Lithuania's second national communication under the Framework Convention on Climate Change

Ministry of the Environment

1. INTRODUCTION

During the summit in Rio de Janeiro in June 1992, Lithuania signed the United Nations Convention on Climate Change (UNFCCC), wherein Lithuania is mentioned as an Annex I Party to the Convention. The Convention was ratified by the Seimas (the Parliament of Lithuania) on 23 February 1995; and in September 1998 the President of the Republic of Lithuania signed the Kyoto Protocol, under which the State has pledged itself to reduce greenhouse gas (GHG) emissions.

2. BACKGROUND INFORMATION ABOUT LITHUANIA

2.1. Geography and Climate

Lithuania is a Central European country, situated in the very centre of Europe, on the eastern coast of the Baltic Sea. It lies on the Eastern European Plain, with characteristic lowlands and hills (the highest point in the country is only 293 metres above the sea level). The area of Lithuania is 65,300 square kilometres, and its Baltic coastline stretches for 90 km. The geographical co-ordinates of Lithuania extend between the latitudes of 56º27' N (northern extremity) and 53º54' N (southern extremity), and between the longitudes of 20º56' E (western extremity) and 26º51' E (eastern extremity). The border with Latvia is 610 km long, with Belarus 724 km, with Poland 110 km, and with Kaliningrad Region of the Russian Federation 303 km.

The territory of Lithuania lies in the northern part of the temperate climate zone. The distance from the equator (6100 km) and from the North Pole (3900 km) determines general solar radiation flux and atmospheric circulation patterns over the country. According to the general classification of climate, almost the entire territory of Lithuania is assigned to the south-western sub-region of the continental forest region of the middle latitudes of the Atlantic Ocean, because its climate is close to that of Western Europe; while the Baltic coast is assigned to the South Baltic sub-region.

The average annual temperature in Lithuania fluctuates from between 6.5 and 7.1º C at the seacoast, to 5.5º C in the northern part of the country. The average temperature is - 4,9º C in January and + 17º C in July, and the length of vegetation period fluctuates from 169 to 202 days.

The landscape of Lithuania is regarded as beautiful, picturesque, with numerous hills and lowlands, rivers (722 of which are longer than 10 km), and over 4000 lakes. Forests occupy 27 % of the territory; and Lithuania is rich in mineral resources including fossiliferous rocks, deposits of anhydrides, dolomite, limestone, clay, gravel, gypsum, chalk, mineral water, etc. Insignificant amounts of oil and gas have also been discovered.

2.2. Population, Social Structure, and Migration

According to the population census of 1989, the population of Lithuania was 3,689,800. At the beginning of 1998, there were 3,704,000 people in Lithuania, which was by 13,000 less than in 1995. Out of this number, 2,525,000 people lived in towns and 1,178,800 in the countryside. From 1979 to 1989, the average annual population growth was 0.83 %; however after 1993 population began to decline. Between 1994 and 1996, the size of the population each year decreased by 0.1 % on average, and after 1996, it declined by 0.43 % in rural areas and increased by 0.05 % per annum in towns. The maximum population growth of 46 000 people per annum (equivalent to the annual growth rate of 1.2-1.3 %) was observed in the 1960s. In 1998 the population density was 56.8 persons per square kilometre.

The increase in emigration, which followed after the reestablishment of independence, has stabilised since 1997. Between 1991 and 1996, twice as many people emigrated from Lithuania than arrived (77,505 and 28,027 respectively). The reason behind this situation was a change of the political status of the country, economic and policy reforms leading to the return of people exiled during the Soviet period as well as the departure of a certain percentage of ethnic minorities.

The average life expectancy of 72 years registered in 1986, declined to 69 years in 1994. Life expectancy in Lithuania, as compared to the countries of Western Europe, is by 6 - 8 years lower for men and 4 - 6 years lower for women respectfully. Women in towns live on average 10.2 years longer than men, while women in rural areas live 12.9 years longer than men.

2.3. Policy Formulation and Decision-Making Structures

For the first time, Lithuania proclaimed its independence on 16 February 1918. From 1940 until the reestablishment of independence on 11 March 1990, the state was annexed by the Soviet Union. In October 1992, a new Constitution of Lithuania was adopted by a referendum, which officially established Lithuania as a parliamentary republic with President as Head of State who is elected by direct universal suffrage for a five-year term in office. A single-chamber Parliament (the Seimas) of 141 members is elected for a four-year period. The Government is led by Prime Minister who is who is approved by the Seimas upon the recommendation of the President. The last elections to the Seimas took place in October 2000.

The right of legislative initiative belongs to the Seimas, the President of the Republic, the Government and 50,000 electors. The President may introduce draft laws, which Seimas must debate. An issue of critical importance to the state or to the nation may be initiated by the Seimas to be settled at the referendum or may be initiated by the electorate upon the presentation of 300,000 signatures.

2.4. Economy

Before the Second World War, Lithuania was an independent state, integrated into the world economy, however, the occupation and incorporation of the country into the Soviet Union demolished Lithuania's market economy. After the collapse of the Soviet Union and the reestablishment of Independence in 1990, Lithuania substantially changed its core economic and institutional values. A programme of economic reform, including privatisation of state enterprises and price liberalisation, has been developed in order to move from a centrally planned economy to a market-based system. Lithuania has inherited the economy wherein energy consumption per unit of production was 3 times higher than in analogous West European industries. After Lithuania had succeeded from the Soviet Union, the latter critically curtailed the supplies of energy and other resources. As a result, the economic output of Lithuania decreased by one third in 1992 and by one fourth in 1993. By now, however, the declining trend has been successfully reversed.

In 1995, the gross domestic product (GDP) amounted to 24.1 billion Litas; in 1996 it increased to 31.6 billion, and in 1997 it reached 38.2 billion Litas. (1 USD = 4 Litas). The gross domestic product is improving with the restructuring of the economy. Agricultural production decreased by 27.5 % in 1990, by 11.2 % in 1993 and by 28.0 % in 1994. Agriculture and forestry account for 11.4 % and 9.3 % of the country's total economy, respectively, industry - for 28 % to 29 %, and building and construction – for 7.1 %. The main sectors of the economy are food production and processing, light industry, production of machinery and metalworking, production of electronics and electrical appliances, chemical industry, manufacture of building materials, and energy production.

The greatest problem for the economy is its dependence on imported raw materials. For example, as much as 83 % of light industry depends on raw material imports from the Commonwealth of Independent States (CIS) and other countries. Though Lithuania has 1.9 million hectares of forest, and has a long tradition of paper production, today most of the timber and other materials used in the paper industry are imported from other countries.

The food industry in Lithuania is dominated by meat production, diary and fish products. The fishing industry is concentrated in Klaipėda, and in 1993 this industry was the largest in the food sector. High prices of the primary food products have contributed to the decline of food industry.

Lithuanian light industry is well equipped with modern technologies and more than half of the machinery comes from the leading industrial countries. New technologies and a highly qualified labour force in this sector result in the production of high quality goods, so that it is becoming one of the key industries of Lithuania.

The building and construction industry, which is the most privatised industry in Lithuania, uses local raw materials, obtained mainly from quarries situated near Vilnius and Kaunas. The largest cement factory in the Baltic States, which produces 3.6 million tonnes of cement annually, is located in Akmenė, in the north of

Lithuania. Before 1993, the building and construction sector was declining, but since then it has been increasing, and in 1997 it grew by 8.8 %.

2.5. Energy

After the restoration of independence in 1991, all sectors of economy, including energy, have gone through complicated changes. A very sharp increase in primary energy prices and loss of the former Eastern markets brought about a noticeable decline of national energy industry and energy exports. Energy demand and its production decreased almost by half. In 1995, electricity consumption made up only 53 % of the consumption level of 1990 (a decrease from 12.0 TWh in 1990 to 6.35 TWh in 1995).

At the beginning of 1998, the total value of assets of energy enterprises, including municipal district heating enterprises, exceeded 6.5 billion Litas; they employed about 36 thousand people. A share of private capital in the equity of these enterprises was about 15 %. The three largest Lithuanian enterprises ("Ignalinos atominė elektrinė" (Ignalina NPP), the joint-stock company AB "Lietuvos Energija" and the joint-stock company AB "Mažeikiu Nafta") altogether made 83 % of the total capital of the state enterprises, while a number of employees of these three enterprises made 75 % of the total number of the employed in the energy sector. In 1996 and 1997, the energy sector covered about 6-7 % of the national GDP, including the supply of electricity, heat and gas, which made 2.7-2.9 % out of this percentage.

2.5.1. Electric Power

The main producer of electric power in Lithuania is Ignalina NPP. Over the last five years, it alone generated from 77 % to 85 % of the total electricity in Lithuania. In 1999, the total installed electricity generating capacity in the country amounted to 6537 MW, of which 3000 MW could be generated by Ignalina NPP, 1800 MW by the Lithuanian State Power Plant, 828 MW by co-generation plants, 800 MW by Kruonis Hydropumping Plant and 109 MW by hydro-energy plants. As the maximum national energy demand in 1998 was 2077 MW, only one third of the total national energy generating capacity was actually utilised.

In 1990, domestic power consumption was 16.43 TWh, and in 1994 through 1998 it ranged from 11.1 to 11.6 TWh per annum. It is expected that power consumption will increase to 13.8 TWh.

2.5.2. Heating

In 1991, 35.4 Pcal of heat (steam and hot water) were produced. Between 1995 and 1998, heat production had declined from 19.5 Pcal to 17.6 Pcal, and the forecasts show that heat production is likely to decline to 15.5 Pcal in 2005. This means that heat production will decrease by a factor of 2.3 in 15 years. The reasons include reduced heat consumption by industries whose production is slowing down, by decentralisation of hot water and steam supply to industries, by improvements introduced into the metering of heat supply and consumption, and by modernisation of the entire heating sector (renovation of boiler houses, distribution networks, and hubs or nodes), etc.

2.5.3. Oil Industry

At the beginning of the last decade, a large oil refinery was built in Lithuania, and in 1998 it processed 12.8 million tonnes of crude oil. Later, when another oil refining technology was installed, the refining capacity of the plant dropped to 8-9 million tonnes per year.

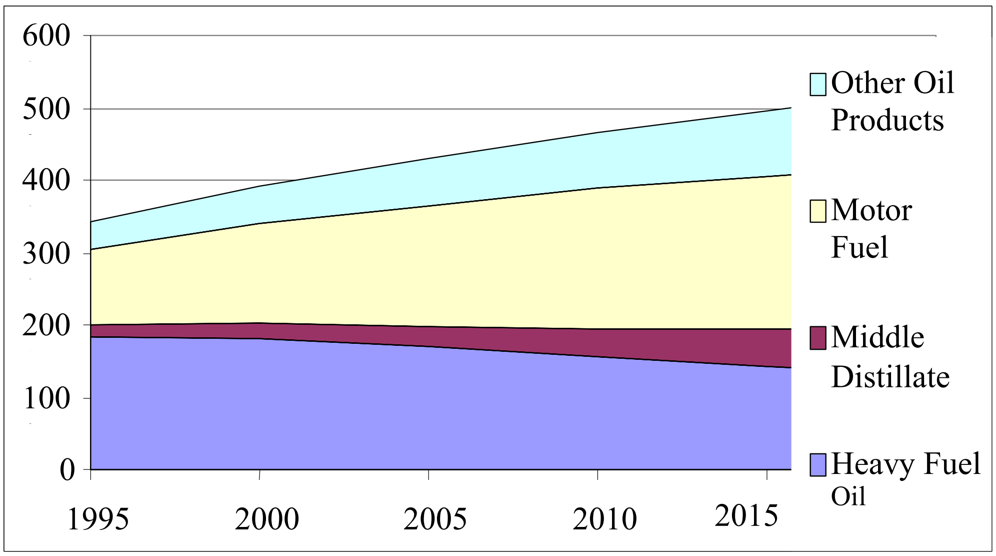


Figure 2.1. The consumption of oil products in Lithuania

2.5.4.

In 1990 and 1991, the consumption of primary energy resources amounted to 18 million TOE (or 753.5 PJ) annually, of which oil products accounted for 43 %, gas for 26 %, nuclear power for 24 %, and other resources (solid fuel, hydropower) for 7 % of the total primary energy resources. Later, from 1993 to 1998, during the transition to the market economy, the consumption of primary energy resources dropped to 9-10 million TOE. The structure of primary energy resources has also changed during this period: the share of oil products and natural gas dropped down to 35-38 % and 19-22 % respectively, while the share of nuclear power and other resources increased to 34-36 % and 8-10 % respectively. The forecast is that the same structure will be retained during the period of 2000–2005. Total primary energy consumption during this decade should increase from 10.2 to 11.6 million TOE, i.e., by 2.5 % annually (see Figure 2.2).

During the last decade, most of Lithuania's primary energy resources were used for generation of electricity (37—38 %) and heat production (20—23 %). The end users consumed 27-30 % of fuel, and 10-13 % were consumed for other purposes (e.g., as raw material for industries, as fuel losses, etc.). It is anticipated that during period of 2000–2005, fuel consumption for energy generation will increase, while its use for heat production will decrease.

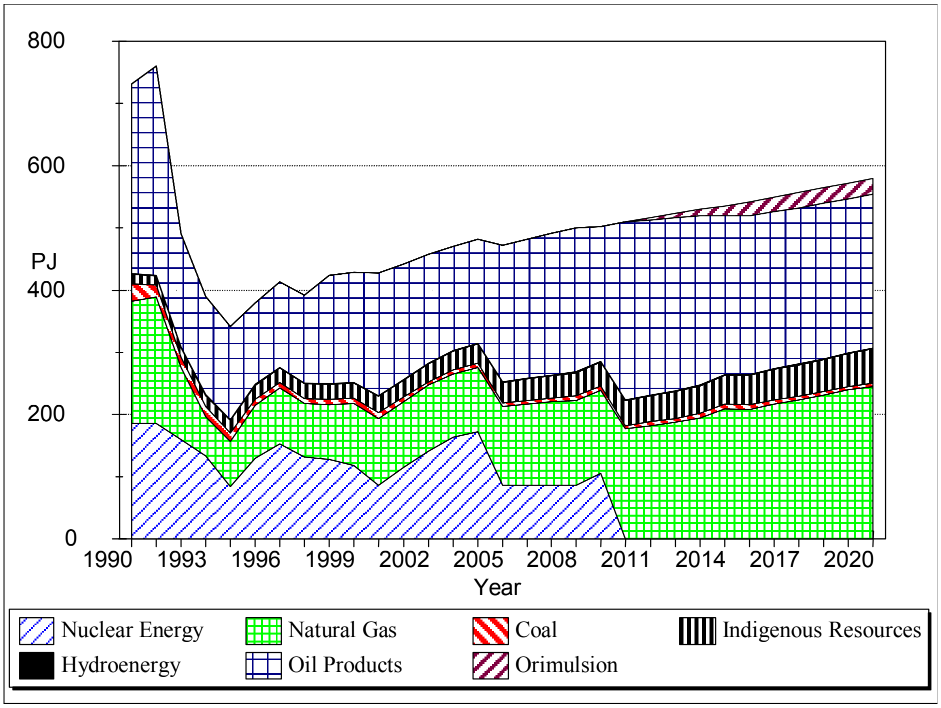


Figure 2.2. Current and projected consumption of primary energy resources (assuming that the Ignalina NPP is closed by 2010)

2.6. Industry

The economic structure of Lithuania has gone through noticeable changes. During the period of 1992–1994 alone, the share of industry in the GDP dropped from 35.5 % to 20.4 %, and the share of agriculture - from 11.6 to 8.1 %, while the share of trade in the GDP structure grew from 4.5 to 23.5 %. Since 1992, economic recession resulted in the reduction of energy consumption, but the latter was slower than the decline in GDP. Therefore, energy demand of the national economy during this period was growing in relative terms. It is evident that the production output varied between different industries. As the most serious decline was observed in the production of electronic equipment, machinery, metalworking, the likelihood of reaching the former levels of production is quite low for these sectors.

On the other hand, the chemical, light and food industries, production of bicycles, leather tanning and processing as well as textile industries are reviving. During the last few years, the production of foodstuffs, clothing, wooden artefacts and chemicals increased significantly. A growing proportion of some industrial products was exported to foreign countries thereby boosting the production by these industries. For example, 69.5 % of machinery and equipment, 76.1 % of electric appliances, and 78.0 % of radio and TV sets and communication equipment were sold abroad. Since 1991, Lithuania's export to the western countries has increased from 5.1 % to 54.6 % of total exports. It should be noted that the share of imports from these countries into Lithuania has also increased from 9.8 % to 67.1 % of the total imports. The main trading partners of Lithuania are Russia, Germany, Belarus, Latvia, Ukraine, the Netherlands, Poland, and Great Britain.

2.7. Transport

Since 1990, the Government of Lithuania has adopted a number of important decisions on the reduction of transport pollution, i.e. national programmes like "Transport and the Protection of Environment", "Measures for the Implementation of the National Transport Development Programme", and other programmes aimed at reducing the negative impact of transport on the environment and on people's health. Due to a difficult economic situation, the implementation of these programmes is slower than expected.

Transportation, storage and communications accounted for 8.5 % of the gross domestic product in 1998. Among major problems encountered by any country is that of providing energy resources sufficient to meet the demand of each individual energy consumer. A country's energy efficiency, as well as the rate of its technical progress, can be evaluated by reference to the relative energy consumption per unit of GDP. The need for energy conservation in Lithuania is of the utmost importance, because the country imports almost all of the consumed oil. Motor vehicles in Lithuania (as well as elsewhere in the world) are the main consumers of light oil products, accounting for almost 70 % of the total. Therefore, it is very important to reduce fuel consumption by road transport. Fuel and lubricants account for between 15 and 20 % of total operating cost of motor vehicles.

The hazardous impact of transport on the environment and people's health is directly related to the quantity of fuel consumed, and therefore fuel economy will reduce the impact of transport on the environment. These interrelated issues should be comprehensively addressed while executing the National Implementation Programme of the UNFCCC. These issues will become even more urgent and pressing, with the number of road vehicles rapidly growing and the volume of passenger transportation and freight haulage increasing as the economy revives.

During the integration of Lithuania into the European Union, it will be necessary to look for new, scientifically approved and tested means of fuel economy and their practical application, so as to increase transport fuel efficiency, to reduce greenhouse gas emissions and thereby the negative impact of transportation on the environment and human health.

2.7.1. Fuel Consumption by Road, Rail, Water and Air Transport

Total final energy consumption in Lithuania has decreased from 368 PJ in 1990 to 186 PJ in 1998. Energy consumption has dropped in all sectors of economy, but the reduction was very significant in industry, building construction and agriculture. Energy consumption by transport has decreased very insignificantly.

The forecasts suggest that energy consumption by transport will continually increase (see Figure 2.3). A rapid growth in private vehicle numbers is the main factor causing difficulties in resolving air quality problems and contributing to the global climate change.

Road transport accounts for the largest share of the energy consumed by transportation. For example, in 1998 road transport alone consumed about 90 % of all the energy used by the entire transport sector. Consequently, road transport is the main target for measures aimed at energy savings and the reduction of greenhouse gas (GHG) emissions. Transport in Lithuania consumes relatively little of the natural gas and LPG, and gasoline consumption is higher than that of diesel fuel.

The total consumption of fossil fuel in Lithuania in 1998 was 6,234,000 tonnes of oil equivalent (TOE), and in 1997 it was 6,007,000 TOE. Road transport consumes the major part of fuel used: 75 % of fuel in 1996, 89 % in 1997, and 90 % in 1998. Road transport is also the main source of air pollution by exhaust and greenhouse gases.

In 1998, the demand for diesel fuel in Lithuania was 696,000 tonnes, 83 % of which was consumed by the transport sector. The consumption of diesel fuel by all sectors of Lithuania's economy as well as by transport is increasing rapidly. The quantity of diesel fuel consumed by road vehicles amounts to 85 % of the total quantity consumed by the entire transport sector. The transport sector also consumes 98 % of all gasoline used in Lithuania; and gasoline accounts for approximately 54 % of the total fossil fuel consumption by transportation.

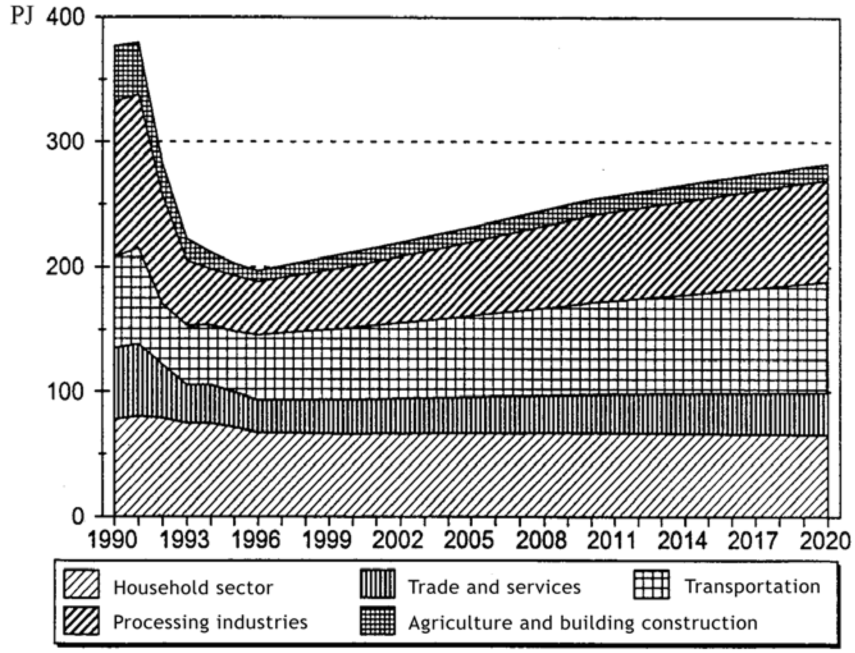


Figure 2.3. The forecast of final energy demand by different sectors of economy.

Aviation kerosene is consumed mainly by air transport and its demand is shown in Table 2.1.

