export purposes; decreased import of sugar bean, cotton, tobacco, enteric crops, etc.

The projections for 2000 indicate increase in the areas planted with cereals by 3 million dka compared to 1996; fodder - by 1,7 million dka; rice - 44 thousand dka. The areas of industrial crops (particularly sunflower) will slightly decrease by about 900 thousand dka. The areas with vegetables and perennial plants will increase by 360 thousand dka and 200 thousand dka, respectively.

It is expected the output in 2000 compared to 1996 to increase by 2200 thousand tons for the grains, 2400 thousand tones for the fodder, 19 thousand tons for rice, 1000 thousand tones for vegetables. The output of the perennial plants is expected to stay constant.

The program for development of the livestock breeding projects output growth of about 60% in 2000 compared to 1990 and 84% by 2010.

Energy

The draft Energy Sector Development Strategy is based on the national priorities and is consistent with the new political and economic situation in the country. The market integration, sustainable economic development and environmental protection are key notions in it.

The main objectives in the energy development in Bulgaria are:

- least-cost energy supply;
- energy independence of the country;
- energy efficiency;
- environmentally-friendly development;
- integration of the Bulgarian energy market and system with the European ones.

It is assumed that the domestic coal consumption after 2005 will be 43 million tons annually, including 35-38 million tons from the "Maritza East" fields. The import coal will be about 3.5 million tons annually in the energy sector. The total amount of imported coal is not expected to exceed 5 million tons. It is expected the consumption of the liquid fuels to rise from 6.3 million tons in 1995 to 12.4 million tons in 2010. The natural gas consumption in absolute values will increase as a result of:

- modernisation and upgrading of the district heating units with gas turbine modules for combined heat and electricity production;
- construction of gas supply systems.

It is expected the consumption of natural gas to increase to 6 billion m^3 in 2000, 6.8 billion m^3 in 2005 and about 7.4 billion m^3 in 2010.

The annual electricity production from hydro power plant is expected to be 3-3.5 TWh in medium humid year.

The remaining renewable energy sources - solar, wind, geothermal energy, biomass and waste could cover about 2-3% of the overall energy demand in the country, and in case of incentives introduction their share could reach 5-6%. By 2010 their share is expected to increase to 9.5%.

The future of the nuclear energy depends on the successful solving of the following problems:

- use of units 1-4 in NPP "Kozloduy" till the end of their lifetime;
- rehabilitation of all generation units in NPP "Kozloduy" and increase of their safety;
- storage and treatment of the exhausted fuel and radioactive wastes.

Till 2000 there should be a decision on the future of the NPP "Belene". The following issues has to be solved:

- coordination of all technological and environmental issues related to the licensing of the chosen site for the construction of NPP "Belene";
- decision on the number and capacity of the new units and on the commissioning schedule.

The coal extraction is closely related to the GHG emissions and climate change. Maritza East fields will have priority in the future coal policy. Currently the coal extraction is 25 million tons annually. In 2010 it will grow to 35-38 million tons, and the electricity production in Maritza East will increase from 12 TWh to 19-22 TWh.

FINAL ENERGY DEMAND PROJECTION

The projections and results presented such as the GDP growth rate and structural changes, industrial production volumes, investment level, import-exports, population growth and employment serve to project the final energy demand. For energy demand projection a *bottom-up approach* is used. The main characteristics of this approach is the combination of expert judgements with the existing projections for development of the corresponding sectors and branches in line with the technological renovation, changes in the ownership and international infrastructure reforms in the region.

According to this approach the useful and final energy demand depends on the economic activities and social needs. In long term horizon the energy demand will be influenced by socio-economic development patterns (economic growth, life style, social behaviour), expected technology mix in all sectors of economy and energy prices increase.

Two final energy demand projections are elaborated: baseline and energy efficiency (mitigation) scenario.

The mitigation scenario differs from the baseline scenario by higher penetration of new technologies, higher energy efficiency improvement rate, successful measures implementation and maximal number of households supplied by natural gas. The energy intensity of the baseline scenario is about 18% higher than that in the mitigation scenario

For the four major sectors and the relevant subsectors expert judgements are used to identify long-term development of the sector that is consistent with the output of macroeconomic analysis, potential for new technologies penetration, corresponding energy demand, options for fuel substitution and better energy efficiency. Dealing with the chemical industry, for instance, the following main productions are considered: fertilizers, inorganic chemicals, rubber and plastics, organic chemicals and fibres production as well as the expected outputs by 2020. In comparison to the First National Communication the new short-term projections for the fuel shift in the ferrous metallurgy are also taken into account.

Special attention is paid to the households and service sectors as far as there exists a substantial potential for energy conservation and fuel switching. The energy demand forecast in households in the energy efficiency scenario assumes higher penetration of new efficient electrical appliances and increased natural gas supply to households.

The final energy demand projections for the baseline scenario and for the mitigation scenario are given in Table 5.3 and in Figures 5.3 and 5.4.

Final energy demand projections for the baseline and mitigation scenarios, PJ

Table 5.3.

	Baseline scenario						Mitigation scenario					
Year	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Solid fuels	57.7	81.7	92.0	104.5	107.0	107.9	57.7	61.8	62.5	68.8	69.4	71.3
Oil and oil products	108.7	136.8	168.9	193.9	232.9	274.4	108.7	124.9	148.9	166.1	199.2	227.7
Gaseous fuels	90.6	92.5	105.2	121.7	138.9	151.6	90.6	87.7	96.7	105.8	117.5	131.1
Electricity	112.7	130.1	139.5	153.5	139.5	153.5	112.7	114.7	124.4	137.7	149.4	161.2
Heat	130.7	149.2	163.6	177.4	195.9	206.8	130.7	129.5	137.3	148.4	161.0	176.3
Total	500.4	590.4	669.1	751.0	814.1	894.2	500.4	518.6	569.9	626.7	696.5	767.6

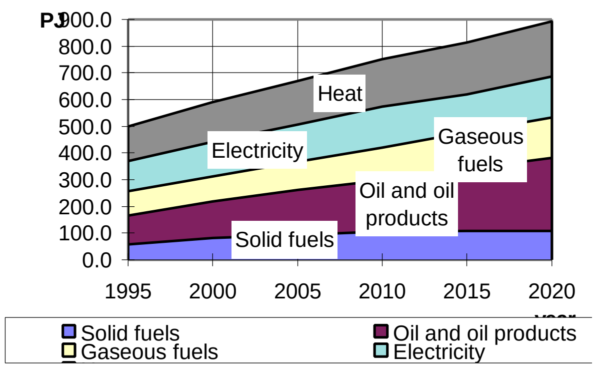

Figure 5.3 Final energy demand projection for the baseline scenario, PJ

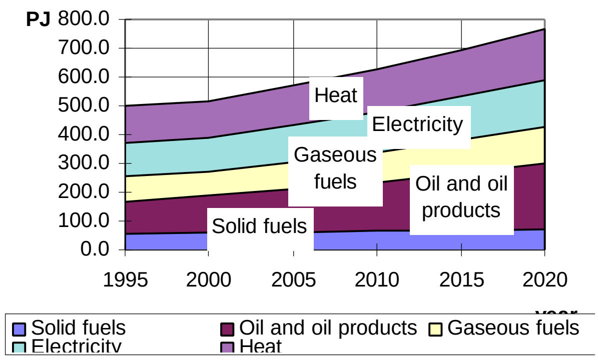

Figure 5.4 Final energy demand projection for the mitigation scenario, PJ

The comparison between the baseline and the mitigation scenarios reveals a substantial additional energy saving potential of 71.8 PJ in the year of 2000, 124.3 PJ in the year of 2010 and 126.6 PJ in 2020.

The comparison between the two scenarios indicates a serious drop in the total energy demand by about 14.1% in 2020 compared to 1995. There is a reconstruction of the fuel base. The solid fuel consumption decreases by about 30% in the mitigation scenario, but the share of the electricity increases by 5-7% in the period after 2010. The share of electricity by the end of the period is going to increase by 21% in the energy efficiency scenario compared to the 17.1% in the baseline scenario, because the new technologies will consume more electricity (at the expense of other energy types) compared to the current technologies. The projections given differ by 21-22% from the projections reported in the First National Communication.

PRIMARY ENERGY DEMAND PROJECTION

GHG emissions from energy sector depend not only on the final energy consumption but on the structure of energy supply system and the primary energy demand as well. Therefore, alternative energy configurations to balance energy demand and supply aimed at GHG emission reduction are evaluated. Four scenarios are developed with ENPEP model and software. The electricity generation units are optimised by IRP manager. With the integrated balance ENPEP method all elements of the energy systems are attached to meet the energy demand.

In the baseline scenario the commissioning of the power generation units is scheduled according to the optimal least-cost planning, as follows:

- Introduction of two new hydro power plants - Gorna Arda and Sredna Vucha with 156 MW and 120 MW installed capacity respectively - 2007 and 2008;
- Commissioning of 3 units x 300 MW in a new imported coal fired TPP - 2016, 2017 and 2018;
- Construction of a new natural gas combined cycle TPP with 2 units of 450 MW each - 2014 and 2016;
- Commissioning of 9 new 300 MW units in the Maritza East complex within the 2004-2020 time period;
- Commissioning of 2 new 600 MW nuclear units in the "Belene" Nuclear Power Plant.

The above listed assumptions are changed in the remaining scenarios as follows:

Energy supply scenario

- the imported coal fired units are not included;
- the combined cycle units are increased by 3 more units;
- the lignite fired units are 6 less;
- there is one more unit with 1000 MW capacity projected to be commissioned in 2006;

Energy efficiency scenario

- the commissioning of the new HPP is postponed by 2-3 years;
- one imported coal fired unit is not included, and the remaining 2 units are projected to be commissioned in 2019;
- the combined cycle units are increased by 2 more units to be commissioned in 2019;
- there is one unit less commissioned in the Maritza East complex;

Mitigation scenario

- the imported coal fired units are not included;
- the combined cycle units are increased by 2 more units;
- the commissioned units in the Maritza East complex are 2 less;

- there is one more 600 MW nuclear unit projected to be commissioned in 2016.

The results for primary energy demand forecast for all the scenarios: the baseline scenario, energy supply scenario, energy efficiency scenario and mitigation scenario are given in Table 5.4. and Figures 5.5, 5.6, 5.7 and 5.8, respectively.

Primary energy demand projections [PJ]

Table 5.4

BASELINE SCENARIO

Year	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
Solid fuel	361.6	406.1	444.3	460.2	434.1	402.1
Oil and oil products	268.7	457.8	463.4	458.3	429.8	541.9
Gaseous fuel	194.2	152.4	201.6	226.3	271.6	315.5
Hydro energy	24.9	26.2	26.2	32.3	32.3	32.3
Nuclear energy	190.1	225.0	178.2	200.0	221.9	221.9
Total	**1039.5**	**1267.4**	**1313.7**	**1377.2**	**1389.8**	**1513.7**

ENERGY SUPPLY SCENARIO

Solid fuel	361.6	401.4	455.8	404.6	377.7	268.8
Oil and oil products	268.7	457.8	463.4	458.3	429.8	541.9
Gaseous fuel	194.2	152.4	201.6	226.3	271.6	363.1
Hydro energy	24.9	26.2	26.2	32.3	32.3	32.3
Nuclear energy	190.1	225.0	178.2	267.6	289.5	289.5
Total	**1039.5**	**1262.7**	**1325.2**	**1389.2**	**1401.0**	**1495.6**

ENERGY EFFICIENCY SCENARIO

Solid fuel	364.7	319.3	350.8	400.9	357.0	260.6
Oil and oil products	268.7	377.3	384.6	382.8	400.4	449.6
Gaseous fuel	194.2	140.1	177.8	196.6	212.5	307.5
Hydro energy	24.9	26.2	26.2	30.7	32.3	32.3
Nuclear energy	190.1	225.0	178.2	155.0	221.9	221.9
Total	**1042.6**	**1087.9**	**1117.6**	**1166.0**	**1224.2**	**1271.9**

MITIGATION SCENARIO

Solid fuels	364.7	319.3	352.8	356.0	363.5	235.4
Oil and oil products	268.7	377.3	384.6	382.8	400.4	449.6
Gaseous fuel	194.2	140.1	177.8	196.6	212.5	295.3
Hydro energy	24.9	26.2	26.2	32.3	32.3	32.3
Nuclear energy	190.1	225.0	178.2	200.0	221.9	267.0
Total	1042.6	1087.9	1119.6	1167.7	1230.7	1279.6

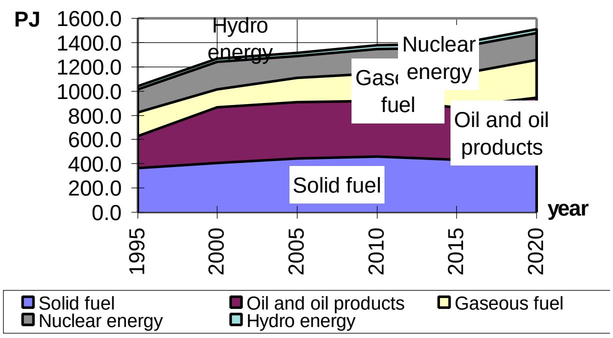

Fig. 5.5. Primary energy demand projection for baseline scenario

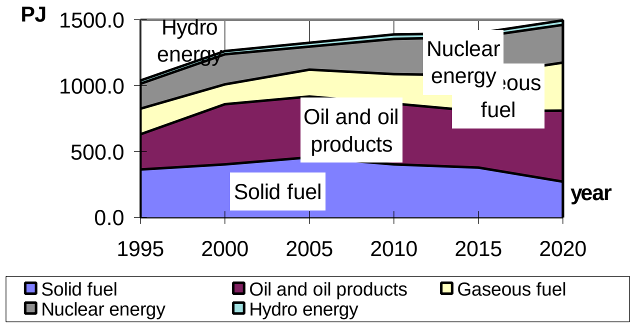

Fig. 5.6. Primary energy demand projection for energy supply scenario

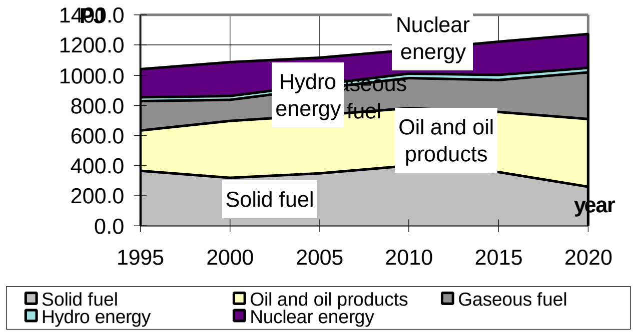

Figure 5.7. Primary energy demand projection for energy efficiency scenario

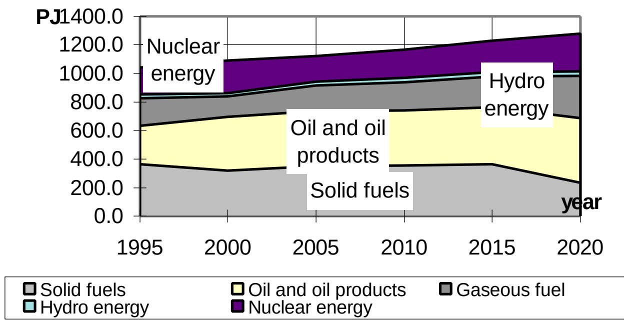

Figure 5.8. Primary energy demand projection for mitigation scenario

Comparison of the projected primary energy demand up to the year of 2020 reveals 1.46 times growth for the period in case of baseline scenario against 1.23 times for the mitigation scenario. The difference is not only quantitative but structural as well. Thus the share of solid fuels for the baseline scenario is 26% in 2020 while in the mitigation scenario it was possible to reduce it to the level of 18% in 2020 on account of increased share of natural gas, nuclear and hydro energy.

The analysis of the aforementioned four scenarios has to be conducted separately for the two pairs of scenarios. In the baseline and energy supply scenarios the total primary energy consumption is similar. The maximal difference of the primary fuel consumption for the mitigation scenario compared to the baseline is at the end of the projection period: -1.19%. The differences are more substantial for the solid fuels (-33%) and nuclear (+30%).

The indicated decrease in the solid fuel consumption has to do with the domestic lignites when different technological and social and economic factors are taken into account.

The next two scenarios - baseline energy supply and mitigation save more energy resources. The differences among them are even lower than in the previous pair, i.e. 0.6%. The average consumption level is lower with about 16%. The differences in the solid fuel and nuclear fuel consumption, -10% and +20% respectively, are lower compared to the scenarios without introduction of energy saving measures in the demand side. In the mitigation scenario there is a drop with 4% of the natural gas consumption, while in the comparison to the other pair of scenarios shows, it occurs that in the scenario with energy supply mitigation the natural gas consumption is 15% lower than in the baseline scenario. This shows the possibilities for replacement of the measures in energy supply that often prove to be cost-effective and easily applicable.

PROJECTIONS ON THE FOREST SINK CAPACITY

Absorption of Carbon Dioxide (CO_2) is realising in forest ecosystems and the carbon budget could be made positive. Inventory results for Bulgarian forests indicate that the forest off-set potential amounted 5-7% from the total emitted quantity of CO_2. According to article 4/6/2/b from UN FCCC (Rio de Janeiro Convention, 1992), Bulgaria adopted as a base year for comparison of the anthropogenic emissions of CO_2 and other greenhouse gases the emission levels in 1988. The prognostic development of the forest ecosystems in near and mid-term future, is directly concerning the measures connected with the duties assumed for Convention observance.

Scenarios for CO_2 off-set and carbon storage until the year 2035

According to the Forest Act formulations (1997), two scenarios have been developed. The following assumptions are laid down in the scenarios:

optimistic scenario	pessimistic scenario
For the whole period of investigation the afforested area of Forest fund remains unchangeable.	The area with forests will be reduced by 5% for 25 years (until 2020), and in the same time the percent of the afforested area will remain 30%. (Article 16(1); 17(1); and 18)
The harvest would be done outside the protected territories (Article 7 (2)) on about a 75% from the mature forests, according to normal rotations: above 81 years for the High-stem forests and above 21 years for the Low-stem and coppice forests.	100% of the mature forests will be harvested, for rotations above 60 years for high-stem forests and above 15 years for low-stem and coppice forests (Article 50(5); and 52(2)) .
After harvesting the areas will be 100% afforested and naturally regenerated (Article 43(1); 44 (1); and 52(1))	
The wood utilisation of all forests, in spite of their ownership, should be completed according to the Forest Land-use Projects (Article 57(1) and 60).	

Optimistic scenario. According to this scenario, a significant biomass accumulation is projected which means that carbon stored will increase up to 16 mln t in 2035. Actually, the carbon stored could be expected to be more, if the cut (planned)/cut (actual) ratio remains the same. For example, the 1995 planned cut, according to the National Forestry Projects, was approx. 6 mln m^3, but the wood biomass actually cut was approximately 4.5 mln m^3. In the same time, according to the optimistic scenario, it should be harvested 9 mln m^3, equal to 30% more than planned for 1995 quantities and twice as much as the actual derived wood biomass in the same year.

Pessimistic scenario. According to this scenario the balance is negative, reaching the highest rate of decrease in 2015, but during the next 5 years the trend reaches almost zero values. The decrease of carbon accumulation could be projected to be small and the 1988 emission level will not be reached.

In 2015 a harvest of approximately 70 mln m^3 wood biomass from the coppice and low-stem forests according to the age class above 41 years is envisaged. The utilisation of wood biomass in these forests is a big problem for Bulgarian forests management, and the solution of this problem has been cancelled during the decades (transfer to longer rotations, etc.). As a result, it was reached the unfavourable age structure, which leads to the potential loses of increment growth and some other unfavourable results, some of which we witness recently - diseases, wiltings, fires, disorder of wood stands, losses of regeneration potential, etc.

It sounds paradoxical, but through pessimistic scenario realisation in the part for 70 mln m^3 coppice harvest two positive results should be achieved: 1) improvement of the status (common) of the wood stands and 2) supplement of enormous quantities of renewable energy sources.

It is not accident that researchers insisted on the quantities of the cutting biomass to be reached 12-13 mln m^3 annually until the year 2000, and after this year, the harvest from the 'traditional' 1.3 mln m^3, to be increased to 2.5 mln m^3, which would normalise the age classes distribution. According to the same author, if this management is not implemented, the annual losses from the increment growth due to the aggravated age structure will be approximately 50 000 m^3.

In such a context, the harvesting of these forests will reveal huge reserves for biofuel energy production development. The woodfuel consumption in our country is approximately 2 mln m^3/year and practically the wood is combusted in rather primitive way.

Additional quantities of technological timber and woods could be obtained also through thinnings in the conifer stands. These quantities could be 2.8 mln m^3 /year. Measures, like thinnings, in its turn would lead to the increase the annual increment by 1.6 to 1.8 fold in treated forest stands. There are about 1.2 mln m^3 biomass left in the forests in the country, from the cuttings and not used.

