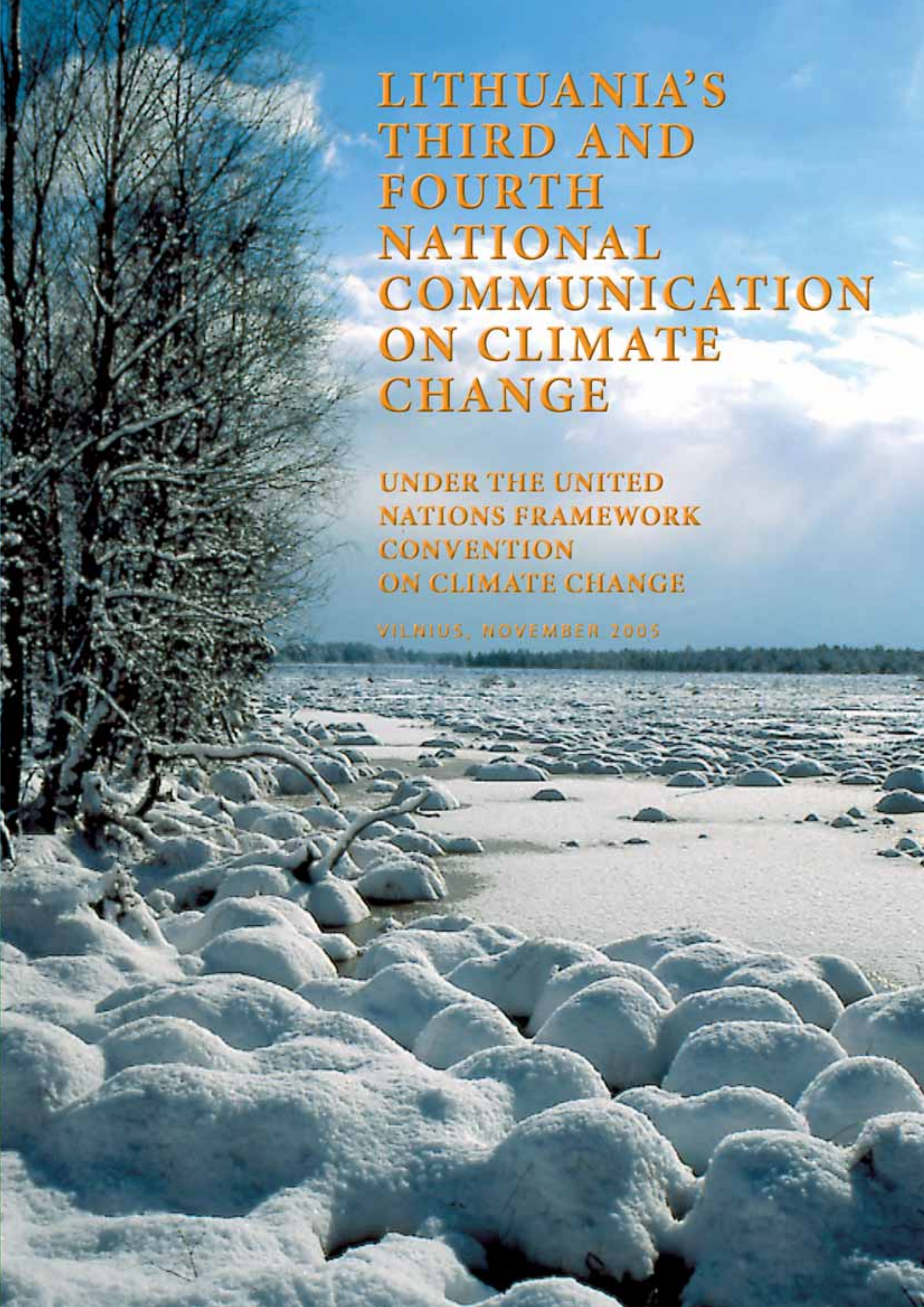


LITHUANIA'S THIRD AND FOURTH NATIONAL COMMUNICATION ON CLIMATE CHANGE

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

VILNIUS, NOVEMBER 2005

THE REPUBLIC OF LITHUANIA

2005

LITHUANIA'S THIRD AND FOURTH NATIONAL COMMUNICATION ON CLIMATE CHANGE

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

VILNIUS, NOVEMBER 2005

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF LITHUANIA

INSTITUTE OF ECOLOGY
OF VILNIUS UNIVERSITY

This Communication was prepared at the Institute of Ecology of Vilnius University using different kind of material available from published and official sources. The material was elaborated and compiled by the *Members of a Task Force Team*:

Mečislovas Žalakevičius, Dr Habil., Corresp. Member of the Lithuanian Academy of Sciences, Institute of Ecology of Vilnius University, *project leader, editor*

Rita Baliulevičiūtė, M. Sc., Institute of Ecology of Vilnius University, *project manager*

Aidė Mazurkevičiūtė, M. Sc., Institute of Ecology of Vilnius University

Arūnas Bukantis, Prof., Dr Habil., Vilnius University

Egidijus Rimkus, Assoc. Prof., Dr, Vilnius University

Gintautas Stankūnavičius, Assoc. Prof., Dr, Vilnius University

Andrius Štaras, Dr, Vilnius University

Vytautas Krušinskas, M. Sc., Ministry of Environment

Jolanta Kotvickaja, M. Sc., Ministry of Environment

Audronė Galvonaitė, Dr, Lithuanian Hydrometeorological Service

Vida Augulienė, M. Sc., Lithuanian Hydrometeorological Service

Rūta Bubnienė, M. Sc., Center for Environmental Policy

Dalia Štreimikienė, Dr, Lithuanian Energy Institute

Foreword

On 11 March 1990, Lithuania restored its independence after 50 years of the Soviet Union annexation. On 1 May 2004, Lithuania became a member of the European Union, and in the same year took part in the elections to the European Parliament for the first time.

Lithuania's Seimas (Parliament) ratified the UNFCCC (Rio de Janeiro, 1992) on 23 February 1995. Lithuania ratified the Kyoto Protocol (Kyoto, 1997) on 19 November 2002. In relation to it, the European Union and Lithuania have undertaken to reduce greenhouse gas emissions in the period 2008–2012 to, on average, 8% below the level in the so-called base year, which is 1990 for carbon dioxide, methane and nitrous oxide and 1990 or 1995 for industrial greenhouse gases.

The Third and Fourth National Communication on Climate Change under the United Nations Framework Convention on Climate Change was prepared at the Institute of Ecology of Vilnius University with participation of specialists from the Ministry of Environment, Institute of Ecology of Vilnius University, Vilnius University, Lithuanian Hydrometeorological Service, Lithuanian Energy Institute, Center for Environmental Policy. The Communication was submitted to and adopted by the National Climate Change Committee and at the seminar of Lithuanian NGO's.

This Communication is an upgrade of Lithuania's Second National Communication under the United Nations Framework Convention on Climate Change which was submitted to the Convention Secretariat in 2002. This Communication includes the Third and Fourth National Communications as we assumed that it would be not reasonable to publish two separate issues in the situation of very fast changes in our country: accession to the European Union, harmonization of legal basis, integration to new European structures, etc.

This Communication includes new chapters, new actions, policies and measures to fulfil country's obligations on the United Nations Framework Convention on Climate Change.

The data on greenhouse gas emissions show that Lithuania, as a new member of the European Union, shall make appropriate efforts to reduce emissions and achieve the Kyoto Protocol emission reduction targets.

ARŪNAS KUNDROTAS
Minister of Environment of the Republic of Lithuania

Published by
Ministry of Environment of the Republic of Lithuania, A. Jakšto g. 4/9, LT-01105, Vilnius
Institute of Ecology of Vilnius University, Akademijos 2, LT-08412, Vilnius

Translation into English
Institute of Ecology of Vilnius University:
Virginija Ginčienė
Virginija Žalienė
Sigita Daugirdienė
Laima Monkienė

Editing
Irena Žalakevičienė

Layout
Gintautas Vaitonis, Dr, Institute of Ecology of Vilnius University

Cover
Eugenijus Drobelis, Dr, Kristina Vaitonienė

Printing
„Petro ofsetas", Joint Stock Company

Printed in 500 copies

Lithuania's Third and Fourth National Communication on Climate Change
Under the United Nations Framework Convention on Climate Change

Editor: Mečislovas Žalakevičius,
translation into English:
Institute of Ecology of Vilnius University, Vilnius: Republic of Lithuania,
Ministry of Environment,
Institute of Ecology of Vilnius University, 2005.