Table 2.1. Consumption of Aviation kerosene

Transport	Consumption, Gg		
	1996	1997	1998
Road	0.2	0.2	0.1
Air	30.5	30.9	26.4
Other	0.3	-	-
Total	31.0	31.1	26.5

Liquefied petroleum gas (LPG) is currently the most environmentally friendly fuel used by transport; yet, transport consumes only 14 % of the total quantity of LPG used in Lithuania. The biggest consumer of LPG is the household sector of Lithuania.

All in all, 276 sea-going vessels are registered under the Lithuanian flag, with the total tonnage of 494,500 GRT (gross registered tonnes). Of this number, 96 vessels belong to Lithuania's marine trading fleet, with the total tonnage of 368,000 GRT, which is 0.11 % of the global fleet, and about 0.07 % of the world's total shipping tonnage. Fuel consumption by ships on long voyages differs very much from fuel consumption in ports. For example, sea-going ferries consume between 25 and 50 tonnes of fuel on the routes between Klaipėda and the ports on the western shore of the Baltic Sea, and between 0.6 and 0.8 tonnes during their time in the port. The fuel consumed by these ships in the port does not exceed 2-4 % of the ship's total fuel consumption. This proportion will vary according to the type of vessel, the routes covered, and the purpose of the voyage.

A longer period moored or anchored in the port (from 1 to 5 days on average) may be compensated for by a longer voyage, which may last from 48 hours (to the North Sea) to 1-2 months (to North and South America, the Far East, etc.).

Shipping companies under specific trading conditions obtain most of the fuel consumed by the Lithuanian registered vessels in foreign ports. The total annual fuel consumption by Lithuania's merchant shipping fleet does not exceed 200 to 230 thousand tonnes; and more than half of the quoted amount (approximately 125,000 tonnes) is consumed beyond the boundaries of the Baltic Sea. In the Baltic Sea region, the Lithuanian marine vessels use less than 50-60 thousand tonnes of fuel, including less than 30,000 tonnes of heavy marine fuel oil. Of the total quantity of fuel consumed, more than 65 % is heavy marine fuel oil.

2.8. Agriculture and Forestry

Agriculture is the second largest source of greenhouse gases (the energy sector is the largest), emitting 48 % of all methane and 82 % of nitrogen oxide emissions. Historically, agriculture has always been a very important sector of Lithuania's economy, and like other economic sectors, it has undergone sudden changes and reforms since the country achieved independence. These changes include land privatisation and the introduction of market-based prices, which influenced a significant drop in agricultural production in 1992 and 1993.

The land area of Lithuania is 6,530,000 hectares, of which 3,505,100 hectares (approximately half of the land area) are allocated for agricultural purposes, and 1,979,300 ha for forests. The land area used for agriculture amounts to 3,356,000 hectares, including 2,877,000 ha of arable land. In Lithuania, 3,042,000 ha of land were under cultivation in 1998, of which 2,616,000 ha of land were reclaimed.

In 1993, agricultural production accounted for 20 % of the GDP and 20 % of the country's exports; and the agricultural sector employed 22 % of the labour force. Livestock production (mainly cattle-breeding and rearing) accounted for two thirds of the total agricultural output, while grain production accounted for the remaining one third.

Cereals and forage crops are the core of Lithuania's crop-based agriculture, and the area of land used for growing sugar beet, potatoes and vegetables has increased. In 1997, agricultural productivity per 100 hectares was 2.51 tonnes of cereals, 15.1 tonnes of potatoes, 14.9 tonnes of vegetables and 28.4 tonnes of sugar beet. Also in 1997, 1.068 million head of livestock and 7.4 million poultry were reared in Lithuania, yet this was less than in 1990 when 2.3 and 16.8 million head of cattle and poultry were reared. The principal agricultural products of Lithuania are cereals, (including wheat and rapeseed), potatoes, sugar beet, milk, beef, veal, pork, poultry and eggs; and these products account for 85 % of total agricultural production. The agricultural sector continues to be a major consumer of energy and chemicals, even though price liberalisation and problems in obtaining material supplies have caused some agricultural practices to shift away from those inherited from the former Soviet Union.

Today, the composition of the agricultural sector is the following: 53 % private farms, 18 % agricultural joint-stock companies, and 29 % smallholdings. By 1997 the total amount of agricultural production in private farms increased by more than 60 % when compared with that of 1990, while the productivity of agricultural joint stock companies fell by more than 7 %.

Lithuania is situated in the mixed forest zone, and forest is the dominant natural vegetation type. It was established that an optimal forest area is 30-33 % of the country's territory. Forests are an extremely important carbon sink in Lithuania and, according to calculations produced by the Ministry of Environment; forests absorb one fourth of the total carbon dioxide emissions produced by fossil fuel combustion. Forests occupy one third of the country's territory, and three fourths of this forested area is used for the production of timber. Pine forests make up 38.1 % of the total forested area, spruce 20.7 % and birch 21.1 %. The country's forests also include grey and black alder scrub, and aspen woods; but ash and oak-groves are rare in Lithuania.

The state of the forest in Lithuania is not satisfactory: many areas are drained, monocultures are prevailing, and in some places, forests are devastated by intensive tourism and visitors. Since 1993, damage has increased due to windfall trees, diseases, the spread of pests, large extent of forest harvesting, illegal tree felling, and due to the increasing impact of acid rain. Furthermore, the consumption of fuel per capita in Lithuania is 1.5 times higher than in western countries, while forest productivity is lower. Transboundary and domestic air pollution amplifies the danger for the forest.

Bogs and marshes occupy 4.9 % of the country's territory. 71 % of this area is occupied by marshes, 22 % by bogs and 7 % by temporary wetlands.

Since 1956, forest inventory has been made every five years. The data are updated annually. In 1998, the national inventory of forests in Lithuania was made on the basis of the land plot database. During the last forest inventory, the data were updated, taking into account forest felling and reforestation as a part of forest management. Prior to the last forest inventory, forest groups and categories were specified more accurately as required by the Law on Forest of the Republic of Lithuania of 1994. According to their ownership, forests were subdivided into state-owned, private and pending of privatisation. The inventory data were summarised and published as a separate publication "Lithuanian Forest Statistics".

Table 2.1 Some Statistics on Lithuania's Forests

Land area of the Woodland Fund	2123 thou. ha
Land area under the forest	1979 thou. ha

Land area, overgrown with forest	1860 thou. ha
Out of this number:	
Under forest cultures	424 thou. ha
Volume of timber	334 mil. m^3
Average volume of timber from 1 hectare	180 m^3
Average volume of timber from mature forests	244 m^3
Total volume of timber from mature forests	43.6 mil. m^3
Annual timber increment	11.9 mil. m^3
Average timber increment	6.3 m^3 per ha
The share of increment per 1 hectare	3.7 m^3
Percentage of the forest land	30.1 %
Forest area per capita	0.51 ha
Volume of timber per capita	89 m^3

During the last 5-year period, the area of wood stands has increased by 27.7 thou. ha, especially that of birch and grey alder groves. Not only the area covered by woods, but the volume of timber has also grown, though with the exception of spruce groves. From 1993 to 1998, total volume of timber increment in Lithuania increased by 14 million cubic metres, or almost by 3 million cubic metres annually. The area of mature wood stands and the volume of timber in them have continued to grow intensively.

2.9. Water Management Sector

Lithuania has 29.1 thousand rivers and streams, with the total length of 63700 km. There are 3000 lakes, the area of which exceeds 0.5 ha. Altogether, these lakes cover the area of 880 square kilometres. Above that, Lithuania has nearly 14000 lakes, which are less than 0.5 ha making up 16,2 square kilometres.

The territory of Lithuania is situated in the climatic zone with continuous water excess; i.e. water resources are sufficient. An average annual water flow within the territory of Lithuania is almost 15-16 cubic kilometres. To add the inflow from neighbouring countries, it will make up 26 cubic kilometres per year. In dry years, Lithuanian rivers flow up to 6 square kilometres of water.

A larger part of underground water (60 %) is connected to rivers. Up to 60-80 % of underground water intake is received from rivers.

Underground water used for drinking is taken from the layer ranging from 50-100 to 400 metres deep. Mineral water with salt content exceeding 1 gram of salt per litre lies beneath this layer. The intake of drinking underground water reaches 3.2 million cubic metres per day. That makes up to 25 % of natural underground water resources. It is calculated that the resources exploited exceed the forecast of the consumption of drinking water for the next decade from 2000 to 2010 by 0.5 million cubic metres per day.

In order to satisfy Lithuania's needs 3980 million cubic metres of water were taken from water bodies in 1992, which included 480 million of cubic metres of underground water. The municipal and industrial wastewater discharge into surface water bodies amounts to 3540 million cubic metres. Out of this amount, 3170 million of cubic metres are relatively clean, 366 million cubic metres of wastewater should be treated better and 70 million cubic metres of water (or 19 %) are not treated at all. 96 million cubic metres of discharged water do not exceed the maximum allowable contamination limits (or 26.1 % of the total amount of wastewater discharges). The energy industry is the major water consumer in Lithuania (3800 million cubic metres). The Ignalina Nuclear Power Plant alone consumes 2900 million cubic metres of water for reactor cooling purposes. This amount of water is taken from the Drūkšiai Lake. In 1993, the amount of underground water for drinking and other household needs dropped by 259.8 million cubic metres, if compared to the period from 1989 to 1990.

2.10. The Sector of the Environmental Protection

After the restoration of Lithuania's Independence, the environmental protection has been focused on a few priority sectors, i.e. amendments to the environmental legislation, development of the environmental protection strategy, harmonisation of norms and standards with the EU, efficiency of the environmental impact assessment, monitoring, research, implementation of environmental information and education, strengthening of the co-operation with international organisations, integration of the environmental protection and the development of the society.

International co-operation under various conventions to resolve the above-mentioned vital issues is important to Lithuania. This co-operation aligns international and national legal documents and acts. The Government of Lithuania has already ratified a number of conventions and intends to ratify more in the near future.

Lithuania is a party to the following international conventions:

· Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki, 1974-1992). The 1974 Convention was accessed by the FSU and it came into force in 1980. Lithuania acceded to the 1974 Convention (no ratification needed) in 1992.
· Convention on Fishing and Conservation of the Living Resources in the Baltic Sea and Belts (Gdansk, 1973). Acceded to by Government Resolution No 685 of 10 July 1992.
· Convention on Future Multilateral Co-operation in the Northwest Atlantic Fisheries (Ottawa, 1978). Acceded to by Government Resolution No 685 of 14 July 1992.
· Convention on Civil Liability for Nuclear Damage (Vienna, 1963). Signed by the Government on 15 September 1992. Came into force on 15 December 1992.
· Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsaar, 1971). Acceded to by Government Resolution No 437 of 10 June 1993.

· Convention on Long-Range Transboundary Air Pollution (Geneva, 1979). Acceded to by Government Resolution No 737 of 27 October 1993.
· Protocol on the Application of the Convention on Civil Liability for Nuclear Damage (Vienna, 1963) and the joint Protocol relating to the Application of the Vienna and Paris Conventions on Civil Liability for Nuclear Damage. Both Protocols were ratified by Seimas Law No I-314 on 30 November 1993.
· Convention for the Protection of the Ozone Layer (Vienna, 1985). Acceded to by Government Resolution No 1279 of 19 December 1994.
· Convention on Early Notification of Nuclear Accidents (Vienna, 1986). Signed by the Government on 16 November 1996. Came into force on 16 December 1994.
· Protocol on Substances that Deplete the Ozone Layer (Montreal, 1987). Acceded to by Government Resolution No 1279 of 19 December 1994.
· Convention on Framework Convention on Climate Change (Rio de Janeiro, 1992). Signed by the Government and ratified by the Seimas on 23 February 1995.
· The Kyoto Protocol to the UNFCCC (Kyoto, 1997). Signed by the President of the Republic of Lithuania on 21 September 1998.
· Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel, 1989). Ratified by Seimas Law No VIII-1002 on 28 December 1998.
· Convention on Environmental Impact assessment in a Transboundary Context (ESPOO, 1991). Ratified by Seimas Law No VIII-1341 of 7 October 1999.
· Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992). Signed by the Government on 18 March 1992.

3. EMISSIONS OF THE GREENHOUSE GASES AND OTHER ANTHROPOGENIC POLLUTANTS INTO THE ATMOSPHERE IN DIFFERENT SECTORS OF ECONOMY ACCORDING TO THE SELECTED FIELDS OF ACTIVITIES IN 1990 AND 1998

3.1. Characteristics of energy demands

The greenhouse effect is influenced by many known and still unknown factors. However, a general opinion exists that it is mostly affected by human activities. Significant amounts of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) could be named as the main greenhouse gas emission. Other compounds emitted into the atmosphere contribute to the greenhouse effect indirectly, through photochemical reactions. The following compounds produce indirect impact: carbon monoxide (CO), nitrogen oxides (NO_x), and non-methane volatile organic compounds (NMVOC).

Such compounds as hydrofluorocarbons (HCF), chlorofluorocarbons (CFC), perfluorocarbons (PFC) and other compounds of this type are also considered to produce direct impact. However, in Lithuania, as in many other countries, freons have been replaced with non-toxic compounds in the production of refrigerators and domestic chemicals. In addition, no official statistical data are available about their emissions into the atmosphere and the emission factors for relevant industries.

Part of the carbon dioxide emitted into the atmosphere through human activity is absorbed by flora and the ocean. Some of it, however, remains in the atmosphere. As emitted main greenhouse gases remain in the atmosphere for some 50 to 200 years and their amount constantly increases, the effect of the current emissions will be noticeable during the forthcoming century.

Energy, transport and industry are major sources of greenhouse gas emission and other types of pollution. These sectors comprise a full cycle of fuel consumption, including production, transportation, storage, distribution, recycling and combustion. Lithuania owns several energy demanding industries consuming significant amounts of organic fuel and responsible for high emissions of pollutants into the atmosphere. It would be important to improve production technologies and minimise use of organic fuel.

The structure of used primary energy sources has changed significantly since 1990. Organic fuel consumption has decreased since 1990 and made only 62 % in the middle of last decade (1996), meanwhile the share of nuclear energy has increased to 38 % of the total. Increase of the share of nuclear energy in the total production of electricity (in 1996 up to 83 %, in 1999 – 72.9 %) has resulted in lower emissions of carbon dioxide, sulphur and nitrogen oxides, volatile organic compounds, solid particulates, and thereby in less intense pollution of the environment. The dynamics of the main indices in the Lithuanian energy sector over the last decade are presented in table 3.1.

Table 3.1. Main energy indices in Lithuania in 1990-1999

Indices		**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Electricity Production:	TWh	28.4	29.4	18.7	14.1	10.0	13.9	16.8	14.9	17.6	13.5
Ignalina NPP	-//-	*17.0*	*17.0*	*14.6*	*12.3*	*7.7*	*11.8*	*13.9*	*12.0*	*13.6*	*9.9*
Electricity Export	-//-	12.0	12.8	5.3	2.7	-1.1	2.7	5.2	3.5	6.1	2.7
Heat Production	Pkal	34.2	35.4	25.4	20.3	20.5	19.4	19.7	18.3	17.7	14.3
Crude Oil Processed	Mt	9.5	11.7	4.1	5.2	3.9	3.3	4.3	5.6	6.9	4.6
Export of Petroleum Products	Mt	2.0	3.5	-0.4	1.3	0.2	0.1	1.0	2.3	3.2	1.9
Primary Energy Consumption:	Mtne	17.8	18.5	11.9	9.4	8.1	9.1	9.9	9.2	9.9	8.2
Oil Products	-//-	*7.5*	*8.2*	*4.5*	*3.9*	*3.7*	*3.2*	*3.3*	*3.3*	*3.7*	*2.9*
Natural Gas	-//-	*4.7*	*4.8*	*2.8*	*1.5*	*1.7*	*2.0*	*2.2*	*2.0*	*1.8*	*1.8*
Coal	-//-	*0.8*	*0.6*	*0.4*	*0.4*	*0.3*	*0.2*	*0.2*	*0.2*	*0.1*	*0.1*
Nuclear energy	-//-	*4.4*	*4.4*	*3.8*	*3.2*	*2.0*	*3.1*	*3.6*	*3.1*	*3.5*	*2.6*
Other fuels	-//-	*0.4*	*0.5*	*0.4*	*0.4*	*0.4*	*0.5*	*0.6*	*0.7*	*0.8*	*0.8*
Final Energy Consumption:	-//-	9.0	9.4	6.6	5.2	4.9	4.8	4.7	4.6	4.5	4.1
Final Fuel	-//-	*4.9*	*5.2*	*3.6*	*3.0*	*2.7*	*2.7*	*2.7*	*2.7*	*2.6*	*2.5*
Final Heat	-//-	*3.1*	*3.2*	*2.2*	*1.6*	*1.6*	*1.5*	*1.4*	*1.3*	*1.3*	*1.0*
Final Electricity	-//-	*1.0*	*1.0*	*0.8*	*0.6*	*0.6*	*0.6*	*0.6*	*0.6*	*0.6*	*0.6*
FE/PE	%	51	51	55	55	60	53	53	50	46	50

3.2. Economy and energy

During the last decade, the Lithuanian economy, including its industry and energy sectors, has been influenced by many changes. Two main periods could be identified in the economic development:

1. 1991-1994 – a period of economical decline typical to many post-communists countries;
2. 1995-1998 – stabilisation and development of economy.

Development in the second period could also be noticed while investigating data about changes in gross domestic product (GDP). In 1994, GDP was calculated as 56 % of the 1990 level. In 1995 GDP increased by 3.3 %, 1996 – 4.7 %, 1997 – 6.1 % (Figure 3.1).

In 1997, industry (including electricity, gas and water supply) made up the major share of GDP – 25.2 %. In 1998, GDP growth was hampered by the Russian economic crisis and hence GDP failed to reach an expected level of 5 %. In 1999, GDP decreased by 4.1 % and its growth was noticeable only in certain service sectors (transport, communications, financial co-operation, hotels, etc.).

Changes in final consumption of energy are similar to changes in GDP (Figure 3.2). During the last years, however, this ratio has been slightly changed: GDP has been moving upwards and final consumption of energy has been falling. This could have been influenced by the increase of energy efficiency and by the relative increase of the service sector.

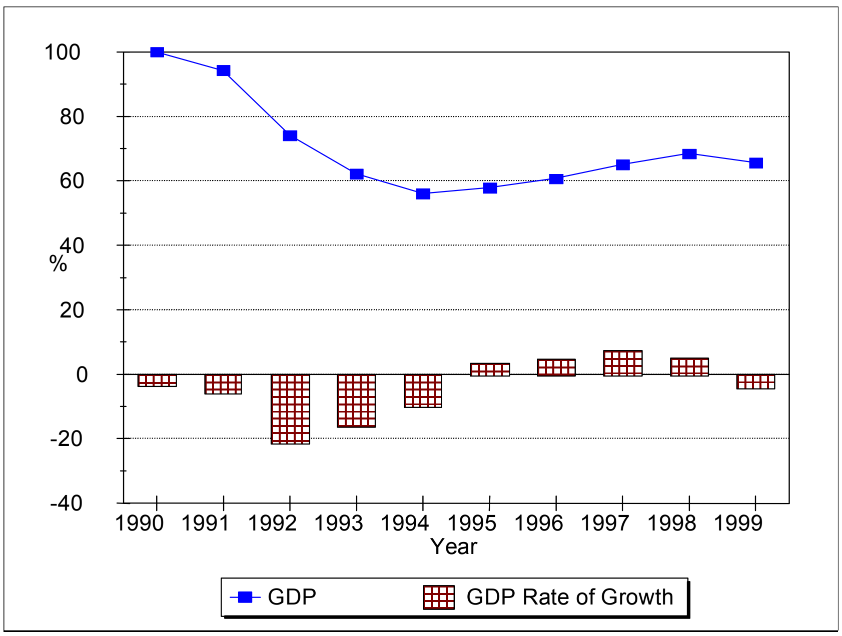


Figure 3.1. Changes in GDP and its annual growth rate.

Final consumption of energy in different sectors of economy has been also changing significantly during 1990-1999 (Figure 3.3). Final consumption of energy resources has considerably decreased in agricultural and construction sectors due to downturn of production. Less energy has been also consumed in the industrial sector. Meanwhile, the impact of transport, household and service sectors (trade and services) on final consumption of energy is less important.

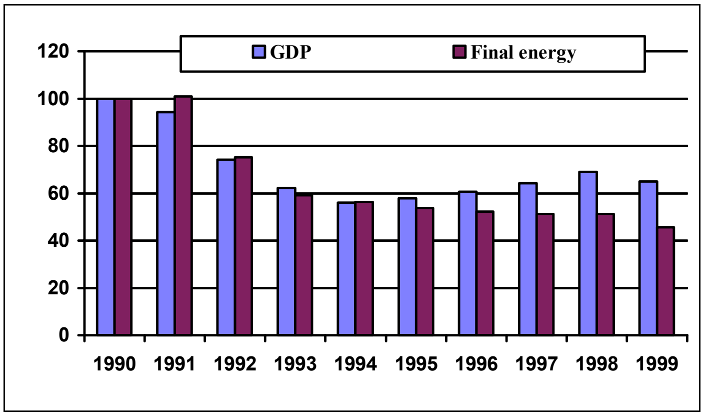


Figure 3.2. Final energy consumption and GDP (index in 1990 = 100)

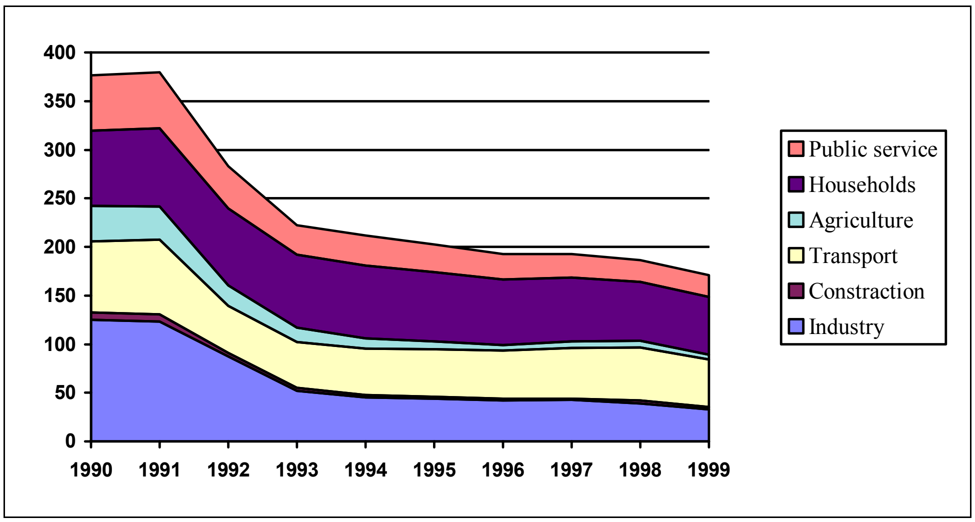


Figure 3.3. Final energy consumption in different economic sectors, PJ

Primary energy consumption during economic stabilisation (1995-1998) is presented in Figure 3.4. It allows concluding that petroleum products made the greatest share of organic fuel in a total balance. Decline of coal consumption and minor increase in the consumption of local resources is noticeable. A positive feature is rather considerable share of ecologically cleaner fuel – natural gas. It is planned to constantly increase the segment of natural gas in the total fuel balance.