There are possibilities for 250 000 ha reclamation of lands not appropriate for agricultural activities which are out of the forest fund. These lands could be used for establishment of biofuel wood production plantations. As it has been made all over the world, the status of agricultural lands is remaining and the plantations have been used in very short rotations from 2 to 10 (15) years. Having all of these wood sources and possibilities for the Bulgarian conditions, the wood biomass utilisation as a renewable industrial energy resource, should be followed by economic stimulation and low regulation and government protection.

The projections on the aggregated carbon stored in the wood biomass is given in Tables 5.6-5.9. The optimistic scenario is used in the projections provided in the tables.

The aggregated accumulation accounts for the balances harvest/increment, mitigation measures as new afforestations: devastated lands, shelter belts, etc.

Figure 5.12. gives projections on the carbon accumulation for both scenarios.

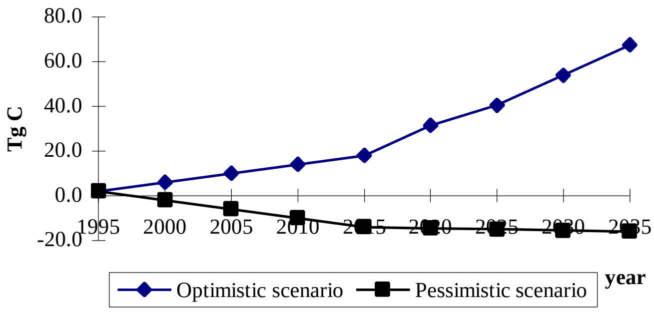

Figure 5.9. Projected carbon accumulation in wood biomass: optimistic and pessimistic scenarios

GHG EMISSION PROJECTIONS

GHG inventory results reported in Chapter 3 reveal that the following GHG emission sources are the major contributors for GHG emissions in Bulgaria:

- Energy, including stationary and mobile combustion - for CO_2, CH_4, N_2O, NOx, CO and NMVOC;
- Industrial processes - for CO_2, CH_4 and N_2O;
- Solvent use - for NMVOC;
- Agriculture - for CH_4, N_2O, NOx and CO;
- Land use change and forestry - for CO_2;
- Landfills - for CH_4.

Due to the change in ownership in agriculture as well as to the expected change in agricultural practice and structure it is very hard to project emissions originating from agriculture.

In regard to the GHG emissions from landfills, two contradictory tendencies exist: reduced population and increased waste per capita. Under these assumptions CH_4 emissions quantity will increase by 80% in the period up to 2020.

Therefore, at the final stage of the analytical process the GHG emissions are projected for all four scenarios exercising IMPACT module of ENPEP model for emissions from energy sector including energy resources mining, transmission and distribution. A spreadsheet model is used to project the emissions from industrial process. In general, the emission categories and emission factors used in both ENPEP model and the spreadsheet model, follow the IPCC methodology. The ultimate goal of this approach is to make results for GHG inventory consistent with the GHG projections.

To project CO_2 and other GHG for all scenarios, the emission factors from the GHG inventory are used and the following activities are considered:

- for GHG from energy combustion - projection on the quantities of fuels consumed in different sectors of economy; and fuels for energy transformation;
- for GHG from coal mining, oil and gas systems - projection on the quantities of coal mined in underground and open cast mines as well as quantities of oil and gas production, transportation, distribution and refining;
- for GHG from industrial processes - projection on the quantities of industrial output for cement, lime, ammonia, soda ash, glass, steel and others.
- GHG emissions from agriculture are projected under 2 scenarios: without measures for energy savings and in case of limited penetration of such measures, particularly in the livestock breeding.
- The projections for the CO_2 sequestration in the forests in based on the new Forestry Act where there is rule set the increments to exceed the wood quantities used for construction and combustion.
- There is a projection for the emissions from diesel and gasoline combusted by the transit road transport.
- The fugitive emissions in gas transportation are projected in accordance to the plans for development of the gas transmission network and transit of natural gas. The projected figures for transit of natural gas are: 6.3 billion Nm^3 in 2000, and 18 billion Nm^3 in each year of the 2005-2020 period.

The total GHG emissions are calculated as a sum of energy related emissions, process emissions, and the emissions from natural gas transit.

The difference between the levels of GHG emissions for the baseline scenario and the mitigation scenario serves to estimate the effect of all measures incorporated within a single scenario, that is not a simple sum of effect of all measures put together.

CO_2 EMISSION PROJECTIONS

CO_2 emission projections: baseline scenario, energy supply scenario and energy efficiency scenario

The results for CO_2 emission projections for the baseline scenario are given in Table 5.5. The comparison between total CO_2 emission projections for the end of the study period and those in the 1995 shows 1.65 times increase in the emission level, while the GDP and the final energy demand growths are 2.53 and 1.79, respectively. Therefore, the expected structural changes in Bulgarian economy and GDP will lead to reduction of energy intensity and CO_2 emission intensity even in the baseline scenario.

At the other hand the comparison to the emission level in 1988 which is the base year for Bulgarian implementation of FCCC requirements shows that in the year 2000 the CO_2 emissions will reach 73%

of the base year level, in 2010 they reach the level of 89% and at the end of the period they are 98.9% mainly due to the projected significant increase of the forest sink capacity.

The updates in the projections for the this scenario when compared to the First National Communication show a decrease of about 31% by the end of the period. A reason for the difference is the great changes in the expected GDP growth rates, that are harmonised with the situation under currency board.

Tables 5.5, 5.6 and 5.7 give CO_2 emission projections for the baseline, energy supply and energy efficiency scenarios. A trend for stabilisation and decrease of the CO_2 emissions after 2015 can be observed in all scenarios with GHG mitigation measures application.

CO_2 emissions and removals [Gg] - baseline scenario

Table 5.5.

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	55419	67116	77043	82479	87594	91244
I Energy	56225	67118	76151	80418	84568	87650
A Fuel Combustion	56225	67118	76151	80418	84568	87650
B Fugitive Emissions from Fuels	0	0	0	0	0	0
2 Industrial Processes	5602	6295	7108	8201	8992	9451
3 Solvent and Other Product Use	0	0	0	0	0	0
4 Agriculture	0	0	0	0	0	0
5 Land -Use Change & Forestry	-7520	-7614	-7710	-7807	-7905	-8004
6 Waste	400	468	535	599	665	723
7 International Transit Road Transport	712	849	959	1068	1274	1424
International Bunkers	882	1142	1464	1625	2044	2428

CO_2 emissions and removals [Gg] - energy supply scenario

Table 5.6.

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	55419	66637	77911	76433	81743	78980
I Energy	56225	66639	77019	74372	78717	75386
A Fuel Combustion	56225	66639	77019	74372	78717	75386
B Fugitive Emissions from Fuels	0	0	0	0	0	0
2 Industrial Processes	5602	6295	7108	8201	8992	9451
3 Solvent and Other Product Use	0	0	0	0	0	0
4 Agriculture	0	0	0	0	0	0
5 Land -Use Change & Forestry	-7520	-7614	-7710	-7807	-7905	-8004
6 Waste	400	468	535	599	665	723
7 International Transit Road Transport	712	849	959	1068	1274	1424
International Bunkers	882	1142	1464	1625	2044	2428

CO_2 emissions and removals [Gg] - energy efficiency scenario

Table 5.7.

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	55419	54111	62174	69848	70342	68881
I Energy	56225	55086	62753	69814	69562	67303
A Fuel Combustion	56225	55086	62753	69814	69562	67303
B Fugitive Emissions from Fuels	0	0	0	0	0	0
2 Industrial Processes	5602	5379	5735	6310	6912	7620
3 Solvent and Other Product Use	0	0	0	0	0	0
4 Agriculture	0	0	0	0	0	0
5 Land -Use Change & Forestry	-7520	-7630	-7741	-7854	-7968	-8085
6 Waste	400	426	469	510	563	618

7 International Transit Road Transport	712	849	959	1068	1274	1424
International Bunkers	882	940	1034	1124	1241	1363

CO_2 emission projections for the mitigation scenario

The results for CO_2 emission projections for the mitigation scenario are given in Table 5.8. The comparison between total CO_2 emission projections for the end of the study period and those in the 1995 shows 1.18 times increase. Due to the expected macroeconomic restructuring, intensive penetration of new efficient technologies in the mitigation scenario and the restructuring of energy supply sectors towards limitation of shares of fossil fuels the pace of CO_2 emission increase will be lower as by the end of the period they are expected to be 28% lower than in the base-line scenario.

The comparison to the emission level in 1988 which is base year for the Bulgarian implementation of FCCC requirements shows that in 2000 the CO_2 emissions will be 58.7% of the emissions in the base year and at the end of the period they will be 71%. Therefore, a complex implementation of mitigation measures in all economic sectors, including energy, would lead to a long-term stabilisation of the CO_2 emission level.

CO_2 emissions and removals [Gg] - mitigation scenario

Table 5.8.

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	55419	54111	62224	64647	71092	65377
I Energy	56225	55086	62803	64613	70312	63799
A Fuel Combustion	56225	55086	62803	64613	70312	63799
B Fugitive Emissions from Fuels	0	0	0	0	0	0
2 Industrial Processes	5602	5379	5735	6310	6912	7620
3 Solvent and Other Product Use	0	0	0	0	0	0
4 Agriculture	0	0	0	0	0	0
5 Land -Use Change & Forestry	-7520	-7630	-7741	-7854	-7968	-8085
6 Waste	400	426	469	510	563	618
7 International Transit Road Transport	712	849	959	1068	1274	1424
International Bunkers	882	940	1034	1124	1241	1363

The above mentioned GHG mitigation potential is considerably higher than that estimated in the First National Communication.

PROJECTIONS ON OTHER GREENHOUSE GASES

Projections on other GHGs as N_2O and CH_4, as well as on the precursors have been accomplished for the baseline and mitigation scenario following the same assumptions as for CO_2 projections and the same structure of emission resources.

Projections on other GHGs: baseline scenario, energy supply scenario and energy efficiency scenario

Projections on N_2O and CH_4 for the baseline scenario are given in Tables 5.9 and 5.10, respectively. Tables 5.11 and 5.12 give projections for the energy supply and Tables 5.13 and 5.14 for the energy efficiency scenario on the CH_4 and N_2O emission, respectively.

CH_4 emission projections for the baseline scenario [Gg]

Table 5.9.

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	1044	1093	1492	1593	1703	1817
I Energy	270	219.9	217.5	231.3	262	297

A Fuel Combustion	5.3	5.80	6.20	7.60	9	10.3
B Fugitive Emissions from Fuels	265	214	211	224	253	287
2 Industrial Processes	3	4	4	5	5	6
3 Solvent and Other Product Use	0	0.0	0.0	0.0	0	0
4 Agriculture	125	121	150	156	151	155
5 Land -Use Change & Forestry	0	0	0	0	0	0
6 Waste	503	589	673	754	837	910
7 International Transit Road Transport	3.6	4.3	4.9	5.5	6.5	7.3
8 Transit of natural gas	139	155	442	442	442	442
International Bunkers	0	0	0	0	0	0

N_2O emission projections for the baseline scenario [Gg]

Table 5.10.

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	35	40	45	48	52	56
I **Energy**	9.7	11.6	12.2	11.5	10.6	9.6
A Fuel Combustion	9.7	11.6	12.2	11.5	10.6	9.6
B Fugitive Emissions from Fuels	0	0	0	0	0	0
2 Industrial Processes	8	9	11	12	13	14
3 Solvent and Other Product Use	0	0	0	0	0	0
4 Agriculture	3	2	3	3	3	4
5 Land -Use Change & Forestry	0	0	0	0	0	0
6 Waste	0	0	0	0	0	0
7 International Transit Road Transport	14.0	16.7	18.9	21.1	25.1	28.1
International Bunkers	0	0	0	0	0	0

CH_4 emission projections for the energy supply scenario [Gg]

Table 5.11.

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	1044	1093	1525	1609	1702	1834
I **Energy**	270	219.9	250.9	246.6	260.1	313.6
A Fuel Combustion	5.3	5.90	7.10	7.80	9.1	10.4
B Fugitive Emissions from Fuels	265	214	244	239	251	303
2 Industrial Processes	3	4	4	5	5	6
3 Solvent and Other Product Use	0	0.0	0.0	0.0	0	0
4 Agriculture	125	121	150	156	151	155
5 Land -Use Change & Forestry	0	0	0	0	0	0
6 Waste	503	589	673	754	837	910
7 International Transit Road Transport	3.6	4.3	4.9	5.5	6.5	7.3
8 Transit of natural gas	139	155	442	442	442	442
International Bunkers	0	0	0	0	0	0

N_2O emission projections for the energy supply scenario [Gg]

Table 5.12.

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	35	40	45	47	51	52
I **Energy**	9.7	11.5	12.7	10.6	9.9	5.8
A Fuel Combustion	9.7	11.5	12.7	10.6	9.9	5.8
B Fugitive Emissions from Fuels	0	0	0	0	0	0
2 Industrial Processes	8	9	11	12	13	14
3 Solvent and Other Product Use	0	0	0	0	0	0
4 Agriculture	3	2	3	3	3	4

5 Land -Use Change & Forestry	0	0	0	0	0	0
6 Waste	0	0	0	0	0	0
7 International Transit Road Transport	14.0	16.7	18.9	21.1	25.1	28.1
International Bunkers	0	0	0	0	0	0

CH_4 emission projections for the energy efficiency scenario [Gg]

Table 5.13

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	1044	929	1320	1383	1462	1592
I **Energy**	270.3	167.2	205.3	213.6	218.2	274.9
A Fuel Combustion	5.3	4.90	5.64	6.17	7.2	8.14
B Fugitive Emissions from Fuels	265	162	200	207	211	267
2 Industrial Processes	3	3	3	4	4	5
3 Solvent and Other Product Use	0	0.0	0.0	0.0	0	0
4 Agriculture	125	63	75	77	83	85
5 Land -Use Change & Forestry	0	0	0	0	0	0
6 Waste	503	536	590	641	708	778
7 International Transit Road Transport	3.6	4.3	4.9	5.5	6.5	7.3
8 Transit of natural gas	139	155	442	442	442	442
International Bunkers	0	0	0	0	0	0

N_2O emission projections for the energy efficiency scenario [Gg]

Table 5.14

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	35	35	40	44	47	48
I **Energy**	9.7	9.4	11.0	11.7	10	6.4
A Fuel Combustion	9.7	9.4	11.0	11.7	10	6.4
B Fugitive Emissions from Fuels	0	0	0	0	0	0
2 Industrial Processes	8	8	8	9	10	11
3 Solvent and Other Product Use	0	0	0	0	0	0
4 Agriculture	3	1	1	2	2	2
5 Land -Use Change & Forestry	0	0	0	0	0	0
6 Waste	0	0	0	0	0	0
7 International Transit Road Transport	14.0	16.7	18.9	21.1	25.1	28.1
International Bunkers	0	0	0	0	0	0

The comparison of the results for the N_2O emissions at the end of the study period and in 1995 shows increases of 1.6, 1.48 and 1.37 fold respectively for the three scenarios mainly due to the process emissions. The growth rate of N_2O emission from fossil fuel combustion follows the CO_2 emission rate.

The comparison of the results for the CH_4 emissions at the end of the study period and in 1995, shows that the emissions increase by 1.74, 1.75 and 1.53 for each of the three scenarios mainly at the expense of emissions from natural gas and oil extraction and transportation system. These emissions keep their share of 38-41% of the total emissions during the entire study period. The emissions from coal mining decrease from 25% at the beginning of the period to 16-17% at its end. This is consequence of the orientation of the base-line scenario towards maximal utilisation of the existing open cast mines.

Projections on other GHG emissions for the mitigation scenario

Projections on N_2O and CH_4 for the mitigation scenario are given in Tables 5.15 and 5.16 respectively.

In general the emission growth rate in the mitigation scenario is moderate when compared to the baseline scenario, due to the complex impact of mitigation measures at macro-economic and sector level.

CH_4 emission projections for the mitigation scenario [Gg]

Table 5.15

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	1044	929	1331	1392	1466	1583
I **Energy**	270.3	167.2	216.2	219.2	218.9	262.2
A Fuel Combustion	5.3	4.9	16.5	11.8	7.9	-4.6
B Fugitive Emissions from Fuels	265	162	200	207	211	267
2 Industrial Processes	3	3	3	4	4	5
3 Solvent and Other Product Use	0	0.0	0.0	0.0	0	0
4 Agriculture	125	63	75	80	87	89
5 Land -Use Change & Forestry	0	0	0	0	0	0
6 Waste	503	536	590	641	708	778
7 International Transit Road Transport	3.6	4.3	4.9	5.5	6.5	7.3
8 Transit of natural gas	139	155	442	442	442	442
International Bunkers	0	0	0	0	0	0

N_2O emission projections for the mitigation scenario [Gg]

Table 5.16.

Greenhouse Gas Source and Sink Categories	1995	2000	2005	2010	2015	2020
Total National Emissions and Removals	35	35	40	42	48	47
I **Energy**	9.7	9.5	10.9	10.1	10.7	5.6
A Fuel Combustion	9.7	9.5	10.9	10.1	10.7	5.6
B Fugitive Emissions from Fuels	0	0	0	0	0	0
2 Industrial Processes	8	8	8	9	10	11
3 Solvent and Other Product Use	0	0	0	0	0	0
4 Agriculture	3	1	1	2	2	2
5 Land -Use Change & Forestry	0	0	0	0	0	0
6 Waste	0	0	0	0	0	0
7 International Transit Road Transport	14.0	16.7	18.9	21.1	25.1	28.1
International Bunkers	0	0	0	0	0	0

The comparison of the results for the N_2O emissions at the end of the study period and at the base year 1995, reveals 1.34 fold rise due to the international transit transport. Their share increases from 40% at the beginning of the period to 60% at its end. The N_2O emission from fossil fuel combustion growth rate follows the CO_2 emission rate.

The comparison of this figures and the base-line emissions presents a 9000 t reduction due to the more efficient end use of the energy resources. The comparison of the results for the CH_4 emissions at the end of the study period and in 1995, shows that the emissions increase 1.52 fold mainly due to the emissions from natural gas and oil extraction and transportation systems.

The comparison with the baseline emissions reveals saving potential of 234 kt which has to do with the lower fuel consumption level due to the improved energy efficiency and the smaller share of solid and liquid fuels in the energy balance.

PROJECTIONS ON OZONE-DEPLETING SUBSTANCES

According to the National program supported by GEF and the World Bank, the quantities of the ozone-depleting substances will gradually diminish in Bulgaria. Estimates on the ODS consumption are given in Table 5.17. It is predicted the level of consumption of HCFC to increase in the sectors where it will substitute more hazardous substances with higher global warming potential such as CFC-11, CFC-12 and CFC-502.

Annual consumption of ozone-depleting substances in Bulgaria

Table 5.17.

	1986	1989	1990	1995	1996	1998*	1999**	2000**	2001**
CFC-11	1370	1460	825	10	0	0	0	0	0
CFC-12	1250	1075	735	250	0	25	0	0	0
CFC-113	280	90	160	78	5	0	0	0	0
CFC-114	90	0	0	0	0	0	0	0	0
CFC-115	10	7	7	0	0	0	0	0	0
HCFC-22	170	135	60	110	90	90	80	80	40
Other HCFC	0	0	0	16	15	86	130	140	190
Methilbromid	0	0	0	12	0	0	0	0	0
Tetraclormethane	95	90	75	20	5	1	0	0	0
Methilcloroform	420	150	150	45	1	1	0	0	0
Halon 1301	1	1	1	1	0.1	0.1	0.1	0.1	0.1
Halon 2402	5	5	10	1	0.1	0.1	0.1	0.1	0.1
Total	3395	3015	2135	533	116.2	203.2	210.2	220.2	230.2

*preliminary data

**projected data

SUMMARY ON THE PROJECTED GHG EMISSIONS

The projections on the overall GHG emissions is based on the concept of the Global Warming Potential (GWP) within a 100 years time horizon. The GWP values used for emission projection are shown in table 3.1, Chapter 3.

The emissions of CO_2, CH_4 and N_2O expressed by their GWP values for both the baseline and the mitigation scenarios are given in Tables 5.18 and 5.19 respectively. The analysis of the shares of the different GHG emissions shows a steady decrease of the share if the CO_2 emissions from 71% in 1988 to 64% for the baseline scenario and 61% for the mitigation scenario. One of the reasons for such a decrease of the CO_2 share is the fast penetration of energy efficiency and non and low-carbon fuels into the energy balance due to the mitigation measures that are applied to their full potential in the mitigation scenario and up to 40-50 % of their potential in the baselines scenario. A steady increase of the CH_4 share is observed in both scenarios (from 22% in 1988 to 25% for the baselines and 27% for the mitigation scenario in 2020). The main source of this increase of the CH_4 share could be found in the significant transit transportation of natural gas through the country.