ISBN 9986-443-31-8

Contents

FOREWORD 3

CHAPTER 1. EXECUTIVE SUMMARY 10
1.2. Lithuanian National Circumstances Relevant to Greenhouse Gas Emission and Removal 10
1.3. Greenhouse Gas Inventory Information 11
1.4. Policies and Measures 12
1.5. Projections and the Total Effect of Policies and Measures 13
1.6. Climate Change Impact, Vulnerability Assessment, Adaptation and Mitigation Measures 14
1.7. Research and Systematic Observation 17
1.8. Education, Training and Public Awareness 19

CHAPTER 2. LITHUANIAN NATIONAL CIRCUMSTANCES RELEVANT TO GREENHOUSE GAS EMISSION AND REMOVAL 22
2.1. Government Structure 22
2.2. Population Profile 23
2.3. Geographic Profile 24
2.4. Climate Profile 24
2.5. Economic Profile 25
2.6. Energy 27
2.7. Transport 30
2.8. Industry 33
2.9. Waste 34
2.10. Building Stock and Urban Structure 35
2.11. Forestry and Agriculture 36
2.12. Sources 38

CHAPTER 3. GREENHOUSE GAS INVENTORY INFORMATION 42
3.1. Methodology of Preparation of Emission Inventories 42
3.2. Main Changes in Inventories from the Previous Communication 43
3.3. GHG Emissions 44
3.3.1. Trends of Aggregated GHG Emissions 44
3.3.2. Emission Trends by Gas 44
3.3.2.1. Carbon Dioxide 45
3.3.2.2. Methane 45
3.3.2.3. Nitrous Oxide 45
3.3.2.4. Hydrofluorocarbons, Perfluorocarbons and Sulphur Hexafluoride 45
3.3.3 Emission/Removal Trends by Sectors and Sources 45
3.4. Sources 47

CHAPTER 4. POLICIES AND MEASURES 50
4.1. Policy-Making Process 50
4.1.1. International Agreements and Conventions 50
4.1.2. European Union Level 50
4.1.3. National Action Plans 51
4.1.4. Institutional Arrangements, Monitoring and Supervision 53
4.2. Overview of Policies and Measures and Their Effects in Economic Sectors 53
4.2.1. Energy 54
4.2.1.1. Policies and Measures Oriented to the Energy Sector 54
4.2.1.2. Renewable Energy Sources 55
4.2.1.3. Nuclear Energy 55
4.2.1.4. Residential and Building Sector 56
4.2.2. Transport 56
4.2.2.1. Main Objectives of Transport Policies 56
4.2.2.2. Measures to Mitigate Pollution from Vehicles 57
4.2.3. Industry 57
4.2.3.1. Policy Context in the Industry Sector 57
4.2.3.2. Preventive Environmental Protection and Other Measures 58
4.2.3.3. Limitation of Emissions of Volatile Organic Compounds 58
4.2.4. Agriculture and Forestry 58
4.2.4.1. Context of the Action Policy in Agriculture 58
4.2.4.2. Context of the Action Policy in Forestry 59
4.2.5. Waste Management 59
4.2.5.1. Main Objectives of the Waste Management Policy 59
4.2.5.2. Solid Waste Management 59
4.2.5.3. Sewage Sludge Management 61
4.3. Sources 62

CHAPTER 5. PROJECTIONS AND THE TOTAL EFFECT OF POLICIES AND MEASURES 64
5.1. Projections of GHG Emissions and Effects of Policies and Measures in Fuel Combustion Sector 64
5.1.1. Projections for Primary and Final Energy 64
5.1.2. Projections for CO_2 Emissions 65
5.1.3. Projections for N_2O Emissions 65
5.1.4. Projections for CH_4 Emissions 65
5.1.5. Projections for All GHG Emissions from Fuel Combustion 66
5.2. Impacts of Policies and Measures in Fuel Combustion Sector 66
5.2.1. Impact of Measures in Energy Sector 66
5.2.2. Forecast of GHG Emissions and the Impact of Policies and Measures in Industry and Residential and Service Sector 67
5.2.3. Forecast of GHG Emissions and the Impact of Policies and Measures in Transport Sector 68
5.2.4. GHG Emissions in Energy Sector „With Measures" and „Without Measures" 69
5.3. Projections of GHG Emissions and Effects of Policies and Measures in Non-Energy Sector 69
5.3.1. Projections of GHG Emissions in Agriculture 69
5.3.2. Projections of GHG Emissions from the Industrial Processes Sector 69
5.3.3. Projections of GHG Emissions from LUCF Sector 70
5.3.4. Projections of GHG Emissions from the Waste Sector 71
5.4. Methodology 71
5.5. Uncertainties 72
5.6. Sources 72

CHAPTER 6. CLIMATE CHANGE IMPACT, VULNERABILITY ASSESSMENT, ADAPTATION AND MITIGATION MEASURES 74
6.1. Climate Change Impact 74
6.1.1. Changes in Climate 74
6.1.2. Impact on Agriculture 75
6.1.3. Impact on Forest Ecosystems 76
6.1.4. Impact on Terrestrial, Freshwater and Wetland Ecosystems and Their Components 76
6.1.5. Impact on Biological Diversity, Ecosystems and Their Components in Conditions of Increasing Anthropogenic Pressure 77
6.1.6. Impacts on Groundwater Regime and Chemical Composition, on Hydrological and Hydrophysical Indices of the Baltic Sea, Curonian Lagoon, Lakes and Rivers 77
6.1.7. Wind Erosion 77
6.1.8. Socio-Economic Importance of Climate Change Impacts 78
6.2. Vulnerability Assessment 78
6.2.1. Forecast of Climate Situation according to General Circulation Models for the 21st Century 78
6.2.2. Agriculture and Forestry 80
6.2.3. Ecosystems, Biodiversity and Protected Areas 83
6.2.4. Coastal Zone 83
6.2.5. Human Health and Well-Being of Society 84
6.2.6. Rivers, Floods and Their Possible Impacts 84
6.3. Adaptation and Mitigation Measures 86
6.3.1. Agriculture 86
6.3.2. Forestry 87
6.3.3. Environmental Protection, Rivers, Lakes and Coastal Zone 87
6.3.4. Human Health 87
6.4. Guidelines for Further Work 87
6.5. Sources 88

CHAPTER 7. RESEARCH AND SYSTEMATIC OBSERVATION 90
7.1. General Policy on Research and Systematic Observation 90
7.2. Research 91
7.2.1. State of Research 91
7.2.2. Impacts on Ecosystems and Their Components 94
7.2.3. Research and Development of Technologies for Adaptation to and Mitigation of Climate Change Consequences 94
7.2.4. Socio-Economic Analysis 95
7.3. Systematic Observations 95
7.3.1. Meteorological and Atmospheric Observations 95
7.3.2. Marine Observations 96
7.3.3. State Environmental Monitoring 96
7.4. Sources 97

CHAPTER 8. EDUCATION, TRAINING AND PUBLIC AWARENESS RAISING 100
8.1. Introduction 100
8.2. Education 100
8.3. Environmental Information Accessibility and Public Participation in Decision-Making on Environmental Issues 101
8.4. Training and Participation of the Society 102

8.5. Public Awareness....103
8.6. Sources....104

ABBREVIATIONS....108
Units and Exchange Rate....108

APPENDIXES....110
Appendix 1. Key Source Analysis....110
Appendix 2. Summary Table of GHG Emissions in 1990....111
Appendix 3. Summary Table of GHG Emissions in 1998....112
Appendix 4. Summary Table of GHG Emissions in 2001....113
Appendix 5. Summary Table of GHG Emissions in 2002....114
Appendix 6. Summary Table of GHG Emissions in 2003....115
Appendix 7. GHG Emissions from Fuel Combustion by GHG Emission Sources and Greenhouse Gases....116

THE REPUBLIC OF LITHUANIA

Lithuania's Third and Fourth National Communication on Climate Change

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

CHAPTER 1

Executive Summary

VILNIUS, NOVEMBER 2005

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF LITHUANIA

INSTITUTE OF ECOLOGY OF VILNIUS UNIVERSITY

CHAPTER 1. Executive Summary

1.1. Introduction

The Third and Fourth National Communication has been prepared on the basis of the requirements set forth in UNFCCC/CP/1999/7, Part II – *Guidelines for the Preparation of National Communications by Parties Included in Annex I to the Convention* and analyzes current circumstances in the area of climate change in the Republic of Lithuania. It also documents the state of compliance with obligations following from the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol.

Lithuania ratified the UNFCCC in 1995 and the Kyoto Protocol in 2002. Consequently several legal acts and measures on national level were taken to achieve country's obligations on Convention. A great stimulus for the process was Lithuania's accession to the European Union in 2004. This placed protection of the climate amongst the priority environmental issues in Lithuania.