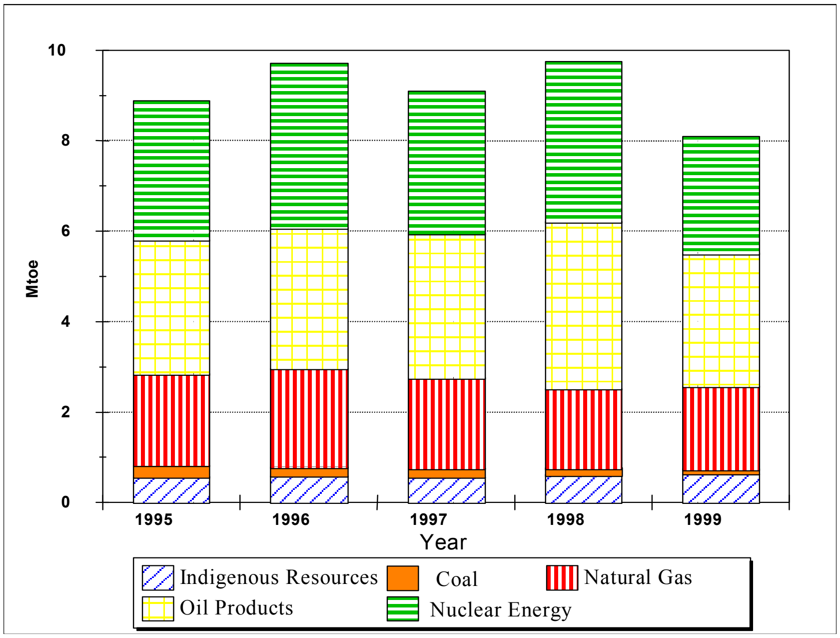


Figure 3.4. Primary energy consumption in 1995-1999

3.3. Methodology

An inventory of greenhouse gas emission is made in accordance with the methodology recommended by the Intergovernmental Panel on Climate Change (IPCC), i.e., using a TOP-DOWN approach, where accuracy of the primary data is very important. This evaluation method is applied both for assessment of individual small-scale and large-scale entities and on using data from official statistics: statistical balance figures of fuel consumption in energy, industry, transport, agriculture, commercial and household sectors.

Surviving through the economic blockade imposed by the Soviet Union back in 1990, Lithuania was forced to look for different furtive ways and means to provide fuel supplies to various sectors, like energy, industry and transport as well as private consumers. Unauthorised fuel supplies during the blockade have upset the accuracy and reliability of the official statistical data. Later the data have been revised and compared with the data from the institutions consuming primary energy sources. However, the official statistics of 1991 remained inaccurate and failed to reflect the actual situation. Thus, the official data of 1991 are not available in official publication No 2190 “Kuro ir energijos balansas // Energy Balance 1990-1995” published by the Department of Statistics of the Republic of Lithuania in 1997 in Vilnius. This sets a precedent to avoid referring to 1991 inventory data or use unofficial statistics.

No common national factors were applied for greenhouse gas emission in the course of the preparation of the National Implementation Strategy of the UNFCCC and the first National Report on Climate Change. More recently, a list of the recommended emission factors for different type of fuel and consumer groups has been prepared. Pollution is calculated based on these emission factors.

Lately, however, it has been recommended to carry out calculations based on the IPCC software product, a beta-version programme of the Common Reporting Format (CRF). This programme was used in recalculating the emissions of the greenhouse gases and other pollutants into the environment in 1998, although this document presents data from other years (except the base year 1990 and 1998). As regards data for other years, recalculations in accordance with the CRF, CORINAIR and other programmes have already started and are in process. The results will become available after the work is completed.

3.4. Emissions of the main greenhouse gases and other types of gas

Emissions of the main greenhouse gases and other type of pollutants having impact on climate change in 1990 are presented in Table 3.2, and emissions for 1998 in Table 3.3.

Table 3.2. Direct and indirect impact of greenhouse gas emission in 1990, (Gg)

GHG sources and sinks categories	*CO_2 Emissions*	*CO_2 Removals*	*CH_4*	*N_2O*	*NO_x*	*CO*	NMVOC
TOTAL:	**42338**	**11651**	**377.95**	**13.15**	**178.29**	**644.1**	**93.65**
1. All Energy	*37332*		*31.35*	*0.95*	*177.89*	*644.1*	*81.36*
1.A. Fuel combustion	37332		5.25	0.95	177.89	644.1	72.76
1.A.1. Energy and transformation activities	16352		0.73	0.36	58.63	43.8	0.74
1.A.2. Industry	5379		0.44	0.14	10.90	18.4	0.44
1.A.3. Transport	5791		1.42	0.19	71.69	492.3	65.03
1.A.4. Households	6313		0.73	0.16	30.16	42.1	3.84
1.A.5. Other	2882		0.43	0.09	6.02	11.0	0.43
Biomass, combustion for energy production	615		1.50	0.01	0.49	36.5	2.28
1.B. Fugitive fuel emission			26.1				8.6
2. Industrial processes	*2203*		*0.2*	*1.4*	*0.4*		*1.2*
3. Use of solvents and other products							*11.1*
4. Agriculture			*180.7*	*10.8*			
4.A. Enteric fermentation			157.3				
4.B. Animal waste			23.4				
4.C. Agricultural soils				10.8			
3. Land use change and forestry	*2803*	*11651*					
5.A. Changes in forest and other biomass stocks		10375					
5.B. Forest and grassland conversion	2803						
5.C. Abandonment of managed lands		1276					
6. Waste			*165.7*				

6.A. Landfills	162.0
6.B. Wastewater	3.7

A comparison of both tables obviously shows that the amount of greenhouse gas emission and other pollutants caused by organic fuel combustion has decreased twice. This tendency with some deviations prevails in all economic sectors as well as in land-use change and forestry, solid waste handling, recycling, and storage, and in wastewater treatment.

Table 3.3. Direct and indirect impact of greenhouse gas emission in 1998, (Gg)

GHG sources and sinks categories	*CO_2 Emissions*	*CO_2 Removals*	*CH_4*	*N_2O*	*NO_x*	*CO*	*NMVOC*
TOTAL:	**17550.5**	**9658.0**	**176.75**	**11.11**	**74.02**	**368.32**	**104.42**
1. All energy	*16103*		*25.28*	*0.19*	*68.17*	*364.37*	*61.26*
1.A. Fuel combustion	16103		7.90	0.19	68.17	364.37	61.26
1.A.1. Energy and transformation activities	7923		0.27	0.05	22.01	1.98	0.59
1.A.2. Industry	964		0.05	0.01	2.62	0.38	0.09
1.A.3. Transport	3754		0.67	0.02	38.49	242.13	46.66
1.A.4. Households	634		0.38	0.00	1.08	3.36	0.38
1.A.5. Other	706		0.10	0.02	1.60	7.41	0.73
Biomass, combustion for energy purpose	2122		6.43	0.09	2.37	109.11	12.81
1.B. Fugitive fuel emission			17.38				
2. Industrial processes	*1196*		*0.02*	*9.27*	*5.85*	*3.95*	*37.17*
3. Use of solvents and other products							*5.99*
4. Agriculture			*82.99*	*1.65*			
4.A. Enteric fermentation			72.89				
4.B. Animal waste			10.10				
4.C. Agricultural soils				1.65			
5. Land use change and forestry	*64.6*	*9658.0*					
5.A. Changes in forest and other biomass stocks		8622.9					
5.B. Forest and grassland conversion	64.6						
5.C. Abandonment of managed lands		1035.1					
6. Waste	*186.9*		*68.46*				
6.A. Landfills	186.9		67.96				
6.B. Wastewater			0.50				

3.5. CO_2 Emission and Removal

Carbon dioxide emission is a result of all combustion processes where coal is involved. This type of emission is unavoidable in organic fuel combustion either. CO_2 is regarded to be a dominant component of emissions from major pollution sources, i.e. energy, transport and industry (Table 3.4).

Table 3.4. CO_2 emissions 1990-1998. (Gg)

	1990*	1992	1993	1994	1995	1996	1997	1998	1998*
1. Energy and transformation activities	37332	21194	16777	16609	14289	14976	13766	14465	16103
2. Industrial processes	2203	n/a	n/a	n/a	390	388	381	1196	1196
5. Land use change and forestry	2803	n/a	n/a	n/a	n/a	n/a	n/a	64.6	64.6
6. Waste									186.9
TOTAL:	**42338**							**15726**	**17750**
5. Land use change and forestry	-11651	n/a	n/a	n/a	n/a	n/a	n/a	-9658	-9658

** - Data calculated in accordance with IPCC Guidelines*

3.6. CO_2 Emission in Fuel Combustion

Fuel combustion processes in energy, industry, transport, commercial sector, household, agriculture and other sectors produce most of the carbon dioxide emissions. Calculations of CO_2 emissions into the atmosphere for different sectors caused by different types of fuel combustion are presented in Table 3.5.

Table 3.5. CO_2 emission from fuel combustion in 1990-1998 (Gg)

	1990	1992	1993	1994	1995	1996	1997	1998	1998**
1.A.Fuel combustion									
Total:	***37332***	***21194***	***16777***	***16609***	***14289***	***14976***	***13766***	***14465***	***13982***
1.A.1. Energy & transformation activities	**16425**	**9281**	**7129**	**7653**	**6692**	**6887**	**6225**	**6808**	**7923**
1.1. Oil products	8072	5047	4829	5081	3846	3932	3401	4554	5153
1.2. Natural gas	7985	4041	2056	2364	2705	2865	2749	2176	2689
1.3. Solid fuel	368	193	244	208	141	90	75	78	81
1.A.2. Industry	**5396**	**3627**	**2642**	**2156**	**1865**	**1940**	**2057**	**2287**	**964**
1.1. Oil products	2919	2970	2101	1647	1430	1550	1407	1540	551
1.2. Natural gas	704	508	325	318	324	336	345	378	359
1.3. Solid fuel	1773	149	216	191	111	54	315	369	54
1.A.3. Transport	**5791**	**3472**	**3462**	**4273**	**3586**	**3893**	**3770**	**3933**	**3754**
1.1. Oil products	5791	3402	3434	4245	3568	3885	3769	3932	3711
1.2. Natural gas		70	10	11	8	8	1	1	1
1.3. Solid fuel			18	17	10				42***
1.A.4.Commercial heating	**1750**	**1366**	**1107**	**946**	**854**	**957**	**582**	**480**	**462**
1.1. Oil products	366	353	309	196	242	212	158	90	86
1.2. Natural gas	282	282	58	80	84	89	84	50	48
1.3. Solid fuel	1102	731	740	670	528	656	340	341	328
1.A.5.Residential	**3330**	**2056**	**1577**	**991**	**825**	**864**	**836**	**707**	**634**

heating									
1.1. Oil products	823	591	255	194	215	193	233	265	234
1.2. Natural gas	525	703	661	493	438	433	352	294	287
1.3. Solid fuel	1982	762	661	304	172	238	251	148	113
1.A.6. Agriculture	**1730**	**794**	**775**	**497**	**391**	**436**	**295**	**250**	**244**
1.1. Oil products	1474	718	743	472	372	408	272	229	223
1.2. Natural gas	65	53	11	12	12	16	18	17	16
1.3. Solid fuel	191	23	21	13	7	12	5	4	5
1.A.7. Other*	**2910**	**597**	**85**	**93**	**76**	**-**	**-**	**-**	**-**
1.1. Oil products	309	514	48	53	36	-	-	-	-
1.2. Natural gas	12	13	4	3	3	-	-	-	-
1.3. Solid fuel	2589	70	33	37	37	-	-	-	-

Note:
* - *official data for 1996 of this sector is not available*
** - *Data calculated in accordance with IPCC Guidelines, (excluding 2122 Gg CO_2 emissions from biomass burning)*
*** - *Emission from LPG used*

The data presented in Table 3.5 provides information about the emissions of combustion products in selected sectors and according to different types of fuel consumed. In 1990, the consumption of fuel in energy sector was approximately 3,5 times higher than in industry sector. In the meantime, CO_2 emission has been relatively lower due to the structure of the fuel consumption balance. Natural gas used in energy makes up to 50 % of all combusted fuel. Carbon dioxide emission factor from the combustion of natural gas is the lowest comparing with other types of fuel. It is therefore natural that the increase in consumption of this type of fuel results in lower CO_2 emission.

In 1998, the situation changed, and gas made 87 % of the total fuel consumed by industry. Therefore, emissions from fuel combustion processes are relatively low in comparison with the energy sector.

Since 1997, the official statistics for bunkers at seas are available. The statistical data presented in accordance with the IPCC programme enable to calculate the amount of pollutants accumulated in 1998 (Table 3.6). Calculation of CO_2 emission has been carried out for the following years based on general emission factors.

Table 3.6. International Bunkers

	1997	1998	1999
CO_2 emissions (Gg)	192	156	231

3.7. CO_2 Emission from the Industrial Sector

Technological processes used by industries are the sources of rather large amounts of CO_2 emission into the atmosphere. However, such emission differs from industrial combustion processes described in the fuel combustion section. Cement, lime and brick production processes are major CO_2 emission sources.

Total amounts of CO_2 emission from industrial production processes are presented in Table 3.7.

Table 3.7. CO_2 emission from production process during 1990-1998 (Gg)

	1990	1992	1993	1994	1995	1996	1997	1998
2. Industrial processes	2203	n/a	n/a	n/a	390	388	381	1196
2.1. Cement production	2069	750	360	350	320	345	345	393
2.2. Lime production	134	n/a	n/a	n/a	70	49	36	52
2.3. Ammonia production	n/a	n/a	n/a	n/a	n/a	n/a	n/a	751

3.8. CO_2 Emission from Forestry and Agriculture

Rather significant amounts of CO_2 emission are the result of land-use changes as well as meadow and forest transformation.

Table 3.8. CO_2 removal from change in biomass stock

	1990	1993	1998
Growing stock volume (mill. m^3)	297	334	348
Mean growing stock (m^3/ha)	163	180	184
Average age of stands	48	49	51
CO_2 removal (Gg)	11651	n/a	9658

3.9. CH_4 Emission

Agriculture and waste are the major sources of methane emission. General emissions in 1990-1998 are presented in Table 3.9.

Table 3.9. CH_4 emission in 1990-1998 (Gg).

	1990*	1992	1993	1994	1995	1996	1997	1998	1998*
1. All energy	31.35	30.60	27.73	25.39	25.73	27.92	30.62	29.24	25.28
1.A. Fuel combustion	5.25	8.60	8.73	7.39	6.73	7.92	11.62	11.86	7.90
1.A.1.Energy & transformation activities	0.73	0.52	0.41	0.46	0.41	0.42	0.38	0.40	0.32
1.A.2. Industry	0.44	0.21	0.15	0.13	0.11	0.11	0.16	0.18	0.07
1.A.3. Transport	1.42	2.10	1.59	1.83	1.99	2.28	2.18	2.12	0.67
1.A.4. Commercial heating	0.22	1.23	1.22	1.07	0.86	1.09	0.69	0.65	0.41
1.A.5. Residential heating	1.80	4.17	4.98	3.67	3.21	3.95	8.16	8.42	6.30
1.A.6. Agriculture	0.21	0.24	0.31	0.16	0.08	0.07	0.05	0.09	0.13
1.A.7. Other	0.43	0.13	0.07	0.07	0.07	-	-	-	-
1.B.Fugitive fuel emissions	26.10	22.00	19.00	18.00	19.00	20.00	19.00	17.38	17.38
2. Industrial processes	0.20	n/a	n/a	n/a	0.01	0.01	0.01	0.02	0.02
4. Agriculture	180.70	308.0	302.0	301.0	95.00	89.00	88.00	82.99	82.99
6. Waste	165.70	n/a	n/a	n/a	139.0	130.0	145.0	68.46	68.46
TOTAL:	**377.95**				**259,74**	**246,93**	**233,01**	**180.71**	**176.75**

**- Data calculate by IPCC Guidelines*

3.10. N_2O Emission

Nitrous oxide emission is presented in Table 3.10. Agriculture is the major source of N_2O emission.

Table 3.10. N_2O emission in 1990-1998 (Gg)

	1990*	1992	1993	1994	1995	1996	1997	1998	1998*
1. All energy	0.95	0.88	0.77	0.61	0.49	0.54	0.54	0.55	0,19
1.A. Fuel combustion	0.95	0.88	0.77	0.61	0.49	0.54	0.54	0.55	0.19
1.A.1. Energy & transformation activities	0.36	0.24	0.20	0.22	0.18	0.18	0.17	0.20	0.06
1.A.2. Industry	0.14	0.09	0.07	0.05	0.05	0.05	0.05	0.06	0.01
1.A.3. Transport	0.19	0.11	0.12	0.14	0.13	0.14	0.14	0.15	0.02
1.A.4.Commercial heating	0.04	0.05	0.05	0.04	0.03	0.04	0.02	0.02	0.01
1.A.5.Residential heating	0.09	0.35	0.30	0.14	0.09	0.12	0.15	0.11	0.08
1.A.6. Agriculture	0.04	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
1.A.7. Other	0.09	0.02	0.01	0.01	-	-	-	-	-
2. Industrial processes	1.4	n/a	n/a	n/a	n/a	n/a	n/a	9.27	9.27
4. Agriculture	10.8	n/a	n/a	n/a	n/a	n/a	n/a	1.65	1.65
TOTAL:	**13.15**							**11.47**	**11.11**

*- *Data calculate by IPCC Guidelines*

3.11. NO_x, CO and NMVOC Emission

Nitrogen oxides (NO_x), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC) are mainly emitted from energy sector as a result of organic fuel combustion and oil processing (Table 3.11).

Table 3.11. NO_x, CO and NMVOC emission in 1990-1998 (Gg)

	1990*	1992	1993	1994	1995	1996	1997	1998	1998*
				NO_x emissions					
1. All energy	***177.89***	***82.35***	***78.86***	***77,89***	***63.59***	***66.18***	***58.46***	***61.94***	***68.17***
1.A. Fuel combustion	**177.89**	**82.35**	**78.86**	**77,89**	**63.59**	**66.18**	**58.46**	**61.94**	**68.17**
1.A.1. Energy & transformation activities	58.63	25.44	19.51	21.04	18.68	19.28	17.18	19.46	22.19
1.A.2. Industry	10.90	6.56	4.57	3.77	3.20	3.34	4.14	4.66	2.70
1.A.3. Transport	71.69	34.78	39.92	42.73	37.90	39.44	33.44	34.43	38.49
1.A.4.Commercial heat.	3.27	2.49	2.37	1.91	1.58	1.92	1.20	1.06	1.36
1.A.5.Residential heat.	4.77	2.60	2.31	1.53	1.29	1.42	1.97	1.88	3.06
1.A.6. Agriculture	22.61	9.86	10.00	6.73	0.79	0.78	0.53	0.45	0.37
1.A.7. Other	6.02	0.62	0.18	0.18	0.15	-	-	-	-
2. Industrial processes	0.40	3.00	2.00	2.00	0.60	0.20	0.40	5.85	5.85
TOTAL:	**178.29**	**85.35**	**80.86**	**79.89**	**64.19**	**66.38**	**58.86**	**67.79**	**74.02**
				CO emissions					

1. All energy	***644.08***	***345.88***	***301.05***	***287,04***	***282.17***	***315.63***	***357.31***	***354.50***	***364.37***
1.A. Fuel combustion	**644.08**	**345.88**	**301.05**	**287,04**	**282.17**	**315.63**	**357.31**	**354.50**	**364.37**
1.A.1. Energy & transformation activities	43.94	12.07	10.93	11.59	9.01	9.12	8.21	9.65	3.79
1.A.2. Industry	18.43	12.70	8.36	7.56	5.99	6.75	5.89	5.75	1.79
1.A.3. Transport	492.30	212.49	158.29	184.55	199.13	219.85	221.26	215.81	242.13
1.A.4.Commercial heat.	5.13	25.15	27.92	22.36	17.87	22.61	13.57	13.09	13.13
1.A.5.Residential heat.	46.00	61.61	69.18	48.61	41.58	51.44	104.04	106.17	101.97
1.A.6. Agriculture	27.27	17.76	24.53	11.56	6.94	5.86	4.34	4.03	1.56
1.A.7. Other	11.01	4.10	1.84	1.71	1.65	-	-	-	-
2. Industrial processes		8.00	7.00	7.00	5.00	4.00	4.00	3.95	3.95
TOTAL:	**644.08**	**353.88**	**308.05**	**294.04**	**287.17**	**319.63**	**361.31**	**358.45**	**368.32**

NMVOC emissions

1. All energy	81.36	52.21	44.86	45.59	43.74	49.97	54.96	54.70	61.26
1.A. Fuel combustion	72.76	47.21	40.86	41.59	41.74	46.97	51.96	51.70	61.26
1.A.1. Energy & transformation activities	0.74	0.54	0.43	0.49	0.44	0.45	0.40	0.43	0.68
1.A.2. Industry	0.44	0.92	0.48	0.54	0.41	0.51	0.46	0.41	0.12
1.A.3. Transport	65.03	37.30	28.38	32.68	34.81	39.13	38.44	37.56	46.66
1.A.4.Commercial heat.	0.24	1.10	1.58	0,96	0.76	1.02	0.71	0.68	1.43
1.A.5.Residential heat.	2.51	3.53	5.10	4.41	4.20	5.07	11.34	12.09	12.18
1.A.6. Agriculture	3.37	3.61	4.74	2.39	1.01	0.79	0.61	0.53	0.19
1.A.7. Other	0.43	0.21	0.15	0.12	0.11	-	-	-	-
1.B.Fugitive fuel emissions	8.6	5.00	4.00	4.00	2.00	3.00	3.00	3.00	0.00
2. Industrial processes	1.2	6.00	6.00	6.00	25.00	25.00	19.00	37.17	37.17
3. Solvent used	11.1	7.00	6.00	6.00	8.00	8.00	7.00	5.99	5.99
TOTAL:	**93.66**	**65.21**	**56.86**	**57.59**	**76.74**	**82.97**	**80.96**	**97.86**	**104.42**

*- *Data calculate by IPCC Guidelines*

3.12. Radiation Effect of the Greenhouse Gases

Gases emitted as a result of human activities have different radiation impact and influence on greenhouse effect. Projections of climate change are based on the fact that radiation impact of different greenhouse gas emissions is expressed in carbon dioxide equivalent. In order to assess the impact of this equivalent, the concept of global warming potential (GWP) is used. However, the GWP of a direct impact gas is not a permanent value: it depends on the period for which radiation impact is calculated. GWP values for different periods are presented in Table 3.12.