A significant reduction of the total emissions after 2000 is observed in the case of mitigation scenario when compared to the baseline scenario. The level of total emissions for the mitigation scenario is 15-21% lower.

GHG emissions estimated in CO_2 equivalent - baseline scenario, Gg CO_2 eq.

Table

Emissions /year	1988	1995	2000	2005	2010	2015	2020
CO_2	96878	62939	74730	84753	90286	95499	99248
CH_4	29667	21924	22957	31332	33453	35763	38157
N_2O	9548	10850	12400	13950	14880	16120	17360
Total	136093	95713	110087	130035	138619	147382	154765

GHG emissions estimated in CO_2 equivalent - mitigation scenario, Gg CO_2 eq.

Table

Emission /year	1988	1995	2000	2005	2010	2015	2020
CO_2	96878	62939	61741	69965	72501	79060	73462
CH_4	29667	21924	19509	27951	29232	30786	33243

N_2O	9548	10850	10850	12400	13020	14880	14570
Total	136093	95713	92100	110316	114753	124726	121275

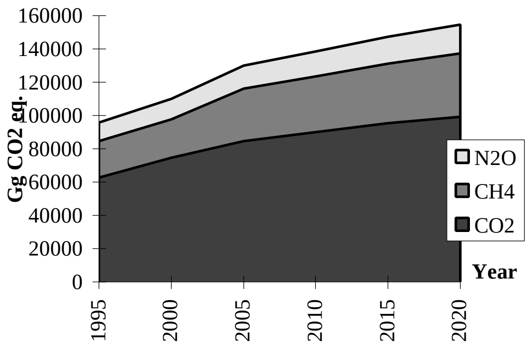

Figure 5.10. Total GHG emissions as CO_2 equivalent: baseline scenario, Gg

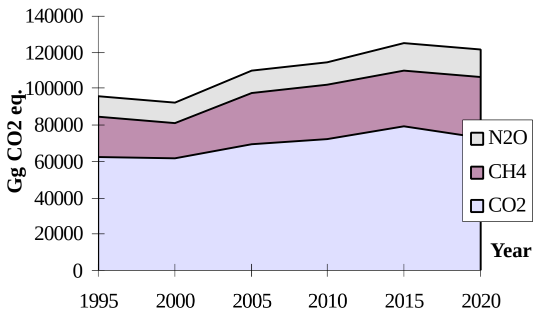

Figure 5.11. Total GHG emissions as CO_2 equivalent: mitigation scenario, Gg

ASSESSMENT OF GHG MITIGATION OPTIONS

Different options for GHG mitigation have been identified and evaluated in regard to their technical feasibility, necessary investments and effect on CO_2 reduction. In general options aim directly or indirectly at fossil fuel combustion reduction and therefore lead to all GHG emission reduction but since CO_2 is the main GHG the options are evaluated versus it. The effect of each measure is evaluated and used in the total estimate of emission mitigation trying to avoid the overlapping.

Assessment of the mitigation potential of each measure in the industrial sector is given in the tables in Annex B. The values given are based on the discounted costs (discount rate = 10%) of emission reduction measures for their entire life cycle. This is one of the reasons the costs per ton CO_2 emission reduction to be so low. Almost all the measures in the industrial sector have one digit cost per ton CO_2 reduction, that is not common for such a type of measures. Besides the long life cycle of these measures there are another reason for the low cost. The list of the measures includes the most efficient mitigation measures. They require low costs and lead to serious savings mainly of electricity. The high emission factors for electricity consumption in the energy intensive industries (1.59 kg CO_2 /kWh) and light industry (1.68 kg CO_2/kWh) also contribute to the low costs. Therefore, a great potential is available in the industrial sector of Bulgaria for reduction of its energy intensity and hence for GHG mitigation, i.e. more than 3 Tg CO_2 annually. The potential for reduced consumption of some other fuels and subsequently for less CO_2 emissions due to fuel combustion is even more substantial. The total mitigation potential in the industrial sector is 5.6 Tg CO_2.

As far as all studied measures are economically feasible, it could be considered that 40-50% of them will be applied without need of a special program for energy efficiency. The remaining 50-60% require additional measures since the financial situation of the enterprises and the limited capital resources do not allow investments to be made even for measures with payback period less than 3 years.

Given that, the baseline scenario set a share of 45% penetration potential of the measures in the industry. The mitigation scenario presents 100% penetration of the measures. The transition form baseline to mitigation scenario needs significant efforts and investments that could and need to be ensured partially by foreign initiatives.

A great mitigation potential of 5.3 Tg CO_2 exists also in the residential and commercial sector that is responsible for 40% of the energy consumption. The financial status of the Bulgarian households would hardly allow the introduction of individual energy efficiency measures, if not externally funded. Therefore the penetration rate in the sector is assumed to be 40% for the baseline scenario.

The energy supply sector has the greatest reduction potential. It accounts for about 40 mln t CO_2 annually (there is substantial overlapping in the value presented). Its execution is hindered by obstacles from political and social nature - increased energy dependence due to the natural gas and nuclear fuel import, increased unemployment because of the reduced extraction local energy resources. The baseline scenario for energy demand is based on the current energy strategy in the country. The demand is meet at least-costs within the limits of the set politic constrains that require maximal extraction of indigenous fuels (mainly coal).

The energy supply scenario relies on a combination of all measures to their optimal size depending on the demand and the technical minimum of the coal mines. The realisation of the scenario is a political issue with economic benefit for the energy supply companies except for the coal mining.

One of the key mitigation measures is the gas supply to households, commercial and administrative buildings. It results in 6.8 Tg CO_2 annually. Only half of this potential is considered in the baseline scenario, while the mitigation scenario explored the entire potential.

Having in mind the country experience, the currency board restrictions and political situation, one could consider the baseline scenario as a likely-to-be scenario. Only significant foreign investment could move the country energy sector towards the mitigation scenario (or energy supply or energy efficiency scenario).

Electricity export. The scenarios development do not consider the electricity export, that recently is an important flow. An export of about 4-6 billion kWh annually could be considered as possible. This export under scenarios different than the baseline scenario could lead to additional emissions of 6-9 million t CO_2.

BULGARIA COMMITMENTS UNDER THE UN FCCC

The analysis of the GHG emission projections indicates that in all cases Bulgaria will meets its UN FCCC commitment to keep the level of the GHG emissions under the values of the base year (1988). Depending on the revival rate of the economy and the direction and rate of the changes in the energy intensity of the production in 2000 Bulgaria could have a reduction of the aggregated emission within the range of 20-32% compared to the base year.

Currently the analysis of the options for meeting the emission reduction target of 8% assigned to the county by the Kyoto Protocol is under way. Having in mind that the aggregated emissions in 1988 were 136093 Gg CO_2 equivalent, the reduction target for the first commitment period 2008-2012 could be estimated as follows: 5 x 0.92 x 136093 = 626025 Gg CO_2 equivalent, or 124205 Gg CO_2 equivalent average annual emissions. When compared to the projected emissions the reduction target is not achievable by the baseline scenario. The projected emissions exceed the emission limitation by 10% due to reasons such as:

- reduced share of the nuclear energy and the total electricity production;
- great transit natural gas flows through the territory of Bulgaria and therefore increased CH4 emissions;
- postponed introduction of mitigation measured due to the lack of investments.

The intermediate scenarios (the energy supply and the energy efficiency scenarios) allow the Kyoto reduction targets to be achieved very close to the limits. Both of the scenarios use the total potential in the energy supply and energy demand, which indicates that their success will require lots of efforts from the Government, business companies, non-governmental institutions and organisations to ensure financial support to the GHG mitigation measures through joint implementation, possible emission trading and other mechanisms. Otherwise the 92% emission limitation seems hardly achievable, and an emission limitation of 100% (as for Russia and the Ukraine) appears as more suitable for the country.

The situation is made even more difficult for Bulgaria due to the fact that in the base year (1988) Bulgaria used to import electricity from the former USSR that accounted for about 10% of the power demand. When the same quantity of electricity is produced in Bulgaria the emissions of CO_2 are 6321 Gg CO_2, i.e. 6.5% of the CO_2 emission or 4.5% of the aggregated emissions in the base year.

Given all above mentioned results, the country would have to conduct additional studies before the decision for ratification of the Kyoto Protocol is taken. Such a decision if not combined with foreign financial support would put additional requirements to the national economy that has to recover after the grave economic crisis.

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CHAPTER 6

EXPECTED IMPACTS OF CLIMATE CHANGE, VULNERABILITY ASSESSMENT AND ADAPTATION MEASURES

This chapter provides a summary of the climate change in Bulgaria for the last century and the climate scenarios for the next century. The impacts of the changes on the forest ecosystems and on agriculture are projected. The framework of the adaptation strategy in the forestry and agriculture is outlined.

¾ ¾

INTRODUCTION

The climate profile of Bulgaria is determined by its belonging to the mild continental zone with regular rotation of four seasons. The diversity of terrain altitudes affect the temperature and precipitation schedules and provokes significant weather variability. More information on the climate characteristics of the country are provided in Chapter 2. The enumerated characteristic allow the territory to be divided into two basic climatic zones - Northern and Southern Bulgaria.

It is necessary to pay attention to the regional current climate when climate change studies are carried out. The First National Communication gives the climate fluctuations (in particular, temperature and precipitation) for both zones within the period 1901-1993. Regional climate variability and trends are often different from the global climate. That is why, in the Second National Communication the climate variability during the last decade relative to the current climate, recommended by the World Meteorological Organisation (1961-1990), was analyzed. A slight warming is observed till 1994 which was the warmest year in the country since the late 19th century - the annual air temperature was approximately 1.5°C above the current climate (Figure 6.1).

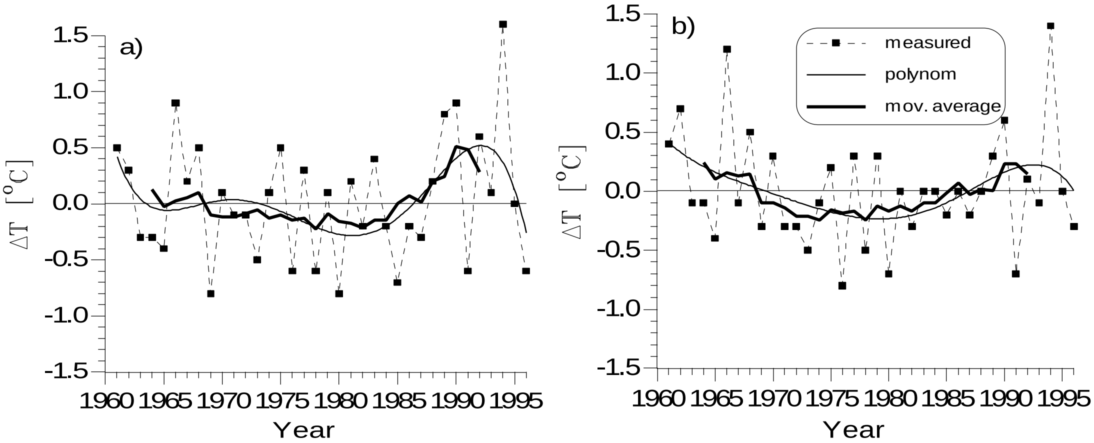


Figure 6.1. Anomalies of annual air temperature in North (a) and South (b) Bulgaria relative to the current climate (1961-1990)

However in 1995 and 1996 the measured annual air temperatures were similar and below current values, respectively. Nevertheless, during the last years only positive anomalies of air temperature during the warm half-year were observed. The observed deficit of annual precipitation during the 1980s continued during the first years of the current decade (Figure 6.2). Less annual precipitation occurred last year (1996) in North Bulgaria, however during the warm-half year (actual crop growing season) rainfall decreased throughout the country. There are some indications that an relative annual precipitation increase will be observed during the next years followed by new deficit during the next decade.

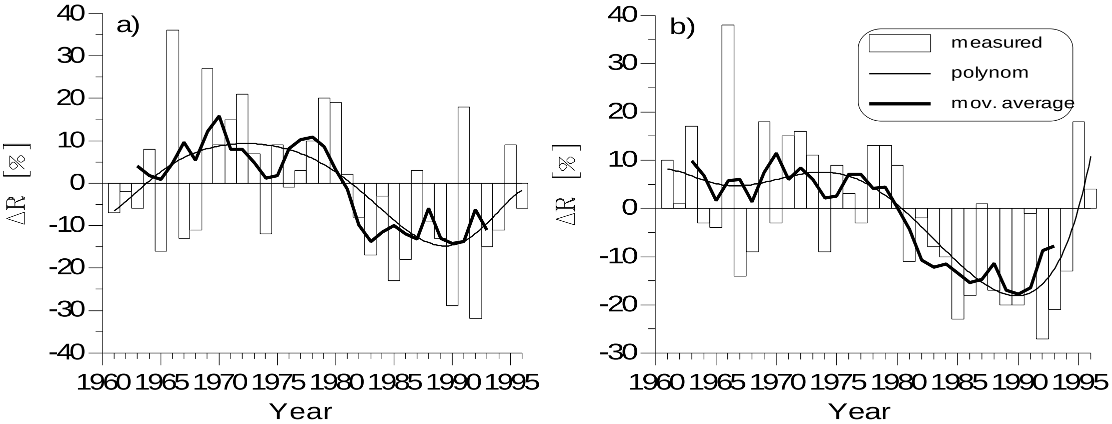


Figure 6.2. Anomalies of annual precipitation in North (a) and South (b) Bulgaria relative to the current climate (1961-1990)

CLIMATE CHANGE SCENARIOS

Several climate change scenarios were created by changing observed data from the current climate (1961-1990) in accordance with doubled CO_2 simulations of seven General Circulation Models[1] (GCMs).

The single levels of CO_2($1xCO_2$) outputs from the GCMs were compared to the average observed regional climate. The outputs of the $1xCO_2$ OSU, HCGG and HCGS models are in a relatively good agreement with baseline air temperature from June to March. They could be considered as the most appropriate global circulation models for monthly air temperature in Bulgaria (except April and May). The $1xCO_2$ CCC and GFDL models simulate relatively well current precipitation throughout the period from November to April. Most of the GCMs underestimate precipitation during the summer months (June-August). The GISS, HCGG and HCGS outputs are most similar to the baseline precipitation during the same period of the year. Generally, the GCMs do not perfectly simulate the present climate in Bulgaria. The model changes from the present to the future climate are more reliable than the present or the future simulation alone. According to the GCMs used in the study annual temperatures in Bulgaria are predicted to rise between 2.9°(HCGS) and 5.8°C (UK89) under an effective doubling of CO_2 ($2xCO_2$), as shown in Figure 6.3.

In general, precipitation is expected to increase during the winter and to decrease during the warm half-year (CCC, GISS, GFDL, OSU). The $2xCO_2$ UK89 and HCGS models even project minor increasing only in November and July, respectively (Figure 6.3). It is essential to emphasize the fact that these climate change scenarios were not constructed to help predict the future. They were designed to help identify the sensitivity of sectors to climate change (such as agriculture and forests).

[1] The GCMs which were used are those from the Goddard Institute for Space Studies (GISS), Geophysical Fluid Dynamics Laboratory (GFDL), Canadian Climatic Center (CCC), Oregon State University (OSU), United Kingdom Meteorological Office (UK89) and Hadley Center (HCGG and HCGS which integrate the negative forcing effect from sulfate aerosols) (Alexandrov, 1997b,d).

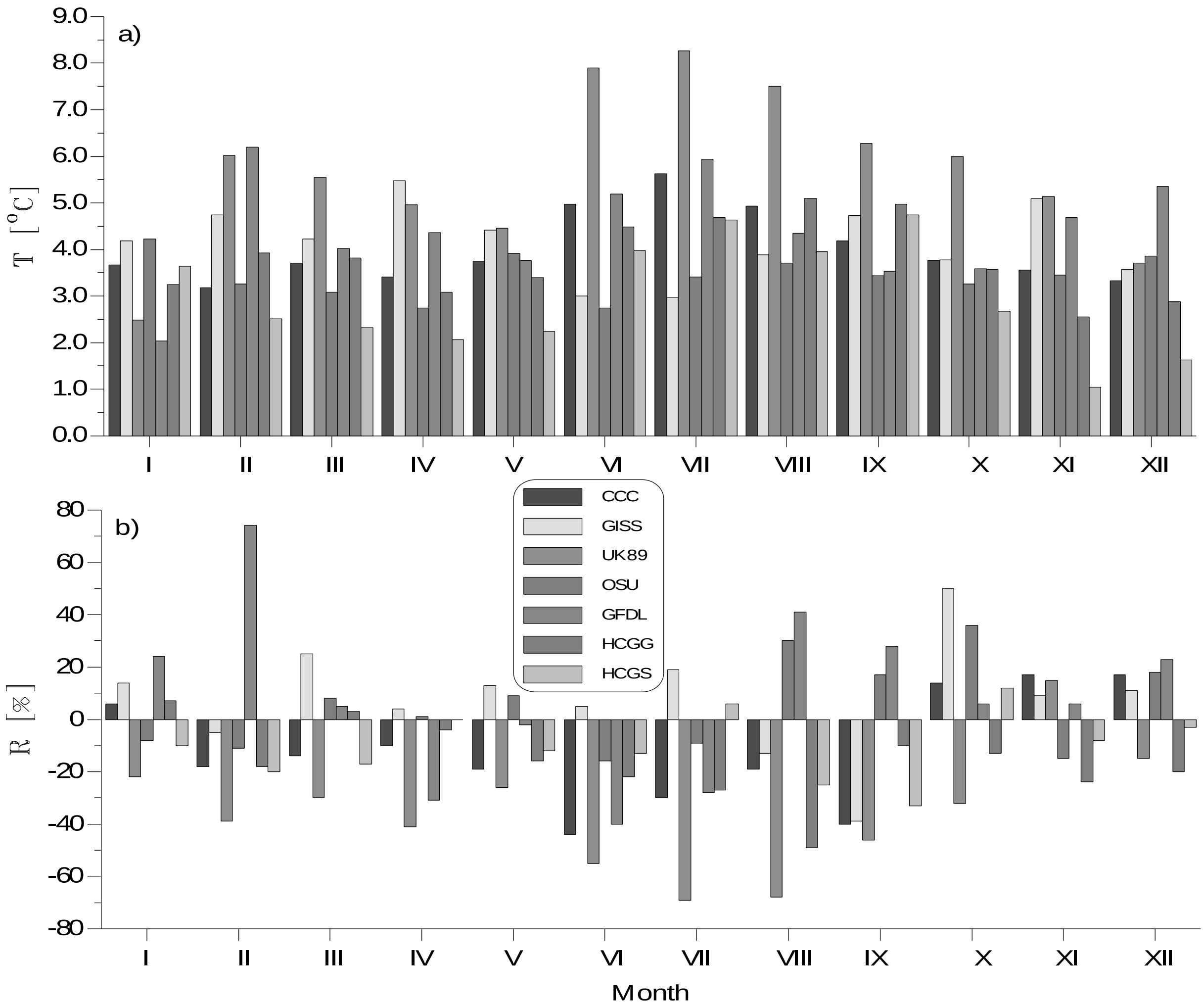


Figure 6.3. Climate change scenarios for Bulgaria - differences/ratios between** $2xCO_2$ **and** $1xCO_2$ **GCM outputs for monthly air temperature (a) and precipitation (b)

VULNERABILITY ASSESSMENT

Agriculture

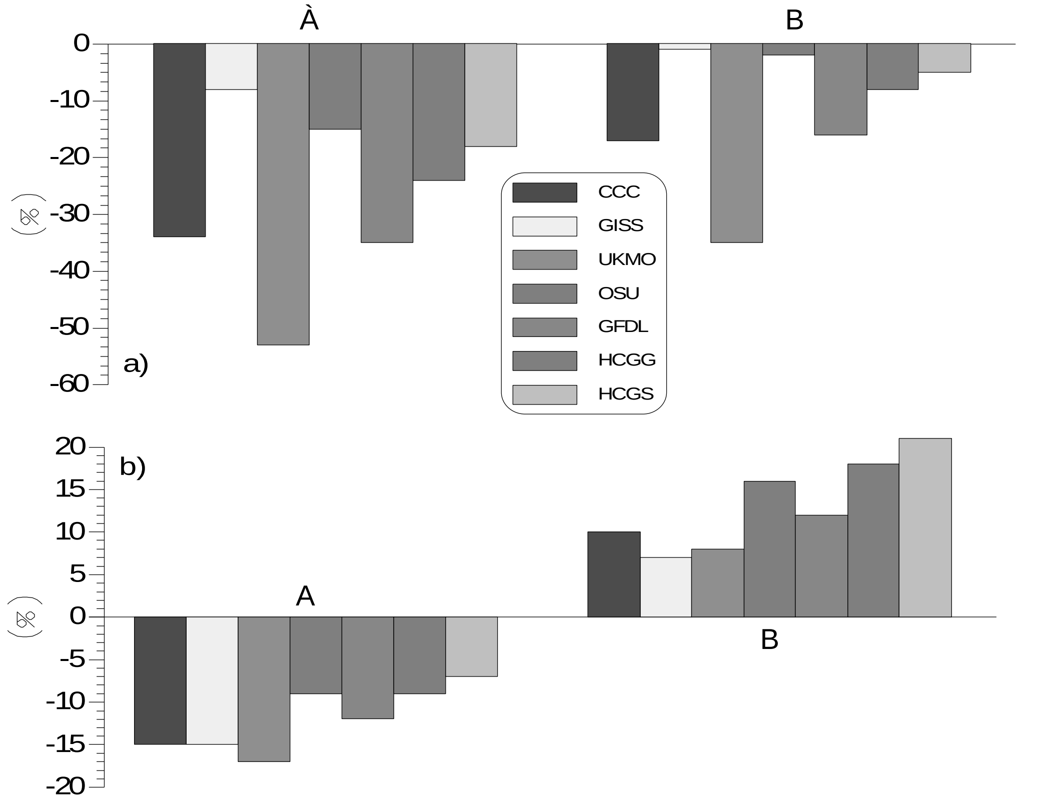
The main CH_4 sources in agricultural sector are the livestock breeding and rice cultivation. The plant-growing and particularly the residues field burning emits nitrogen and carbon oxides.