1.2. Lithuanian National Circumstances Relevant to Greenhouse Gas Emission and Removal

On 11 March 1990, Lithuania restored its independence after 50 years of the Soviet Union annexation. On 1 May 2004, Lithuania became a member of the European Union (EU) and in the same year, took part in the elections to the European Parliament for the first time. Lithuania is a democratic parliamentary republic with the separate powers of the Seimas (Parliament), the President and the Government, and the Supreme Court. The head of the state is the President, the legislative power belongs to the Seimas, and the executive power is provided by the Government formed by the Prime Minister. The Ministry of Environment and institutions under its subordination are responsible for the development of the environmental protection policy. To achieve these goals, the Ministry of Environment works in close co-operation with other ministries, non-governmental organisations and educational and scientific institutions of Lithuania.

Lithuania is a state in Central Europe with an area of 65,302 km² near the Baltic Sea. Its population is 3,425.3 thous people, 33.4% of which reside in villages. There are 106 cities in Lithuania with 2,281.4 thous residents. The population density – 52.8 inhabitants/km². The country's population is constantly decreasing, which is caused by two main factors: extensive emigration and negative population growth. The majority of Lithuanian inhabitants still reside in apartments of old construction which are uneconomical and of poor quality. Though an increase in the construction of new apartments is observed in recent years, yet the demand exceeds the supply.

Lithuania is a country of lowlands. Farming land occupies 52% of the whole Lithuanian land stock, and 85% of agricultural land. The Lithuanian woodland covers 2,069.1 thous ha, or 31.7% of the country's territory. State-owned wood area covers 1,029.9 thous ha, and private-owned forest land area – 641.9 thous ha (31% of the total area). Though Lithuania is situated near the Baltic sea, its climate is not typically maritime. The average annual precipitation amount in the country equals 748 mm. Features of continental climate are characteristic of the eastern part of the country. Climate conditions and natural soil fertility are favourable for growing crops, fruit and vegetables, flax, rape, sugar beet, etc. The major part of agricultural production is constituted by plant growing (1.5 times more than animal husbandry).

The last decade of economic reforms in Lithuania was the most productive in respect to macroeconomy. Market economy and stable macroeconomic environment took hold, though not in all economic spheres. Since 2000, GDP has been constantly increasing. In 2004, it reached 61.9 billion LTL, and its growth – 6.7%, compared to 2003. In recent years, production needed for new construction and reconstruction has largely increased. Manufacture and export of furniture and foodstuffs has also enlarged. More goods are being exported and imported from the countries of the EU.

Energy sector is one of the most important economic sectors in Lithuania. It includes sub sectors of electricity, central heating, oil, natural gas, coal and local fuel, and renewable energy resources. In 2004, the energy consumed amounted to 4,342.3 thous t of oil equivalent. Transport, household and industry are the main energy consumers. Oil products, thermal energy, electrical energy and wood are the commonest sources of energy. The Lithuanian National Energy Strategy (2002) designates basic strategic goals, which are directly connected with energy saving, its more effective use, and expansion and promotion of alternative energy consumption (in 2003, the consumption of renewable energy resources in Lithuania amounted to 8.22 TWh).

Lithuania is a transit country crossed by Trans-European Network corridors. Total length of roads of national importance equals 21,345 km. In 2004, total transportation of freight in Lithuania amounted to 128,989.0 thous t, and transportation of passengers –

to 483,165.5 thous people. The number of motor vehicles in Lithuania is also increasing. It amounted to 1.63 million in 2004. The structure of motor fuels has changed: the consumption of diesel fuel and liquefied petroleum gas has increased. Nevertheless, transport pollution remains intense, as the average age of cars reaches 14 years.

The greater share of the total added value belongs to Lithuanian industry sector. According to the volume of industrial production, oil processing, food production, textile, clothing, leather and wood industries stand for the largest sectors. Privatisation of industrial enterprises, establishment of new market relationships, and introduction of taxes on natural resources and pollution of the environment notably enhanced production efficiency of the majority of the survived enterprises, economical utilization of natural resources, and reduction of environment contamination. In Lithuania the situation is worse with its landfills, which amount to as many as 737. Annual average non-hazardous waste accounts for about 4.8 million t, which is deposited in landfills, whereas hazardous waste accounts for about 142 thous t, the major part of which is stored or processed. Management of radioactive waste and used nuclear fuel poses the most important problems. Ignalina Nuclear Power Plant (NPP) is the main generator of radioactive waste in Lithuania. Radioactive substances have been stored up to now. However, Lithuania has not yet made any decisions about management of used nuclear fuel after termination of its storage in dry-type depositories.

1.3. Greenhouse Gas Inventory Information

Inventory of greenhouse gas (GHG) emissions for all gases and sectors was calculated on the basis of IPCC methodology in its Revised 1996 Guidelines and IPCC Good Practice Guidance. It is based on data and statistics collected from the following sources: Statistics of Lithuania (Statistical Yearbooks of Lithuania, Sectoral Yearbooks on Energy balance, Agriculture, Commodities, Natural resources and Environmental protection); Lithuanian Statistical Yearbooks of Forestry (Ministry of Environment, State Forest Survey Service), and Material from the Environmental Protection Agency (wastewater and waste data). The GHG inventory contains information on anthropogenic emissions by sources and removals by sinks for the following direct (CO_2, CH_4, N_2O) and indirect (CO, NO_x, NMVOCs, SO_2) greenhouse gases. Data on F-gases (PFCs and SF_6) are not provided, only potential emissions of HFCs are presented. Greenhouse gas inventory covers the years: 1990 (base year), 1998, 2001, 2002 and 2003 (National Inventory Report (NIR) submitted to the UNFCCC Secretariat).

Aggregated emissions of direct GHG expressed in CO_2 equivalent without CO_2 removals/emissions from Land-Use Change and Forestry sector (LUCF) decreased by 66% during the period 1990–2003 (Table 1–1). Net CO_2 emissions/removals decreased by 84%, and emissions of CH_4 and N_2O decreased by 55% and 68%, respectively. Between 1990 and 1998, GHG emissions decreased significantly as a consequence of the reconstruction of the economy: the decline in industrial production engendered a sharp decrease in fuel consumption and, as a result, in GHG emissions. The average reduction in GHG emissions from 1990 to 1998 was 3,637 Gg CO_2 equivalent per year. The annual increase of GHG emissions between 2002 and 2003 reached only 8 Gg CO_2 equivalent. However, in 2003, GHG emissions with LUCF were 2% below the emissions in 2002.

The major source of GHG emissions in 1990 was the energy sector, with CO_2 as the main GHG, which is responsible for 74% of all GHG emissions (in CO_2 equivalent), not taking into account removals/emissions from LUCF sector, followed by agriculture (14%), waste (7%) and industrial processes (5%). This pattern changed marginally in the period 1990–2003, at the end of which the energy sector accounted for 71%, followed by agriculture (12%), industrial processes (9%) and waste (8%) (Figure 1–1).

Table 1-1. Trends of GHG emissions by sectors, CO_2 equivalent, Gg

GHG sources and categories	1990	1998	2001	2002	2003	2003/1990	2003/2002
1. Energy	37,633.53	14,885.29	12,624.50	11,556.24	12,036.60	-68%	+4%
2. Industrial Processes	2,671.50	2,710.36	2,122.07	1,976.57	1,610.17	-40%	-18%
3. Solvent and Other Product Use	NE	NE	NE	NE	–	–	–
4. Agriculture	7,143.87	2,540.35	2,972.27	2,169.66	2,113.10	-70%	-3%
5. Land-Use Change and Forestry	-5,482.36	-7,557.51	-7,335.19	-6,720.60	-6,989.43	(27%)	(4%)
6. Waste	3,479.70	1,682.18	1,562.82	1,512.63	1,463.24	-58%	-3%
Total with LUCF	45,446.24	14,260.67	11,946.47	10,494.50	10,233.68	-77%	-2%
Total without LUCF	50,928.60	21,818.18	19,281.66	17,215.10	17,223.11	-66%	+0.0%

LUCF – Land-Use Change and Forestry

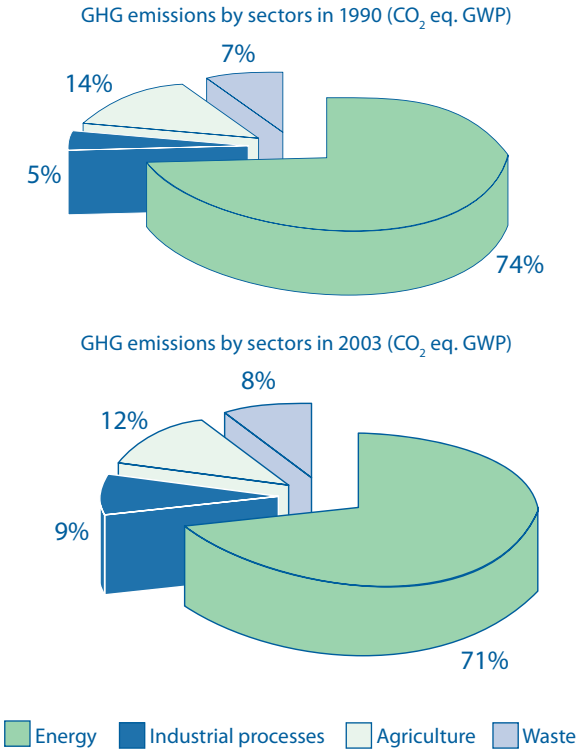


Figure 1-1. Share of GHG emissions by sectors in 1990 and 2003, in CO_2 equivalent

Energy sector – fuel combustion activities are responsible for five key source categories of GHG emissions (CO_2), and fugitive emissions from oil and gas operations (CH_4) – for one key source.