Table 3.12. Global warming potential values of direct impact greenhouse gases for different periods

	GWP factors		
	20 year	100 year	500 year

Carbon monoxide Methane Nitrous oxide	1 56 280	1 21 310	1 6.5 170

In order to present changes in the emissions greenhouse gases, evaluation of the calculated in CO_2 equivalents in 1990 and 1998 is presented in Table 3.13. Calculations were made using GWP values.

Table 3.13.

	CO_2	CH_4	N_2O	TOTAL
GWP factors (for 100 year)	1	21	310	
1990				
Total emission (Gg)	42338	377.95	13.15	42729.1
Total emission by CO_2 equivalent (Gg)	42338	7937	4076	54351
Share of CO_2 in total emission, (%)	77.9	14.6	7.5	100
1998				
Total emission (Gg)	16694	176.7	11.1	16881.8
Total emission by CO_2 equivalent (Gg)	16694	3710.7	3441	23845.7
Share of CO_2 in total emission, (%)	70	15.6	14.4	100

General greenhouse gas emissions expressed in carbon dioxide equivalent are presented in Figure 3.5. Stabilisation of emission started after the rapid decrease of greenhouse gas emission in 1991-1994.

Greenhouse gas emissions are closely related to changes in economy and have similar trends of change. However, various tendencies and activities in certain sectors of economy differ as regards characteristics of changes and amounts of gas emissions. Changes in GDP and CO_2 emission, provided in the Figure 3.6, reflect changes in economy as regards various sectors within the period under analysis.

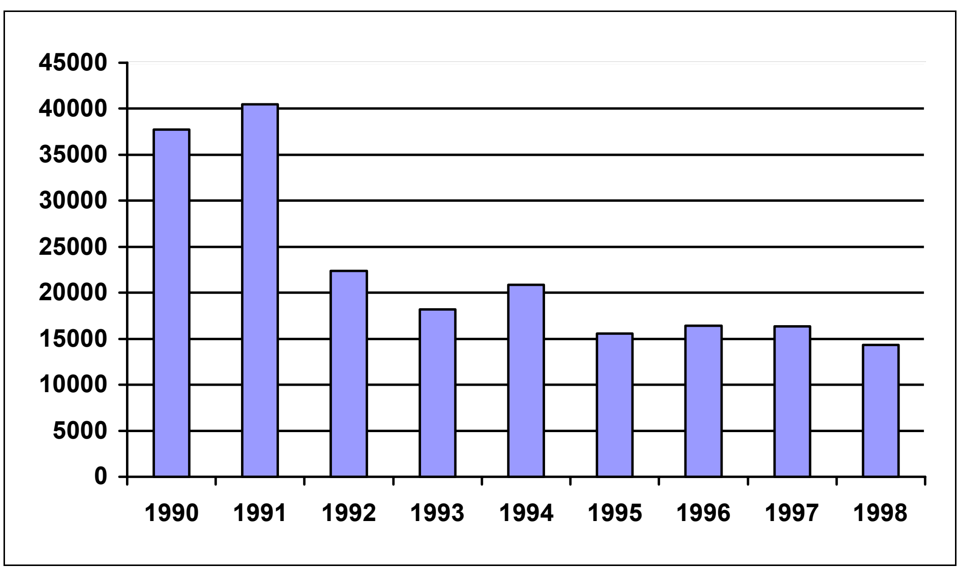


Figure 3.5. Greenhouse gas emission in CO_2 equivalent caused by fuel combustion in Lithuania in 1990-1998, Gg.

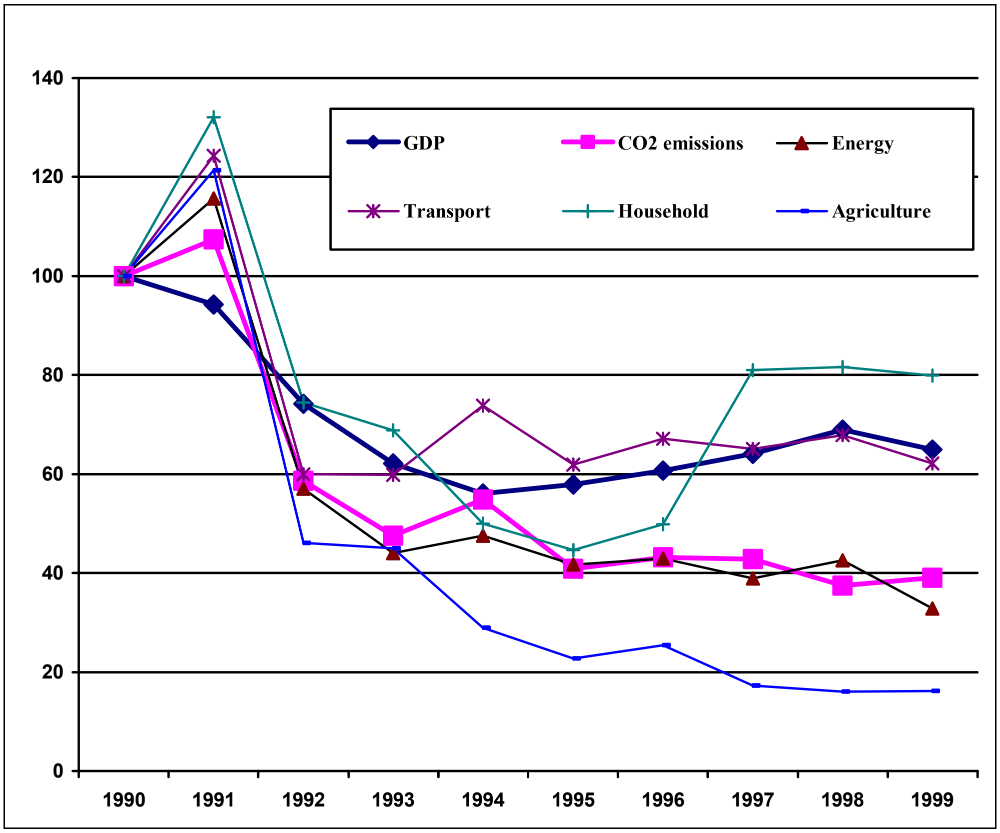


Figure 3.6. Dynamics of GDP and CO_2 emissions (1990 index = 100)

Decrease of the carbon dioxide emission index by 80 %, as compared with 1990, in agricultural sector reflects a decline in agricultural production and decrease in consumption of energy, rather than improved energy efficiency. Emission indices of energy, industry, small enterprises that are major sources of CO_2 emission change similarly to the total carbon dioxide emission index. Change in household CO_2 emission index is influenced by decreased energy consumption in economic sectors and changes in the structure of organic fuel consumed by households. Local fuel resources have been increasingly used for heating.

3.13. Projections of Greenhouse Gas Emissions

Bearing in mind, that the volume of greenhouse gas emissions is influenced by the consumption of energy, it is necessary to foresee, as accurately as possible, future energy demand and to evaluate the possibilities of saving, while making projections of emissions as well as their general impact on the atmosphere and climate. Various institutions work on different forecasts for energy demands. Hence, we will use a forecast prepared by the Lithuanian Institute of Energy, which was used in the National Energy Strategy. The forecast was prepared based on energy consumption estimated as accurately as possible and on the basis of different factors influencing consumption as well as assumptions for future changes. The projection was made on a simulation model MAED (Model of Analysis of Energy Demands).

Final energy consumption has been presented in detail not only by economic sectors (industry and its sectors, agriculture, transport, services and household sector) but also according to certain industrial processes, branches of transportation and social needs of the population. 1996 was taken as the base year.

Projections of final energy demands have been presented in detail according to sectors of economy and energy sources. Energy saving potential has been evaluated for certain economic branches. General growth of economy and income has a significant impact on the introduction of new technologies and on a possibility to swiftly reduce energy consumption. Thus, three scenarios (rapid development, moderate development and slow development) were selected to investigate two options in estimating energy saving potential:

1) basic efficiency;
2) high efficiency.

Basic efficiency option investigated two main factors influencing saving potential: growing prices for fuel and energy; limited investment hampering expeditious introduction of new advanced technologies in production. According to this option, expected energy savings could be up to 20 %.

High efficiency scenario assumes energy efficiency in all sectors, successful introduction of advanced technologies, rapid economic development. It would create favourable conditions to renew industrial funds and make a maximum use out of saving potential. The latter is introduced in the National Energy Efficiency Programme (approved in 1996, presently a revision of the programme is in process). According to this scenario, the expected energy savings in various economic sectors range from 12 % to 45 %.

The highest energy saving potential is expected in household, trade and services sectors. For example, it is possible to save up to 45 % of energy used for building heating if buildings are properly insulated and modern heating systems are installed. However, insulation and modernisation require high investment and their payback extends long into the future. Therefore, real benefit is difficult to expect. With this in mind, it is realistic to start with less costly measures: partial modernisation of heating systems and introduction of general registration. This could save up to 14 PJ of energy used for heating.

In transport sector, cars are major energy consumers. Energy saving potential could be realised through integrated improvement of transport systems at the national, sectorial and enterprise level combined with various other measures.

Since 1990, energy consumption in industry has decreased 3 times and now makes up approximately 20 % of the total final energy consumption. Comparing the technologies used in the Lithuanian industry against the technologies of the western countries one may conclude that energy consumption per production unit in our country is by 20-50 % higher. Therefore, the best way to save energy in the industrial sector is through the introduction of new energy-efficient technologies. They would allow saving one third of the energy consumed by industries.

Expected energy demand estimated according to the methodology described earlier is presented in Figure 3.7. Indices of the increased energy demands are presented in Table 3.14.

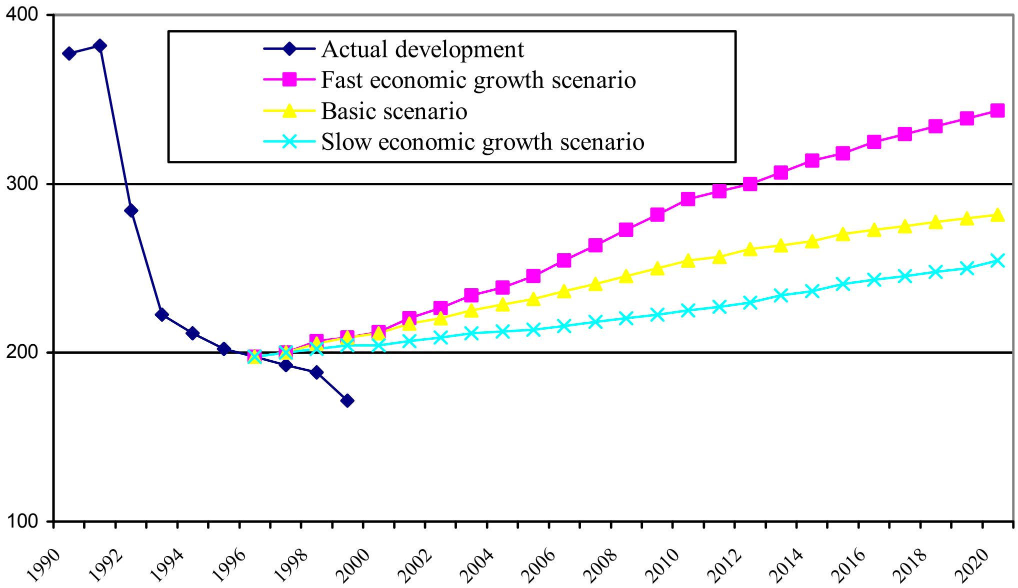


Figure 7. Final energy demand implementing energy efficiency policy (PJ)

Projection of final energy demands in some economic sectors is presented in Figure 2.3. This Figure clearly presents the trends.

The use of fossil fuel and oil products for heating purposes will decrease in the final energy demand structure according to the types of energy (Figure 3.8). The basic scenario foresees an increase in natural gas consumption twice, petrol and electricity demands – about 1,7 times.

Primary energy demand is influenced by both internal factors (rate of economic development, increase of energy consumption efficiency, fuel and energy losses, importance of energy sector, fuel consumption in production of fertilisers and other non-energy production), and external, such as the volume of power surplus export.

Table 3.14. Final energy demands

	Scenarios		
	Slow economic growth, basic efficiency	Moderate economic growth, high efficiency	Fast economic growth, high efficiency
Energy consumption, PJ			

1990	376.4	376.4	376.4
1995	202.4	202.4	202.4
2000	205.0	211.4	213.2
2005	213.7	231.8	245.8
2010	223.9	254.2	290.5
2015	238.5	268.4	318.0
2020	253.6	282.6	343.1
Index (1990 m. = 100)			
1990	100	100	100
1995	53.8	53.8	53.8
2000	54.4	56.1	56.6
2005	56.7	61.6	65.3
2010	59.5	67.5	77.1
2015	63.3	71.3	84.4
2020	67.3	75.0	91.1

Given other conditions are similar, primary energy demands and their structure depend on the operational regime of Ignalina Nuclear Power Plant. However, the Government of Lithuania approved a political decision to decommission the Ignalina NPP, therefore national primary energy demands by 2020 are summarised in Figure 2.2.

The estimates given in Figure 2.2 allow calculating the main greenhouse gas emission, namely, carbon dioxide emission in the energy sector after combustion of the organic fuel in the amount that meets primary energy demands (Figure 3.9). The calculations were based on the two possible options:

1) Closure of the Unit 1 of Ignalina NPP in 2005. Operation of the Unit 2 extends beyond 2010;
2) Closure of the Unit 1 of Ignalina NPP in 2005. Closure of the Unit 2 in 2010 and subsequent energy generation by combustion power plants.

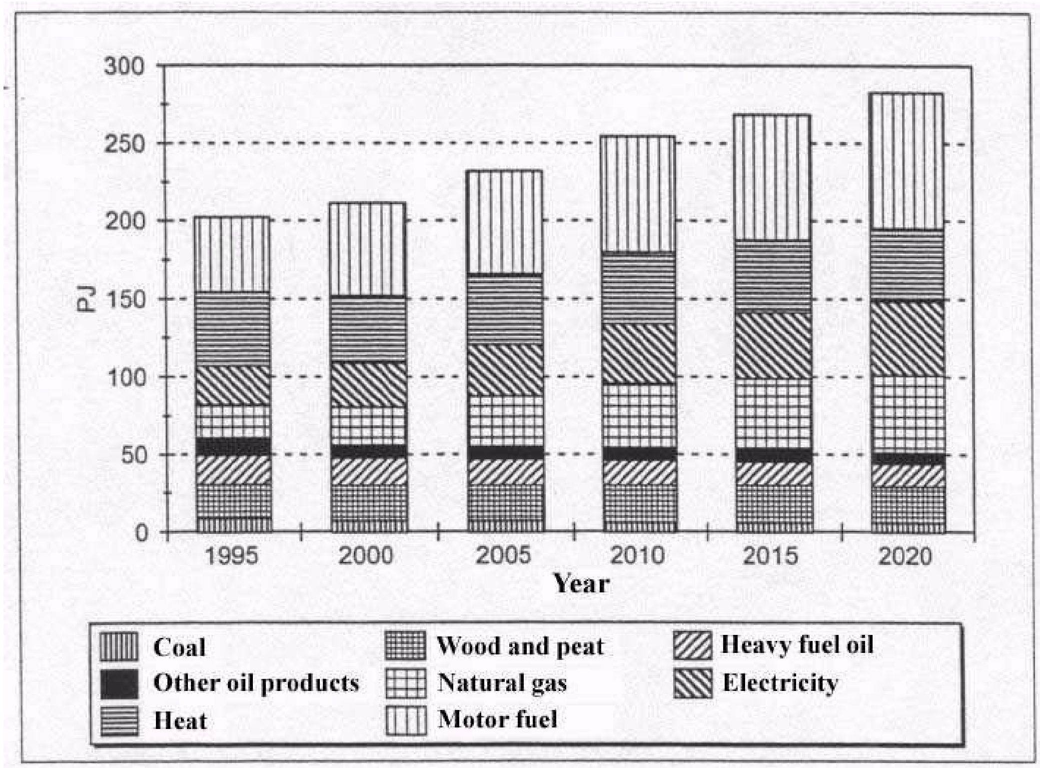


Figure 3.8. Final energy demands: according to type of fuels (basic scenario)

Economic development projections in Lithuania expect a revival of the industrial sector and increase in energy demands, and hence the calculations suggest that, after the closure of the Ignalina Nuclear Power Plant, atmospheric pollution in Lithuania will significantly increase. Figure 3.9 shows that after both units of Ignalina NPP are closed down in 2010 and the power generation is taken over mainly by combustion power plants, carbon dioxide emission caused by fuel combustion will become similar to that of the 1990 level. Calculations were made on the assumption that the Ignalina NPP will be closed down and the power production needs will be compensated by the increased consumption of natural gas. Besides, the estimates do not reflect the amount of carbon dioxide emission resulting from wood and other biomass combustion. Therefore, after intensive industrial development starts and energy demands increase simultaneously with unfavourable changes in the structure of the fuel balance, Lithuania may face difficulties in implementing the requirements of international conventions in the field of atmosphere protection. In case the formation of a favourable fuel balance structure fails, and the share of natural gas is less that expected, it will be complicated to meet the commitment of the United Nations Framework Climate Change Convention requiring to stabilise CO_2 emission to the level of 1990.

Moreover, this becomes of great importance, as Lithuania signed the Kyoto Protocol at the International Climate Change Conference in 1997 and committed itself to the agreement to reduce greenhouse gas emissions into the atmosphere at global level by 5,2 % until 2008-2012. Many European countries, including Lithuania, will have to reduce their greenhouse gas emissions by 8 % until this period. Bearing in mind the closure of Ignalina NPP, our country will have to introduce certain measures in order to fully meet the condition in the event of unexpected situations. Data presented in Figure 3.9 show that CO_2 emissions in energy sector in 2012 will meet not only UN FCCC requirements but also the Kyoto Protocol requirements to reduce CO_2 emission by 8 % from the 1990 level. However, as mentioned above, these calculations and conclusions were made with consideration of the IPCC reference that carbon dioxide from biomass combustion process is not included into the total amount of CO_2 emission. As the share of local fuel, including biomass, will increase in the total fuel balance, the amount of carbon dioxide (including CO_2 emission from biomass combustion) in 2012 will reach the level of 1990 and will not meet the requirement of the Kyoto Protocol.

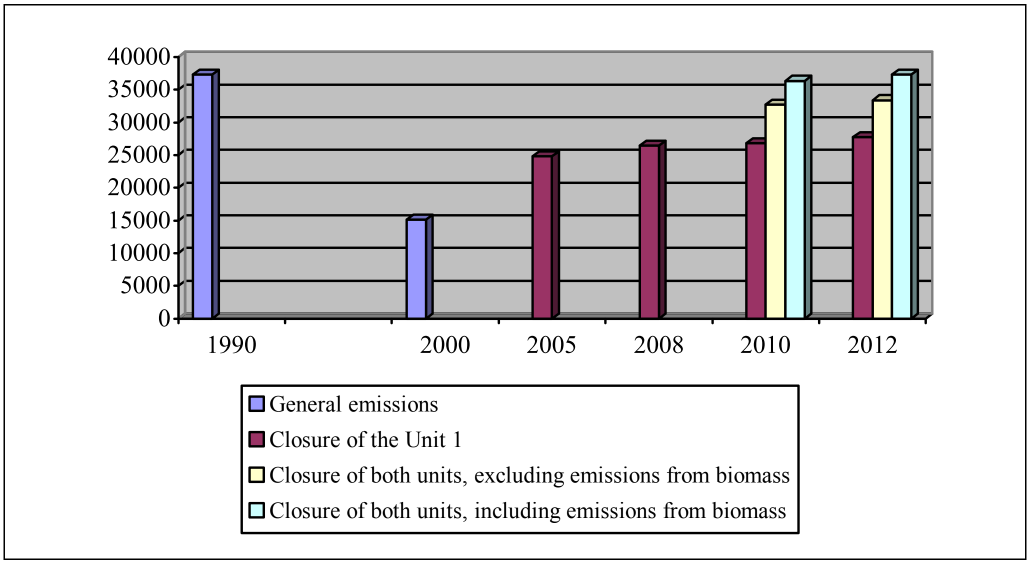


Figure 3.9. CO_2 emission in energy sector and projections after the closure of Ignalina NPP

A reduction of carbon dioxide emissions is possible provided less organic fuel is combusted, renewable energy sources are used more effectively, energy efficiency increases, and structure of fuel balance is regulated.

Global Sustainable Development Action Programme and Rio Declaration on Environment and Development, approved during the United Nations Conference on Environment and Development that took place in Rio de Janeiro in 1992, emphasise that energy production is the major factor for economic and social development as well as for general standard of living. At present, all over the world the production and consumption of energy is mostly based on such type of technologies that will not be tolerated in the future in the context of environmental impact assessment. The future growth of energy demands will make it impossible to rely on the present technologies and exhaustible energy resources. In the future, the control of chemical pollutants and greenhouse gas emission will have to be based on effective production, supply, distribution and consumption of energy as well as a growing need to use environment-friendly energy systems and, in particular, to employ renewable energy sources. Use of all energy resources will have to depend on their possible impact on environment and human health. Many efforts should be put in order to remove all obstacles preventing the development of environment friendly energy supply systems that would support sustainable development.