Studies based upon diverse climatic scenarios for the atmospheric circulation have shown that in the next century serious changes in the heat and precipitation modes in Bulgaria will occur due to the doubling of the CO_2 concentration. Numerous studies on the fluctuation of the air temperature and precipitation rates in the previous century proved that such changed towards warming and droughts are already registered. Simultaneously there are large ranges of fluctuation in the temperatures and precipitation rates within the last decade.

The increase of temperatures at an effective doubling of the CO_2 concentration leads to the increase of the agroclimatic thermal potential in Bulgaria - longer growing period and bigger amount of effective temperatures during the same time interval. The precipitation amounts increase or slightly decrease during the potential growing period and decrease in the non-growing period due to the shifting of the dates of sustainable air temperature transition in autumn and spring to the beginning and the end of the winter season.

The climate change scenarios derived for Bulgaria were used to evaluate changes in potential and actual crop growing season and grain yield of maize and winter wheat. Under equilibrium $2xCO_2$, the potential crop growing season was projected to increase by 1-2 months. Hence, a northward shift of productive potential was evident. The sum of the plant effective temperatures will also increase.

The altered temperature and precipitation databases corresponding to each of the climate change scenarios were used to run the GENERIC CERES 3.00 simulation models of maize and winter wheat. All scenarios project shorter vegetative (sowing-silking/anthesis) and reproductive (silking/ anthesis-full maturity) stages of maize and winter wheat. The changes were driven by the temperature increases of the scenarios. There was an obvious trend of decreasing grain yield of maize and wheat -Figure 6.4.



Legend: A, B - without/with direct influence of CO_2 on development, growth and yield formation of maize and winter wheat

Figure 6.4. Departures of grain yield of maize (a) and winter wheat (b) under 2x CO_2 scenarios, relative to the current climate at 2 experimental crop stations - Kojnare (a) and Zinmica (b)

Simulated grain maize yield decreases in Bulgaria were caused primarily by warming and precipitation deficit during the growing season of this crop. Some changes were observed when the direct effect of increased CO_2 had been assumed in the study. In this case the decrease of maize grain yield was no so adverse and winter yield increased relative to the current climate. The reason of these changed results was the influence of increased levels of CO_2 as a fertilizer (Figure 6.4).

<u>Forestry</u>

In order to define the forest ecosystem vulnerability under the possible climate changes, as well as to find measures for their adaptation to the new conditions, an information is necessary for the Bulgarian forests calibrated to a basic period. 1990 has been chosen for a base year in the study. The meaning “status of Bulgarian forests” includes information about the areas, tree species, growth rate, total volume etc. The status of the Bulgarian forest was thoroughly described in the First National Communication. In general, the total area of the forests in the country, the percentage of woodiness, the protected territories and the total area of the coniferous forests has increased within the last few decades.

The areas of annual afforestations have varied from 28 040 ha up to 89 660 ha, and this allowed over 1 million ha of new forests be established in the past 35 years, hence, over 1/3 of the country’s forests were re-established. The creative policy in the field of forestry resulted in a quick increase of the total volume of above-ground mass of wood in the forests of Bulgaria. The total volume of wood in the Bulgarian forests has increased from 244.68 mil. m^3 (in 1955) up to 396.02 mil. m^3 (in 1990), i.e. the amount of standing wood has increased for 35 years by 61.8%.

The consequences of this favourable effect on the forests in Bulgaria are obvious: the erosion in all the large water-catchment basins in the country was liquidated; the living conditions in enormous territories in the country were improved, as well as the forests' microclimatic, hydrological, meliorative and other positive effects, i.e. all the peerless favourable functions of the forests in Bulgaria are improved.

The analysis on the condition of the forest vegetation from the last decade in Bulgaria show that the coniferous forest vegetation which was widely introduced during the last decades under 800 m a.s.l., i.e. out of its natural habitats, forms very hardly stable forest ecosystems. The main reason is the discrepancy between the ecological conditions (mainly rainfalls) and the requirements of the coniferous tree species. Due to this reason they are physiologically in a chronic water deficit and in drought periods like this one in 1983-1994 they begin to disintegrate.

The tendency subsequently encompasses the high fields of West Bulgaria - North Bulgaria - South Bulgaria - Black Sea Coast - Southern parts of the country. In this sequence the vulnerability of the forest vegetation to the adverse dry climate increases.

The problem with the discrepancy of the ecological conditions of the forest vegetation is not a new one in Bulgaria forestry. During the last years decay of the conifer plantations (*Pinus sylvestris, P. nigra*, more rarely *Picea abies* and *Pseudotsuga menziesii*) has been observed due to the improper introduction of these species in the low part of the country. The main reason for this dangerous phenomenon was the discrepancy between the climatic conditions in this part of the country and the ecological requirements of newly afforestated coniferous species. If the projections about the carbon dioxide doubling during the next century come true the ecological conditions in Bulgaria will drastically go worse.

The climate change scenarios derived for Bulgaria were used to evaluate potential changes in forest vegetation. The altered temperature and precipitation databases corresponding to each of the climate change scenarios were used to run the Holdridge life zone (1967) classification model.

The changes are from "cool temperate moist forest" to "warm temperate dry forest" for North Bulgaria, and for South Bulgaria the "warm temperate dry forest" will remain typical. In the warmest country regions (station Sandansky) "subtropical dry forest" could be expected, which means drastic warming and droughts. Since 60.6% of forests are in the zone below 800 m , it is clear, that most of the Bulgarian forests would be vulnerable to the drastic climate change under the eventual doubling of carbon dioxide in the near future. The changes in the mountain regions of the country (station Smoljan, 1180 m a.s.l.) would pass from "cool temperate wet forest" to "warm temperate moist forest". At an eventual climate warming a moving of the species composition from South to North could be expected, which means shifting of tree and shrub vegetation from the South-Bulgarian into the North-Bulgarian and from the South-Bulgarian borderside into the South-Bulgarian forest vegetation area respectively. That means that it could be expected that the South-Bulgarian borderside area will be settled by typical Mediterranean vegetation, a part of which is to be seen there even at present. More important representatives of this vegetation are *Cercis siliquastrum L., Cupressus sempervirens L., Olea europaea L., Pinus brutia Ten., P. halepensis Mill., P. pinaster Ait., P. pinea L., Quercus aegilops L., Q. ilex L., Q. suber L., Q. trojana Webb.*

In addition to the First National Communication, hereafter the forest vulnerability was evaluated following the GAP models. The prediction of the forest ecosystem responses to long-term climate changes requires hierarchical constructed dynamic models, which to be capable to cover and describe in a mechanistic manner the combination of the basic ecosystem processes and their interrelationships in space and time. The forest GAP models are individually based programs which simulate the vegetation response functions to the environmental conditions. The model could evaluate the possible changes in the species composition, forest structure and productivity of specific forest sites. The model requires detailed information on specific forest species and environmental factors. The model could evaluate the dynamics of particular forest site in response to the climate change.

The GAP model results show that in case of climate warming in the near 90 years, the following consequences could be expected:

A. In the lowlands - Tree species diversity reduction. In spite of that, this biodiversity would be greater compared with the biodiversity in the mountain regions. The selected tree species guarantee increased bioproductivity. It could be considered that if proper selection is made, optimal bioproduction could be realised under changed climate conditions.

B. In mountains - It could be expected increase of tree biodiversity. It could be realised by means of the natural shifting of tree vegetation from lower to higher sites in the mountains. This process would be combined with biomass production increase.

C. Both in lowlands and mountains - Increased biomass productivity would be accompanied by increased CO_2 absorption.

Either using Holdridge Life Zones Classification Model and JABOWA-II Gap Model, two climate zones of climate change influence have been established: from 0 to 600-800 m a.s.l. and over 800 (1000) m a.s.l. Working with Holdridge model, critical situation for the future of the forests in the lowlands and lowhill regions on the whole was outlined, while developing gap model situations it could be seen that the status of the forests (in all altitudes) wouldn't be critical at all. Because the Holdridge model provides a regional mapping system for interpreting spatial changes throughout the country or regions, while the forest gap model evaluates the temporal dynamics of a given forested site in response to climate change, it could be considered that the GAP model results are more objective.

ADAPTATION

Agriculture

Using a computer Decision Support System for Agrotechnology Transfer (DSSAT) some possible adaptation measures for maize were tested. Under $2xCO_2$ climate change scenarios the sowing dates should occur 15-30 days earlier than those under current climate conditions. Generally, the changes in fertilization (N, P and K) did not compensate grain decreasing. The DSSAT Seasonal Analysis program was run to determine the most appropriate timing and water amount of irrigation applications. The tested treatments of the irrigation numerical experiment assumed maize growth and development under rained conditions, different date(s) and water amount of irrigation. Both biophysical and economic analyses were done. The strategic analysis, was done in respect to the simulated value of harvest maize yield and net return (Figure 6.5). An attempt to estimate the genetic coefficients for new maize hybrids which might be more adaptable to the changed climate conditions in the future was also done. An increase in the actual value of the respective coefficients compensated for the projected grain yield losses caused by the $2xCO_2$ climate change scenarios in the country. Moreover, maize grain increase was observed in some cases.

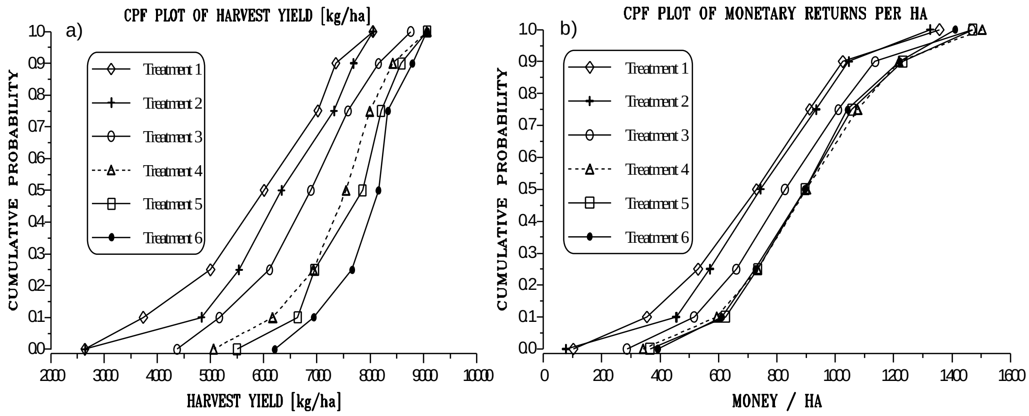


Figure 6.5. Cumulative probability function plots of the simulated harvest maize yield (a) and monetary returns (b) in Kojnare under 2xCO_2 CCC climate change scenario.

Warming will lead to increase of crop growing season and will move upper limits for agricultural production to 1000 m a.s.l. at suitable areas. This result will impose:

<u>*New zoning of the agroclimatic resources and agricultural crops*</u>

- Expanding areas of the most important agricultural crops over new regions characterized by improved thermal and moisture conditions.
- Utilization of a variety of cultivars and hybrids, especially long-maturing, high-productive cultivars and hybrids with better industrial qualities.
- Cultivation of new agricultural crops grown with Mediterranean origin.

<u>*New cultivars and hybrids to be adapted to climate change*</u>

- The new cultivars of winter agricultural crops to pass through the winter season organogenesis under higher temperatures without deviations from the normal crop growth and development.
- The new cultivars and hybrids to be with higher dry-resistance, especially at the end of the vegetative period and at the beginning of the reproductive period.
- Higher maximal air temperatures not to provoke thermal stress effects, especially during crop flowering and formation of the reproductive organs.
- The new cultivars and hybrids to grow and photosynthesis under an increased concentration of carbon dioxide.

<u>*Measures for increase of the irrigation effectiveness*</u>

- Introduction of irrigation technologies with decreased water charges and without losses during water transportation and distribution.
- Restoring and reconstruction of the already constructed hydromeliorative fund.
- Reconstruction and building of new test-pits for utilization of groundwater.
- Utilization of river water and precipitation for moisture storing irrigation during the winter season.
- Utilization of waste water and drainage system water.

<u>*Adaptation phytosanitary measures*</u>

- Development of special submodels incorporated into models of agroecosystems which simulate plant-protection situations, related to climate change.

- Assessment of already used pesticides and the way of their utilization and potential effectiveness of the chemical method against crop diseases and pests.
- Improving technologies for plant protection and priority development of non-chemical methods against crop diseases and pests.
- Improving the monitoring for the phytosanitary situation in the country.

Forestry

The First National Communication thoroughly deals with the forestry sector and the available adaptation and mitigation measures. Current Communication only adds the latest research in the field.

For the forests in the low part of the country (up to 800 m a.s.l.), where most significant climate changes can be expected, as a strategic task in the management of the forest resources in the country, the aim for a fight for adaptation of the forests to the aridisation of the climate and for prevention of the forest resources from worsened climatic conditions is put in question.

For the forests in the higher parts of the country, i.e. over 800 m a.s.l. where the expected changes probably will not be drastic, the more ambitious aims of preserving the biodiversity; resistance of the ecosystems; multifunctional utilization; system of protected natural territories are discussed.

Due to the study results the first *National strategy for conservation of the forests and development of the forestry in the Republic of Bulgaria* (1996), along with the basic priorities addresses also subjects as:

- Helping the forests adaptation to the unfavourable climatic conditions;
- Preserving the biodiversity and genetic resources of the flora and fauna at an ecologically suitable reproductivity of the forest resources.

The change in the selection of the species for afforestation is the most realistic method for adaptation of the forest ecosystems to future climate changes.

If the experience at the Bulgarian forestry from the last few decades is analyzed, it will be find out that there is a clear tendency to a change (Figure 6.6).

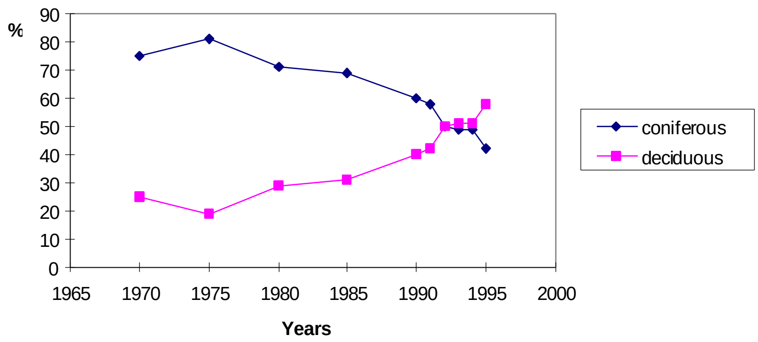


Figure 6.6. Afforestation with coniferous and deciduous species in Bulgaria during the period 1970-1995

The figure shows that the tendency of more wide use of the deciduous species in the afforestations in our ecological conditions is correct. At future warming and drought, expected as a consequence from the greenhouse effect in the atmosphere, the participation of the deciduous tree species will grow.

It should be known that in 1955 the conifers in Bulgaria were only 11% of the forest area and after 40 years of increased afforestation activity with conifers this percent increases to 38.

If the climate changes are in a direction of warming and drought, a considerable xerophytisation of the vegetation can be expected. The hygrophytes and some mesophytes will be strongly reduced. The vegetation will be concerned on a species and intraspecies level.

A strong reduction can be expected among the representatives of 32 local vegetation genera and 57 species. This concerns also the introduced forest tree and shrub species. About 17 genera and 22 species are assumed as being too sensitive to the expected climatic changes.

The coming changes in the biodiversity will appear in reduction and fall off of the boreal forest species and increased participation of the species more resistant to drought and warming. Main role for conservation of the vegetation cover most probably will play these natural species which have the necessary morphological and physiological features to survive under the new forest vegetation conditions. Such a resistance can be expected mainly from 18 families with forest tree and shrub species, 46 genera and 70 species. At an eventual xerophytisation of the growth conditions, representatives of 21 families, 33 genera and 48 species could suitable.

These data show that the natural and introduced forest tree and shrub species in Bulgaria have great capacity for good adaptation to the eventual climate change in the next century.

The Cedar ssp. trees are representatives of the few conifer species which would be recommended as appropriate in the future afforestations in the conditions of climate changes. Besides they are drought-resistant, have a great potential of bioproductivity which responses quite well to the new ecological conditions. There are favourable conditions for cedar trees growth in the lowland belt - from 0 to 700 m a.s.l., and appropriate terrain for these species are localised in the southern half of the country. The annual areas for afforestation might reach from 180 to 400 ha.

The fellings are a powerful method for improving the condition and increasing the productivity of the forests. Through them, the species composition can be regulated and the adaptation of the forest ecosystems to the changed climatic conditions can be considerably increased.

Through thinning out of the young stands, the living space of the rest of the specimen is increased, the light and water regime is improved. In that manner the adaptation possibilities of the tree stands are increased and as a result the biomass increases too. The forestry management plans project about 120 000 ha to be cultivated annually with average timber output of 2 801 800 m^3.

Some other adaptation measures were already enumerated in the First National Communication.

REFERENCES

1. Grozev, O., V. Alexandrov and I. Raev, 1996. Vulnerability and Adaptation Assessment of Forest Vegetation in Bulgaria. In Adaptation to Climate Change. Shpringer Verlag, New York.
2. Grozev, O. and Al. Delkov, 1997. Will the lowland forests adapt? Gora #1/97, 5-7, (in Bulgarian).
3. Grozev, O., R. Miltchev and P. Ivanov, 1998. Gap Model Application for the Description of the future Forest Stands Composition (in print)
4. ? ???????????? ????? ???? ?? 1989 ?? 1996 ?. ? ? ? , ? ?? ??.
5. ? ??????? ?? ?????????? ?? ??? ???????? ?? 2000 ??????, 1995, ? ? , ? ??????? ?? ????????, ? ?? ??.
6. ? ?????????? ? . 1994. ???????? ?? ?????????? ????? ? ????????? ?? ??? ? ????? ??????. ? .??. ?? ? ???? ?????????? ???????? “? ????? - ?????? ??????????”. ? .???.230 - 235.
7. ? ?????????? ? ?. 1995. ? ?????? ?? ????????? ?? ??????? ????? ?????? ????? ??????????? ??????? ??????? ? ????????. ? .??. “? ??????? ?????????? ?????? ? ????? ?? ??????????? ?? ???????. ? .?.2. ?????? 1 ???. 38-41.
8. ? ???? ? ., ??????????? ? . 1996. ? ?????? ?? ???????? ????????? ?? ??????? ????? ???????????????? ??????? ?? ????????. ? ????????????? ????? ?. ? ? ? ???, ? 9, ???. 72-77.
9. Alekxandrov V. 1996. Vulnerability Assesments of Agricultural Vegetation in Bilgaria. Proceedings of the Regional Workshop on Climate Change. Vulnerability and Adaotastion. Praha, Czech Republic.cc.1-112.
10. Alexandrov V. 197. Vulnerability if Agronomic Systems in Bulgaria. Climatic Change. Vol 36. Kluwer Academic Publishers. Netherlamds.pp.135-149.
11. Bogdanov.St.1996. Invemtory of Grenenhouse Gas Emission in Bulgaria 1967 - 1996. Groemhose Gas Emission Inventoris.pp.237-252.
12. Novelli P.C. et all. Recent Changes in Carbon Dioxide, arbon Monoxid and ethans and the Implications for lobal limate Change. Buletin wmo v.44,n.1,pp.332-38.