GHG emissions from agriculture in Lithuania consist of emissions of methane and nitrous oxide. Agriculture is the second largest source of greenhouse gases, emitting 40% of all methane and 51% of all nitrous oxide.

In 2003, net emissions/removals made 6,989.43 Gg CO_2, and comparing to 1990, they increased by 1,507.07 Gg CO_2. During 1998–2003, forest area expanded by 46,700 ha making an increase in sink strength. Over the last few years, between 9,000 and 11,000 ha have been reforested annually exhibiting an increase in sink strength as well.

Emissions of greenhouse gases CH_4 from the waste sector in Lithuania originate from two major source categories: solid waste disposal on land and wastewater (industrial, domestic and commercial) handling.

1.4. Policies and Measures

Upon ratification of the United Nations Framework Convention on Climate Change in 1995 and its Kyoto Protocol in 2002 and seeking to honour its commitments, Lithuania faced a necessity to adopt legal acts and other measures on a national level. Accession of Lithuania to the EU in 2004 made the country bound by the EU requirements.

In 1998–2004, a number of important legal acts were adopted on a national level. Most of them dealt with the environmental part of the EU *acquis communautaire* Implementation Action Plan. The National Sustainable Development Strategy approved by the Government of the Republic of Lithuania on 11 September 2003 is one of the key instruments governing sustainable development of Lithuania's economy, environmental protection and social policy. The strategy provides a list of sustainable development indices used for monitoring the implementation of the National Sustainable Development Strategy.

In 2000, the National Sustainable Development Commission (reorganized in 2003) was formed with a view to ensuring coordination of sustainable development on the highest level. The prime objective of the National Climate Change Committee formed in 2001 (reorganized in 2004) is to facilitate ensuring the goals set in the National Sustainable Development Strategy in connection with the mitigation of GHG emissions and to help implementing measures intended for achievement of such goals.

Energy. The National Energy Strategy drawn up in 2002 provides concrete solutions regarding the terms and conditions of decommissioning of the Ignalina NPP, pays regard to new environmental requirements, and amends energy development trends set in 1999. Based on the National Programme for Increase of Efficiency of Energy Use drawn up in 2001, it was calculated that upon introduction of paramount measures for saving energy resources and energy, the country could save about 25% of energy resources consumed. In addition, it is important to introduce measures promoting use of renewable energy sources. Special measures must be taken in relation to the decommissioning of the Ignalina NPP. The housing and construction sector is also awaiting reorganizations. The Lithuanian Housing Strategy establishing long-term objectives and priorities of the housing policy (which may also facilitate mitigation of GHG emissions) is the key instrument in the construction sector.

Transport. Implementation of sustainable development principles in the transport sector is contemplated in such strategic instruments as the State Long-term Development Strategy, Master Plan of the Territory of the Republic of Lithuania, Long-term Economic Development Strategy of Lithuania until 2015. One of long-term priorities is to use more environment-friendly and alternative fuels and vehicles. The purpose of the Law on Biofuel, Biogas and Biooil of the Republic of Lithuania adopted in 2004 is to reduce GHG emissions and pollution. One of the meas-

ures under the law is to offer statutory allowances to manufacturers and users of biofuel, biogas and biooil.

Industry. Long-term objectives and their implementation measures in the industry sector are laid down in the National Sustainable Development Strategy. Besides, a number of important measures applicable to GHG reductions are set out in the Strategy of Economic Factors of Environmental Protection, which is a constituent part of the Long-term Economic Development Strategy of Lithuania until 2015. The Procedure for Reduction of Volatile Organic Compound Emissions Due to the Use of Solvents in Installations of Certain Activities adopted in 2002 is intended to mitigate direct and indirect impacts of volatile organic compounds (discharge from dye, solvents, glue and other preparations) upon environment.

Agriculture and Forestry. The purpose of the Agricultural and Rural Development Strategy drawn up in 2000 is to establish agricultural and rural development trends for 2000–2006. Another important instrument in the sector of agriculture is the State Programme for the Reduction of Waters' Pollution from Agricultural Sources approved in 2003, incorporating measures for its implementation. Long-term development trends in the forestry sector are established in the Long-term Economic Development Strategy of Lithuania until 2015.

Waste Management. The prime objectives of the State Strategic Waste Management Plan approved in 2002 are to protect nature and human health from pollution impacts, create a rational waste management system and set waste management targets, measures and actions. The waste management system is currently under reorganization and modernization so that it would harmonize with the EU requirements and mitigate GHG emissions. The Law on Package and Package Waste Management adopted in 2001 established the principle "polluter pays".

1.5. Projections and the Total Effect of Policies and Measures

Projections are presented in accordance with technical reports prepared for the Ministry of Environment: Technical report No. 28–1 Projections of GHG from fuel combustion sector and Technical report No. 28–2 GHG projections – non-energy sector. F-gases (PFCs and SF_6) projections and GHG projections under three: „without measures", „with measures" and „with additional measures" scenarios have not been yet estimated in Lithuania. Total GHG emissions projections according scenarios "without measures" are presented only for energy sector. It is expected that in future more material on GHG projections will be available due to extensive research and calculation procedures. That would enable to write a report of the projections section according to UNFCCC methodological recommendations.

Projections of GHG emissions from fossil fuel were conducted based on perspective energy development scenarios submitted for Lithuanian Energy Strategy (2002). These projections should be assumed as GHG emission projections „with measures" because they are based on final energy demand and primary energy supply projections developed in National Energy Strategy (2002). Energy projections include climate change mitigation measures because forecast of final energy demand include energy saving potential evaluated in National Energy Efficiency Program, and primary energy demand include all other climate change measures foreseen in National Energy Strategy (measures to promote utilization of renewable energy resources, promotion of CHP, implementation of emission ceilings, fuel standards, etc).

General growth of economy and income has a significant impact on the introduction of new technologies and on a possibility to reduce energy consumption. Thus, three scenarios of economic growth were selected: 1) fast economic growth (annual growth rate of 7% up to 2010 and 3% from 2010 to 2020; 2) baseline scenario (4.7% up to 2010 and 3% from 2010 to 2020); and 3) slow economic growth (2% up to 2010 and 3% from 2010 to 2020).

Final energy consumption has been presented by: 1) economic sectors (industry and its sectors, agriculture, transport, services and household sector); 2) industrial processes; 3) branches of transportation; and 4) social needs of the population.

The projection of final energy demand was made on a new version (2000) of simulation model MAED (Model of Analysis of Energy Demands). For the primary energy supply forecast the mathematical model was developed at Lithuanian Energy Institute for modeling of energy sector development for 25–30 years. This model was based on the Message mathematical model that was originally elaborated by the International Institute of Applied System Analysis (IIASA), and its enhanced version is currently distributed by the International Atomic Energy Agency (IAEA). Calculations of emissions of GHG from agriculture and industrial processes were based on the EU Clean Air for Europe (CAFÉ) program. The baseline agricultural scenario was developed by IIASA and local experts.

Calculation of CH_4 emissions from solid waste disposal were carried out using a simplified approach employing the EXCEL tabular processor, based on projections of trends in accordance with the IPCC methodology for inventories of GHG. Emissions data calculated in Common Report Format (CRF) for 2001 were taken as a reference year data.

It is forecasted that due to utilization of renewable energy resources (through a reduction in the use of fuel oil), GHG emissions will reach 302 thous t by 2010, 379 thous t by 2015, and 451 thous t by 2020. Due to increased utilization of biomass in boiler houses, and less amount of fuel oil, GHG emissions will decrease to 3.2 Mt in 2010, to 3.5 Mt in 2015, and to 3.8 Mt in 2020. The reduction of GHG emissions as a result of switching from fuel oil to natural gas makes 21.3 kg/GJ. Therefore, the reduction in CO_2 emissions resulting from the increase of the share of CHP in electricity production will cause a considerable decrease of GHG emissions by 2010 – 345 thous t, by 2015 – 404 thous t, and by 2020 – 483 thous t.