The main goal is to reduce the negative impact of energy sector on the environment, promote policies and programmes which help improve development of the environment-friendly and cost-effective energy systems, in particular, renewable ones, through cleaner and cost-effective energy production, supply, distribution and consumption. To achieve this task, it is necessary to develop cost-effective and environment-friendly energy resources which could meet a growing energy demand on the national level, encourage appropriate methodologies that allow in the process of environmental impact assessment to take political decisions regarding sustainable development with consideration of energy production, environmental and economic interests. There is a need to promote better research, development and use of energy saving technologies, with a particular emphasis on renovation and modernisation of energy systems. We must evaluate existing energy supply systems, in order to define ways to implement cost-effective and reliable energy systems from environmental point of view, including new and renewable energy resources, with the emphasis on social, physical, economical and political characteristics. On regional and cross-regional levels, energy plans should be approved and possibilities of effective energy distribution from new and renewable energy resources analysed. Following the national social and economical development and environmental protection priorities, energy efficiency improvement strategies and programmes should be supported. Increase possibilities for effective planning and implementation of management programmes in the field of development, use and promote new and renewable energy resources and implement appropriate norms for the efficient energy consumption and emissions at the national level that would encourage development of cleaner technologies.

It is expected that after Lithuania becomes a member of the European Union, it will positively solve all problems in the field of energy and environment, will be able to introduce changes necessary for meeting the requirements of all international conventions and protocols. Lithuania, together will all other European countries, will comply with the provisions of the European Energy Charter, which requires Contracting Parties to pay special attention to energy efficiency improvement; development and use of renewable energy resources; promotion of cleaner fuel and technologies as well as technological means reducing environmental pollution; closer co-operation in analysing, developing and implementing effective energy production and cleaner technologies, means and processes with less harmful impact on the environment. The Contracting Parties are required to reduce obstacles for energy consumption effectiveness through encouragement of investments, financing mechanisms for initiatives in the field of energy consumption efficiency. Each country will have to prepare, implement and regularly revise energy efficiency programmes.

Pursuant to the provisions of the National Energy Strategy and the revised National Energy Efficiency Programme, Lithuania has to reach the following objectives:

1. Promote use of wood, forest and agricultural as well as household waste and other types of local fuel by applying economic, legal and institutional means.
2. Seek that the percentage of energy produced from local and renewable energy resources by year 2010 comply with the requirements of the EU Directives.

3. Encourage and educate the agricultural and forestry sectors to grow such cultures that could be used in the production of energy resources.
4. To introduce a compulsory use of local energy resources supplied by a newly built or renovated small-scale energy entities of local importance.
5. Use the experience accumulated during the implementation of pilot projects financed by foreign donors promoting local and renewable energy resources.
6. Prepare and develop bio-fuel industry.
7. Prepare an action plan for the production of various types of bio-petrol and their mixtures, and for guaranteeing their production quality.
8. Develop legal framework to promote use of local and renewable energy resources.
9.

4. POLICY AND MEASURES

4.1. Review of the pollution reduction policy by sectors

4.1.1. Measures for the Sequestration of CO_2

4.1.1.1. Energy

The main goals of the energy policy, set up in the Law on Energy by the Republic of Lithuania, are as follows: energy conservation, efficient consumption of primary energy resources, stimulation of producers and consumers to efficiently use and consume indigenous, renewable and waste energy resources, reduction of hazardous impact to the environment by the energy sector. This law also provides that the national tax policy, soft loans or subsidies provided by the state (municipality) have to stimulate efficient energy use and consumption of renewable and waste energy resources.

The country will aim at further increasing the consumption of indigenous resources by implementing economic, legal and organisational means, encouraging the consumption of firewood, peat, and other indigenous fuels, by developing and enhancing the use of other energy resources (hydropower, waste energy, biogas, household waste, wind, and solar and geothermal energy) based on the experience of pilot projects.

On implementing measures, envisaged by the National Energy Strategy and National Environmental Strategy for the energy sector, measuring and ecological control equipment is installed to achieve more efficient fuel combustion and reduction of air pollution. Programmes for emission reduction are prepared and environmental projects are carried out. Lithuania’s environmental investment projects in the energy sector will be developed in accordance with the requirements and principles of the Kyoto Protocol under the United Nations Framework Convention on Climate Change.

Since 1 June 1998, the regulation on import and combustion of heavy fuel oil with sulphur content not exceeding 2.5 % of the mass of heavy fuel oil (instead of the former limit value of 3 %) has come into force in Lithuania.

The major source of air pollution in the sector of energy is the combustion of the imported fossil fuels. The annual CO_2 emissions in energy sector have been continuously dropping from 37.3 million tonnes of CO_2 in 1990 to 10.5 million tonnes in 1998. The reduction of emissions was mainly caused by slow down of production. It is necessary to switch from the consumption of imported fossil fuels to the indigenous, renewable and waste energy resources.

4.1.1.1.1. Hydropower

Lithuania uses 14 % of the available technical resources of hydropower, thus producing about 1 % in the total energy balance and 3 % in the total electric power balance.

Technical or real resources of hydropower in Lithuania are estimated to be 2.7 TWh per annum. About 2.2 TWh per annum or 80 % of total resources fall on the largest Lithuania's rivers - the Nemunas and the Neris, with about 0.5 TWh of annual resources (or 20 %) left for other average and small rivers, the number of which reach 470. Though large hydropower plants are economically more efficient and more significant from energy-generation point of view, they still remain a long-term goal because of high investment requirements, excess capacities of existing power plants and strict environmental regulations.

Meanwhile, small hydropower plants (SHPP) with capacities less than 10 MW, built on smaller rivers and first of all on existing, yet unused, reservoirs, according to standard designs, with standard equipment for energy generation, supplying energy to the power grid, fully automatic with no need for full time maintenance personnel have already become economically efficient and profitable. A rapidly growing network of these plants across Lithuania testifies to their efficiency. At present, there are 15 new SHPP built, and their number totals to 25. Their aggregate capacity is 8 MW and they generate 0.03 TWh of electric power per annum. Generation of this amount of energy otherwise than through combustion of heavy fuel oil results in smaller emissions of air pollutants: about 8586 tonnes less of CO_2, 129 tonnes less of SO_2, 12 tonnes less of NO_x, and 0.6 tonnes less of particulate matter.

Kaunas HPP (101 MW), generating 0.35 TWh of power per year, has been efficiently operating for a long time.

The main goal is a further development of SHPPs in Lithuania. The construction of SHPPs should be implemented in two stages:

- reconstructing earlier neglected plants and installing new SMPPs on the existing reservoirs (this option is by one third cheaper than a development of a new site). It is realistic to have about 131 SHPPs with total capacity of 16 MW generating 0.06 TWh of energy annually. A move from heavy fuel oil combustion towards generation of an equivalent amount of hydropower will reduce the emissions of CO_2 by about 17172 tonnes, SO_2 by 258 tonnes, NO_x by 24 tonnes, and particulate matter by 1.2 tonnes a year. It is expected that the above mentioned number of SHPPs will be built in 7-10 years time; and
- building new SHPPs on the rivers. It is realistic to generate up to 0.5 TWh per year. The construction of these power plants will take longer. A move from heavy fuel oil combustion towards generation of an equivalent amount of hydropower will reduce the emissions by about 143100 tonnes of CO_2, by 2150 tonnes of SO_2, by 200 tonnes

of NO_x, and by 10 tonnes of particulate matter. New SHPPs will be built on more efficient and environmentally acceptable stretches of rivers, with lower head of water and bigger installed water yields than on the existing reservoirs. Thus, all environmental requirements would be observed.

4.1.1.1.2. Solar Energy

Lithuania lies between 54º and 56º North Latitude, where every square metre receives on average 1000 kWh of solar energy per annum. Lithuania's territory occupies the area of 65200 square kilometres. In the course of a year, its territory receives 65400 TWh of solar energy.

It would be possible to use solar energy for thermal purposes in Lithuania by installing solar batteries for water heating or drying of agricultural production and installing solar heating systems for premises. There are a few solar heating systems already assembled, their aggregate area reaching about 100 square metres. Solar batteries from stamped steel radiators are manufactured by the enterprise "Santechnines detales". A relative price for a battery like this is about 300 Litas (or 75 US dollars) per square metre and its energy efficiency is about 250—290 kWh per square metre per season. With the assistance of the Danish Energy Agency it is planned to implement a pilot project of solar batteries with the aggregate area of 150 square metres for heating water in Kačergine Children's Sanatorium near Kaunas.

To implement the National Energy Efficiency Programme, film-type solar batteries are designed and already used for drying agricultural production. Their energy capacity per season is up to 200 kWh per square metre. However, the assembling and storage of these batteries are inconvenient and a life cycle of the film is short. These collectors could be used by small farmers. At present, the aggregate area of film solar batteries for drying agricultural production is about 180 square metres. To substantiate the applications of solar batteries for heating of premises, new research has been started.

It is planned that by 2005, the area of solar batteries installed for thermal purposes will exceed 1000 square metres and the batteries will produce over 260 thousand kWh of thermal energy. A move from heavy fuel oil combustion towards generation of an equivalent amount of solar energy would reduce emissions of CO_2 by 74.4 tonnes, SO_2 by 1.1 tonnes, NO_x by 0.1 tonnes, and particulate matter by 0.01 tonnes per year.

The development of solar energy use in Lithuania is slowed down by high costs, which result in prices by far exceeding the conventional energy price.

4.1.1.1.3. Firewood

Firewood is one of the most important and traditional renewable energy sources in Lithuania and constitutes a great part of the indigenous fuels. It has been used more widely during the implementation of the National Energy Efficiency Programme.

About 30 % of the country's territory is covered by forest that makes up 1970 thousand hectares. Not only firewood may be used as fuel. Forest felling, forest thinning, waste of wood processing industry, biomass of fast-growing trees and shrubs in plantations may be also used for this purpose.

The annual wood fuel consumption potential is about 3 million solid cubic metres (or 1.4 million solid cubic metres of logging waste in forests, 0.6 million solid cubic metres of industrial waste and 1 million solid cubic metres of firewood). Nowadays about 2 million solid cubic metres of firewood and wood waste are utilised for energy production by thermal power plants, which supply heat to centralised networks. Their aggregate capacity is about 100 MW. Wood is also burned in small local thermal units and installations. The 2 million solid cubic metres of wood combusted instead of heavy fuel oil reduce the emissions of CO_2 by 1000 thousand tonnes, SO_2 - by 15024 1 tonnes, NO_x - by 1397 tonnes, and particulate matter - by 69 tonnes a year.

For five years, wood fuel actually was not used in Lithuanian power plants. Today, with the assistance of PHARE programme and with the help of the Swedish, Danish and other governments, the total installed capacities of wood-based energy production exceed 110 MW. This would be equivalent to the combusted 99000 tonnes of heavy fuel oil, and it would cost 8.8 million US dollars. A move from heavy fuel oil combustion towards generation of an equivalent amount of energy from wood fuel would reduce the emissions of CO_2 by 322839 tonnes, SO_2 - by 4851 tonnes, NO_x - by 495 tonnes, and particulate matter - by tonnes 89 per year.

About 30 thousand hectares of land in Lithuania is not suitable for agricultural purposes. Besides, there are about 20 thousand hectares of peat-bogs, whose exploitation is coming to an end, and which would be suitable for plantations of fast-growing trees and shrubs. If an average yield would be 10 tonnes of dry biomass per hectare, it would be possible to grow about 500 thousand tonnes of biomass. Therefore, it is planned to develop technologies and a strategy for creating and exploitation of trees and shrubs plantations for energy purposes.

4.1.1.1.4. Straw as Fuel

Annually Lithuania produces about 4.5 million tonnes of straw, of which about 10 % (0.5 million tons) could be used as fuel to produce 1.5 TWh of energy. This could save about 1.5 % of imported fuels which, in its turn, would reduce emissions of CO_2 into the atmosphere by 429300 tonnes, SO_2 by 6450 tonnes, NO_x - by 600 tonnes, and particulate matter - by 30 tonnes.

The first boilers for the combustion of straw were installed in 1997. Today a dozen of these boilers are in operation. They are produced by several Lithuanian enterprises or imported from Denmark and other countries.

4.1.1.1.5. Peat as Fuel

Peat is yet another fuel, which could be used in Lithuania. Some time ago peat accounted for a significant share in the national fuel balance. For example, in 1940s and 1950s, a number of quite big electric power plants in Vilnius (48 MW) and

Petrašiunai, Kaunas (60,5 MW) combusted only peat. Today peat is combusted exceptionally by a few small power plants of local importance.

The currently exploited and a few additionally selected peat bogs could, without major negative impact on the environment, yield about 1.2 million tonnes of peat, thus meeting up to 3 % of the country's needs

Utilisation of peat will be more efficient after the adoption of the National Programme for the Rational Use and Protection of Operational and Neglected Peat Bogs, which is under preparation. Peat fuel is to be combusted by small capacity boilers. Big boilers in towns and cities could combust peat only together with municipal waste.

In 1999, with the assistance of the Danish government, a new pilot project was implemented in Kupiškis District, where Šepeta boiler house was converted into peat-burning boiler. This will also increase and speed up the consumption of peat in Lithuania.

4.1.1.1.6. Wind Energy

The most suitable sites for the construction of windmills would be in the western and north-western parts of Lithuania, especially on the Baltic Sea coastline, where the annual potential of wind energy reaches 0.15 TWh. Substitution of heavy fuel oil combustion by wind energy production would decrease air pollution by 42930 tonnes of CO_2, 645 tonnes of SO_2, 60 tonnes of NO_x, and 3 tonnes of particulate matter. It is expedient to use wind energy in those areas where wind speed exceeds 5-6 m/s. Such areas could be found in Lithuania on the Baltic Sea coast and the Kuršių Nerija. Large capacity windmills built either offshore or on the continent would be the most cost-effective.

The plan is to construct a demonstration unit of windmills with the capacity of about 4 MW in Klaipėda County.

Lithuania has developed the assessment methodologies and made a preliminary assessment of wind energy resources. In order to develop wind energy generation in Lithuania, it is necessary to use the most advanced technologies, to compile databases, to analyse technical and economic characteristics of wind power generators, to make an assessment of local conditions and to prepare the strategy for the construction of windmills.

4.1.1.1.7. Geothermal Energy

As much as 80 % of Lithuania's territory is suitable for the use of geothermal energy, and experts estimate its potential annual production as 0.22 TWh. If heavy fuel oil were replaced by geothermal energy, the emissions of air pollutants would be reduced by 62964 tonnes of CO_2, by 946 tonnes of SO_2, by 88 tonnes of NO_x, and by 4,4 tonnes of particulate matter.

To expand the use of geothermal energy resources, a demonstration power plant in Klaipėda is under construction. Global Environmental Fund, the World Bank, and the Government of the Republic of Lithuania and the Danish Environmental Agency finance its construction. The designed capacity of the geothermal plant is 40 MW. The implementation of the project will cost 78 million Litas (or 19.5 million of US dollars).

It is expedient to assess geothermal resources on the entire territory of Lithuania and include them into the national energy balance. It is also necessary to investigate in which sectors/fields geothermal energy is used and new technologies employed. Analysis of the existing management and operation practices of geothermal power plants is needed. Then it would be necessary to make an environmental impact assessment, to prepare a geological, technical and economic feasibility study for the renovation and application of drilled or closed boreholes, to generate geothermal energy, and to prepare geological, technical and economic calculations on the operation and maintenance of geothermal power plants.

4.1.1.1.8. Biogas

The organic matter, which could be used for biogas generation, is produced and accumulated through agricultural production. The most important organic resources are livestock manure and organic waste of food industry. However, a profitable generation of biogas is possible only at really large farm complexes or by integrated associations of smaller pig and cattle farms. The annual energy potential of manure accumulated in agricultural livestock companies of Lithuania is as follows: extensive piggery complexes could produce 15 million of cubic metres of biogas, private piggeries owned by farmers and agricultural companies could generate 7.2 million cubic metres, and private cattle farms - up to 65.2 million cubic metres of biogas. The aggregate energy potential of all manure accumulated at the above mentioned livestock enterprises and farms is 87.4 million cubic metres annually, comparable to 0.52 TWh. If heavy fuel oil were replaced by manure-based biogas, the emissions of air pollutants would be reduced by 148824 tonnes of CO_2, by 2236 tonnes of SO_2, by 208 tonnes of NO_x, and by 10,4 tonnes of particulate matter.

In 1998, there were 292 registered landfills, 12 of them over 500 thousand cubic metres of holding capacity, with accumulated 22 million cubic metres of municipal waste. Assuming the waste density in landfills is about 0.55 kg/m^3, the total mass of waste could amount to 12.1 million tonnes, which would yield 24 million cubic metres of methane. Energetic value of this methane is 0.27 TWh, and presently it is not used. Substitution of heavy fuel oil by waste-based biogas would reduce the emissions of air pollutants by 77274 tonnes of CO_2, by 1161 tonnes of SO_2, by 108 tonnes of NO_x, and by 5,4 tonnes of particulate matter.

4.1.1.1.9. Energy from Industrial Waste

Energy generation from industrial waste may be considered as a large replenishment to primary energy resources. Research in the field of energy production from industrial waste started in 1991 and was renewed concurrently with the implementation of the National Energy Efficiency Programme. In 1997 and 1998, Lithuanian Energy Institute developed a programme on the assessment and utilisation possibilities of waste energy resources in industrial enterprises, in companies producing building materials and those processing agricultural production. It was established that generation of waste energy varies greatly among companies. The average waste energy resources of larger enterprises estimate at 0.23 TWh per year. If heavy fuel oil were replaced by waste energy resources, the emissions of air pollutants from all the above enterprises would be reduced by 65826 tonnes of CO_2, by 989 tonnes of SO_2, by 92 tonnes of NO_x, and by 4.6 tonnes of particulate matter. The largest resources could be recovered in enterprises with the installed water circulation cooling systems (51.3 %), from the heat emitted together with combustion products (22.1 %), from warm water discharged to the municipal sewage (12.5 %), and the rest is discharged through the ventilation systems as hot air and condensed substances, which are not returned into boiler houses. At present different technical measures help the enterprises to recover 0.92 TWh of energy per year, which accounts for 18.5 % of the total amount of heat discharged into the ambient environment. Energy resources wasted through warm sewage water discharge (0.3 TWh per annum) could be easily recovered by wastewater treatment plants of the major cities and big towns. Vilnius, Kaunas, Siauliai, Klaipeda and Alytus waste water treatment plants equipped with heat pump compressor stations with the aggregate capacity reaching 270 MW could convert 0.68 TWh of electric power to 2.09 TWh of thermal power per year. Thus, energy from waste instead of energy from the combustion of heavy fuel oil would reduce emissions of air pollutants by 598158 tonnes of CO_2, by 8987 tonnes of SO_2, by 836 tonnes of NO_x, and by 42 tonnes of particulate matter.

4.1.1.1.10. Municipal Waste

Municipal or household waste could also be used as an indigenous fuel. At present, it is dumped into landfills, which is a tremendous environmental nuisance, especially in sites with no proper control and no environmental protection measures.
There are about 500 thousand tonnes of municipal waste produced in Lithuania annually. Residents and enterprises generate 67 % and 33 % respectively. The five major cities (Vilnius, Kaunas, Klaipėda, Šiauliai and Panevėžys) are the largest producers of waste, generating about 360 thousand tonnes of waste per year. According to the analyses of municipal waste carried out in Vilnius and Kaunas, average calorific value of waste is about 0.7 MJ/kg. It means that the waste accumulated by the five Lithuanian cities could be converted into 0.55 TWh of energy, equivalent to 1 % of the primary energy needs of the country.

4.1.1.2. Transport

4.1.1.2.1. Forecast of Fuel Consumption

Until present, the largest share in the primary energy balance falls to oil products from Russia imported via oil pipelines. In the near future, it will be possible to import oil products from the Western countries via Būtingė import-export terminal.

The demand for oil products in future is mainly predetermined by two opposite trends: the consumption of heavy oil products by energy sector will be decreasing, while the consumption of light oil products, mainly by the transport sector, will be increasing (see Figure 2.1). As Lithuania is in a transit zone between eastern and western economic areas, the extent of all transport services will grow significantly. All these demands will be fully satisfied by the existing and newly built transport, processing, storage and distribution infrastructure well adjusted to the new demands.

The projections of fuel consumption by transport take into account the tendencies of a steady growth of the number of vehicles and the population as well as decrease of fuel consumption per road unit in Lithuania and in Western countries.

4.1.1.2.2. Review of Transport Pollution

Industrial enterprises, energy plants and transport vehicles in Lithuania emit about 0.5 million of tonnes of air pollutants per year. The transport sector is one of the major air polluters in Lithuania, and its emissions constitute over 70 % of total air emissions.

The constituents of the fuel directly determine the composition of air emissions. The emission of carbon dioxide and sulphur dioxides are directly proportional to C and S content in the fuel, i.e. every tonne of carbon in the fuel consumed generates 3.67 tonnes of CO_2, and a tonne of sulphur generates 2 tonnes of SO_2.

According to the methodologies used by the Ministry of Environment to calculate air emissions, carbon monoxide constitutes three fourths of the total transport exhaust emissions. Therefore, the most important task would be to reduce carbon dioxide exhaust emissions by transport, employing all possible means and measures. To achieve this, it is necessary both to improve the ignition process in engines and to introduce neutralisation systems of exhaust gases (e.g., catalytic converters), which convert the larger part of carbon monoxide into carbon dioxide.

Nitrogen oxides NO_x is the second largest air exhaust pollutant, the concentration and accumulation of which is mainly caused by mobile pollution sources. The highest concentration values of nitrogen oxides are registered in city crossroads where traffic is very intensive.

The most effective way to reduce sea transport emissions is to use marine fuel with lower sulphur content. This could be handled by fuel producers. The price for new fuel should be reduced quite significantly against the existing prices, if oil-refining industry introduces new desulphurisation technologies.