13. Slavov N., Alexandrov V. 1997. Influence of the lobal Climatice Chang on Agroclimatice resources in Bulgaria. Comptes Rendus de B'Academie Bulgare des cience, vol.50,n.2,pp.31-34.

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CHAPTER 7

JOINT IMPLEMENTATION OF THE FCCC COMMITMENTS

Pursuant to Article 3.3 of the UN Framework Convention on Climate Change, efforts to address climate change may be carried out co-operatively by the interested Parties. Article 4.2(a,b) gives more specific information on the joint implementation options (JI).

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With respect to the mechanism of joint implementation mechanism recommended by the UN FCCC and reaffirmed by the Kyoto Protocol, the viewpoint of the Republic of Bulgaria concerning Joint Implementation (JI) initiative is as follows:

- JI is economically effective because it allows the achievement of least-cost maximum global emission reduction of GHGs;
- JI mechanism would facilitate the state-of-the-art technologies penetration in the countries in transition and in the developing countries;
- JI is a voluntary activity under the responsibility of two or more parties that has to be undertaken and/or accepted by the Governments of the two counterpartners;

A Project Preparation Unit attached to the Bulgaria Ministry of Environment has been established to ensure the effective fulfilment of the UN FCCC commitments. It will widen its activity by collection, evaluation and implementation of GHG reduction projects. The main goals of the Project Preparation Unit are as follows:

- Retrieval and identification of projects.
- Preparing a list of top quality projects.
- Retrieval of sources to finance project realisation.
- Evaluation of projects following implementation from the viewpoint of generalising the experience from joint implementation mechanism.

Currently the Project Preparation Unit develops a list of the most economically and environmentally feasible projects to be offered for joint implementation. Most of the mitigation measures enumerated in Chapter 4 and Annex II could also be considered as projects searching for financial support and suitable for JI. There are opportunities for setting of bandies of projects in order to achieve better performance.

At the same time it should be acknowledged that the JI (Joint Implementation) initiative is not well known in Bulgaria yet. In the Bulgarian context, JI is economically feasible way to reduce the GHG emissions, but this notion should be communicated to all stakeholders. In 1995 the Ministry of Environment and the Bulgarian based fondation for energy efficiency called "EnEffect" organised an international conference "Joint implementation of project to prevent climate change and options to invest in energy efficiency projects in Bulgaria". In April 1998, the JI mechanism was described on the meeting of the Municipal Energy Efficiency Network held in Belene. The mayors and the energy efficiency managers to the municipalities were acquainted with the options and procedures to get !financial support for GHG mitigation projects.

It should be noted that some of the projects enumerated in the JI chapter of the First National Communication have been already financed and under implementation using other financial mechanisms and sources. This is the case with the energy efficiency zone in Gabrovo financed by GEF that is currently under implementation. There are few new proposals for JI currently under discussion but still there is no a JI project implemented in Bulgaria.

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CHAPTER 8

CLIMATE CHANGE RESEARCH IN BULGARIA

A survey of the Bulgarian researches on the climate change issue is given. The basic part of the studies address the climate change in Bulgaria during the last decade, the impact on the forests, agriculture and water resources and the relationship with the global climate change.

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Climate is traditionally one of the main fields of research interest in Bulgaria and a lot of studies on its genesis and characteristics have been carried out. A major part of these studies has been performed by the different institutes of the Bulgarian Academy of Sciences (BAS) and independent research institutes.

Bulgarian Climate Change Program provides information and research results to Bulgarian Government and society on climate, climate change and related topics. It is implemented through different projects at both national and international level such as Bulgaria Country Study to Address Climate Change that was a multidisciplinary study under the US DOE financial support[1] and aimed to study GHG emissions by sources and sinks and to evaluate alternative options for GHG mitigation as well as vulnerability and adaptation to the climate change. Energoproekt was a national co-ordinator of the Bulgarian Country Study to Address Climate Change in which the National Institute of Meteorology and Hydrology, the Institute of Economy, Institute for Nuclear Research and Nuclear Energy and other institutes also took part. Study results were used in the preparation of the First National Communication. The project ended in 1997 and was extended in the Support for National Action Plan (SNAP) project developed once again with the financial support of US CSP. The overall objective of the project is to facilitate the fulfilment of the commitments of Bulgaria under the UN FCCC. It has to define not only the priority actions at different sectors of economy and to integrate them at national level, but also to define the necessary domestic and international financial sources to facilitate plan implementation, as well as to ensure the required public support. The main elements of the projects are preparation of the National Action Plan, technology assessment; outreach and educational activities. The Second National Communication is based on the research results of the project and is prepared within the frame of the project.

Energoproekt PLC is a company for study, research and design in the energy sector and in the climate change field. The company is certified in DIN EN ISO 9001:94 and licensed by the PHARE program for business within EU. The Research Division of Energoproekt carries out all climate change energy-related studies, economic and environmental evaluations, GHG emission inventories and projections, mitigation policies and measures assessments, as well as the GHG abatement development. Energoproekt PLC is one of founders and leading participants in the National Co-ordination Centre on Global Change.

The National Co-ordination Centre on Global Change has been established pursuant to a decision taken by the Board of the Bulgarian Academy of Sciences. The Centre’s goal is to combine the efforts of all governmental and non-governmental organisations working in the field. Since its establishment the activities of the Centre has been focused on its recognition at national and international level. At the national level establishment of networks of institutes and organisations has started. Currently members of the network are more than 20 institutions and organisations such as the institutions of the BAS, as well as the National Centre of Environmental Protection and Sustainable Development, the National

[1] Cooperative agreement DE-FC02-93PO10099 between US DOE and Energoproekt PLC

Statistical Institute, Energoproekt PLC, Economic Analysis and Forecasts Agency, University of National and International Economy, Union of the Scientists, Balkan Centre for Architecture and Ecology, etc. Active support to the activities of the Centre is provided by the Pennsylvania State University.

The institutes of the Bulgarian Academy of Sciences working in the field of climate change and developing related studies are as follows:

National Institute of Meteorology and Hydrology(NIMH): In 1997 the main directions of the climate change related studies developed in NIMH were as follows:

1) *global climate change and its regional impacts*

- improvements of the methods for long-term weather forecast in Bulgaria;
- climate in the south-eastern part of Europe.

2) *research on climate oscillation and climate elements on the territory of Bulgaria*

- regionalization of the anthorpogenic climate changes for modelling purposes (climate oscillation);
- contemporary particularities of the climate over Bulgarian territory;
- influence of the climate variability and change on agroclimatic resources and productivity of main agricultural plants in Bulgaria;
- vulnerability and adaptation measures for the forestry and agricultural vegetation in Bulgaria with regard to climate change. Assessment of the GHG sequestration potential of the forests. Climate change mitigation in the non-energy sector.

3) *studies on the renewable energy sources*

- Renewable energy sources (wing, solar radiation and biomass) and technologies for their utilisation in Bulgaria;
- Trends in the changes in the river flows in Bulgaria; Water balance of Bulgaria;
- Droughts in South-Eastern Europe (FRIEND AMHY program);
- Climate change related changes in the underground water flows in the karst systems.

4) *anthropogenic emission and their impact on the vulnerability of the environment*

- development and exploitation of a regional model for monitoring and assessment of the transboundary air pollution in South-Eastern Europe. Bulgarian contribution to the European Monitoring of Environment Program (EMEP);
- inventory of the anthropogenic volatile organic compounds emissions;
- impact of the local micro-meteorological condition on air quality;
- information database on the meteorological conditions and air and water pollution.

The research and studies in the field of climate change, vulnerability and adaptation measures, mitigation options and others will continue in the future. Thus in the agricultural sector there are two main directions outlines for further research:

- *Climate change assessment*: Utilization of different global circulation model outputs for assessment of the regional climate changes in Bulgaria; Utilization of simulation models of agroecosystems for assessment of the influence of climate change on major crop productivity; Periodical zoning of the agroclimatic resources in Bulgaria under climate change; Periodical zoning of the major agricultural crops under already established changes of the agroclimatic resources in the country.

- *Vulnerability and adaptation of agricultural crops under climate change:* Identification and collecting in a genetic bank with samples of agricultural crops and wild plants that are steady to climate anomalies, water shortage, diseases and pests; Selection and introduction of high-productive cultivars and hybrids which will be resistant to climate change and will have high quality production; Development of technologies for production of agricultural crops adapted to climate change; Improvement of the methodology for land re-evaluation in relation to climate change; Development of technologies for effective utilization of manure and crop waste and for improvement of measures to cope with soil erosion; Development of measures for animals' adaptation under climate change; Development of feasibility studies for the applied measures.

The Institute of Oceanology develops projects related to the climate characteristics of the regional seas: Black sea, Caspian Sea and the Mediterranean sea. The particularities are investigated and projections are made.

The Space Research Institute, in collaboration with Sofia University "St. Kliment Ohridsky", designed an original highly efficient method and a device for the transformation of solar energy into thermal energy or electricity. The method and the device are acknowledged as invention and are copyright-protected by patent No 123/31.03.1997, issued by the Patent Office of the Republic of Bulgaria. The design was awarded a Diploma and a Gold Medal at the International Invention and Innovation Show "EAST-WEST EURO INTELLECT '1997".

The Forestry Institute works in the field of vulnerability and adaptation of the forestry vegetation. New research and studies are envisaged for:

- Vulnerability of the main forestry ecosystems in Bulgaria under climate change;
- Adaptation potential of the basic three species and ecosystems in case of climate change;
- Changes in the biodiversity of the forests in Bulgaria in case of climate change;
- Monitoring of the state of forest ecosystems in Bulgaria under climate change;
- Improved forestry management and legislation under changed ownership and market economy;
- Development of pilot projects with tree species stable to climate change.

The Institute of Nuclear Research and Nuclear Energy takes also active participation in the climate change issues. It has taken part in a project concerning the *Energy-environment interaction: modelling and policy* financed by the Ministry of Environment. The Institute in co-operation with the Institute of Economy, Energoproekt and other experts, participates in the development of macroeconomic and energy demand forecasts and mitigation measures.

In the Institute of Botanics to the BAS, there are some projects developed related to the history of the flora and paleoecology in the last 15 000 - 20 000 years. These analyses are indirectly related to the climate change issues (vegetation and its history in the Stara Planina region, paleobotanic studies of the Rodopa mountains; vegetation and environmental dynamics in the mountains of Rila, Pirin and Alps; vegetation dynamics and environmental changes in the Northern part of the Pirin mountain, etc.). The results give information the changes in the species and vertical allocation of the main forest species in the last 12 000 years. Thus the climate changes could be reconstructed. The anthropogenic contribution to the changes is investigated. The changes in the upper bound of trees in our mountains are studies that provide information on climate variations.

The Central Laboratory of General Ecology develops research related to the changes of the CO_2 flows in the coastal ecosystem and the impact of oil spills. The preliminary results show increased CO_2 concentration, eutrophication and ecosystem distortions.

The Central Laboratory of Solar Energy and new Energy Sources to the Bulgarian Academy of Sciences has been involved in the field of renewable energy sources development and solar energy since

1978. The subject of activities of the laboratory is fundamental and applied research, implementation of scientific results, consulting and expertise in the field of solar energy and new energy sources.

Last two years the Laboratory participated in four international projects under the JOULE and TEMPUS programmes of the EU, mainly concerning materials and structures and their photovoltaic properties. A demonstration project for a photovoltaic powered water pumping installation supported by UNESCO have just came to its end. A turbine pump powered by a 1 kW solar generator extracts water from a 70 m deep well with a debit of 1 l/sec. Besides, about 10 other projects have been elaborated under contracts with the National Scientific Fund, foreign companies, universities and the "Ecology - Energy - the Balkans" programme.

Based on 10 W, 20 W and 40 W solar modules of 14 % efficiency solar electric systems have been developed with output voltage of 12 V, 24 V and 48 V and power rating from 10 W to 5 kW depending on consumers' requirements. The systems provide autonomous electricity supply for households, agriculture, communications, etc.

Solar collectors for hot air supply (up to 120^oC) have been developed applicable in drying installations for herb, mushrooms, timber, agricultural and industrial products.

New building materials and elements have been studied in regard to their thermo-physical and thermo-technical parameters. The thermo-physical processes have been simulated and on that basis low energy consuming buildings were modelled. An energy saving heating system including heat pumps are to be installed to the greenhouses in the Botanical park of the Bulgarian Academy of Sciences.

The future plans include further studies on highly efficient solar cells, devices and systems able to deliver clean and cheap energy. The accumulated knowledge and experience encouraged the staff to submit two National Priority Projects in the frames of the World Solar Decade (1996-2005) concerning the construction of a 300 kW solar electric plant and an International Test Ground for solar energy devices and installations.

REFERENCES

1. ? ????????, ? . ? ??? ?????, ? . ? ??????? ? ? . ? ??????: ????? ????????? ?? ? ???? ??????? ???? ????????. - ? ???????? ?????????, 1997, 3/2 /??? ?????/.
2. Tzvetanov, P., M. Ruicheva, M. Denisiev , Scenarios of Energy Demand and Efficiency potential for Bulgaria, Proceedings, International Workshop on Greenhouse Gas Mitigation Technologies an Measures, Beijing 12 – 15 November 1996
3. ? ????????, ? . ? ???????, ? . ? ??? ????? ? ? . ? ??????: ??????? ?? ?????????????? ? ? ????? ???? ???? ????????. - ? ???????? ?????????, 1997, 3/2 /??? ?????/.
4. Simenova K., Christov C., Vassilev C., Tzvetanov P. Bulgarian Climate Change Action Plan and Projects to Promote Clean Energy Proceedings, International Workshop on Greenhouse Gas Mitigation Ttechnologies and Measures, Beijing 12 – 15 November 1996
5. ? ????????, ? . ? ??? ?????: ? ??????????? ???? ??? ? ?????????????? ?? ? ???? ??????? ?? ????? ?? ???????? ? ? ????? ?????? ???????. - ? ???????? ?????????, 1997, 3/3 /?????? ?? ?????/.
6. Tzvetanov, P., M. Ruicheva, M. Denisiev , Scenarios of Energy Demand and Efficiency Potentia for Bulgaria, Applied Energy, Special Issues, Greenhouse Gas Mitigation Technologies and Measures for Developing and Transition Countries, London 1997
7. Tzvetanov, P, Country Report of Bulgaria, the Energy Conservation Initiative, Group of Governmentally Designated Experts, First Meeting, Brussels, November 18 – 19, 1997
8. Tzvetanov, P, National Energy Efficiency Plan. Energy Efficiency Low of Bulgaria, the Energy Conservation Initiative, Group of Governmentally Designated Experts, Second Meeting Copenhagen, March 2 – 3, 1998
9. ?????? ?. 1997. ??????? ?????? - ????????? ???????. ? : "? ???? ? ?????????", ??? 68, ??.1-3, 15-17 ?.
10. ? ?????, ? ., ? . ?????? ? ? . ? ??????., 1997. ? ??????????? ??????????? ? ???? ???. ? ????? ???? ??????? ???????? - ? ? ? "???????? ??? ?????? ? ????????", ???????????.
11. ? ????? ???, ? ., ? . ? ???????, ? . ? ??????., 1997. ? ???? ??????? ? ??????? (??? ?, ??????????, ????????? ?? ? ??????? ????). ? ????? ???? ??????? ???????? - ? ? ? "???????? ??? ?????? ? ????????", ???????????.
12. ? ???, ? ., 1997. ? ???????????? ???????? ?? ? ???? ??? ????? ?????. ? ??????? ?? ?? ? (?????? ?? ?????), 11 ???
13. Alexandrov, V. and N. Valkov, 1993. A simple stochastic model of climate for calculation of crop productivity. Bulgarian Journal of Meteorology and Hydrology, Vol. 4, No. 3, pp. 132 - 139.
14. Alexandrov, V., 1993. Long-term variations of rainfall during growing season of some crops in Bulgaria. Proceedings of International Symposium on Precipitation and Evaporation, Bratislava, Slovakia, 20-24 September,Vol. 2, pp. 99-104.
15. Alexandrov, V., 1994. Maize Growth under Dry and Warm Climate. Proceedings of the 5-th Symposium on Physics and Agriculture, Sofia, 1994, pp. 230-235. (In Bulgarian)
16. Alexandrov, V., 1995a. Vulnerability Assesments of Agricultural Vegetation in Bulgaria. Proceedings of the Regional Workshop on Climate Variability and Climate Change Vulnerability and Adaptation, Praha, Czech Republic, pp. 1-12.
17. Alexandrov, V., 1995b. Climate Variability and Drought in Bulgaria. Proceedings of the EWRA'95 Symposium, Nicosia, Cyprus, 14-18 March 1995, Published for EWRA by Balkema, Rotterdam, Brookfield, The Netherlands, pp. 35-42.
18. Alexandrov, V., 1995c. Influence of Climate Variability and Change on Agroclimatic Resources and Productivity of Main Crops in Bulgaria. PhD thesis, 187 pp. (In Bulgarian)
19. Alexandrov, V., 1995d. Influence of Climate Change on Grain Yield of Main Cereal Crops in Bulgaria. Proceedings of the 4-th National Conference on Grain, Kostinbrod, Vol. 2, No. 1, pp. 38 41 (In Bulgarian).
20. Alexandrov, V., 1997b. Climate Variability and Change and Water Resources in Bulgaria. Proceedings of the XXII General Asembly of the European Geophysical Society, Vienna, Austria (In Press).
21. Alexandrov, V., 1997d. GCM Climate Change Scenarios for Bulgaria. Bulgarian Journal of Meteorology and Hydrology (in Press).
22. Alexandrov, V., 1997e. Duration of the Period between the Last Spring and First Autumn Frost Proceedings of the 6-th Symposium on Physics and Agriculture, Sofia (In Press; In Bulgarian).