According to perspective energy balances, final energy demand in transport will make 18.68 TWh in 2015 and 20.8 TWh in 2020, and CO_2 emissions from transport sector during the same years will make 4.56 Mt and 5.06 Mt, respectively. Thus, saving of 1 TWh in 2015 and 2020 will reduce GHG emissions by 0.24 Mt in respective years. Realization of energy saving potential of 1.7 TWh will correspond to 0.41 Mt in the reduction of GHG emissions.

Projections of emissions in industry, household, services sectors were calculated with respect to energy saving, which will allow GHG emissions to decrease to 0.12 Mt in 2005. Evaluation of waste management sector forecasts that CH_4 emissions in landfills will decrease from 52.3 Gg/year in 2001 to 19.1 Gg/year in 2020. Projections of CO_2 emissions/removal in LUCF sector will decrease from 5,448 in 2005 to 5,120 Gg in 2020.

During preparation of projections of GHG emissions and energy consumption a number of uncertainties were taken into consideration:

- Forecast of GDP growth rates includes some uncertainties;
- Final energy demand forecast is related with uncertainties in foreseen energy efficiency improvement;
- The future prices of energy resources are very uncertain, and they are one of the major driving forces in selection of generation sources in least cost power sector development plan;
- The level of the primary energy demand is based on internal factors (GDP growth rates, growth of energy efficiency, losses in fuels and energy, own use of the energy sector, fuel consumption for production of fertilizers and other non-energy use), as well as volumes of the surplus electricity used for export.

Sensitivity analysis indicated that the biggest impact on energy demand was caused by GDP growth rates, structural changes of economy and energy intensity decrease.

1.6. Climate Change Impact, Vulnerability Assessment, Adaptation and Mitigation Measures

CLIMATE CHANGE IMPACT

Change in Climate. Due to climatic and geographic features Lithuania falls into a group of countries vulnerable to climate change. The highest rate of temperature rise was registered in winter, whereas summer changes were insignificant. During the 19th–20th centuries the average annual air temperature in Lithuania increased by 0.6°C, the average temperature in the cold season by even 1.0°C. In the 20th century a tendency for precipitation in cold seasons to increase and in summer to decrease was registered. Besides, climate in Lithuania is increasingly losing its territorial specificity and can further be described as reflecting the global climate phenomena observed in large areas and regions.

Impact on Agriculture. Temperature and precipitation amounts as well as their regimes have special impacts upon agricultural crops. Countrywide investigations show close subjection of phytomass resources, CO_2 removal, productivity of agricultural cultures, abundance of pests and spread of diseases to climate change. Impacts on agricultural technologies are not sufficiently investigated therefore special research is necessary.

Impact on Forest Ecosystems. Trees serve as sensitive bioindicators of environmental changes caused both by anthropogenic activity and global warming. In the course of the last two decades, Lithuanian forests have been suffering global warming impact namely mass drying out and degradation of spruce forests, defoliation of trees, change in forest productivity, etc.

Impact on Terrestrial, Freshwater and Wetland Ecosystems and Their Components. Climate change affects various ecosystems and their components – habitats, species, communities and populations. Climate change impacts manifest through increase of eutrophication of water basins, marshes and wetlands;

changes in the timing of spring arrival of birds; periods, dynamics, distances, directions and flyways of bird migrations; breeding timing of birds; shifting of bird breeding distribution areas and ranges; changes in bird wintering areas and in wintering populations; restructuring of species composition of birds breeding in Lithuania; changes in Important Bird Areas and Habitats; changes in insect development cycles, flying timing, population abundance and dynamics. Global warming impacts are more dramatic on water and wetland birds than on terrestrial avifauna.

Impact on Biological Diversity, Ecosystems and Their Components in Conditions of Increasing Anthropogenic Pressure. Forecasts about climate change impact on biological diversity, ecosystems and their components become more complicated due to the ever-increasing anthropogenic pressure. So far there is no clear understanding of the balance between the climate impact and anthropogenic effect and changes of such balance in time and space and how it acts upon the status of ecosystems, habitats or species. Global warming impacts are likely to be greater recently than effects of man-induced activities in Lithuania.

Impacts on Groundwater Regime and Chemical Composition, on Hydrological and Hydrophysical Indices of the Baltic Sea, Curonian Lagoon, Lakes and Rivers. Climate is one of the factors directly responsible for the chemical composition of groundwater as climate not merely determines trends of hydrochemical processes, but conditions intensity of soil formation, weathering and activity of microorganisms as well as vegetation character. However, no special investigations have been carried out in this area in Lithuania. Climate greatly affects long-term variations in the dates of ice cover formation on rivers making the process later in time and shorter in duration. It was the first time over the past four decades when up to 90% of the Baltic Sea area remained ice-free in winter due to global warming. Special long-term observations in this sphere are needed.

Wind Erosion. A detailed analysis of wind and precipitation parameters helped to determine the scale of wind erosion in Lithuania. Since 1991 the reducing area of arable lands and belated sowing works has lowered a possibility of wind erosion under deflation-favourable meteorological conditions. Further studies are necessary in this sphere.

Socio-Economic Importance of Climate Change Impact. Changes in climate, ecosystems, and their components and in biological resources due to global warming bring new urgent practical ecological problems related to different economic and environmental sectors, human health and well-being of the society. Consequently, revision of strategies, action plans and programmes in different spheres of economy and society is needed. However, the situation in different branches of economy is far from being satisfactory.

VULNERABILITY ASSESSMENT

Forecast of Climate Situation According to General Circulation Models for the 21st Century. According to the results of calculations based on five climate change models designed and used worldwide (HadCM2, UK; ECHAM4, Germany; CGCM1, Canada; GFDL-R15, USA, CSIRO-Mk2, Australia; and CCSR/NIES, Japan), air temperature should further increase in Lithuania in the 21st century. The highest temperature change rates will occur in the second half of this age. Air temperature in cold seasons (December-March) will increase in particular. In warm seasons of the year, air temperature will not go up so quickly. Lithuanian climate will further become more marine-type. Precipitation amounts are forecasted to be greater by the end of the 21st century. Mean wind velocity changes will be minor. The average number of days with snow cover should decrease by 15–25 days in Lithuania in the 21st century. The greatest changes are expected in the eastern part of Lithuania. The period of snow cover at the seaside is predicted to hardly reach 50 days. Character of annual hydrography of rivers influenced by snow nutrition will be noticeably changed.

Agriculture and Forestry. Changes in temperature and precipitation regimes will further affect productivity of agricultural cultures and production quality, and will require increasing financial investments in agriculture and its separate fields. A need to combine varieties, change and adapt cultures or their arrangement in the territory of the country to the ever-changing climate conditions will further remain. Impacts upon productivity of forests, especially those in protected territories and forest habitats, productivity and quality of minor forest goods will become stronger. Spread of new diseases and pests will increase investment costs.

Ecosystems, Biodiversity and Protected Areas. In biological diversity, further degradation of ecosystems and habitats, extinction of species due to their shifts northward, arrival of new species, loss of part of values of protected areas due to changes in species distribution areas and northward and northeastward shifts will occur. Many customary species protection and management measures applicable in environmental protection will lose their efficiency, which will

necessitate new concepts, ways and measures for their conservation for future generations, cooperation between countries in creating new common systems or networks of protected territories. This is highly urgent for a network of European protected areas NATURA 2000, which is rather conservative, its creation is not harmonised with climate change processes.

Coastal Zone. It is forecasted that the water level in the Baltic Sea may rise by 0.3–0.6 m throughout the 21st century. If such water rise rate holds on, sea water level by Klaipėda at the end of the 21st century would be by 0.65 m higher than the level to date. Investigations show that upon rise of water level by 9 cm, the transverse profile of our coasts will gradually start changing, and when water level jumps up to 0.3 m, essential transformation of coast will begin. With water level rise by 0.6 m and more, the coastline will start changing drastically and part of the territory will be flooded. The rise of the Baltic Sea water level would mostly affect Lithuanian coastal areas by Nida, Pervalka-Juodkrantė, Palanga-Būtingė.

Human Health and Well-Being of Society. Global warming is forecasted to cause further spread of ticks transmitting tick-born encephalitis and Lyme disease all over Lithuania as well as spread of bloodsucking insects in South Lithuania (Druskininkai resort) in particular. Pollen spread timing and change cause new problems for prophylaxis and therapy of allergic diseases.