The presented data suggest that the main priority in the reduction of transport exhaust emissions should be given to road transport vehicles.

4.1.1.2.3. Actions to Reduce Greenhouse Gases

The Action Plan is prepared in accordance with the decisions and regulations of the Government of the Republic of Lithuania, international obligations, HELCOM Recommendation 17/1, Agenda 21 adopted by the Council of the Baltic States, and other international documents and acts.

Most of the provided means and measures focus on the road traffic due to the prevailing impact of road transport on the ambient environment and people's heath over other modes of transport. On the other hand, the measures described influence railway, water and air transport as well.

The measures outlined in the programme prepared are implemented with support of international, regional and national donors and though different development programmes.

4.1.1.2.4. Tasks and Action Plans

Tasks and action plans are prepared according to the requirements of the 1992 National Programme “Transport and the Protection of the Environment”, the 1994 National Transport Development Programme and the 1996 Updated/Amended National Energy Efficiency Programme.

Actions and measures:

Harmonisation of national legislation and norms or standards with the EU directives on transport and environment;
Development of infrastructure and environmental costs assessment; the programme on the infrastructure of the transport sector entities and the management of polluted territories of the country;
Technical examination of transport vehicles;
Fuel quality management and control;
Management of transportation of hazardous goods;
Management of the environmental protection in Klaipėda Port;
Personnel training on ISO 14000;
Management of chemical substances and waste in transport;
Removal and withdrawal, monitoring and control of the contaminated sediments on the bed of the Klaipėda Port channel.

4.1.1.2.5. The Measures to Be Taken in the Transport Sector to Comply with the Requirements of Sustainable Transport Development

Traffic flows should be managed through structural changes and economic instruments, with the consent of the public. Unnecessary use of transport should be avoided by optimising the number of operations. The development of public transport, more active walking and cycling should be encouraged; efficiency of transport systems should be enhanced.

A wider use of electricity and reduction of hazardous emissions in the transport sector should be encouraged for the benefit of the environment and public health. These efforts must be well co-ordinated; they should comprise the use of best available technologies and better quality fuel. The negative impact of transport can be reduced in active co-operation with international institutions, especially with the institutions of the European Union, the United Nations and the Organisation for Economic Co-operation and Development.

Social policy should be developed with the help of economic instruments and in accordance with the requirements of the EU. This will influence the possibilities to improve fuel quality, to extend the use of environment-friendly transport vehicles, to develop financing and transport infrastructure. An integrated approach and co-ordinated implementation of a set of various measures will be needed for the implementation of economic instruments.

Public awareness on negative impact of transport on peoples' health and the environment as well as the preventive actions and measures should be increased. The environmental component in the transport cost structure should be made more significant.

The negative impact of transport on natural resources and vulnerable territories is to be minimised. Re-use and utilisation of waste should be encouraged. Use and consumption of hazardous substances should be replaced by the consumption and use of alternative, less polluting and hazardous.

The development of future measures to achieve the above goals should include consistent renovation and sustainable development of transport systems.

Actions and measures to be taken:

Legal and economic instruments:
· Implementation of the EU legal and/or economic instruments exercising the control of the number of transport vehicles;
· Implementation of legal and economic instruments to promote the trade in vehicles consuming little fuel.

Improvement of the conditions for public transport, pedestrians and bicyclists:
· Promotion of public transport by strengthening its competitiveness (changing and/or reducing tariffs and costs for the development of motor transport fleet); enhancement of road transport fleet and rolling-stock capacities (e.g., terminals, junctions with tracks for pedestrians and cyclists, provision of special services, renewal of road transport fleet and rolling-stock), as well as promotion of the interest in public transport by making it more attractive (e.g., functionality of bus stops, shorter waiting and ride time, less public transport changes, information technologies, improvement of the quality of vehicle fleet, intermodal services, requirements for special groups, e.g., "Transport for everyone");
· Investments in new routes of public transport, pedestrian and cyclist tracks, economic support for the development of public transport;
· Promotion of the competitiveness of railway transport by zoning, planning of transit network, improving traffic safety, renovating and employing the available means and equipment in the most efficient way.

Land use planning:
· Regional development and creation of new territories, co-ordinated with the availability of public transport services, paying special attention to changing values and needs and modal alternatives during the land use planning.

Efficiency of transportation:
· Promotion of the competitiveness of railway transport on transit routes Lithuania - Belarus - Russia/Ukraine;
· Assessment of the possibilities to develop transport systems, taking into account the economy and the environment, traffic development in the sea-coast area, enhancement of the competitiveness of the local tonnage and promotion of the optimal development of the Klaipėda Port and the network of its terminals.

4.1.1.2.6. Effects of the Proposed Actions

Economic instruments:

They will mitigate the growth of the number of private transport vehicles and will promote technological upgrading.

International experience has shown that economic management (taxation of primary energy) was able to reduce energy consumption over the last decade by 20-30 % if compared with the earlier situation (and will be able to reduce it in the future) Increasing number of private vehicles will also require to improve maintenance conditions of the public transport. Investment and financing required will depend on implementation methods.

Modal changes:

If a number of cyclists increases twice, private transport traffic will drop by 2-5 %. This measure could have saved approximately from 2 to 7 million litas (0.5 - 1.75 million US dollars respectively) of the national budget in 2000. In future an additional revenue of 0.5 to 1.2 million Litas (or 0.1 - 0.54 million US dollars respectively) could result from this process.

Demands for financing:

Air pollution by transport vehicles is mostly typical to big cities. According to the data of Vilnius monitoring station, transport is responsible for about 90 % of the total air pollution. These data correspond with the indicators of big European cities, though the indicators of air quality in cities and towns of Lithuania are better (though NO_x and ozone permitted limit values are occasionally exceeded).

There are three ways to reduce air pollution from transport exhausts in Lithuania: reduction of transport emissions, control of fuel quality, and modernisation of public transport and transport infrastructure.

4.1.1.2.7. Mid-Term Reduction of Energy Consumption

Renovation of vehicle fleet and promotion of economic solutions:

It is possible to reduce energy consumption by different modes of transport by 20 % through the introduction of technical measures increasing the efficiency of fuel consumption or by giving preference to lighter and less powerful transport vehicles. Fuel consumption by new transport vehicles (up to one third of today's standard) will continue to decline in the coming century.

Efficient transportation:

According to the observations, transportation that is more efficient enables to save about 5 % of energy consumption. Reduced fuel consumption and time saved on transportation will increase income of transport companies.

4.1.1.2.8. Long-Term Reduction of Energy Consumption

The existing assessment methods do not allow to fully and comprehensively demonstrate the changes in energy consumption. The target of 5-10 % reduction of energy consumption may be set for a period of 10 to 15 years.

Long-term changes will be much higher. Land use planning will enable to have a better air quality in new residential suburbs by eliminating inconveniences caused by traffic and providing a better infrastructure.

Economic growth will promote traffic development and intensify it. Structural development of transport systems is preferable, as it is friendlier towards the environment.

According to the traffic safety goals, the suggested measures could reduce traffic growth by at least 1 % a year. This, in its turn, would reduce the needs of investment to further develop traffic infrastructure. Economic instruments will help increase competitiveness and save costs.

4.1.1.2.9. Road Construction and Maintenance Policy

Road construction and reconstruction should be an indispensable part of the environmental protection. The goal of the integrated road planning is to analyse the suggested alternatives with consideration of the existing environmental conditions and the possible impact of the road. Integrated planning should include:

- Environmental monitoring.
- Assessment of the impact on the environment, human health and living conditions.
- Assessment of the impact on the landscape and biodiversity, as well as natural resources.
- Assessment of the impact on the development of the infrastructure.

Modern, clean, safe and effective technologies should be used in road construction works.

4.1.1.2.9.1. Fuel Quality Management

Over the recent years, Lithuania’s oil sector was influenced by serious competition on the European and global scale. In order to protect Lithuania’s interests, the priorities should be placed on the improvement and control of fuel quality. This issue could be managed within the framework of the National Quality Programme with a special focus on the development of the state management, standardisation, metrology and the conformity assessment of liquid fuels.

Main tasks are:

a) Management of the quality of liquid fuels:

- to make products produced and traded in Lithuania sufficiently safe, with the minimum possible harmful effect on human health and environment,
- to set compulsory requirements for oils products in conformity with the requirements of the EC directives,
- to analyse the quality of locally produced and imported fuels;
- to prepare and organise the implementation of a programme for the improvement of the state supervision system of the quality management of the market;

b) Standardisation:
- to prepare and to ensure the implementation of a European standards working programme, giving it high priority,
- to take part in the international and European Union standardisation activities,
- to develop standard terms and a data base of standardisation documents and acts for oil products;

c) Metrology:
- to collect the necessary data base of legal documents and acts on metrology and to harmonise them with the international documents and EU legislation,
- to validate the measurement equipment used in the Lithuanian oil sector according to the international standards,
- to verify the measuring equipment subject to the regulation of legal metrology when certifying the quality of oil products.

d) Conformity assessment:
- to take measures to protect the national interests and Lithuania's consumers from oil products, hazardous to the environment and human health,
- to establish uniform trade conditions,
- to increase the competitiveness of the Lithuanian oil products,
- to establish certification institutions and to validate testing laboratories.

4.1.1.2.11. Possibilities to Use Alternative Fuels

The main energy saving objective for the Lithuania's transport sector is to considerably reduce the consumption of petroleum products, because almost all crude oil is imported to Lithuania. The reduced consumption of petroleum products by transport, in its turn, would improve the quality of the environment, especially in cities. Among the most promising means to reduce the consumption of oil products by road transport vehicles is the consumption of alternative fuels by internal combustion engines.

As Lithuania is mainly dependent on the imported oil, it is necessary either to save the resources or to switch from petroleum to indigenous renewables. The most suitable alternative fuel in our economic and climatic conditions is ethylene alcohol and biodieseline produced from biomass. To address the issues, the Prime Minister of Lithuania set up a commission for the development of biofuel industry and biofuel consumption.

In 1994, upon the request from Panevėžys alcohol company "Sema", the Department of Road Transport of Vilnius Gediminas Technical University conducted a theoretical research and experimental tests on the application of alcohol production wastes as fuels for internal combustion engines. The comparative analysis of alcohol-based fuels and oil products was made with regard to their use for internal combustion engines.

The research has proven that the combustion processes in carburettor engines without any special modifications are reliable and stable while using alcohol mixtures if the level/quantity of ethanol in the mixture does not exceed.

Tests have also demonstrated that the emissions of carbon monoxide CO were reduced by 20 times, those of hydrocarbons CH – by 3 times and carbon dioxide CO_2 – by 15 times in all operation modes when carburettor engines were running on the mixture of petrol and alcohol (14 ethanol). Very similar results, though less effective, were received by combusting methanol. Tests with biodieseline (bio diesel fuel) yielded very optimistic results.

4.1.1.3. Forestry

When a serious desiccation process of Lithuanian spruce groves was over, the scope of sanitary forest felling decreased considerably: 1833.9 thousand cubic metres of forest were cut in 1997, and 1047.5 thousand cubic metres in 1998. The general forest statistics demonstrates that the state of forests in Lithuania is improving, both their area, and accumulation of timber resources are increasing. This testifies to a stabile use of forest resources and the development of ecological and social functions of the forest.

In 1998, both national inventory and FAO inventory of the Lithuanian forests were prepared under the programme of inventorying the temperate and boreal forest resources (TBFRA-2000). The most important results are provided in table 4.1.

Table 4.1. Forests and other types of woodlands according to the availability of timber

Indicators:	Area 1000 ha
Forests; total, of which:	1979
Coniferous prevailing	914
Deciduous prevailing	678
Mixed	387
Exploited forests	1686
Coniferous prevailing	752
Deciduous prevailing	594
Mixed	340
Non-exploited forests	272
Due to their conservation and protection purpose	249
Due to economic reasons	43
Other lands, overgrown by woody vegetation (bushes and shrubs)	72
Coniferous prevailing	6
Deciduous prevailing	39
Mixed	27

The Lithuanian Forestry Institute performs Forest monitoring. According to the data on defoliation of the tree crowns in 1998, 16 % of Lithuanian forests were affected. About one fifth of the forests (or 18.2 %) had no signs of defoliation. Most tree crowns (or 66.2 %) were characterised as slightly affected by defoliation (11-25 %). The worst state was found among the populations of alders and oaks (their average defoliation was about 25 %). It was the first time when the state of the deciduous stands was worse than that of the coniferous. In most of the cases, the trees were affected by insects, abiotic factors, fungi and diseases. In spite of the 1998 data, the condition of the Lithuanian forest is gradually improving. During the last decade, (from 1988 to 1998), the worst situation was observed from 1993 to 1995.

The area of private forests is constantly increasing. It is forecasted that by the end of land privatisation process, private forests will account for 40-45 % of the total forest area. According to the data available, in early 1999 the area of private forests was 281.6 thousand hectares, owned by 110.8 thousand owners. The average area of a private forest domain is 3.2 ha. There are significant changes in the intensity of use of private forests. In recent years, however, the amount of forest felling, especially clear felling, has increased. On the other hand, it should be noted that reforestation is also increasing. The Forest Fund was established to provide financial support for the development of forestry, national and regional parks.

Lithuania has great capacities to use timber. At present, only 61.6 % of the net annual increment of Lithuanian exploited forests are harvested. The most extensive forest felling was done in the pre-war Lithuania. Today, the volume of timber is almost trebled, if compared to the pre-war period. The intensity of forest felling in Lithuania today is much lower than in many European countries.

Means and measures to be taken:

· to prepare a strategy on the preserved territories.
· to prepare a new draft law on the preserved territories of the Republic of Lithuania (new version)
· to prepare the national inventory of the Lithuanian forest, to assess timber resources, its quality, and to evaluate the usage norms of these resources
· to prepare the |Forest Development Strategy
· to prepare a programme for the enlargement of the Lithuanian forest area

4.1.1.4. Agriculture

Agriculture is one of the most important sectors of Lithuania's economy, where the renewable resources are used best of all. During the period from 1992 to 1997, the agriculture in Lithuania underwent the most crucial changes: the processes of the restitution of land ownership rights, transformation of economic entities, adjustment to the market conditions were quite intense. Large private farms have emerged after the restitution of the ownership rights, or as a result of land sale or land lease.

More than half of the Lithuania's soils are wet, therefore they have been meliorated. This resulted in almost complete loss of bogs and marshes. At present, the meliorated areas provide about 90 % of the vegetable and other crop production.

Under the guidance of the Water Management Institute of Lithuania and the Danish Agricultural Consultancy Centre, the Code for Good Practice in Agriculture (CGPA), which is a compendium of compulsory and recommended measures for the management of agricultural production, was prepared and adapted to Lithuania's economic and environmental conditions in 1999. It is an optimal farming system, ensuring sustainable economic development of a farm. The CGPA is a first document of this type in Lithuania, providing the framework for sustainable and organic agricultural management system. It is a compendium of regulations and advice set up by legal acts of the European Commission, the Helsinki Commission and national legislation on sustainable and profitable farming without infringing the environmental regulations and damaging the environment.

The CGPA for Lithuania is a document, attributing great importance to climate change mitigation issues:

· In the field of tilling and growing of agricultural crops: the protection of the environment through the development of plant-growing agriculture, intensive, protective and organic agriculture, plants with longer vegetation period and intermediate plants; mechanical soil cultivation; significance of vegetation and other natural factors for land cultivation and improvement of soil structure; agricultural machinery in farming lands and soil compression; fertilising and liming of soils; types of organic fertiliser, their characteristics, nutrient substances in the manure, application of organic fertilises and the maximum recommended density of animals; times and technologies for manure and slurry spreading; norms and times for the application of mineral fertiliser; plans and other fertilisation measures; land liming; plant protection and dangers of pesticide usage; the reduction of pesticide consumption by alternative measures; pesticide consumption technologies; measures of safety and protection of the environment when consuming pesticides.
· In the field of animal husbandry: setting of grassland and pastures; pasturage and pasture maintenance; forage preparation and storage; building of animal shelters (volatilisation of ammonia, sustainable feeding; manure storage.
· In biodiversity and landscape management:
biodiversity; landscape formation; control of water regime; means and measures to fight the processes of erosion.

In 1997, the Government of the Republic of Lithuania has established the Rural Development Fund, the funds of which are used according to requirements of the National Agricultural Development Strategy:

· by implementing investment programmes of high priority: ecological agriculture, revival of agricultural activities in unproductive lands;
· by developing the research and analysis system of agricultural resources and product quality;
· by financing agricultural research works, consultation and training, by developing agricultural information system.

First ideas of ecological agriculture may be noticed already back in the 1920s, but it was not until the 1960s, that people all over the world became more interested in these ideas. The development trend of ecological agriculture in Lithuania is quite similar to those of foreign countries though production rates are much smaller. From 1987 to

1993, the first pilot programme for the restructuring of the traditional agriculture to ecological and sustainable agriculture was developed and approved by the Government. In 1993, the implementation of this programme started in the Karst Region in northern Lithuania. Also in 1993, the Government approved the programme for the protection of underground waters and the development of ecological and sustainable agriculture in the most vulnerable areas of the Karst Region. It is implemented by the Tatula Programme organisation.

Since 1997, ecological farming has been promoted on the entire territory of Lithuania. Funds are provided for the investment projects, which win competitions. Since 1997, subsidies are paid to the farmers who engage in ecological and sustainable farming.

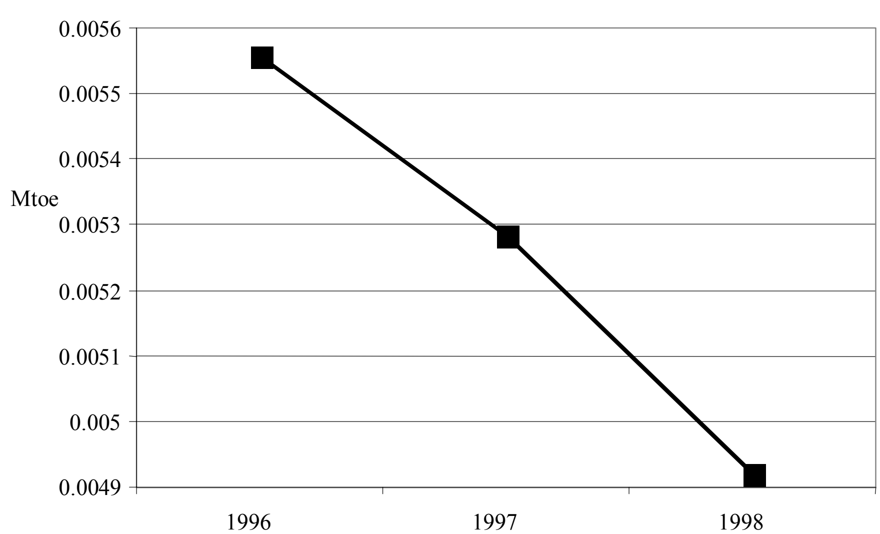
Organic farms in Lithuania are inspected and supervised by "Ecoagros", the enterprise established by the Ministry of Agriculture and the Ministry of Health, in accordance with the requirements and standards set up by the European Union and International Federation of Organic Farming.

An organic farming community "Gaja", which unites all farmers and those who are interested in organic agriculture, was established in Lithuania. The "Gaja" community has about 200 members. The Community spreads information among farmers, landowners and consumers about the development of organic agriculture and organic products, participates and arranges national and international projects and programmes on the development of organic agriculture, arranges seminars, workshops, training courses for Lithuanian farmers, organises visits to organic farms in foreign countries, publishes and disseminates the information on organic farming, provides consultations, prepares plans for shifting from chemical to organic farming, collects and provides information on the production grown in organic farms, develops the market of clean production both in Lithuania and abroad.

4.1.2. Means for the Reduction of CH_4 Emissions

4.1.2.1. In Energy Sector

Methane is the main component (98 %) of natural gas, widely used as fuel in Lithuania's energy, industry and household sectors. In comparison to 1990, the



consumption of natural gas has decreased by 2.6 times in 1998 (4.7 MTOE and 1.8 MTOE respectively).
The decline in the consumption of natural gas caused the reduction of methane emissions into the atmosphere. The data on methane emissions reduction from 1996 to 1998 are presented in Figure 4.2.

Figure 4.2. Methane emissions from 1996 to 1998

In 1996, methane emissions were 0.0056 MTOE (or 0.21 % of the total consumed amount of 2.6 MTOE) and in 1998, these figures were 0.0049 MTOE (or 0.27 % from the total consumed amount of 1.86 MTOE).

Methane emissions are caused by the gas leakage through non-hermetic sealing of the mains and equipment in gas supply systems during their maintenance. Natural methane leakage depends on the technical condition of gas systems. Methane is emitted into the atmosphere from gas systems through non-hermetic equipment of gas distribution and regulation stations, through the mains and distributing pipelines, through non-hermetic installation of lead-in and internal equipment of the gas mains.

As regards methane consumption for the technological purposes, its emissions into the air from the mains of gas-mains and gas systems is as follows:

1. gas consumption for scavenging the gas pipes before their operation, after maintenance, assemble works or other works when the pipeline had to be emptied;
2. gas consumption for discharging the gas into the ambient air before the maintenance or other works when the pipeline has to be emptied
3. gas consumption during the commissioning and adjustment works in gas installations of dwelling houses;
4. gas consumption for the commissioning and testing of equipment in gas regulation posts, gas distribution stations and regulating installations;
5. gas consumption during the escape of gases into the ambient air through safety valves;
6. gas leakage from an operating gas pipe during an accident.

Lithuania is modernising its gas systems at present. New gas regulations posts and gas distribution stations are designed and built in accordance with the requirements of state-of-the-art European technologies. Anykščiai, Utena and other towns provide a good illustration of such modernisation. These measures help reduce methane emissions into the ambient air.

5. PROJECTIONS AND IMPACT OF POLICIES AND MEASURES

5.1. Projections and Removal of CO_2 Emissions

5.1.1. Energy

Due to the recession of industry, ambient air pollution by stationary sources has dropped almost by half since 1990. Today all the air protection requirements of the international conventions signed by Lithuania in the field of environmental protection are met.