23. Alexandrov, V., 1997f. Land Cover/Use and Bioproductivity. Global Change in Bulgaria. Pennsylvania, USA (In Press)
24. Alexandrov, V., 1997g. Influence of Climate Variability and Change on Agroclimatic Resources and Productivity of Cereal Crops in Bulgaria. Journal of Bulgarian Academy of Sciences. (In Bulgarian; In Press).
25. Alexandrov, V., 1997h. GCM Climate Change Scenarios - Warning for Bulgarian Agriculture. Proceedings of the National Conference on Disasters. Sofia (In Bulgarian; In Press).
26. Alexandrov, V. , 1997c. Drought and Crop Production in Bulgaria. Proceedings of the Internationa Workshop on Drought and Desertification, Bet Dagan, Israel, WMO, Switzerland (In Press)
27. Brazdil R., Budicova M., Auer I., Boem R., Cegnar T., Fasko P, Lapin M., Gajic-Capka M., Zaninovic K., Koleva Ek., Niedzwiedz T., Ustrnul Z., Szalai S., Weber R., (1996). Trend of Maximum and Minimum Daily Temperatures in Central and Southeasterrn Europe. International Journal of Climatology, vol. 16, 765-782
28. Dakova, Sn., 1997. Drougth in South-Eastern Europe, "Flow Regimes from Int?rnationa Experimental and Network Data", Paris, 160-166 pp.
29. ? ????? ?., ? . ? ??????, ? ?????? ???? ????????? ???????? ?????????? ? ?????? ? ???, ? ??. ? ? , ? ? ? , ? ., 1996, 32, 5, 655-675.
30. ? ????? ?., ? . ? ??????, ? ??????? ??? ????????? ???? ????????? ?????????? ? ?????? ? ???, ? ?????? ?? ? , M., 1996, 350, 4.
31. Eremeev V., V. Ivanov, D. Trukhchev, V. Tuzhilkin, Climatic circulation of Black Sea waters derived from the adaptation calculations with mesoscale resolution, in: Diagnosis of the state o marine enviroment of the Azov-Black Sea basin, MHI UAS, Sevastopol, 1994, 121-135.
32. Grozev, O., V. Alexandrov and I. Raev, 1996. Vulnerability and Adaptation Assessments of Fores Vegetation in Bulgaria. In: Smith, J. et al. (editors), 1996. Adapting to Climatic Change - Assesments and Issues, Springer, New York, USA, pp. 374-383.
33. Guenev, M., 1996. Tendency of Annual Runoff Variations in Bulgaria Aiming their Forecasting. International Symposium on Runoff computations for Water Projects, St. Petersburg, Russia (In Print), 8 p.
34. Guenev, M., Krastev, L., 1995. Long Term River Flowvariations in Central North Bulgaria. Proceedings of the International Workshop on Drought in the Carpatiens Region, Budapes Hungary, p. 167 - 170.
35. Guenev, M., Krastev, L., 1996. Conterporary Aspects of Investigation of River Flow Variation XVIII Conference of The Danube Countries on Hydrological Forecasting and Hydrological Bases o Water Management, Graz (Austria), p. B-19 - B-24.
36. ? ?????? ???, ? ., 1997. "B?????? ?? ????? ??????? ?? ?????????? ??????????? ????? ?????? ????? ?? ????????", BJM&H
37. Ibrayev R., D. Trukhchev, Model study of the seasonal variability of the Black Sea circulation, NATO ASI Series, Series 2: Environment, Kluver Academic Publishers, (in print).
38. Iotova, A. (1995): An attempt to assess the energy related climate variability - Proceedings International Conference on Past, Present and Future Climate, 22-25 August 1995, Helsinki Finland, pp. 288-290
39. Iotova, A. (1995): Bulgarian Case Study in the DECADES Inter-Agency Project: Environmenta aspects analysis of electricity generation options in Bulgaria - Proceedings of the Internationa Symposium on Electricity, Health and the Environment, 16-19 Oct. 1996, International Atomic Energy Agency, Vienna, Austria, pp. 636 -646
40. Iotova, A. (1995): Sustainable Energy Development - Proceedings of the Sustainable Developmen Workshop organised by the Environmental Sciences and Policy Department, Central European University, 17 - 19 August 1995, Budapest, Hungary
41. Ivanov P. Possibilities for Utilization of the Sun Radiation and the Wind as an Renewable Energy Sources in Bulgaria. International Seminar "Energy Strategies and Information - European NGO Seminar 1994", Energie und Umweltzentrum am Deister e.V., 4-8 July, 1994, Germany.
42. Ivanov P. The Wind Energy Potential on the Bulgarian Territory. International Task Force on Renewable Energy Sources, Sofia 12-14 Oct. 1994
43. Ivanov P. Computerized Technology System for Determination of Wind Energy Potential in Bulgaria. Energy Forum'94, Varna, 1994 (in Bulgarian).
44. Ivanov P. Renewable Energy Sources in Bulgaria. J. Energy of the Next Century, vol.3, Kiev, 1996 (in Russian).
45. Ivanov P., L. Trifonova. Economically Accessible Renewable Energy Resources in Bulgaria. Energy

Forum'96", 12-14 of July 1996, Varna, 1996 (in Bulgarian).
46. Ivanov P., L.Trifonova, St.Lingova. Possibilities for Utilization of renewable Energy Sources in Bulgaria. The First International Exhibition: "Environment and Sustainable Development of Bulgaria", 7-17 November, Sofia, 1996 (in Bulgarian).
47. Ivanov P., L.Trifonova. Determination of the Availability of Renewable Energy Resources to Specific Technologies, XV Kongres der Internationalen Konferenz fur Industialle Energiewirtschaft, Leibzig, 23-25 September 1996
48. Ivanov P., L.Trifonova. Renewable Energy Potential and Sustainable Development of Bulgaria. The European Congress on Renewable Energy Implementation. Athens, Greece. 5-7 May 1997. (in print)
49. Ivanov P., L.Trifonova. Energy from Biomass an Alternative for Utilization of Wastes in Bulgaria. J. Chemistry and Industry, Vol. LXVII, No 1-3/1997
50. Ivanov P., L.Trifonova. Renewable Energy Potential in Bulgaria (resources and technology implementations). Universite d'ete "Energies Ecologiques". Sofia - Sozopol en Bulgarie, 25 Mai - 02 June 1997. (in print).
51. Ivanov P., L.Trifonova. Reply to comments on the paper "An Investigation of Renewable Resource and renewable Technology Applications in Bulgaria" by L.Latinov. J.Environmental Management. Springer (EP#1843b).
52. Ivanov P., L.Trifonova. Total, Accessible and Reserve Wind Energy Resources in Bulgaria. J. Energy, vol. 3-4, 1996 (in Bulgarian).
53. Ivanov P., St. Lingova, L. Trifonova. Renewable Energy Resources in Bulgaria. International Conference " Energy Forum'96", 12-14 of July 1996, Varna, 1996 (in Bulgarian).
54. Ivanov P., St. Lingova. Energy Potential of the Complex "Solar Radiation and Wind" in Bulgaria. The First National Conference on Renewable Energy, Sofia, 10-11 October 1994 (in Bulgarian).
55. Ivanov P., St.Lingova, L.Latinov, L.Trifonova. Assessment of the Renewable Energy Sources. In monograph: "Investigation for Bulgaria Faced on Global Problem of Climate Change. Publ. house of ENERGOPROECT , Sofia, 146 pp.,1996 (in Bulgarian).
56. Ivanov P., St.Lingova, L.Trifonova, D.Renne, J.Oxi. An Investigation of Renewable Resources and Renewable Technology Applications in Bulgaria. J. Environmental Management, Vol.20, Supplement 1, Springer.1996. pp.S83-S93.
57. Ivanov P., St.Lingova, L.Trifonova. Renewable energy in Bulgaria an Alternative for GHG Mitigation. Workshop on Methods to Assess Mitigation Options for Countries with Economies in Transition. Warsaw, June 13 to 16 1995
58. Koleva Ek. (1995) Drought in the Lower Danube Basin. Drought Network News. Vol. 7, No 1 Feb., Nebraska, USA, 6-7.
59. Koleva Ek., L. Krastev, E. Peneva, E. Stanev (1997) Verification of high resolution climatic simulations for the area of Bulgaria. Part I:The state of the climate for the period 1961-1990 Bulg. Journal Meteor. And Hydrol.
60. Koleva Ek., L. Kristev, C. Boroneant (1996) Drought Tendencies in the Lower Danube Basin. Proceeding of XVIIIth Conference of the Danube Countries, August, Graz, Austria
61. Krastev L., Ek.Koleva (1996) Regionalization of the Monthly Temperature and Precipitation field of Bulgaria. In proceeding: Environmental Statistics and Earth Science, 20-24 August, Brno, Czech Republic
62. lexandrov, V., 1997a. Vulnerability of Agronomic Systems in Bulgaria. Climatic Change, Vol. 36, Kluwer Acad. Publ., Printed in the Netherlands, pp. 135-149.
63. ??????? ?., A. ????????, ?????????????????? ??????? ????????????? ????? ??????????, ????????? ? ??????? ? ? ????? ????, ? ??. ? ?, ? ? ?, ? ., 1995, 31, 6, 809-819.
64. ??????? ?., ? . ?????, ?. ??????????, ?????????? ???????????? ??????? ??????? ???? ? ?????????????? ?????? ??????????????? ?????????? , ? ??. ????????. ??????, ???????????, 1993, 5, 51-64.
65. ???????? ?., ? . ???????, ? . ???????, ? . ???????, ???????? ??????????? ????? ?????????? ??? ?????????????? ???????? ??????????? ????, ? ??????????? ? ??????????, ? ., 1997, 1, 91-99.
66. Ostrozlik M., M.Murinova, Ek.Koleva, (1995) Long-term Variations of Air Temperature as a Characteristic of Climatic Fluctuation, Contributions of the Geofisical Institute of the Slovak Academy of Sciences, Bratislava, 62-73.
67. Peneva E., E. Stanev, Ek. Koleva, L. Krasteb (1997) Verification of high resolution climatic simulations for the area of Bulgaria. Part II: Intercomperison between UKMO, HIRHAM and ARPEGE simulations and klimatic data for the period of 1960-1990. Bulg. Journal Meteor. And

Hydrol
68. Raev, I., U. Asan and O. Grozev. Accumulation of CO2 in the above-ground biomass of the forests in Turkey and Bulgaria in the recent decades. Special report, Volume 1. *Proceedings of the XI World Forestry Congress*, 13-22 October 1997, Antalya, Turkey.
69. Raev, I., N. Slavov, O. Grozev, V. Alexandrov, Z. Vasilev, B. Rosnev and A. Delkov, 1996 Assessment of Forest Potential for Absorbing Greenhouse Gases. Vulnerability and Adaptation Assessments of Forest and Agricultural Vegetation in Bulgaria under Climate Change. Mitigation of the Influence of Climate Change in the Non-energetic Sector. Bulgarian Country Study to Address Climate Change Inventory of the Greenhouse Gases Emission Sources and Sinks Alternative Energy Balance and Technical Programs, Sofia, pp. 22-40 (In Bulgarian).
70. Raev, I., O. Grozev and V. Alexandrov, 1995. The Problem of Expected Climate Change, Soil Conservation and Afforestation. Proceedings of the National Conference on Soil Conservation Sofia, pp. 84-93. (In Bulgarian).
71. Raev, I., O. Grozev and V. Alexandrov, 1997.Land Use /Land Cover/. Bioproductivity and Global Change. Bulgaria -USA: Global Change in Bulgaria, CIRA, Pennsylvania State University,. 17 - 19 June, Blagoevgrad,pp.35.
72. ???? ?., ? ?. ?????? ? ??? ?????? ?? ? ? 2 ? ?????? ???? ???? ?? ??????????? ???? ???? ??????? 1955-1993, 1996. ? ???? ????????? ?????? ???? ??????? ?? ?????????, ???????? ? ????????? ?? ???????? ???????, (3-5 ? ??, '96,? ?? ??), ? ?? I, PSSA, ? ?? ??, 268-278.
73. ????, ? ., ? .?????? ? ? . ? ??????????, 1995. ? ?????? ?? ?? ????? ??? ???? ?????? ???? ??? ? ?????????????????? ??????????? ? ????????. ? ????? ???? ??????? ? ? ?? ????????? ??????? " 90 ?????? ????? ? ???????? ?? ??????? ? ????????", 16 - 20 ????? ??? 1995, ? ?? ??, 84 - 93.
74. Raev, I., A. Alexandrov, O. Grozev, R. Petrov, D. Bardarov, R. Miltchev, P. Ivanov, N. Slavov, E Ivanova, N. Rousev, D. Slavov, N. Houmbadjieva, V. Alexandsrov, P. Ivanov, L. Trifonova and R. Ilieva, 1997. Action Plans at Sectoral Level. Element 2. Stage A. ENERGOPROEKT, Sofia, December 1997.
75. Sharov, V., E. Koleva and V. Alexandrov, 1997. Climate Variability and Change. Global Change in Bulgaria, Pennsylvania, USA (In Press).
76. Sharov, V., P. Ivanov and V. Alexandrov, 1994. Meteorological and Agrometeorological Aspects of Drought in Bulgaria. Romanian Journal of HYDROLOGY & WATER RESOURCES, Vol. 1, No. 2, pp. 163-172.
77. Slavov, N. and V. Alexandrov, 1993. Drought in Bulgaria: 1993 Update & Historical Perspective Drought Network News, International Drought Information Center, USA, Vol. 5, No. 2, pp. 12-15.
78. Slavov, N. and V. Alexandrov, 1996. Influence of Expected Climate Change on Agroclimatic Resources in Bulgaria. Plant Sciences, Vol.XXXIII, No. 9, pp. 72-77 (In Bulgarian).
79. Slavov, N. and V. Alexandrov, 1997. Influence of Global Climate Change on Agroclimatic Resources in Bulgaria. Comptes Rendus, de l'Academie Bulgare des Sciences, Vol. 50, No. 2., pp 31-34.
80. Trukhchev D., A. Kosarev, D. Ivanova, V. Tuzhilkin, Numerical analysis of the general circulation in the Caspian Sea., Comptes rendus de l'Academie bulgare des sciences, Sofia, 1995, 48, 11-12, 35-38.
81. Trukhchev D., A. Kosarev, V. Tuzhilkin, Specific features of the Black Sea seasonal climatic circulation: Part I. Variability of the upper layer circulation., Comptes rendus de l'Academie bulgare des sciences, Sofia, 1995, 48, 8, 21-24.
82. Trukhchev D., D. Ivanova, Numerical study of the climatic general circulation of the Mediterranean Sea (in January), Comptes rendus de l'Academie bulgare des sciences, Sofia, 1995, 48, 7, 43-46.
83. Trukhchev D., I. Oliounine, Report on monitoring and data base managament, Intergovernmental Oceanographic Commisison workshop report on the Black Sea, Varna, Bulgaria, September 30-October 4, 1991, IOC UNESCO, 1993.
84. Trukhchev D., R. Ibrayev, Seasonal variability of the Black Sea climatic circulation, in: E. Ozsoy and A. Mikaelyan (eds.), Sensitivity to change: Black Sea, Baltic Sea and North Sea, NATO-ASI Ser., 2. Environment -Vol. 27, Kluwer Acad. Publ., 1997, pp. 365-374.

Trukhchev D., V. Tuzhilkin, A. Kosarev, Specific features of The Black Sea seasonal climatic circulation. Part II. Deep sea circulation and evolution of the cold intermediate layer., Comptes rendus de l'Academie bulgare des sciences, Sofia, 1995, 48, 9-10, 35-38.

1. Christov Chr., S. Todorova, Chr. Vassilev, K. Simeonova. Assessment of Options to Mitigate the Greenhouse Gas Emissions from Energy Demand, Energy Forum'96, Varna, 12-14 June, 1996, pp

220-224.
2. Vassilev Chr., Christov, Chr., K. Simeonova, Vl. Krastev- Energy demand and Supply Scenarious to mitigate the greenhouse Gas Emissions for the Energy Sector. Energy Forum'96, Varna, 12-14 June, 1996, pp 27-32.
3. Ch. Christov, Ch. Vassilev, K. Simeonova, S. Todorova Comparative Assessment of options to Mitigate the Greenhouse Gas Emissions in Energy Demand and Supply. . Energy Forum'96, Varna, 14-14 June, 1996, pp 254-257.
4. Simeonova K., Ch. Christov, Ch. Vassilev, S. Todorova. Strategy for Energy System Development to Mitigate the Greenhouse Gas Emeissions in both Energy Demand and Supply. Energy Forum'96 Varna, 14-14 June, 1996, pp 220-224.
5. Christov Ch., Ch. Vassilev, K. Simeonova, S. Todorova, V. Krastev- Assessment of the Mitigation Options in the Energy System in Bulgaria. Proceedings of International Workshop on Greenhouse Gas Mitigation Technologies and Measures. 12-15 November 1996, Beijing, China.
6. ? ?. ? ??????, ? ?. ? ??????, ? . ? ?????????- ? ??????????? ?? ???????? ? ?????????? ??????? ?? ???????. ???????? ? ???? '97, ? ????, 11-13 ? ?? 1997 ?. ???. 115-118.
7. ? ???????? ? . ? ?. ? ??????, ? ?. ? ??????, ? . ? ???????- ? ????????????? ?? ???????? ?? ????????? ?????? ? ???????? ? ?????? ?? ?????? ??????? ?? ????????????? ?? ? ????????. ? ?????? ??????? ?? ? ?????????? ?? ?????????? ??????? ? ????????, 17-19 ? ?? 1997 ???????????.
8. Simeonova, Christov Chr., Vassilev Chr. and others.- Mitigation Analysis for Bulgaria, Global Climate Change Mitigation Assessment: Results fror 14 Transitioning and Developing Countries, August,1997
9. Katia Simeonova, Christo Christov, Christo Vassilev, Plamen Tzvetanov,Peter Ivanov- Bulgarian Climate Change Action Plan and Projects to Promote Clean Energy. Proceedings of Clean Energy Symposium, 23-26 September 1997, Szentendre, Hungary (in press).
10. Katia Simeonova, Christo Christov, Christo Vassilev, Plamen Tzvetanov,Peter Ivanov- Bulgarian Climate Change Action Plan and Projects to Promote Clean Energy., Proceedings of International Seminar Energy Strategies and Market Behaviour, 5-8 October 1997, Varna, Bulgaria.
11. ? ?????? ? ?.- ? ?????????? ?????? ?? ? ????????? ?? ?????????????? ?? ????????? ?????? - IPCC ? CORINAIR, ? ??????? ? ???? '98, ? ????, 10-12 ? ??,1998
12. Chr. Christov, Hr. Vassilev, S. Todorova- Greenhouse gase emissions in Bulgaria for 1990-1995, ? ??????? ? ???? '98, ? ????, 10-12 ? ??,1998

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CHAPTER 9

EDUCATION AND PUBLIC AWARENESS

The global warming is one of the most serious environmental concerns in the history of mankind. Bulgarian society gradually starts to get aware of the consequences of the global climate change. Better environmental education and public awareness are primary objectives of the corresponding responsible institution. Public interest and support can turn crucial for the application of the long-term governmental strategy and climate change policy. The measures to be implemented require co-ordinated joint actions by the governmental organisations and NGOs.

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The serious economic and political changes in Bulgaria provide a good opportunity to reassess and structurally adjust all sectors and fields of the economy and lifestyle. The above statement refers also to the education where some changes are required in order the environmental awareness to become an inherent part of the consciousness of the population.

The Bulgaria Ministry of Education and Sciences (MES) has the task to ensure the development of a legislative basis for the promotion of environmental education. Moreover, it has to do with the country application to join the European Union which takes account for the environmental policy carried out in the countries. Environmental protection should be integrated in the planning procedures at national and sectoral level, thus involving new principles in the educational policy.

The environmental education in Bulgaria follows the experience of the countries with traditions in the field. It is already included through the curriculum in the main subjects areas in school and kindergarten. The content of the lectures in the different forms of class and non-class activities includes environmental issues. The objective of this kind of education is to create wider perception of the environment, pollution and the options for environmental protection and sustainable development.

The main subjects that cover the environmental issues, also include the anthropogenic contribution to the environmental disasters and climate change. Thus in chemistry lessons pupils /6-12 grades/ get aware of:

- air, water and soil pollutants (H, C, N, P compounds);
- biological and physiological functions of hydrogen and oxygen - acid rain, greenhouse gases, ozone depletion, and the impacts of these global environmental problems on the living organisms;
- natural cycles;
- chemical and technological processes;
- energy processes;
- environmentally friendly lifestyles;
- laboratory work - soil analysis; acidity; water purification; pollution standards.

In 1996 the Ministry of Education and Science approved and assisted the distribution of the environmental education bulletins focusing on different science disciplines taught at schools. This came true with the support of the Environmental Education and Technologies Association sponsored by PHARE. The objective of the bulletins was the environmental knowledge to be provided in amusing way /e.g. games in the classrooms or the so called "green schools"/.

In 1997, a program entitled "Environmental education in the secondary school" was developed and approved in the Ministry of Education and Science. It aimed to encompass the elements of the environmental education allocated in different school subjects in one general (interdisciplinary) subject on the ground of the existing structure and resources. There are special programs developed for the pre-school and primary school levels concerning teaching programs in geography, chemistry, physics, as well as for non-class and non-school activities.

With regard to the importance of the environmental education issue and the necessity for the assessment and examining of the environmental awareness of the pupils, the Ministry developed a project for set national requirements on the environmental education in the natural sciences field.

In October 1997 a National Environmental Program was adopted by Ministry of Education and Science. It aims to upgrade the environmental knowledge and requires interdisciplinary approach in the subjects (particularly biology, physics, chemistry, geography), optional courses in environmental education, special lessons on environmental issues, activities outside class and school area.

The program has a modular structure (I. non-living nature; II. living nature; III. Interactions between living and non-living nature; IV. mankind and environment; V. interactions between man and environment; VI. global environmental issues; VII. sustainable development). The modules are differently addressed at different school levels and subjects. Various forms of teaching are recommended (discussions, exhibitions, walks, competitions, monitoring, expeditions, etc.). The climate change is not sufficiently addressed but, however, it is included in the sixth module at high grades.

The program still has only optional character. For its wide application a good awareness campaign in the municipalities is required, staff qualification and training, preparation of educational materials.

At the beginning of April 1998, a seminar was organised by the MES in cooperation with the National Educational Institute and the European Council entitled "Environmental requirements of school contents". The seminar was a stage of the activities within the frame of the European project "Secondary Education in Europe" of the Council for Cultural Cooperation to the EC.

Till 1996 in the higher education there were no state requirements for the professional qualification "ecologist". The Ministry of Education and Science has prepared a regulation for the uniform state requirements in the field *environment and environmental protection*, adopted by a Governmental Decree No. 241. The higher education (Bachelor and Master degree) in the field can be obtained in the country's Universities. The education follows programs including obligatory and optional subjects. Environmental protection is included as a subject in all technical universities in Bulgaria. A common form of environmental awareness of the grown-ups is the participation of the students in students' environmental NGOs.

Along with the environmental education a sound public awareness campaign outside schools has to be performed. It has to be in compliance with the Bulgarian situation and to address particularly the win-win options, or the so-called good housekeeping practices. The options for informal education in the field of environmental protection include use of mass media - newspapers, TV programs, booklets; use specialised conferences to put accent on the issue (e.g. lamp producers conferences to promote energy saving bulbs); conferences, workshops for the public; continuous information to the journalists; work with NGOs; work with communities; pilot projects and dissemination of their results; practical advises supplemented with economical information, etc. Some of these options are already used in Bulgaria to make the population aware of the global warming phenomena and consequences.