Rivers, Floods and Their Possible Impacts. In forecasting river runoff changes in the 21st century, ECHAM4 (predicting the greatest changes) and GFDL-R30 (predicting the smallest changes) global climate models have been relied upon. The greatest changes are forecasted for the hydrological area of Žemaičių highlands. Hydrological changes in hydrological areas of middle and southeast Lithuania are not so expressed. It is forecasted that cases with intensive precipitation will be gradually more frequent in Lithuania with the increasing risk of floods. Besides, higher temperatures in winter will make precipitation fall in the form of rain. Such rapid rise in water-flow will further increase a risk of floods. In particular, sudden, severe and localized floods in unexpected places will become more frequent, which can increase numbers of injured.

ADAPTATION AND MITIGATION MEASURES

Measures for adapting to climate change and mitigating climate change impact are various. For the purpose of reduction GHG emissions, the Government of Lithuania set a number of measures such as energy saving, rational and efficient energy use, reduction of losses, development of alternative energy (solar, wind, water), wider use of biotransport, etc. A number of mechanisms have been created to implement such measures. This section describes adaptation and impact mitigation measures applicable to certain branches of economy (energy, agriculture, forestry, health protection) and environmental protection.

Upon ratification of the Kyoto Protocol, Lithuania as other EU countries committed to reduce GHG emissions by 8% in the period 2008–2012 (against vs the data of 1990). Upon putting a focus on the use of renewable energy sources, a number of power plants using biomass, water, geothermal or solar energy have noticeably increased in Lithuania. In the Treaty of Accession of Lithuania to the EU, Lithuania has committed until 2010 to increase electricity generated from renewable resources (biofuel, household waste, water, wind energy) by 7%, and general alternative energy production by up to 12%. According to the procedure for promotion of energy produced from renewable and waste energy resources approved by the Government, the aggregate capacity of new to-be-built power plants will hopefully reach 210 MW until the year 2010, 170 MW of which will be generated by wind mills. As to other renewable energy resources, wider use of straw, biogas, municipal waste and wood, as well as geothermal energy is under consideration.

Agriculture. Promotion of environmental protection and ecological farming that fosters biological diversity and landscape is one of three key strategic goals of the Ministry of Agriculture for 2005–2007. The Ministry of Agriculture pointed out to the following activities related to the UNFCCC: afforestation of uncultivated land; use of agricultural waste for the production of energy, cultivation of new energetic plants for alternative energy. The Ministry of Agriculture is seeking to develop technologies enabling better and more efficient use of renewable local energy sources and mitigation of hazardous emissions. Another important direction is ecological agricultural production, with implementation measures set in the action plan projected by the Government and in the Law on Agriculture and Rural Development. Taking into account recent trends and upon evaluation of effects of different factors, it is forecasted that certificated areas will increase by about 40–50% per year on average until 2010.

Forestry. To enhance the country's adaptation to climate changes, CO_2 removal is being increased by planting new forest areas and by carrying out afforestation of barren and unused agricultural land. Changes in forest and other woody biomass stocks in Lithuania reduced total CO_2 emissions by 40.6% in

2003 (10.8% in 1990). The EU support would allow planting 4 thous ha forest per year.

Environmental Protection, Rivers, Lakes and Coastal Zone. If climate warming forecasts come true, most of the country's natural ecosystems will become vulnerable. Therefore a need arises to intensify special investigations with a view to determining the scope of impact and possible means and measures for impact reduction and mitigation. A shortage of such measures is primarily felt in conservation of protected territories (including NATURA 2000 areas), red-listed species and communities, certain ecosystems (especially wetlands) and habitats. So far, no strategy or vision to protect the above-mentioned values and to respond to the ongoing processes and expected changes has been designed, nor have the principles or ways to designate protected areas and protect species been changed in the face of climate change impacts. Special protection and management programmes are intended to stop beach degradation processes in the coastal area of the Baltic Sea and its resorts.

Human Health. No adequate attention is paid to human health protection under climate change conditions. Special investigations on the scope of climate change impacts are missing, little attention is paid to prophylaxis of certain diseases and illnesses, educating the public and raising its awareness. The Government is annually allocating significant amounts for the extermination of bloodsucking insects in the Nemunas River however the problem is not so far finally settled.

Guidelines for Further Work. One of the key objectives in carrying out the UNFCCC is consistent implementation of the already created national and adapted EU legal basis, designed strategies, action plans, Government resolutions and acts, regulations and plans of adopted programmes. Greater attention should be paid to searching for alternative energy sources. It is highly important that the UNFCCC implementation would cover a possibly wider spectrum of problems and spheres, all branches of economy and all environmental areas where climate change impacts are felt or probable, though not yet determined: agriculture and forestry, health protection, principles for designation of protected areas, red-listed species and communities, NATURA 2000 territories and habitats, protection of Baltic coast. Greater attention should be paid for implementation of joint inter-institutional programmes, to educating the society and raising its awareness.

1.7. Research and Systematic Observation

GENERAL POLICY ON RESEARCH AND SYSTEMATIC OBSERVATION

The Lithuanian higher education system comprises 21 higher education institution in the university sector and 27 higher education institutions in the non-university sector. There are 35 public research institutes in Lithuania, 18 of which are university research institutes. The Law on Science and Studies (1991) and the Law on Higher Education (2000) form the legal basis for universities and research institutions. The majority of higher education and research institutions are within the jurisdiction of the Ministry of Education and Science. General expenses for R&D in Lithuania are low (merely 0.68% of GDP) though the European Council has determined that this index should reach 3% in the EU countries by the year 2010. Investigations of climate change and climate systems represent a small share in R&D.

RESEARCH

State of Research. The National Strategy for Implementation of the UNFCCC designed in 1996 and the action programme with a number of research works were not fulfilled for the shortage of financing. In view of the EU thematic priorities under the EU Framework Programme for Research, in 2002 the Government approved the underlying national research priorities, including financial support in 2003–2006 in the area Changes in Ecosystems and Climate. However, the Lithuanian State Science and Studies Foundation, controlling competition-based financing of Lithuanian science, did not finance research works on climate change impacts, adaptation or mitigation. The main research related to the fulfillment of commitments under the UNFCCC is carried out in Vilnius University, Institute of Ecology of Vilnius University, Lithuanian Energy Institute and, partially, in state research institutes (Institute of Geology and Geography, Lithuanian Institute of Agriculture, Institute of Agriculture Engineering of Lithuanian University of Agriculture, and Institute of Botany) within the framework of their planned research trends. Such research covers searching for alternative energy sources, making alternative energy sources more efficient, climate change and forecasts, climate impact upon ecosystems and biological diversity and resources, impact upon forests and agricultural cultures, etc. In fulfillment of the UNFCCC commitments Lithuania's efforts in research area are unsatisfactory.

Impacts on Ecosystems and Their Components. There is no special research programme intended to study climate change impact upon ecosystems and their components, adaptation to such impacts and their mitigation. The existing basic research is not sufficient. Investigations currently pursued only at the Institute of Ecology of Vilnius University show that climate change impacts are observed both on individual ecosystems and their components – species, communities and habitats. New data are obtained on the impact of climate change on biological diversity, spring arrival of birds, periods, dynamics, distances and directions of bird migration, breeding timing of birds and changes in breeding characteristics of mammals, shifting of bird breeding distribution areas and ranges, bird wintering areas and changes in wintering populations, restructuring of species composition of birds breeding in Lithuania, changes in Important Bird Areas and habitats, system of protected territories and their values.

Research and Development of Technologies for Adaptation to and Mitigation of Climate Change Consequences. By conducting planned scientific research, researchers and laboratories of the Lithuanian Energy Institute, the Institute of Agriculture Engineering of Lithuanian University of Agriculture are solving the issues of the use and development of alternative energy sources in the country. The Lithuanian Energy Institute is engaged in creating GHG emission mitigation technologies. Research on increase of efficiency of the use of solar energy and making equipment cheaper in Lithuania are conducted at the Semiconductor Physics Institute, Institute of Physics, Kaunas University of Technology and Vilnius University. Researchers of the Institute of Agriculture Engineering of Lithuanian University of Agriculture, Lithuanian Institute of Agriculture are creating soil tilling and cropping technologies saving energy and resources, technologies to improve production quality under climate change conditions. The Institute of Ecology of Vilnius University has prepared methodical recommendations to increase efficiency of conservation of biological diversity in the protected areas.

Socio-Economic Analysis. The country still lacks information about climate change impact on society – human health, spread of new diseases and increase of sickness rate, recreation and tourism, economic indices. With the change of the environment and its components new problems occur in implementing the principles of sustainable development in transport, industry, energetics, fishery and other branches of economy. Change in biological diversity (separate species or distribution ranges of communities) gives rise to new environmental problems, which can be resolved only with the help of new financial resources for research and, consequently, redistribution of state subsidies, new unplanned expenses having effects upon society.