The requirements of the National Environmental Strategy (1996) for the energy sector are as follows: to promote energy conservation and the consumption of renewable energy resources, to reduce emissions/pollution by electric and thermal power plants by making combustion processes more efficient and by using less polluting fuels. A special attention should be given to technological changes, which could benefit the environment greatly. For the mid-term period, it is proposed that the gradual introduction of best-available technologies (BATNEEC), which do not requite special additional costs and meet best practice of foreign countries, be given the main focus.

Safe use of nuclear energy is a prerequisite for the development of energy sector. Therefore, it is necessary to implement all additional recommendations and safety improvement measures provided in the Report on Safety Analysis of the Ignalina NPP and to ensure the implementation of all international agreements and conventions in this area.

In 1991 Lithuania signed the Treaty of Non-dissemination of Nuclear Missiles with the International Energy Agency (IEA) and became a real member of the IEA in 1993. Obligations to this Treaty were supported by the Law on the Control of the Import, Export and Transportation of Strategic Goods, which was adopted in 1995. In 1994, the Convention on Physical Safety of Nuclear Substances was ratified and its main principles were defined by the Resolution of the Government adopted the same year. In relation to the nuclear liability of a third country, Lithuania signed a very important Vienna Convention on Civil Liability for Nuclear Damage (ratified in 1992) and its joint Protocol.

With respect to the above statements, the following main short-term environmental protection measures and trends were proposed for the energy sector:

- sustainable structures of primary energy supply with the increased share of natural gas and renewable energy resources. The Government has to prepare a programme for the replacement of the consumption of heavy fuel oil with high sulphur content by natural gas, taking into account technical-economical possibilities of power plants to combust natural gas as well as encourage the consumption of natural gas and renewables through economic measures (ecological taxes, reduced profit tax),
- safe maintenance of the Ignalina NPP, by installing a second-level switch off system in both units of the NPP and by introducing other safety measures as provided in the Report on Safety Analysis of the Ignalina NPP; installation and licensing of the storage container for the used nuclear fuel by the Ignalina NPP;
- development of a programme for the reduction of SO_2 and NO_x emissions by Lithuania's power plants. This plan, developed by the Ministry of Environment on the basis of the plans of SO_2 and NO_x emissions reduction measures prepared by power plants, will help determine gradual measures for emissions reduction in the country;
- a further development of environmental audit; implementation of emissions monitoring measures in energy generation sources with the capacity exceeding 50 MW;
- implementation of cheap emission reduction measures in energy generation sources (modernisation of burners, introduction of a secondary combustion scheme, smoke re-circulation, steam supply, spray of heavy fuel oil);

- a further strengthening of legislation, integrated into the environmental laws of the EU; adoption of new laws (on Ambient Air Protection, on Energy Conservation, on Management of the Ignalina NPP, on Management of Radioactive Waste, on Radiation Safety, etc.);

- implementation of emission limit values, with regard to best available technologies which do not require additional costs (BATNEEC) for the new energy generation installations/sources and gradual introduction for the existing installations/plants/energy generating sources;

implementation of methodology for integrated planning of resources, based on the assessment of the profit to the environment or avoided harm when combusting different fuels in energy enterprises;

- ensuring of environmental regulating measures in energy sector with the emphasis on economic means and measures; a further enhancement of the taxation system for the pollution of the environment by paying back the collected resources to energy enterprises and thus enabling them to implement pollution reduction measures;

- preparation of energy production development plan, taking into account emission reduction targets and selection of new generating sources by supplementing economic criteria by environmental ones.

The difference between environmental measures applied in Scenarios I and II is that in case of Scenario I, the phase out of heavy fuel oil with large sulphur content and orimulsion has to be started earlier and quicker, because after the closure of Ignalina NPP, combustion of heavy fuel oil with large sulphur content will not promote and ensure the compliance to the environmental requirements.

6. IMPACT OF GLOBAL CLIMATE CHANGE ON NATURAL ECOSYSTEMS, AND BIOLOGICAL DIVERSITY. ESTIMATION OF THEIR VULNERABILITY AND ADAPTATIONS

6.1. Introduction

When preparing the first national communication, the data on impact of global climate change on Lithuanian ecosystems, flora and fauna were absent. Preparation of the National Strategy implementation programme encouraged carrying out the research on the impact of climate warming on ecosystems, habitats, communities and separate species of fauna in Lithuania, which was undertaken by the Institute of Ecology.
Recently this impact on the ecosystems in Lithuania has become evident. The impact is observed both on individual ecosystems and on their components – birds, amphibians, reptilians, etc. An increase of eutrophication of water basins, marshes and wetlands is noticeable. The new data on the impact of climate changes in the following areas have been obtained at the Institute of Ecology during the research period:

- biological diversity,
- first spring arrival of birds,
- periods and dynamics of birds migration,
- distances and directions of birds migration,
- breeding timing of birds,
- shifting of areas of breeding distribution,
- selection of wintering areas and their changes, wintering population,
- populations of birds during migrations and between them, selection of areas and their changes.

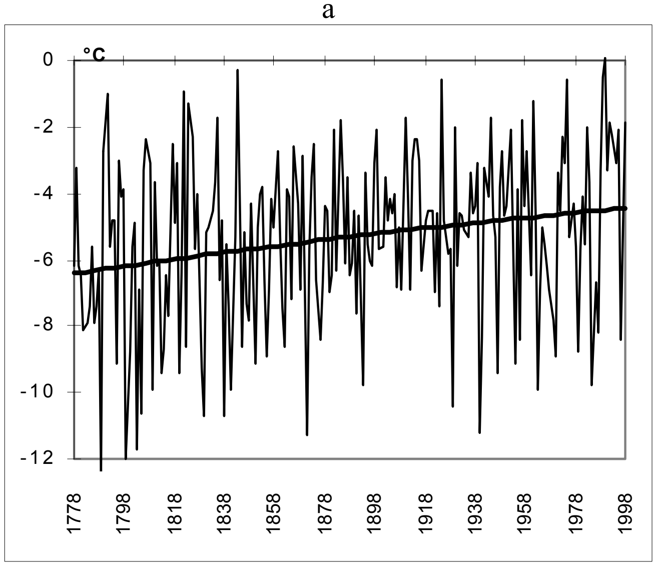
6.2. Variations of climate in Lithuania

Climate may be the most important factor influencing dynamics of other natural processes, main directions of economy, technical and cultural level of societies, their social constitution. Climate is a dynamic and sophisticated system.
The global climate warming started in 1800's. Recently it has been gaining speed. The global temperature of the Earth's troposphere increased by 0.5-0.6^o C in the 20th century and by 0.2-0.3^o C within the last 40 years since 1955 (WMO Statement, 1997).
Information on variations of climate within the last two centuries in Lithuania may be found in the data of meteorological observations in Vilnius. Air temperature is recorded since 1770, the amount of precipitation – since 1887. Meteorological observations in other places of Lithuania were started significantly later, in the end of 19th – beginning of 20th century.

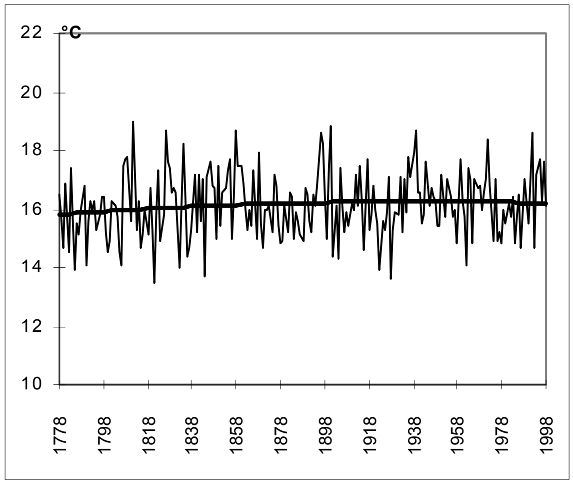
Air temperature in Lithuania within the last two hundred years was changeable. The average annual temperature since the end of 18th century increased by approx. 1^o C. During the 20th century this increase was 0.4-0.5^o C. Particularly, winters and springs became warmer (by 1.5-2.0^o C). Summer and autumn temperatures underwent the smallest changes (Fig.6.1). The cool climate was in Lithuania in the end of the 18th century and in the first decade of 19th century. It was the end of the “small glacial period” which started in the 15th century. Warm summers prevailed in Lithuania in 1820-1860. Later, the average summer temperature started to decrease and in the beginning of the 20th century summers in Lithuania were by 0.6^{o} C cooler than in the middle of the 19th century. The summer temperature in the end of the 20th century became similar to the summer temperature of the middle of the 19th century. The changes of average autumn temperature are similar. Three warm periods (1815-1836, 1890-1925 and the one starting in 1966) and three cool ones (1780-1814, 1837-1889 and 1940-1965) may be selected to reflect variations of spring temperatures. The largest variations were noticeable in winter temperatures. The maximum deviation of winter temperature is 12.5^{o} C (that of spring – 8.3^{o} C and those of summer and autumn – 6.4^{o} C). Particularly cold winters prevailed at the end of the 18th century – beginning of the 19th century and in the middle of the 20th century. Since 1960s, winters and springs are becoming substantially warmer.

Not only the average air temperature but also extremity of thermal conditions was changing within the last two centuries. The prominent period is 1885-1933 when variations of average annual temperature were in the range of 2.9^{o} C. This is the period of monotonous climate when, due to intensive cyclonic circulation, the mild winters and cool summers were prevailing. The examples of extreme climate periods would be found in 1777-1840 and the recent period which started in 1940. Variations of the average annual temperature are within 4.2^{o} C and 3.9^{o} C, accordingly.

a



b



c

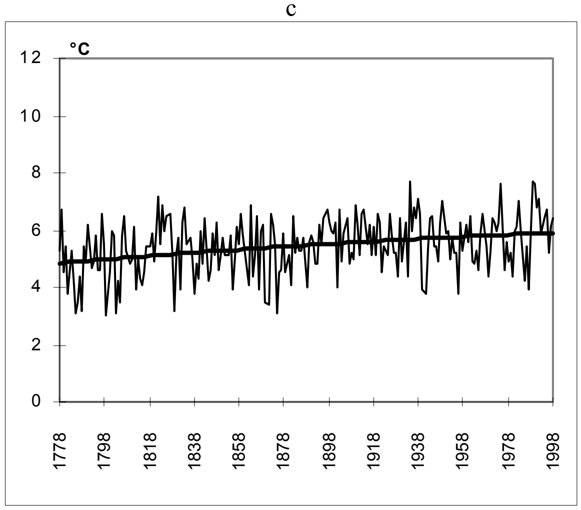


Fig 6.1. Variations of air temperature and their polynomial trend in 1778-1998 in Vilnius (a – winter, b – summer, c – annual)

Estimation of variations of precipitation is equally important, particularly from the practical point of view. These variations show the diversity of agroclimatic and ecological conditions in the past. The annual variations of the amount of precipitation in Vilnius since 1887 were in the range of 393 mm. During the warm period of the year (April – October) this range was 466 mm, during the cold one (November – March) – 282 mm. Three wet periods may be selected since 1887 (1897-1906, 1921-1936, 1945-1962). Comparatively short dry periods alternate between the wet ones. The dry period, which started in 1963, seems to continue. The recent average amount of precipitation is equal to the amount of precipitation in the early 20th century but is less than that of 1920's-1930's and 1950's. A tendency of a monotonous increase of the amount of precipitation in the cold period of year and a decrease in the warm period is observed since the middle of the 20th century. Thus, the difference between the amounts of precipitation of the cold and warm periods is decreasing. Distribution of precipitation throughout the year is becoming homogenous. It may be interpreted as the development of the marine climate features in Lithuania.

6.3. Climate Scenarios in Lithuania for the 21st century

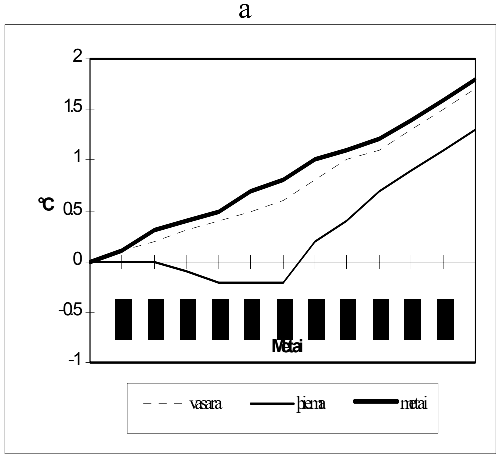
Variations of climate in Lithuania are undoubtedly connected with the processes, which take place in the entire climate system of the Earth. This makes Lithuania potentially susceptible to global climate changes, as well as to the positive impact of the reduction of greenhouse gas emissions.

The amount of CO_2 in atmosphere in the end of the 19th century was 0.020-0.028 % depending on the season. Recent concentration of CO_2 has reached 0.036 % because of the combustion of mineral fuels (World Climate News, 1999). In climate models, the greenhouse effect of various thermodynamically active gases is converted into equivalent effect of CO_2. This method and the application of dynamic climate models helped to determine that, if equivalent CO_2 concentration increases twice (up to 0.057 %) as compared with the pre-industrial period, the average air temperature in the Baltic area would increase by 2-4^o C and the amount of precipitation – by 20-40 mm (Barrow, Hume, Semenov, 1995). It may happen in 2040-2090. If climate changes are of this or even smaller scale, agroclimatic conditions of wintering and particularly of vegetation of flora would change essentially. The warming would have an impact on energy production, industry, and natural ecosystems.

Scenarios of changes of the air temperature and the amount of precipitation in Lithuania until 2050 were projected on the basis of three main prognostic models of climate: GFDL (the model of Princetown Laboratory of Dynamics of Geophysical Processes, USA), UKTR (the model of Meteorology Centre of the UK) and MPI (the model of Max Planck Meteorology Institute, Germany) (Carter, Poseh, Tuomenvirta, 1995). Taking into account the opportunities offered by these models in evaluating the present climate conditions in Lithuania, the GFDL model was chosen as the most suitable. Therefore, this model was chosen to predict changes of climate indicators and agroclimatic resources.

According to the GFDL model, the average summer temperature in the first half of the 21st century would increase and in 2050 it would exceed the recent average by 1.7^o C (see Fig.6.2.a). Particular warming would be in July and in 2050 it would be as much as 1.7-1.9^o C. The average sum of summer active temperatures, which recently (1961-1990) is 1440-1510^{o}C, would reach 1580-1660^{o}C in 2050. Due to this, the vegetation period of agricultural plants until full ripe should shorten by 8-10 %.

a



b

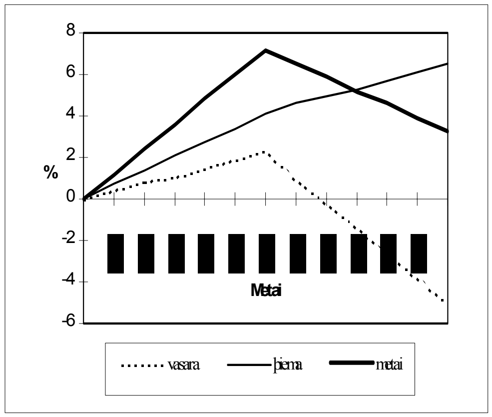


Fig.6.2. Scenarios of changes of air temperature (a) and amount of precipitation (b) in Vilnius according to the GFDL model.

According to the GFDL model, the amounts of summer precipitation would slightly increase until 2020 (by 1-2 %) and start decreasing in the subsequent period. The amount of precipitation in 2050 would be lower by 5-6 % (12-14 mm) than the present level (see Fig.6.2.b).

The changes of the summer coefficient (HTC), which characterises moisture supply to vegetation, were predicted for Vilnius, Dotnuva and Vėžaičiai with the help of the GFDL. $HTC = \frac{\sum p}{0.1\sum t}$, where $\sum p$ is the total amount of summer precipitation (in mm), $\sum t$ - the sum of summer active temperatures (in^{o} C).

It became evident from the prognosis of the summer coefficient for 2005, 2020 and 2050, that the values of this coefficient would gradually decrease and in the middle of the 21st century would be by 0.2-0.3 lower than the recent ones. This decrease would be most significantly influenced by the July and August indicators, because the temperature of this period would increase and amount of precipitation – decrease. Aridity of July-August should increase substantially already in the beginning of the 21st century. The HTC of this period would decrease by 0.1-0.2 by 2005, 0.2-0.3 by 2020 and 0.3-0.4 by 2050. The changes in moisture supply to vegetation in May, June and September would be small, because the higher air temperature - the larger the amount of precipitation. Such increase of aridity in July and August would be particularly unfavourable for late vegetables, root vegetables and pasture vegetation.

Winter temperature would change only slightly until 2020 but later on it would start increasing and in 2050 would be by 1.2-1.3^{o}C higher than at present (see Fig.5.2). Wintering conditions of vegetation would change. Since the increase of temperature is firstly noticeable in February and March (according to the GFDL model), the duration of snow cover would decrease almost twice. The cover would become thinner; there would be more sleet and rain. The average total amount of winter precipitation in 2050 would exceed the current level by 5-6.5 % (7-9 mm) (see Fig.6.2). Wintering agricultural plants would be more susceptible to unfavourable agrometeorological phenomena: soaking, lifting, and rotting. Thin, dense and unstable snow cover would be an unreliable protection for the vegetation against low temperatures, particularly against sudden falls of temperature.

According to the GFDL model the average annual temperature in Lithuania within the next 50 years would increase by 1.5-1.7^{o} C, the amount of precipitation would increase by 7 % (approx. 48 mm) by 2020. Later this amount would start decreasing (Fig.6.2).

6.4. Impact of global climate change on biological diversity, terrestrial, freshwater and wetlands ecosystems

6.4.1. Impact of global climate change on biological diversity

Climate-related factors are among the most important abiotic factors, which have an impact on living nature – species, communities, and ecosystems. The impact of climate on biota and abiotic components becomes even more complicated due to increasing pressure of human activities in all areas, especially in those, where natural resources are intensively exploited. This situation is observed in certain Lithuanian regions and fields of economy.

More vegetation pests and diseases appear under warmer conditions. It is distribution range is crossing our country. Besides, the planted forests, particularly of a single culture, are more sensitive to different changes, including those of climate. Adaptation of forest plants with longer life expectancy is more complicated than adaptation of agrocenotic species. This all could lead to faster changes in species variety of Lithuanian forests. These shifts may cause changes in fauna. Variations of wind, temperature and humidity increase sensitivity of forests to contaminants causing acid rains. Therefore, an integrated evaluation of risk to ecosystems is needed.

Together with the changes in physical parameters of climate, such as temperature, precipitation, radiation, the changes in chemical composition of atmosphere may have a crucial impact on flora and fauna composition. Species variety and structure of ecosystems are shifting because of this phenomenon. The amplitude of negative ecological, social and economic consequences in our country may be very high.

Hydrological cycles are affected by climate change. Warming of near-surface air increases the temperatures of soil and water. This may cause changes in the composition of water communities. The speed and scope of water eutrophication are increasing.

Until now, investigations and protection of biological diversity, flora and fauna, and selection of protected areas were performed without taking into consideration permanent natural succession and climate change, which currently strongly affects distribution of fauna in different seasons. For this reason, the present steadfast system of protected areas, as well as their selection procedures is inadequate for the existing situation and continually changing environmental conditions. The protected areas nowadays often fail to fulfil their primary function. Climate change introduces its own corrections and creates specific problems. Therefore, periodic inspections of these and other territories, as well as environmental audit of the protected areas are necessary in Lithuania.

Climate change reduces stability of ecosystems. New, more competitive flora and fauna species occur, including pests and pathogenic organisms. Transformation of vegetation associations and forests creates new conditions for fauna, particularly for amphibians, insects, reptilians, and birds. Their habitats are changing, and so are their distribution ranges and composition of fauna communities, as some species become extinct. The rate of succession of fish and other aquatic animals varies, dependent on the declinations from the temperature optimum. The rate of species extinction depends on the speed of climate warming and rate of spreading of these species, which differs greatly between species. These processes are not sufficiently investigated in Lithuania, but they have been already traced. Due to climate changes species become more sensitive to various diseases. This affects the natural pool of a concrete species and their conservation possibilities.

Since different species have their characteristic temperature optimums, a temperature change of less than 1^{o} C will change the distribution of species. When climate tends to become warmer, the distribution ranges of various species are shifting northwards (latitudinal drift, to the north and north-east in Lithuania) or upwards in the mountains (altitudinal drift). The shift of species distribution ranges is a very complicated process and includes the processes of extinction and spreading of species – colonisation of new territories.

Former climate changes, which lasted a few millenniums, resulted in the extinction of many species. Recent processes are much faster and have a more expressed influence on biota. Extinction of species is accelerated by the existing ecological barriers – cities, roads, industrial enterprises, etc. Besides, population size matters greatly. The smaller the population is the higher the speed of its extinction. The species with naturally smaller distribution range, or with the distribution range reduced by melioration, destruction of habitats, intensive forest felling, which recently have been taking place in Lithuania, and other factors, will be the first to disappear.

The organisms in aquatic ecosystems adapted themselves to temperature conditions. Oxygen content in water, cycles of development and conditions of nutrition of fish, crustaceans depend on temperature. It is especially stable in the spawning areas. Since the most valuable migratory fishes are coming back from the sea to spawn in the same rivers, the change of conditions would cause irremediable losses of separate populations and subsequent decrease of fish resources. Climate change affecting flora and fauna also affects national economy. This impact can be expressed in material loss in terms of diminished resources in fishery, forestry or hunting industry.

The impact of climate change on wetlands and water basins is manifold. It affects aquatic and wetland organisms. Water is warming, ice-free periods and duration of temperature stratification become longer because the temperature increases in the lakes. In rivers, water becomes warmer, too. Annual and seasonal water flow and hydrological cycle are changing. Substantially larger influence of increase of temperature is observed on the littoral and in shallow water basins, wetlands. The impact of climate change is very important in wetlands. They may dry up, which accelerates succession and may lead to a change of flora and fauna. Ecological impact of climate change is strongly affected by economy. An indicator of such irreversible change could be the increasing fragmentation of wetlands and shallow waters. This shows the degree of the growing pressure on the environment.

When limnological parameters are changing, so do the ecosystem and the structure of fish communities, usually undergoing a regressive succession. A number of species in the communities decreases, and the communities shift towards later successive stages, as the area and depth of water bodies, relative permeability and limpidity of water, as well as its cold layer at the bottom decrease, while the parameters related with eutrophication and ageing of water bodies become more expressed.