Bulgaria Country Study to address climate change prepared data to be reported to the society. The study results were disseminated through seminars, conferences organised for experts in the governmental administration and scientists. A survey on the findings was published and submitted to governmental organisations, NGOs, libraries, Universities and Research Institutes. Some results were published in the periodical scientific editions and reported at national and international happenings and conferences.

A series of seminars were organised for the experts in the governmental administration, industry and in the scientific field. The goals of these seminars were to identify the core of the problem, the possibilities for its technical solution, to discuss the required investments for emission reduction, as well as the measures for the national economy and environment to adapt to the climate change.

Articles on climate change issue are published in the periodic scientific editions and are reported at national and international scientific conferences and workshops. Some papers are published in the magazines and newspapers. Translations of books on global change were issued (e.g. Policies and Measures for Climate Change Mitigation: compilation of executive summaries from studies on policies and measures for possible common action, 1997; Global Warming: The Complete Briefing by John Houghton, 1996) and books by Bulgarian authors concerning environmental problems were also published (e.g. Eco-Cathastrophies by Garo Mardirosian, 1995) in the last few years.

Along the factors to increase energy efficiency are: delivering specialist energy training to meet identified needs; raising the motivation and awareness of all staff; implementing publicity and advertising campaigns; maintaining momentum by integrating energy efficiency into company culture and procedures.

The human factor is quite important. It is crucial for no cost measures which put emphasis on the awareness, motivation and empowerment of people using existing equipment. Energy training has a significant relationship to all the other key aspects of energy management. Such training activities are already undertaken in Bulgaria. Thus within the framework of THERMIE program there was a project for Preparation of local training material for Central and Eastern Europe (THERMIE Code RUE56), Training courses in energy management (THERMIE Codes RUE31 and RUE45). The Energy Efficiency Centre EnEffect conducts training of the managers and experts. The two main focuses of the training are: study of energy efficiency as a process and financial barriers for implementation of energy efficiency projects (and in particular how to overcome them). The same NGO works to create local educational materials via issuing of adapted programs and textbooks, coining of new programs and materials in the field of energy efficient planning, investment and design. Thus in the design field Building Design Guidelines have been prepared for architects. Within the frame of INNOBUILD projects an international competition "Live in cities" was performed for students. Posters, guidelines and other materials were created.

A very important point is the establishment of energy efficiency centres to disseminated information, knowledge, consulting services to the industry and households. The Municipal Initiative for Energy Efficiency is established within the frame of the project Strategy for GHG Mitigation Through Energy Efficiency. The demonstration projects undertaken are a good initiative to prove the benefits from the energy efficiency. The strategy also included creation of database, articles on energy efficiency, bulletin of the Municipal network for energy efficiency.

ANNEX A

1995

STANDARD DATA TABLE 1

Energy: 1A Fuel Combustion Activities (Sheet 1) - Reference Approach

Fuel			Production t	Imports t	Exports t	Intern. bunkers t	Stock change t	Apparent cons. t	Conversion factor GJ/t	Apparent cons. TJ	Carbon EF t C/TJ	Carbon content t C	Carbon content Gg C	Carbon Stored* Gg C	Net C emissions Gg C	Fraction carbon oxidised	Actual C emissions Gg C	Actual CO_2 emissions Gg CO_2
Liquid Fossil	**Primary Fuels**	**Crude oil**	42873	7972845	0	0	23288	7992430	42.54	339982	20	6799640	6799.64		6799.64	0.99	6731.64	24682.69
		Natural Gas																
	Secondary Fuels	**Motor gasoline**		10724	335805		-4377	-320704	43.96	-14098	18.9	-266452.2	-266.45	4.25	-270.70	0.99	-268.00	-982.66
		Avia Gasoline		1835	0		-54	1889	43.94	83	18.9	1568.7	1.57	0.01	1.56	0.99	1.54	5.66
		Jet Kerosene												0.00				
		Other Kerosene		142648	40779		3444	98425	43.12	4244	19.6	83182.4	83.18	0.18	83.01	0.99	82.18	301.31
		Diesel Oil		98895	1384085	63025	11580	-1359795	41.87	-56932	20.2	-1150026	-1150.03	0.34	-1150.37	0.99	-1138.87	-4175.84
		Residual Fuel		289727	213576	212157	24735	-160741	39.80	-6397	21.1	-134976.7	-134.98	0.00	-134.98	0.99	-133.63	-489.97
		LPG	0	782	15013	0	-373	-13858	52.24	-724	17.2	-12452.8	-12.45	0.00	-12.45	0.99	-12.33	-45.20
		Ethane												0.00				
		Naphta	0	63	0	0	-10716	10779	41.84	451	20.2	9110.2	9.11	0.00	9.11	0.99	9.02	33.07
		Bitumen												0.00				
		Lubricants	0	19898	40046	4622	-3717	-21053	40.19	-846.12	10	-8461.201	-8.46	25.54	-34.00	0.99	-33.66	-123.43
		Petroleum Coke												0.00				
		Rafinery Feedst.												0.00				
		Other Oil												0.00				
Liquid Fossil Total			42873							265763				0.00				19205.63
Solid Fossil	**Primary Fuels**	**Anthracite**	24471	401323	0	0	-21770	447564	23.95	10719	26.8	287269.2	287.27	0.00	287.27	0.98	281.52	1032.25
		Black Coal	169801	3051245	0	0	226504.0	2994542	25.80	83975	25.8	2166555	2166.56	59.23	2107.33	0.98	2065.18	7572.33
		Brown Coal	3186699	0	0	0	-7167	3193866	11.54	36846	26.2	965365.2	965.37	0.00	965.37	0.98	946.06	3468.88
		Lignite	27448896	0	0	0	-230224	27679120	6.58	182216	30.7	5594031.2	5594.03	0.00	5594.03	0.98	5482.15	20101.22
		Peat												0.00				
	Secondary Fuels	**BKB**	0	0	0	0	-480	480	18.75	9	25.8	232.2	0.23	0.00	0.23	0.98	0.23	0.83
		Coke	0	111549	3060	0	23842	84647	30.15	2552	29.5	75284	75.28	0.00	75.28	0.98	73.78	270.52
Solid Fossil Totals										316317				0.00				32446.04
Gaseous Fossil		**Natural Gas** $10^3 m^3$	49849	5747741	0		22507	5775083	33.24	191941	15.3	2936697.3	2936.70	347.43	2589.26	0.995	2576.32	9446.50
Total			92722	5747741	0	0				774021				0.00				**61098.17**
Biomass Total			1853578		81496	0	-17920	1790002	4.42	7919	29.9	236778.1	236.78	0.00	236.78	0.9	213.10	781.37

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STANDARD DATA TABLE 1

Energy: 1A Fuel Combustion Activities (Sheet 2) - Detailed Technology Based Calculation

SOURCE AND SINK CATEGORIES	ACTIVITY	EMISSIONS ESTIMATES								AGGREGATE EMISSION FACTORS			
Sector Specific Data by fuel	A Consumption (PJ)	B Quantities Emitted (Gg of Full Mass of Pollutant)						C Emission Factor (t Pollutant/TJ) C=B/A					
		CO_2	CH_4	N_2O	NO_x	CO	NMVOC	CO_2	CH_4	N_2O	NO_x	CO	NMVOC
1A Fuel Combustion Activities	701.12	56224.9	5.25	9.73	137.48	722.24	50.31	80.19	0.01	0.01	0.20	1.03	0.07
Natural Gas	163.49	9126.1	0.33	0.29	10.46	3.19	0.23	55.82	0.00	0.00	0.06	0.02	0.00
LPG	3.68	229.74	0.00	0.00	0.18	0.04	0.00	62.40	0.00	0.00	0.05	0.01	0.00
Gas Oil	3.07	221.19	0.01	0.01	0.43	0.05	0.00	72.06	0.00	0.00	0.14	0.01	0.00
Residual Fuel Oil	82.02	6093.11	0.17	1.24	12.25	1.24	0.10	74.29	0.00	0.02	0.15	0.02	0.00
Anthracite	10.78	1192.48	0.13	0.16	4.24	0.52	0.13	110.59	0.01	0.01	0.39	0.05	0.01
Black Coal	35.44	3925.96	0.44	0.63	15.39	1.40	0.44	110.78	0.01	0.02	0.43	0.04	0.01
Brown Coal	34.89	3272.11	0.18	0.65	6.51	20.45	0.17	93.78	0.01	0.02	0.19	0.59	0.00
Lignite	161.92	17850.47	0.57	6.47	24.68	7.06	0.57	110.24	0.00	0.04	0.15	0.04	0.00
Coke	27.39	2903.21	0.00	0.00	0.00	0.00	0.00	106.00	0.00	0.00	0.00	0.00	0.00
Diesel Oil	43.69	3215.98	0.23	0.08	33.78	17.16	5.81	73.61	0.01	0.00	0.77	0.39	0.13
BKB	19.27	1930.53	0.03	0.11	3.62	62.65	0.03	100.17	0.00	0.01	0.19	3.25	0.00
Motor gasoline	48.05	3414.75	1.79	0.05	16.12	309.96	42.53	71.07	0.04	0.00	0.34	6.45	0.89
Avia Gasoline	0.09	6.05	0.01	0.00	0.01	1.97	0.05	70.80	0.06	0.00	0.07	23.08	0.54
Jet Kerosene	13.91	982.19	0.03	0.00	3.93	1.62	0.24	70.63	0.00	0.00	0.28	0.12	0.02
Biomass Burning	15.73	0.00	1.16	0.00	3.15	291.43	0.00	0.00	0.07	0.00	0.20	18.52	0.00
Wood	7.88	0.00	0.12	0.03	0.82	3.01	0.00	0.00	0.02	0.00	0.10	0.38	0.00
Kerosene	0.01	0.56	0.00	0.00	0.00	0.00	0.00	70.66	0.00	0.00	0.28	0.12	0.01
Dry Gas	8.25	514.55	0.01	0.00	0.46	0.12	0.00	62.40	0.00	0.00	0.06	0.01	0.00
Coke Gas	9.38	585.37	0.01	0.00	0.63	0.16	0.00	62.40	0.00	0.00	0.07	0.02	0.00
Blast Gas	12.19	760.53	0.02	0.00	0.82	0.21	0.00	62.40	0.00	0.00	0.07	0.02	0.00

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STANDARD DATA TABLE 1

ENERGY: 1B1 Fugitive Emissions from Fuels (Coal Mining)

SOURCE AND SINK CATEGORIES	ACTIVITY DATA Production (Mt)	METHANE EMISSIONS (Gg)	EMISSION FACTOR m^3/t
1B1 Solid Fuels	30.83	69.79	
1B1a Coal Mining	30.83	69.79	
1B1ai Underground Mines	3.38	44.98	
Underground activities		39.36	17.50
Post-mining activities		5.62	2.50
1B1aii Surface Mines	27.45	24.81	
Surface Activities		22.90	1.20
Post-mining activities		1.91	0.10
B1b Solid Fuel Transformation	0.00	0.00	
B1c Other	0.00	0.00	

1995

STANDARD DATA TABLE 1

ENERGY: 1B2 Fugitive Emissions from Fuels (Oil and Natural Gas)

SOURCE AND SINK CATEGORIES		ACTIVITY DATA	EMISSIONS ESTIMATES			AGGREGATE EMISSION FACTORS		
		Fuel Quantity (PJ)	CH_4 (Gg)	CO_2 (Gg)	NMVOC (Gg)	CH_4 (kg/GJ)	CO_2 (kg/GJ)	NMVOC (kg/GJ)
1B2 a Oil			0.1					
i Exploration								
ii Production of Crude Oil		1.82	0.00			0.00265		
iii Transport of Crude Oil	(Qnty. loaded on tankers)	33.91	0.03			0.00075		
iv Refining/Storage	(Qnty.refined)	33.82	0.03			0.00075		
v Distbn of Oil Products	(Qnty.consumed)	0.00	0.00					
vi Other		0.00	0.00					
1B2 b Natural Gas			194.81					
i Production/Processing	(Qnty.prodused)	1.66	0.38			0.22700		
ii Transmission/Distribution	(Qnty.prodused)	191.00	140.96			0.73800		
iii Other Leakage	(Qnty.prodused)	191.00	53.48			0.28000		
1B2 c Venting and Flaring			0.00					
i Oil	(Qnty.prodused)	0						
ii Natural Gas	(Qnty.prodused)	0						
iii Combined	(Qnty.prodused)	0						
1B2			194.87					

1995

STANDARD DATA TABLE 2

Industrial Processes

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES						AGGREGATE EMISSION FACTORS					
	A Production Quantity (kt)	B Full Mass of Pollutant Gg						C Ton of pollutant per ton of Product (t/t)					
		CO	CO_2	CH_4	N_2O	NOx	NMVOC	CO	CO_2	CH_4	N_2O	NOx	NMVOC
A Iron and Steel	8069		2236	3.318					0.277	0.000	0.000	0.000	0.000
B Non-Ferrous Metals													
Aluminium Production													
Other													
C Inorganic Chemicals													
Nitric Acid	1033				8.26				0.000	0.000	0.008	0.000	0.000
Fertiliser Production													
Other (Ammonia)	1203		1037						0.862	0.000	0.000	0.000	0.000
D Organic Chemicals													
Adipic Acid													
Other (Methanol)	18			0.04					0.000	0.002	0.000	0.000	0.000
E Non-Metallic Mineral Products													
Cement	2070		1032						0.499	0.000	0.000	0.000	0.000
Lime	952		747						0.785	0.000	0.000	0.000	0.000
Other (Glass+Soda ash)	1270		549						0.432	0.000	0.000	0.000	0.000
F Other(SIC)													

1995

STANDARD DATA TABLE 3

Solvent and Other Product Use

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES				AGGREGATE EMISSION FACTORS			
	A Quantity Consumed (kt)	B Full Mass of Pollutant (Gg)				C Ton of Pollutant per ton of Product (t/t)			
		CO_2	N_2O	HFC	NMVOC	CO_2	N_2O	HFC	NMVOC
A Paint Application	26.95				10.97				0.407
B Degreasing and Dry Cleaning					0.00				
C Chemical Products Manufacture/ Processing					0.00				
D Other (vegetable oil)	190.42				3.43				0.018
E Residential Use of Solvents	8.38				8.38				1

1995

STANDARD DATA TABLE 4

AGRICULTURE: 4A & B Enteric Fermentation & Manure Management

SOURCE AND SINK CATEGORIES	ACTIVITY DATA	EMISSION ESTIMATES		AGGREGATE EMISSION FACTOR	
	A	B		C	
	Number of Animals	Enteric Fermentation	Manure Management	Enteric Fermentation	Manure Management
	(1000)	(Gg CH_4)	(Gg CH_4)	(kg CH_4/animal)	
1 Cattle	635	44.55	10.68	70.15	16.82
b Dairy	360	29.12	7.39	81.00	20.56
c Other	276	15.43	3.29	56.00	11.95
2 Buffalo	14	0.75	0.12	55.00	9.00
3 Sheep	3391	27.12	0.95	8.00	0.28
4 Goats	814	4.07	0.15	5.00	0.18
5 Camels and Llamas	0	0.00	0.00	0.00	0.00
6 Horses	142	2.55	0.29	18.00	2.08
7 Mules/Asses	295	2.95	0.34	10.00	1.14
8 Swine	2063	3.09	22.82	1.50	11.06
9 Poultry	18868	0.00	2.21	0.00	0.12
10 Other					

1995

STANDARD DATA TABLE 4

AGRICULTURE: 4C Rice Cultivation- Flooded Rice Fields

SOURCE AND SINK CATEGORIES	ACTIVITY DATA		EMISSION ESTIMATES	AGGREGATE EMISSION FACTOR
	A	B	C	D
	Area Cultivated in Megahectares (Mha)	Megahectare-Days of Cultivation (Mha-days)	Methane (Gg CH4)	CH4 Average Emission Factor (kg CH4 per ha-day)
				D= C/B
1 Continuously Flooded	0.0014	0.1421	0.5885	4.1400
2 Intermittently Flooded	0			
3 Other	0			

1995

STANDARD DATA TABLE 4

Agriculture: 4D Agricultural Soils

SOURCE AND SINK CATEGORIES	ACTIVITY DATA			EMISSION ESTIMATES			REMOVAL ESTIMATES	AGGREGATE EMISSION FACTORS		
	A Amount Nitrogen Applied in Fertiliser and Manure (t N)	B Area Cultivated (ha)	C Amount of Biological Fixation of Nitrogen (t N)	Emissions of N_2O,CO_2,CH_4 (Gg)			G Removals of CO_2 (Gg CO_2)	H (t N_2O/t N)	(tCO_2/ha)	(tCH_4/ha)
				D	E	F		1000 D/A	1000 E/B	1000 F/B
				N_2O	CO_2	CH_4		N_2O	CO_2	CH_4
List by type of crop										
ALL CROPS	159930	4693000	0	2.51	0	0	0	0.01571		

1995

STANDARD DATA TABLE 4

Agriculture: 4F Field Burning of Agricultural Residues

SOURCE CATEGORIES	ACTIVITY DATA		EMISSION ESTIMATES					AGGREGATE EMISSION FACTORS				
Crop Type	A Annual Burning of Crop Residues (Gg dm)	B Carbon Fraction (t/t dm)	C Full Mass of Pollutant (Gg)					D Pollutant per tonne of Dry Matter (kg/t dm) D=(C/A) *1000				
			CH_4	N_2O	NOx	CO	CO_2	CH_4	N_2O	NOx	CO	CO_2
1 Cereals	530.72	0.48	1.70	0.03	1.12	35.66		3.20	0.06	2.10	67.19	0.00
2 Pulse	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
3 Tuber and Root	15.60	0.42	0.04	0.00	0.00	0.91		2.78	0.00	0.00	58.46	0.00
4 Sugar Cane												
5 Other												

1995

STANDARD DATA TABLE 5

Land Use Change and Forestry: 5A (Sheet 1)
Changes in Forest and Other Woody Biomass Stocks -

Annual Growth Increment

SOURCE AND SINK CATEGORIES Sector Specific Data (units) Land Type			ACTIVITY DATA A Area of Forest/ Biomass Stocks kha	UPTAKE ESTIMATES B Total Carbon Uptake Increment (Gg C)	AGGREGATE UPTAKE FACTOR C Carbon Uptake Factor (t C/ha) C=B/A
Tropical Forests	Plantations				
	(specify type)				
	Other Managed	Moist			
	Forests	Seasonal			
		Dry (or Woody			
		Savannas)			
	Other				
Temperate Forests	Plantations	Mixed (w)			
	(specify type)				
	Commercial	Evergreen	1177	1244	1.06
		Deciduous	2180	2117	0.97
	Other Woodlands				
Boreal Forests					
Other Ecosystem Types					
Non-Forest Trees(specify type)			Number of Trees (1000)	Annual Carbon Uptake (Gg C)	Carbon Uptake Factor (tC/tree) C=B/A

1995

STANDARD DATA TABLE 5

Land Use Change & Forestry : 5A (Sheet 2)
Changes in Forest and Other Woody Biomass Stocks -

Annual Harvest

SOURCE AND SINK CATEGORIES Sector Specific Data (units)	ACTIVITY DATA A Amount of Biomass Removed (kt dm)	CARBON UPTAKE ESTIMATES B Carbon Emission/Removal Estimates (Gg C)	AGGREGATE EMISSION FACTORS C Carbon Emission Factors (t C/t dm)
			C=B/A
Total Biomass Removed in Commercial Harvest	2707	1218	0.45
Traditional Fuelwood Consumed			
Total Other Wood Use			
	206	92	0.447
Total Biomass Consumption	2911	1310	0.45

STANDARD DATA TABLE 5

Land Use Change & Forestry : 5A (Sheet 2)
Changes in Forest and Other Woody Biomass Stocks -

Annual Harvest

SOURCE AND SINK CATEGORIES Sector Specific Data (units)	ACTIVITY DATA A Amount of Biomass Removed (kt dm)	CARBON UPTAKE ESTIMATES B Carbon Emission/Removal Estimates (Gg C)	AGGREGATE EMISSION FACTORS C Carbon Emission Factors (t C/t dm)
			C=B/A
Total Biomass Removed in Commercial Harvest	2707	1218	0.45
Traditional Fuelwood Consumed			
Total Other Wood Use			
	206	92	0.447
Total Biomass Consumption	2911	1310	0.45

1995

STANDARD DATA TABLE 5

Land Use Change & Forestry: 5A (Sheet 3)
Changes in Forest and Other Woody Biomass Stocks-Net

CO_2 Emissions/Removals

SOURCE AND SINK CATEGORIES	A EMISSIONS/UPTAKE C (Gg)	B EMISSIONS/REMOVALS CO_2 (Gg)
		B=Ax(44/12)
Total Annual Growth Increment	3361	12324
Total Annual Harvest	1310	4803
NET EMISSIONS (+) OR REMOVALS (-)	-2051	-7520