SYSTEMATIC OBSERVATION

Systematic observation related to the implementation of the UNFCCC are pursued by several institutions, such as the Lithuanian Hydrometeorological Service, Environmental Protection Agency and Marine Research Centre that are within the jurisdiction of the Ministry of Environment, and others.

Meteorological and Atmospheric Observations. The main tasks of the Lithuanian Hydrometeorological Service are meteorological, hydrological and agrometeorological observations and forecasts. The meteorological observation network covers all territory of the country and includes 18 meteorological stations, 3 aviation meteorological stations, including 9 climatological stations. Water-gauging network consists of 59 stations. Lithuania is a member of the World Meteorological Organization since 1992.

The Environmental Protection Agency (EPA) is responsible for environmental quality monitoring, gathering and storing of environmental data and information as well as for assessment and prognosis of environmental quality, managing, processing and reporting of information related to UNFCCC issues. Alongside with fixed stationary observations, movable expeditionary observations should be organized in order to obtain more detailed data, e.g. efficient soil moisture in spring and summer periods in view of impeding drought conditions as well as other environmental and natural emergencies, etc. Recently in Lithuania we are lacking phenological observations.

Marine Observations. Marine observations are pursued at the Marine Research Centre of the Ministry of Environment, the Institute of Ecology of Vilnius University, Institute of Geology and Geography, Vilnius and Klaipėda Universities. Research related to UNFCCC implementation issues are concentrated on circulation and transformation of water masses, water pollution, on impacts on coastal ecosystems, dynamics of coasts, biological diversity, wise use of biological resources and their protection strategies and measures. Investigations are carried out in the framework of both national and international (HELCOM) monitoring programmes. In Lithuania we are so far lacking observations of Baltic Sea currents, water level fluctuations, sea water chemical composition change.

State Environmental Monitoring. The monitoring in the area of observing the state of ambient air was launched in Lithuania in 1967. In 1999–2004 the network of the municipal ambient air quality monitoring was updated. In 2004, it joined 13 automatic air quality assessment stations carrying out permanent measurements of the concentration and meteorological parameters of nitrogen oxides, sulphur dioxide, carbon monoxide, solid particles, ozone, benzene and toluene.

The Ecosystem Status Monitoring was initiated by the Convention on Long-range Transboundary Air Pollution signed by the EU countries in 1979. In 1988, 6 international cooperation programmes, including the ICP IM programme aimed at determining, evaluating and forecasting the status of conditionally natural ecosystems and their long-term trends with regard to long-range transmissions of air pollutants (in particular, sulphur and nitrogen compounds), impacts of ozone and heavy metals, regional peculiarities and climate change, were initiated on the basis of the convention. The programme of the State Environmental Monitoring of 1999–2004 has not pointed out to climate change impact upon ecosystems and their components.

A new State Environmental Monitoring Programme drawn up based on the EU legal acts and directives, covers impacts upon ecosystems, wildlife and protected areas however it does not include any climate change and anthropogenic impact balance research. The programme only partially reflects the UNFCCC requirements.

1.8. Education, Training and Public Awareness

Public knowledge of causes and consequences of climate change and possibilities of their mitigation is still not sufficient in Lithuania despite several actions undertaken recently by scientific institutions, NGO's, media, etc. The society does not know yet how to change its lifestyle and habits so as to reduce its share in GHG emission. So far, climate change issues have been dealt with mainly by the Ministry of the Environment, whereas other Ministries (Transport, Agriculture, Economy, Education and Science), which must be the key actors in the Kyoto Protocol enactment, have been less active.

EDUCATION

During the period of restored independence, Lithuania adopted new legislation on the development of the national system of education and vocational training which was in line with the Lisbon Summit (European) Council Conclusions, Employment Increase Programme for 2001–2004 and Lifelong Learning Strategy. Thus, it is possible to assert that Lithuania has appropriate legislation for the development of modern educational system and social partnership. The National Strategy for Sustainable Development sets out long-term goals in the sphere of education and science, which incorporate the sector of global climate change. Problems of global climate change and related topics of vulnerability, sensitivity, impacts on economy, ecosystems and society, adaptation and mitigation measures are covered in educational system of secondary schools and study programmes offered by several universities of Lithuania: Vilnius University, Vilnius Pedagogical University, Klaipėda University, Šiauliai University, Vilnius Gediminas Technical University, Vytautas Magnus University, Kaunas University of Technology and Lithuanian University of Agriculture. Problems of climate change trends and impacts were raised at several different level conferences, organized by the Ministry of the Environment, Institute of Ecology of Vilnius University, Vilnius University, Lithuanian Academy of Sciences, Klaipėda University and Marine Research Center. Despite these efforts, the general public, decision-makers and responsible specialists in economic sectors of the country are still insufficiently informed about local and global environmental problems.

ENVIRONMENTAL INFORMATION ACCESSIBILITY AND PUBLIC PARTICIPATION IN DECISION-MAKING ON ENVIRONMENTAL ISSUES

Lithuania has adopted and enacted all legal acts indispensable for guaranteeing its citizens environmental information accessibility, the right to receive such information and participate in decision-making. These rights are ensured by the UN European Economic Commission Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention), EU Directives (the European Council Directive 90/313/EEC on Free Access to Environment-Related Information, EU Directive on Environmental Impact Assessment) and laws of the Republic of Lithuania. One of the main institutions responsible for the accessibility of environment-related information, implementation of respective international, EU and Lithuanian laws as well as other documents is the Ministry of Environment. The Public Information and Public relations Department under the aforesaid

ministry frames and pursues the policy of public education and information on issues within the ambit of the ministry, draws up and coordinates projects on environmental education.

TRAINING AND PARTICIPATION OF THE SOCIETY

As a result of harmonization of Lithuanian legal acts containing regulations for environmental protection with those of the EU, requirements for executive and surveillance organizations have become much stricter. Especially strict requirements have been imposed on the qualification and technical training of municipality and enterprise specialists and environment protection inspectors. The majority of these organizations still do not meet present-day requirements. The problem still unsolved is a want of competent specialists to improve the quality of work to be produced and ensure the timely submission of draft documents to the UNFCCC secretariat. To solve this problem, it is necessary to train specialists to compile GHG inventories, perform GHG emissions monitoring, make expert assessment of GHG emission/removal, prepare NIRs, make assessment of the situation, plan necessary investigations and assessments. The main impediment for this work is the shortage of funds and approach to the requirements set down by the Convention to the country.

PUBLIC AWARENESS

Issues of public environmental education and information about climate change-related problems and ways to address them are included in the National Strategy and Action Programme for Environmental Education, Information and Public Awareness of Society, drawn up by the Ministry of the Environment in 1998, in the National Strategy and Action Plan for the Implementation of UNFCCC. Regretfully, due to the shortage of funds, quite a number of measures projected in the above documents were not implemented. It was not until 2004, that the Ministry of the Environment increased its attention to public environmental education and awareness raising, that the fulfilment of measures set in the above-mentioned documents became more active. Public attention to climate change in Lithuania has considerably increased in recent years due to special publications in press (daily and weekly newspapers, popular magazines), reportages and interviews in TV and radio broadcasts whose authors or presenters have often included scientists of universities or scientific research institutes of the country. A series of climate change-related events organized in 2005 by the Embassy of the United Kingdom in Lithuania and the British Council (the photo exhibition NorthSouthEastWest, the round-table discussion Climate Change: Promotion of Closer Cooperation and international videoconferences Climate Change and Citizenship) received a strong response in press and generated great interest of the society. A significant role in the implementation of Convention commitments is performed by the UNDP and Global Environment Fund (GEF) Small Grant Programme (SGP), NGOs aiming at environmental education of the society. The Lithuanian Bureau of the Regional Environmental Centre for Central and Eastern Europe (REC) has also started vigorous activities in this field. The portal site *http://www.aplinkosauga.lt/* devoted to environmental issues is available in Lithuania. Its aim is to present the latest information on environmental protection as well as provide environmentalists with the opportunity to publicize information by themselves, comment on it, initiate discussions and participate in them. Despite all the work that is being carried out, the information on climate change, its present-day and future impacts, is still lacking, and the level of environmental awareness of communities, especially of those in rural areas of Lithuania, is still too low. In summary, it must be admitted that over the last decade Lithuania has failed to raise the level of public environmental awareness and develop a more responsible and caring approach to nature.