Different parameters of a population change at a different speed. The parameters, which influence population structure (genotype diversity, the frequencies of particular alleles and genotypes) according to the trends of environmental factors, change within a few generations (treating a generation as the time span until puberty). Many parameters related with reproduction and production change within one generation. Growth changes most rapidly within one-year generations. For this reason, it is an informative parameter in operational monitoring.

6.4.2. New issues and the ways to address them

Global climate change brings new conservational and developmental challenges in Lithuania. Firstly, there are international commitments to be fulfilled by the state after signing a number of international conventions on the protection of biological diversity, flora and fauna. Altered environmental conditions caused by climate change result in changes of the characteristics of ecosystems, biotypes and distribution of organisms. Human activities, like the expansion of seaports, construction of new dumping sites, operation of oil terminals, etc., make the situation even more complicated.

Secondly, different ongoing or possible processes in the living nature discussed above may result in new impacts on different sectors of economy causing additional problems in aviation, agriculture, fishery, forestry, hunting, municipal, industries and other fields.

Thirdly, our theory of bird migration control determines the ratio of internal and external controlling mechanisms and a dynamic equilibrium of their interaction, which can be disturbed by climate change. The balance of this interaction and the parameters of migration control may also change. Additional research and new recommendations for concrete regions and geographical zones are necessary in order to apply theory in practice.

Fourthly, monitoring of the impact of climate change on biota is necessary. It should be closely co-ordinated with ecological monitoring activities. A national research programme including the main areas and aspects of the impact of climate change should be developed. Such a programme is also relevant to other countries of Western, Central and Eastern Europe. This was emphasised at the special conference on problems of climate change in Budapest, in 1999.

Fifthly, the research, carried out by the Institute of Ecology, indicates that many valuable territories, which should be protected, are beyond the boundaries of the existing protected areas. The current steadfast network of protected areas in Lithuania fails to fulfil its role effectively because of the new developments in nature caused by climate change. There is a need for an audit of the protected areas in order to re-assess the existing network and to modify the status of some protected areas, where necessary.

New wintering sites of merganser and large populations of waterfowl at the Lithuanian coastline appearing due to climate warming raise new tasks for their protection in the context of new international conventions signed by Lithuania. The Ministry of Environment in particular, and Lithuanian authorities in general, face new challenges trying to accord these tasks with the development of the Baltic Sea region: expansion of oil and cargo terminals, development and deepening of sea ports, development of tourism and recreational activities, etc.

6.5. Impact of climate change on dynamics of the Baltic Sea coast

The rising level of the ocean affects the Baltic Sea. The preliminary investigations of the dynamics of the Baltic Sea level showed, that the sea level has been rising at the Lithuanian and Kaliningrad coastline. The rate of eustatic water level rise was 2.2 mm per annum in 1962-1976, and 3.3 mm per annum in 1976-1994. It resulted in a significant extension of the washed away fragments of the Lithuanian coast. The coastline at Būtingė has retreated by more than 30 m within the last 30 years, new centres of coastal erosion appeared in the Kuršių Nerija near Nida, dunes protecting the beaches and coastal dunes deteriorated. Increasingly often storms result in seawater surges and floods sweeping across the littoral plain and the flooding residential houses on the inland coast of the Baltic Sea, also contributing to salinisation of soil. The global ocean level rise will activate the following processes:

- on the beaches – degradation, uncovering of moraines or peat on the main shore, intensive washing of protective dunes;
- in the littoral lowlands (on the blown sand plain of the Kuršių Nerija, in the zone between Palanga and Šventoji, in the Nemunas delta) – almost all the areas on approximately sea level may be submerged, the level of ground water may rise, resulting in bog formation and degradation of forests;
- in the hydrographic network – with the rise of the erosion baseline, hydrological properties of rivers falling into the Baltic Sea will change.
-

In addition to the rising water level, other physical-geographical factors, such as changes of winds and amount of precipitation, of the coastal structure, deposits of transported material, and resistance of the submarine slope, may influence the processes of coast formation. Strong storms appear to be more frequent and wash out coastal material, which is not fully restored. This is one of the main reasons for the decreasing deposits of transported material at the Lithuanian coast. The increasing frequency of storms may further support this tendency.

South-north migration of transported material is prevailing at the Lithuanian coast. For this reason, the deposits of transported material shall inevitably decrease to the north of Klaipėda, after the planned essential reconstruction and deepening of Klaipėda seaport.

A general trend of decrease of transported material at the accumulating shore of the Kuršių Nerija has been observed in recent years. The section of intensive abrasion of shore has extended from the southern up to the central part of the Spit, i.e., to the Lithuanian. Besides, recently signs of coastal degradation were noticed near the Klaipėda seaport, in the former accumulation zone.

According to the scenario of a minimal rise of water level, by 2030 the sea level should rise by approximately 9 cm. Even a small rise of water level would make various shore sections develop differently. The sections with a small slope would be gradually flooded and a new coastline formed along the sections with a greater slope. For this reason, the coastal line would become more tortuous, coastal lagoons would be formed in some places. Moraine loam shores of the Curonian Lagoon at the Cape of Ventė, Rasytė, and in its southern part, where littoral bottom is covered with gravel, coarse gravel and stones, will be less affected by wave abrasion. The Baltic coast mainly consists of soft, easily washed material (except for the fragment between Klaipėda and Palanga). Therefore the rise of water level would inevitably move the coastal line inland. Through the chain of lithodynamic processes, it would also change the balance of littoral transported material. Negative processes first of all are likely to take place in the shore sections short of transported material: the zones between Šventoji and Latvia, in Palanga resort, etc.

7. RESEARCH AND MONITORING

7.1. Research, simulation and projection of climate

7.1.1. National Environmental Monitoring Programme

The environmental monitoring, as defined in the Lithuanian laws on Environmental Protection and on Environmental Monitoring, is a systematic observation of the condition and changes of the environment ant its components, evaluation and prediction of anthropogenic influence. Monitoring providing the data of national significance, which enable to evaluate the status of the environment on a national scale, is included in the National Monitoring Programme.

The main aim of monitoring is to carry out a systematic observation, to analyse and predict the status of the environment, to determine the changes caused by anthropogenic impact. All this paves the way towards the efforts to take measures for improving the condition of the environment, allows to estimate the efficiency of the environmental protection measures already in place and to provide information on the status of the environment according to the requirements stemming from the international commitments and national legislation.

Natural processes are affected both by natural and anthropogenic factors. Impact of both factors (the latter in particular) is important, as regards monitoring structure. The environmental monitoring includes:

- monitoring of anthropogenic sources of pollution,
- monitoring of the main natural spheres and components (air, water, soil, biota),

- monitoring of natural and anthropogenic ecosystems (marshes, meadows, forests, etc.),
- monitoring of the main natural territorial components (types of landscape).

The environmental information system is included in this programme as an independent and equally important part of a monitoring system. This system is to ensure optimal and targeted use of data, obtained during the environmental monitoring, and to assess the condition of environment and its processes.

The programme of environmental monitoring does not cover monitoring of public health. It falls under a separate programme designed for this purpose. On the other hand, it will be closely co-ordinated with the programme of environmental monitoring.

The Law on Environmental Monitoring establishes three levels of implementation of the monitoring system:

- national
- municipal
- economic entities.

State monitoring is performed on all the three observation levels. Local and a part of regional monitoring activities are under the competence of municipalities. Monitoring performed by the economic entities is oriented towards the observations on local level only and is a constituent part of the monitoring of pollution sources.

7.1.2. Meteorological, hydrological and agrometeorological observations

Lithuanian Hydrometeorological Service is subordinate to the Ministry of Environment of the Republic of Lithuania. The main tasks delegated to this service are meteorological, hydrological and agrometeorological observations and prognosis. Lithuanian Hydrometeorological Service provides hydrometeorological information to the Lithuanian institutions, enterprises and organisations, takes part in the international projects and programmes, prepares and publishes manuals, annals and reviews. The observation network covers the entire Lithuania.

Lithuania is a member of the World Meteorological Organisation since 1992. The Lithuanian Hydrometeorological Service takes part in the BALTEX joint project of the Baltic States. The CLICOM programme has been implemented in co-operation with the meteorology service of the UK, the system BALTMET is in operation.

7.1.3. Research

Research on climate system and quality of environment is performed in the universities and research institutes of Lithuania. The most important recent programmes are the following:

“Peculiarities of variability of meteorological elements describing climate” (The Institute of Geography),

“Anomalies of climate elements in Lithuania and conditions of their formation in the 20th century” (The Institute of Geography), "Influence of climate variations on recent physical-geographical processes in Lithuania" (Vilnius University, the Institute of Geography, the Institute of Physics),

"Impact of global climate warming on Lithuanian agroclimatic resources" (Vilnius University).

There are plans to investigate the impact of climate variations on biological diversity and human health in Lithuania.

7.2. National research and prognosis of terrestrial and water ecosystems, biological diversity, fauna and flora

Research will be developed to evaluate climate change because the latter complicates forecast of changes in biota. Models tend to be inaccurate; they have to be corrected by including new environmental parameters with the aim to determine the trends of changes and possible consequences. Special investigations covering separate ecosystems are needed for this reason. A number of such investigations and observations of natural elements in Lithuania are performed in the framework of state ecological monitoring.

Hydrophysical and trophic parameters of the Lithuanian water basins are modified by the changes in climate conditions. Succession of communities proceeds. More detailed research is needed to estimate of these changes. Currently available information is sufficient only for determination of the trends of these changes. However, it is not sufficient for establishing the parameters defining links and relations and for preparation of prognoses. To perform evaluation and prognosis of the intensity of potential changes, it is necessary to quantitatively evaluate the trends of natural factors, interconnections of variability of communities and unified operation of natural factors

Monitoring of biota's reaction to climate change is performed by the Institute of Ecology. To determine the effects caused by climate change, it is necessary to separate short-term variations from long-term tendencies. Absence of information concerning the reaction of species and communities on climate change is among the most important problems. Primary monitoring will show the sensitivity of globally rare and endangered species, populations and communities to climate change. It should be supplemented by more specific monitoring of sensitive and endangered species. Monitoring will cover protected species, communities, ecosystems, condition of natural resources in use, and prognosis of their status. Monitoring of impact of climate change on biota is co-ordinated with the ecological (biological) monitoring and programme of biodiversity research in Lithuania.

Prognosis of changes of biota is complicated by climate change. It has a direct connection with the preservation of biological diversity. The available models of mathematical statistics, which do not take into account climate change, are not operative and precise. They have to be modified and improved to include new environmental parameters, their variations, trends and possible consequences. To this end, particular investigations covering different elements of ecosystems are needed. The Lithuanian national programme of climate change research in the framework of the National Strategy has been prepared for this reason. This programme involves researchers from different areas and addresses main global environmental problems, related with climate change.

It is very important for the protection of species included in national Red Data Books. Already the first studies emphasised that many species included in the Lithuanian Red Data Book are outside their main distribution range or live in fragmented areas. Global climate change raises problems of the protection of other species, which are not included in the national Red Data Books. Some species whose habitats are changing should be observed more closely or even included in the special lists of national Red Data Books. Potentially they are the species, which may be included into the Red Data Books due to rapid changes in nature. Climate change also provokes new problems for the protected areas. Species tend to leave the protected areas due to the environmental changes. Fixed protected areas fail to fulfil their task because the object under protection is changing. Therefore, protection of selected species and habitats in Lithuania appears more promising than a fixed network of protected areas.

7.3. Research and prognosis in agriculture and forest industry

A number of research works is performed in Lithuania. They are important for the prognosis of changes in agriculture and forest industry and for the studies of climate change, monitoring and prognosis of its impact. The following programmes with their goals and expected outcomes are worth mentioning:

Decrease of pollution in agriculture and development of ecological agriculture (measures against wash of nutrients from soil, ecological investigations of soils in the karst region, decrease of pollution with biogenic substances, monitoring of agriculture during the period of transition from intensive to ecological agriculture, decrease of run-off of pollutants to water basins, alternatives to pesticides and mineral fertilisers in ecological farms, selection of cultivation techniques and sorts of agricultural plants in ecological farms, measures to increase efficacy of ecological agriculture);

Information system of agriculture and forest industry (creation of an integrated information system of agriculture and forest industry, which shall collect, process and provide information to the Ministry of Agriculture, other agricultural institutions and organisations);

Acceleration of technical progress in agriculture and decrease of energy consumption (investigations of aggregation and energy compliance of imported and local agriculture machines, preparation of measures for the production and use of bioenergy, demonstration of the application of renewable energy (solar and wind) at farms, investigation of use of biological fuel and oils in agriculture);

Increasing of the genetic productivity of animals and poultry, and improvement of production quality (environmental impact assessment of animal husbandry in different regions of Lithuania and preparation of measures to decrease pollution of production);

Preparation of long-term agricultural development strategy (preparation of alternative prognoses of the agricultural development in Lithuania);

Investigation and evaluation of possible alternatives, selection of the best alternative of agriculture strategy (development of tactical, economic and legal measures to implement a possible strategy);

Programme of restoration and protection of forests and increase of timber stands productivity (forest coverage optimisation programme for Lithuania, preparation of measures to support spontaneous planting of forests, investigations of condition of forests in the areas of local contamination, creation of new repellents and investigations of their efficiency);

Programme of forest monitoring and evaluation of biological diversity in the protected areas (forest reserve assessment programme, status evaluation of national parks);

Preparation of measures for applying new alternative energy sources in agriculture and household sector (optimisation of water heating systems with solar collectors and wind power plants);

Development of the technologies based on biological fuel (investigation of straw and crushed wood combustion technologies);

Investigation of measures and means aimed to protect water bodies against pollution caused by human activities (environmental protection measures for agriculture; reduction of water contamination and migration of biogenic substances and heavy metals in soils fertilised with sewage sludge, environmental standards of sewage sludge application);

Assessment and forecast of anthropogenic impact on the properties of soils (influence of different agrochemical measures on soil fertility);

Establishment of optimum soil acidity parameters (evaluation of soil acidity variation by different regimes of fertilisation and establishment of optimum parameters of liming);

Impact of liming on the dynamics of biogenic elements in treated soils (maps of acidity of soil and washing of nutritional substances);

Evaluation of quantitative and qualitative changes of agroecosystems for different levels of chemical treatment (stability and sustainability of agroecosystems in the context of various external conditions);

Investigation of spreading specifics of diseases and pests damaging field crops, and forecast of their abundance (review of spreading of the most important diseases and pests);

Assessment of soil contamination with heavy metals in the fields subject to various types of fertilisation (allowed heavy metal concentrations, measures for decrease of contamination).

7.4. Monitoring

The recent programme of flora monitoring is mainly focused on monitoring of forests as one of the most important stabilisers of negative anthropogenic processes and one of the most sensitive components of environment. Tree damaging processes and condition of forests are monitored since 1988, according to the European programme of forest monitoring “ICP Forests”. The international monitoring programme on forest status, biodiversity and productivity (EMAP) is carried out in Lithuania, as well as in other Baltic States, since 1994.

Lithuania takes part in the programmes targeted at preservation of genetic resources of European forests (EUFORGEN) and forest monitoring. The project of forest sector development is carried out in co-operation with a Swedish consulting company. The aim of this project is to improve the national register of forests and a system of forest resources forecast, by applying new methodologies, based on remote techniques and use of GPS equipment, in register and forest management. The joint project

"Development of private forest sector in Lithuania" is commenced together with the FAO.

Long-term dynamics of meadow communities are observed at three agrostations.

There was no consistent wetland monitoring in Lithuania, though some activities carried out can be regarded as monitoring according to their techniques and type.

The goal of monitoring is to evaluate and forecast the main trends of changes in variety, abundance and productivity of species.

The objectives of monitoring are: to provide information on the variety, status and productivity of species, to identify the areas of human activities, which are most dangerous to the variety and productivity of flora, to quantitatively evaluate the changes in flora composition, to establish data bases allowing to characterise the variety of species.

The national research programme "Ecological sustainability of regional development in the historical context: Lithuanian example" (ECOSLIT, 1992-1998) was investigating interaction of all the components of regional system (atmosphere, soil, water, fauna and humans) under the influence of anthropogenic pollution.

8. EDUCATION, TRAINING AND PUBLIC AWARENESS

8.1. Training

Lithuania was one out of the three selected countries, which took part in the training programme CC:TRAIN, prepared by the Secretariat of the United Nations Framework Convention on Climate Change (UNFCCC) and United Nations Institute of Training and Research (UNITAR). CC:TRAIN helps the participating countries in preparation of the implementation strategies for the UNFCCC. A working group consisting of representatives of governmental and non-governmental organisations has been formed for the implementation of this programme. The aim of this group was to prepare the national strategy and action plan for the implementation of the UNFCCC. This working group was commissioned to co-ordinate other problems related to climate change and perform special tasks (e.g., to prepare national studies, etc.). Two tasks have been completed with the help of the CC:TRAIN programme. The National Strategy and Action Plan for the implementation of the Convention have been prepared and an active national working group was established. The strategy and the plan were approved by the Lithuanian Government.

The Ministry of Environment is designated by the Government to co-ordinate the implementation of the UNFCCC. In 1994, the Ministry of Environment established a working group to carry out CC:TRAIN programme. Different institutions, dealing with climate change and related national problems were included into the working group. Representatives from the Ministry of Environment, Ministry of Agriculture, Ministry of the Economy, Ministry of Transport, Ministry of Health, Lithuanian Hydrometeorology Service, Lithuanian Academy of Agriculture, Lithuanian Green Movement, Lithuanian Academy of Sciences, institutes of Ecology, Botany, Geography and Vilnius University were also included in the working group.

In 1994, a national workshop was organised in the framework of the CC:TRAIN programme. The aim of this workshop was to raise awareness of the public and the decision-makers on the problems tackled by the UNFCCC and the related national commitments of Lithuania. The three-day workshop was organised for the national working group to train the staff to prepare the national communication. A document on the national strategy for the implementation of the UNFCCC was prepared in 1995-1996. This document was discussed by all the institutions concerned. The final draft of the document was presented at a national workshop in September 1996 and approved by the Lithuanian Government on October 25, 1996. The following goals and objectives are included in the National Strategy:

- to help implement national commitments after signing the UNFCCC;
- to collect available information on an expected impact of climate change and its significance to Lithuania, to identify the missing elements of information and to forecast information needs in future;
- to offer alternative scenarios of national economy, social sphere and environmental protection in connection with climate change;
- to work on policies and measures, allowing the state to adapt to and to mitigate the impact of climate change;
- to prepare and select projects addressing the problems related with global climate change, eligible for GEF funding;
- to raise national awareness on climate change and UNFCCC.

The Atmosphere Division of the Ministry of Environment has completed the inventory of greenhouse gas emissions in Lithuania according to the methodology recommended by the Intergovernmental Commission on Climate Changes (IPCC). The inventory data are included in the National Strategy. The methodology was presented at the workshop organised by the CC:TRAIN.

Lithuanian energy, agriculture and forest industries go through substantial changes and any decision may influence future development of these sectors. Decisions made today will influence their greenhouse gas emissions until 2010 and later. The National Strategy lists different measures and actions, which may contribute to the decrease of the emissions of gases and to the development of national economy, social security and environmental protection. The Strategy, however, does not specify potential ways to decrease the emissions and cut the expected expenses of the planned measures. Measures and means of softening the impact on the state are not outlined either. On the other hand, the Strategy holds important information on national commitments in the fields where Lithuania would be vulnerable to climate change, including the ways of reducing this vulnerability.

The need for impact mitigation sets more important and urgent tasks for Lithuanian economy in this transient period, than the problems of adaptation to climate change.
During the CC:TRAIN workshop, Lithuania performed a number of actions, which usually are included in the GEF projects. They comprised:

- rising concern about climate change and awareness of the problems tackled by UNFCCC among decision makers, workers of related sectors and general public;
- initiation of dialogue, information exchange and co-operation between representatives of governmental, non-governmental, academic and business sectors;

- collection of information on relevant research and special activities performed in Lithuania;
- providing access to international links, connections and information on climate change, including the Internet and the World Network of Weather Observations (WWW).

8.2. Education and public awareness

Education on and public awareness of the problems of climate change and the ways to address them are the necessary condition of implementation of commitments defined by the UNFCCC. These items are included in the general programme of education in environmental protection, which is prepared by the Ministry of Environment in 1998. The education problems and connected tasks are defined in the National Strategy and actions plan of implementation of the UNFCCC. It is very important for the understanding of society of problems of climate change, factors, causing climate change, possible negative consequences in Lithuania and world, possible means of decrease of negative impact.

There are no special programmes in problems of climate change devoted to students of universities, high and secondary schools. Primary information, included in the programmes of elementary ecology, biology and chemistry is not integrated. Adapted teaching programmes and teaching literature should be prepared to improve the situation.

The formal system of education is defined in Lithuania. As a rule, these institutions are under the Ministry of Education and Culture or are influenced by this ministry. The system of non-formal education in environmental protection is created and developed. This system covers various governmental and non-governmental institutions, which take part in environmental education. These institutions will be the basis for development of education in environmental protection.

The problems of global climate change and related topics are covered in the Department of Natural Sciences of Vilnius University when biology and geography bachelors and masters are prepared. The Centre of Environmental Studies of this Department is educating bachelors and masters in ecology and environmental research. The problems of global climate change were raised in conferences, organised by Lithuanian Academy of Sciences, Palace of Scientists and Institute of Ecology. These problems were discussed in public presentations of scientists on TV and radio, papers in press. Lectures were given in different regions and towns of Lithuania.

National and municipal institutions of all levels are responsible for implementation of tasks and objectives of education in environmental protection according to their competence defined by legislation. Many rights by the law of environmental protection are given to all the citizens and public organisations. On the other hand, the law obliges to do duties in environmental protection, preserving natural resources and not violating rights and interests of other users of natural resources. Thus, all the habitants of Lithuania shall take part in the process of education in environmental protection.

The Parliament (Seimas) of Lithuanian Republic defines the official environmental protection policy. Education is a part of this policy.

Lithuanian Government, the Ministry of Environment and other regulatory bodies perform state management of environmental protection.

Municipalities are responsible for the protection of environment in their territories as defined by legislation.