1995

STANDARD DATA TABLE 6

WASTE: 6A Solid Waste Disposal on Land, 6C Waste Inciration, 6D Other Waste

SOURCE/SINK CATEGORIES	ACTIVITY DATA Gg	EMISSION ESTIMATES Gg						AGGREGATE EMISSION FACTORS kg/t						CH_4 RECOVERED Gg
Disposal Method	A	B CO_2	C CH_4	D N_2O	E NOx	F CO	G NMVOC	H CO_2	I CH_4	J N_2O	K NOx	L CO	M NMVOC	N
	Quantity Waste Landfilled (Gg)							1000B / A	1000C / A					
A1 Landfills	4449.26	399.69	399.69						89.83					
A2 Open Dumps														
	Quantity of Waste Treated (Gg)	CO_2	CH_4	N_2O	NOx	CO	NMVOC	CO_2 1000B / A	CH_4 1000C / A	N_2O 1000D / A	NOx 1000E / A	CO 1000F / A	NMVOC 1000G / A	
C Waste Incineration														
D Other Waste														

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WASTE: 6B Wastewater Treatment

SOURCE AND SINK CATEGORIES	ACTIVITY DATA		EMISSION ESTIMATES			AGGREGATE EMISSION FACTORS			CH_4 RECOVERED
Wastewater Type	**A** Annual BOD ($Gg BOD_5$)	**B** Quantity of BOD Anaerobically Treated ($Gg BOD_5$)	**C** Total Methan Released (Gg)	**D** Carbon Dioxide (Gg)	**E** Nitrous Oxide (Gg)	**F** Methane ($GgCH_4/GgBOD_5$)	**G** Carbon Dioxide ($GgCO_2/GgBOD_5$)	**H** Nitrous Oxide ($GgN_2O/GgBOD_5$)	**I** Quantity CH_4 (Gg)
						F=C/B	G=D/B	H=E/B	
B1 Industrial Wastewater	894.94	447.47	98.44			0.22			
B2 Domestic and Commercial Wastewater	153.02	22.95	5.05			0.22			
B3 Other									

1995

TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (SHEET 1) (Gg)										
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	**CO_2 Emissions**	**CO_2 Removals**	**CH_4**	**N_2O**	**NO_x**	**CO**	**NMVOC**	**HFCs**	**PFCs**	**SF_6**
Total National Emissions and Removals	63109	7520	901.4	20.6	161.3	760.6	73.4			
1 All Energy (Fuel Combustion + Fugitive)	56225	0	269.9	9.7	137.5	722.2	50.3			
A Fuel Combustion	56225	0	5.3	9.7	137.5	722.2	50.3			
1 Energy & Transformation Industries	37479		1.8	9.4	68.1	9.8	1.9			
2 Industry	8414		0.2	0.0	8.8	2.3	0.0			
3 Transport	7394		2.0	0.1	51.6	329.7	48.4			
4 Small Combustion	2625		0.1	0.1	5.0	88.5	0.0			
5 Other	314		0.0	0.0	1.0	0.6	0.0			
6 Traditional Biomass Burnt for Energy	0		1.2	0.0	3.1	291.4	0.0			
B Fugitive Emissions from Fuels	0	0	264.7	0.0	0.0	0.0	0.0			
1 Solid Fuels			69.8							
2 Oil and Natural Gas			194.9							
2 Industrial Processes	5602		3.4	8.3	0.0	0.0	0.0			
3 Solvent and Other Product Use							22.8			

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TABLE 7A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (SHEET 2)		(Gg)								
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	HFCs	PFCs	SF_6
4 Agriculture	0.0	0.0	125.0	2.5	1.1	36.6	0.0			
A Enteric Fermentation			85.1							
B Manure Management			37.6							
C Rice Cultivation			0.59							
D Agricultural Soils	0.0			2.5						
E Prescribed Burning of Savannas										
F Field Burning of Agricultural Residues			1.7	0.0	1.1	36.6	0.0			
G Other										
5 Land Use Change & Forestry	0.0	7520	0.0	0.0	0.0	0.0	0.0			
A Changes in Forest and Other Woody Biomass		7520								
Stocks										
B Forest and Grassland Conversion										
C Abandonment of Managed Lands										
D Other										
6 Waste	400	0	503.2	0.0	0.0	0.0	0.0			
A Solid Waste Disposal on Land	400		399.7	0.0	0.0	0.0	0.0			
B Wastewater Treatment			103.5							
C Waste Inciration			0.0							
D Other Waste			0.0							
7 Other										
International Bunkers	882		0.0	0.0	22.7	1.7	0.3			

1995

TABLE 7B SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES

SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (Gg)										
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	HFCs	PFCs	SF_6
Total National Emissions and Removals	63109	7520	901.4	20.6	161.3	760.6	73.4	0.00	0.00	0.00
1 All Energy (Fuel Combustion + Fugitive)	56225		269.9	9.7	137.5	722.2	50.3			
A Fuel Combustion	56225		5.3	9.7	137.5	722.2	50.3			
B Fugitive Fuel Emission	0		264.7	0.0	0.0	0.0	0.0			
2 Industrial Processes	5602		3.4	8.3	0.0	0.0	0.0			
3 Solvent and Other Product Use	0		0.0	0.0	0.0	0.0	22.8			
4 Agriculture	0		125.0	2.5	1.1	36.6	0.0			
5 Land Use Change & Forestry	0	7520	0.0	0.0	0.0	0.0	0.0			
6 Waste	400		503.2	0.0	0.0	0.0	0.0			
7 Other	0		0.0	0.0	0.0	0.0	0.0			
International Bunkers	882		0.0	0.0	22.7	1.7	0.3			

ANNEX B

MITIGATION MEASURES IN INDUSTRIAL SECTOR

Annex II provides information on the indicators and results of the evaluation of the reduction potential of the GHG mitigation measures in the industrial sector by subsectors. The necessary investments and expected annual energy savings, as well as the expected annual emission reduction of CO_2, CH_4 and N_2O are evaluated.

When the GHG emission reduction potential of the measures is evaluated, the following assumptions are laid down:

- the reduced electricity consumption leads to reduced power generation in the fossil fuel based power plants. The production in hydro, nuclear and cogeneration plants stays constant. When the emission factors for the electricity are estimated the auxiliarities and the transmission/distribution losses are also taken into account. The losses are assumed to be 8% for the electricity delivered to the most energy intensive industrial brunches, and 14% for the electricity consumed by the light industry, in services, households and street lighting.
- the reduced heat consumption provokes a corresponding decrease in the heat generation by cogeneration district heating and industrial plants. The heat delivery losses are considered to be 3% for the main industrial sectors, and 12% for the light industry, services, and households.
- the GHG mitigation potential due to reduced fuel consumption (natural gas, coal, residual, etc.) is estimated using average emission factors as in the GHG inventory.

The cost of carbon saved is estimated on the bases of discounted investment cost for the live cycle of the measure. The assumed discount rate is 10%. The cost of CH4 and N2O saved is not considered. It is complimentary to the CO2 reduction.

The measures listed in the Tables, as well as the measures given in the text of Chapter 4, formulated as separate projects, could be accepted as proposals for JI activities. In order to achieve better emission reduction performance bundles of project could also be considered for financial support.

Mitigation measures in ferrous metallurgy

Table II-1

Measure	Investments million $ US	Annual energy savings	Annual emission reduction CO_2 [Gg]	CH_4 [Mg]	N_2O [Mg]	CO_2 reduction cost [$/t CO_2]
1. Introduction of continuous slab and billet pouring plants at the Kremikovtsi Integrated Works:						
1.1. economy of electricity;	150	200 mln kWh	318	4	99	36.8
1.2. natural gas saving		50 mln Nm3 natual gas	94	2	0	
2..Introduction of a pulverized coal blowing plant in the blast furnaces and upgrading of their air heaters at the Kremikovtsi Integrated Works (economy of coke);	50	300 000 t coke	856	0	0	
3. Re-engineering and refurbishment of the sinter belts at the Kremikovtsi Integrated Works: 3.1. electricity saving;	25	50 mln kWh	80	1	25	19.0
3.2. natural gas saving		30 mln Nm3 natual gas	56	1	0	
4. Re-engineering and refurbishment of the heating furnaces of Mill 1700 GB at the Kremikovtsi Integrated Works (economy of natural gas);	8	15 mln Nm3 natual gas	28	1	0	31.6
5. Re-engineering and refurbishment of the arc furnaces and continuous pouring lines at the Stomana J.S.C. Works (economy of electricity);	25	80 mln KWh	127	2	40	21.4
6. Refurbishment of the heating furnaces of mills 2300 and 500-2 at the Stomana J.S.C. Works (economy of natural gas);	5	10 mln Nm3 natual gas	19	0	0	27.9
7. Upgrading of the energy flows at the Kremikovtsi Integrated Works and Stomana J.S.C.	20	100 mln Nm3 mixed (coke-flare) gas	188	5	0	
7.1. economy of electricity 7.2. economy of natural gas		100 mln kWh	159	2	50	4.5
7.3. coke-oven and blast-furnace gas.		10 mln Nm3 natual gas	19	0	0	
8. Re-engineering and refurbishment of the thermal power facilities at the Kremikovtsi Integrated Works and Stomana J.S.C. (economy of heat).	2	300 Tcal thermal power	106	4	23	2.8

Mitigation measures in non-ferrous metallurgy

Table II-2.

Measure	Investments million $ US	Annual energy savings	Annual emission reduction CO_2 [Gg]	CH_4 [Mg]	N_2O [Mg]	CO_2 reduction cost [$/t CO_2]
1. Application of a method for receiving the incoming heavy fuel oil by means of weighing the full and empty railway tank cars (economy of heavy fuel oil)	0	2 thous.t residual	6.2	0.23	0	0
2. Replacement of the flow gauges downstream of the tank to the inner consumers (economy of heavy fuel oil)	0	5 thous.t residual	15.4	0.58	0	0
3. Regular checks of the heavy fuel oil quality by an independent laboratory (economy of heavy fuel oil)	0	2 õèët residual	6.2	0.23	0	0
4. Refurbishment of the steam pipe network (economy of heat)	0.005	1600 Gcal.	0.6	0.0	0.12	2.82
5. Introduction of Larox systems (economy of electricity)	0.01	600 thous. kWh	1.0	0.0	0.30	1.26
6. Change of the fuel substituting natural gas for heavy fuel oil (economy of heavy fuel oil)	0.8	21 thous. t residual	64.6	2.4	0	1.30
7. Electricity consumption metering system (economy of electricity)	0.067	320 thous. kWh	0.5	0.0	0.1584	21.38

Mitigation measures in chemical industry

Table II-3.

Measure	Investments million $ US	Annual energy savings	Annual emission reduction CO_2 [Gg]	CH_4 [Mg]	N_2O [Mg]	CO_2 reduction cost [$/t CO_2]
1. Redesign of the ammonia production at Agrobiochim - Stara Zagora (heat saving)	16.7	2350 thous. Gcal	832	33.4	183	2.82
2. Redesign of the ammonia production at Agropolichim - Devnya(heat saving)	11.1	600 thous Gcal	212	8.5	46.8	5.65
3. Production of lime- ammonium nitrate at Agrobiochim - Stara Zagora	22.2	550 thous Gcal 16 mln kWh	195 25	7.8 0.3	42.9 7.92	12.8
4. Rehabilitation of the catalytic reforming plant at Neftochim - Bourgas	40	970 thous Gcal 9 mln kWh	343 14	13.8 0.2	75.7 4.46	13.7
5. Rehabilitation of the catalytic reforming plant at Neftochim - Bourgas	25	860 thous Gcal 10 mln kWh	304 16	12.2 0.2	67.1 4.95	10.8
6. Production of ammonium nitrate at Agropolichim - Devnya	30	700 thous Gcal 3 mln kWh	248 5	9.9 0.1	54.6 1.49	14.0
7. Reduction of heat losses through redesign and updating of the heat exchangers and improvement of thermal insulations at Neftochim, Polymeri, Neochim, Agropolychim, Chimco, Sviloza, Antibiotic, Biovet, Solvay-Sodi (heat savings).	0.5	420 thous Gcal	149	6.0	32.8	2.82

Mitigation measures in light industry

Table .II-4

Measure	Investments million $ US	Annual energy savings	Annual emission reduction CO_2 [Gg]	CH_4 [Mg]	N_2O [Mg]	CO_2 reduction cost [$/t CO_2]
1. Energy efficient lighting installations (electricity saving)	15	200 mln kWh	336	4.2	105	6.55
2. Improvement of the energy efficiency of steam boiler facilities	6	8843 t residual 7035 th. Nm3 natural gas	27 13	1.0 0.3	35.1	14.0
3. Updating of the steam generation and compressed air plants	3	34450 t residual 67.163 mln kWh	106 113	4.0 1.4		7.4
4. Automated systems for energy consumption control (electricity saving)	1	10 mln kWh	17	0.2	5.23	9.52
5. Energy-saving and ecologically clean energy sources (heat saving)	0.4	12000 Gcal	5	0.2	3.92	12.44
6. Energy-saving electric drives (electricity saving).	3	27 mln kWh	45	0.6	14.1	8.93

Mitigation measures in food processing industry

Table .II-5

Measure	Investments million $ US	Annual energy savings	Annual emission reduction			CO_2 reduction cos [$/t CO_2]t
			CO_2 [Gg]	CH_4 [Mg]	N_2O [Mg]	
1. Internal gasification of a steam boiler plant at the Maritsa Canning Works - Pazardgik (saving of electricity);	0.1	1 480 MWh	2.49	0.03	0.77	4.762
2. Construction of a local water supply system for the refrigerator, Maritsa Canning Works - Pazardgik (saving of electricity);	0.007	220 MWh	0.37	0.00	0.12	2.976
3. Supply and installation of 20 pcs high-efficiency condensate separators, Maritsa Canning Works - Pazardgik (saving of electricity);	0.017	60 MWh	0.10	0.00	0.03	4.167
4. Supply and installation of 6 pcs Curtis regulators for electrick truck control, Maritsa Canning Works - Pazardgik (saving of electricity);	0.04	96 MWh	0.16	0.00	0.05	4.167
5. Design and building of local heating systems with water as heating medium (saving of electricity);n transport sector;n meat and vegetable can sector;n half-finished product sector, vac. jiuce shop, FRUCTO - Sliven	0.019	437 MWh	0.73	0.01	0.23	3.571
6. Supply and installation of automatic doors for refrigerating chambers, FRUCTO - Sliven (saving of electricity);	0.067	740 MWh	1.24	0.02	0.39	8.929
7. Sectionalization of the main building lighting, YAGODA Canning Works - Yambol	0.003	64 MWh	0.11	0.00	0.03	2.976
8. Installation of local lighting of four process lines, YAGODA Canning Works - Yambol (saving of electricity);	0.002	47 MWh	0.08	0.00	0.02	10.12
9. Building of a system for selection and automatic return of the process condensate, MALINA Co. Ltd. - Dupnitsa (saving of electricity);	0.005	126 MWh	0.21	0.00	0.07	8.929
10. Introduction of a chemical additive for heavy fuel oil doping, SERDIKA AD - Stara Zagora (saving of heavy fuel oil);	0.001	3 t residual	0.01	0.00	0	0.016
11. Building of a system for steam boiler plant preparation with automatic temperature monitoring T = 95-98oC, MELTA-90 AD (saving of electricity);	0.002	72 MWh	0.12	0.00	0.04	2.976
12. Capital repair of the thermal insulation of the main steam line and condensate line, Maritsa Canning Works Pazardgik (saving of natural gas).	0.002	122 000 Nm3	0.23	0.00	0	2.664

Mitigation measures in machine building and metalworking, electrical and electronic industry

Table II-6

Measure	Investments million $ US	Annual energy savings	Annual emission reduction			CO_2 reduction cost [$/t CO_2]
			CO_2 [Gg]	CH_4 [Mg]	N_2O [Mg]	
Measures						
1. Energy audit with an Action Plan	2.547	620 000 MWh	985.8	12.40	307	0.34
		480 000 Gcal	169.9	6.82	37.4	
2. Integrated output and energy information system	13.89	54 000 MWh	85.9	1.08	26.7	35.2
		420 000 Gcal	148.7	5.96	32.8	
Measures for saving of heat energy						
3. Pressure control in the steam distribution process	1.667	115 000 Gcal	40.7	1.63	8.97	2.98
		24 650 tce(residual)	55.9	2.10	0	
4. Hot water temperature control	3.473	92 900 Gcal	32.9	1.32	7.25	11.9
		19 900 tce(residual)	45.1	1.69	0	
5. Water and air leak control in the condensation pots	1.389	137 000 Gcal	48.5	1.95	10.7	2.98
		29 400 tce(residual)	66.7	2.50	0	
6. Introduction of process mode sheets	0.463	200 000 Gcal	70.8	2.84	15.6	0.75
		42 650 tce(residual)	96.7	3.63	0	
7. Introduction of a heat exchanger system utilising the condensate heat	1.389	120 000 Gcal	42.5	1.70	9.36	2.47
		25 600 tce(residual)	58.1	2.18	0	
Measures for electricity saving						
8. Switching off the unloaded transformers (saving of electricity)	0.463	28 300 MWh	45.0	0.57	14	1.887
9. Real-time control improvement (saving of electricity)	3.38	97 750 MWh	155.0	1.95	48.3	3.774
10. cosj improvement (saving of electricity)	7.871	270 000 MWh	429.3	5.40	134	5.031
11. Replacement of filament lamps by energy-saving ones (saving of electricity)	0.787	19 300 MWh	30.7	0.39	9.55	5.66
12. Isolation of electrolyte furnaces (saving of electricity)	0.278	36 000 MWh	57.2	0.72	17.8	1.258
13. Transfer of tests to non-peak hours of the day (saving of electricity)	0.093	7 000 MWh	11.1	0.14	3.47	1.887
14. Improvement of furnace operating conditions (saving of electricity)	0.185	51 500 MWh	81.9	1.03	25.5	0.629

Mitigation measures in construction

Table .II-7

Measure	Investments million $ US	Annual energy savings	Annual emission reduction			CO_2 reduction cost [$/t CO_2]
			CO_2 [Gg]	CH_4 [Mg]	N_2O [Mg]	
1. Introduction of highly efficient construction machines using diesel fuel (saving of diesel engine fuel)	69	22 130 t diesel fuel	73.1	2.7	0	124.1
2. In-operation inspection checks of fuel consumption (saving of diesel engine fuel)	0.56	3 540 t diesel fuel	11.7	0.4	0	7.867
3. Saving of heat (heat economy)	0.27	3 300 Gcal	1.2	0.0	0.26	31.07
4. Introduction of scientific and technical achievements (heat economy)	0	2 590 Gcal	0.9	0.0	0.2	-

Mitigation measures in the building materials industry

Table II-8

Measure	Investments million $ US	Annual energy savings	Annual emission reduction			CO_2 reduction cost [$/t CO_2]
			CO_2 [Gg]	CH_4 [Mg]	N_2O [Mg]	
I. Cement production						
1. Switching from gas to solid fuel (saving natural gas)	20	151980 thous Nm3natural gas	285.6	7.13	0	9.03
2. Transition from a wet production process to a dry one (saving natural gas)	55.56	180940 thous Nm3natural gas	340.1	8.49	0	21.29
3. Replacement of part of the fuel by motor-car tiers, combustible waste (saving natural gas)	55.56	90017 thous Nm3natural gas	169.2	4.22	0	53.26
II. Production of structural ceramics						
1. Fuel consumption control (saving fuel oil)	0.031	4702 t residual	14.5	0.54	0	0.32
2. Fuel base change - from boiler fuel to domestic solid fuel (saving fuel oil)	1.222	25672 t residual	79.0	2.96	0	1.95
3. Combustible waste utilization - substitutes 20 % of the main fuel (saving fuel oil)	0.049	7292 t residual	22.4	0.84	0	0.32
4. Economies of fuels through RES utilization (saving fuel oil)	0.183	3822 t residual	11.8	0.44	0	1.95
5. Drying with solar energy (saving fuel oil)	0.058	2640 t residual	8.1	0.30	0	0.97
6. Economical methods of drying (saving fuel oil)	0.09	2037 t residual	6.3	0.23	0	2.27
III. Quicklime production						
1. Dosing (mechanical) and measuring (meteorological control) of used fuel (saving hard coal)	0.111	4790 t coal	11.07	0.28	0	1.73
2. Control of the heat and process conditions (saving hard coal)	0.004	2140 t coal	4.95	0.12	0	0.13
3. Mechanization of charging the shaft furnace with reporting of the quantity of fuel consumed (saving hard coal)	0.042	1800 t coal.	4.16	0.11	0	1.73
4. Installation of temperature conditions control instrumentation (saving hard coal)	0.004	2140 t coal.	4.95	0.12	0	0.13