THE REPUBLIC OF LITHUANIA

Lithuania's Third and Fourth National Communication on Climate Change

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

CHAPTER 2

Lithuanian National Circumstances Relevant to Greenhouse Gas Emission and Removal

VILNIUS, NOVEMBER 2005

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF LITHUANIA

INSTITUTE OF ECOLOGY OF VILNIUS UNIVERSITY

CHAPTER 2. Lithuanian National Circumstances Relevant to Greenhouse Gas Emission and Removal

2.1. Government Structure

On 11 March 1990, Lithuania restored its independence after 50 years of the Soviet Union annexation. Following the collapse of the communist regime, the present-day political system and state administration structure were established. An important step towards democratic society was taken in October 1992, when Lithuanian citizens elected the Lithuanian Parliament (the Seimas) during the first free direct elections, and adopted Lithuania's Constitution under referendum. On 1 May 2004, Lithuania fulfilled its main goal becoming a member of the European Union. In June of the same year, Lithuanian citizens took part in the elections to the European Parliament for the first time, to which 13 members were elected.

According to the Constitution, Lithuania is a sovereign democratic republic with the separate powers of the Seimas, the President of the Republic and the Government, and the Supreme Court. The head of the parliamentary republic is the President elected for the period of five years during direct general elections. The President settles the basic issues of foreign policy, pursuing it together with the Government, and carries out other authorized actions (issues acts-decrees, appoints and dismisses state officials according to the established order, signs international treaties and proposes them to the Seimas for ratification, etc.). The 4th President of restored independent Lithuania Valdas Adamkus was elected in 2004.

The one-chamber Parliament (the Seimas) is comprised of 141 member elected for four-year period. The Seimas is the supreme legislative power considering and adopting constitutional amendments, passing laws, accepting resolutions concerning referendums, ratifying and denouncing international treaties, etc. The last elections to the Seimas were held in 2004 with a majority being won by the Labour Party. The latter together with Socialdemocratic, Socialliberal parties and the Union of Farmers' and New Democracy parties made the majority in the Seimas, and formed the 13th Government in the history of Lithuania. It provides the executive power of the Republic of Lithuania. The head of the government – Prime Minister – is confirmed by the Seimas under the proposal of the President. The Prime Minister forms the government. At present, there are 13 ministries in Lithuania, which manage state affairs, implement laws and resolutions of the Seimas, as well as decrees of the President, etc.

Lithuania is a unitary state. In accordance with the Law of the Republic of Lithuania on Direct Rule of Administrative Territorial Units (1994), the state is divided into counties and municipalities. A municipality is an administrative territorial unit, which is governed by self-government institutions elected by the community of local residents pursuant to the local self-government and other laws of the Republic of Lithuania. A county is a higher administrative territorial unit, the governing of which is organised by the Government pursuant to the county governing and other laws of the Republic. Having restored its independence, the state underwent two stages of the reform of its administrative territorial units. As a result, the Lithuanian territory has been divided into 10 counties, and 60 municipalities have been established. The latter, accordingly, are split into smaller administrative units. Local self-government is implemented by the councils of city and district municipalities.

The Ministry of Environment and institutions under its subordination are the main authorities responsible for the development of the environmental protection policy. State institutions (the Ministries of Agriculture, Economy, Finance, Interior, Education and Science, and Transport, State Prices and Energy Control Commission, State Enterprise Energy Agency), educational institutions (Vilnius University, Kaunas University of Technology, Vilnius Gediminas Technical University, Lithuanian University of Agriculture), scientific research institutions (Institute of Ecology of Vilnius University, Lithuanian Energy Institute, Institute of Agriculture Engineering of Lithuanian University of Agriculture, Lithuanian Forest Research Institute, etc.), non-governmental organisations (AER Use Commission of the Presidium of the Lithuanian Academy of Sciences, Lithuanian Green Movement, Institute of Lithuanian Scientific Society, Center for Environmental Policy, etc.) contribute to the development of environmental protection. Municipalities of different regions tackle environmental problems, and evaluate the possibilities of using local and alternative fuel. They also initiate projects of local and renewable energy resources' utilization. Moreover, they provide local conditions for private investments, and take part in international projects. For the implementation of projections on renewable energy, not only know-how

or experience, but also financial and/or political support are indispensable. Consequently, the market participants in Lithuania established associations for uniting their efforts and gaining stronger political financial power (Lithuanian Wind Energy Association, Lithuanian Association of Agricultural Engineers, the Lithuanian Chamber of Agriculture, etc.).

Striving for common environmental protection goals with other states, Lithuania signed/ratified the UN Framework Convention on Climate Change (1995), the Kyoto Protocol (2002), the Vienna Convention for the Protection of the Ozone Layer (1994), the Montreal Protocol on Substances that Deplete Ozone Layer (1994), etc. (more extensively – in part 4 of this Communication).

2.2. Population Profile

In recent years, the population of Lithuania is constantly decreasing. In 1992, 3,706.3 thous people resided in Lithuania, whereas at the beginning of 2005 – 3,425.3 thous. During 1992–2005, the decline made 281 thous (7.6%). 33.4% of all Lithuanian inhabitants live in the countryside (1,143.9 thous), city dwellers making twice as many – 2,281.4 thous (Table 2–1).

In Lithuania, the population decline is caused by two main factors: extensive emigration and negative population growth. In 1990, it was positive (17.1 thous), but as soon as in 1995 it became negative, and in 2004, it was –10.9 thous. During the six months of 2005 the decrease of 6,487 inhabitants occurred. Rapid international emigration, having started after restoration of Lithuania's independence, markedly grew up with the accession of Lithuania to the EU. That same 2004 year saw the disparity between newcomers and emigrants of nearly 10 thous people. During the first half of 2005, 6,253 people emigrated, and 2,202 came to Lithuania (Table 2–2).

Due to economic reasons, young people emigrate most often, that is why Lithuanian society is ageing. At the beginning of 2004, children up to 15 years of age made 17.7%, 60-year or older people – 20% of all inhabitants. The average life expectancy in 2004 was 72.06 (77.75 for women, 66.36 for men; Table 2–3).

Population migration occurs within the country as well. More people from rural areas leave for the bigger cities. At the beginning of 2005, the capital city Vilnius was inhabited by 541,278 (density 1,378.6 inhabitants/km^2), Kaunas – by 364,059 people (2,349.8 inhabitants/km^2). The medium population density declined from 56.8 inhabitants/km^2 in 1998 to 52.8 inhabitants/km^2 in 2004. In 2004, 15.8% of all inhabitants worked in the sectors of agriculture, hunting, forestry and fishery, 28.2% – in industry and construction, and 56% – in the sphere of services [19].

To stabilize the demographic situation in the country, in 2004, Lithuanian authorities approved The Strategy of the National Demographic Policy, Mother-child State Program, The National Strategy for Managing Consequences of the Ageing of Population, the goals of which were: implementation of demographic policy in Lithuania, reduction of emigration, and improvement of social welfare.

Table 2–1. Residents in towns and villages (2005 – at the beginning of the year), thous

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total	3,693.7	3,702.0	3,706.3	3,693.9	3,671.3	3,643.0	3,615.2	3,588.0	3,562.3	3,536.4	3,512.1	3,487.0	3,475.6	3,462.5	3,445.9	3,425.3
Towns	2,513.9	2,526.8	2,531.4	2,510.4	2,486.4	2,458.2	2,432.9	2,428.6	2,398.5	2,377.2	2,357.1	2,334.2	2,326.2	2,317.2	2,297.4	2,281.4
Villages	1,179.8	1,175.2	1,174.9	1,183.5	1,184.9	1,184.8	1,182.3	1,159.4	1,163.8	1,159.2	1,155.0	1,152.8	1,149.4	1,145.3	1,148.5	1,143.9

Source – Statistics of Lithuania

Table 2–2. Migration

	2002			2003			2004			January- May 2005		
	Arrived	Departed	Statistical difference	Arrived	Departed	Statistical difference	Arrived	Departed	Statistical difference	Arrived	Departed	Statistical difference
Total	5,110	7,086	-1,976	4,728	11,032	-6,304	5,553	15,165	-9,612	2,202	6,253	-4,051
Males	2,815	3,664	-849	2,594	5,173	-2,579	2,968	7,146	-4,178	–	–	–
Females	2,295	3,422	-1,127	2,134	5,859	-3,725	2,585	8,019	-5,434	–	–	–

Source – Statistics of Lithuania

Table 2–3. Average life expectancy

	1998	1999	2000	2001	2002	2003	2004
Total	71.39	71.76	72.19	71.78	71.91	72.19	72.06
Males	66.00	66.36	66.77	65.95	66.21	66.48	66.36
Females	76.66	77.01	77.45	77.58	77.58	77.85	77.75

Source – Statistics of Lithuania

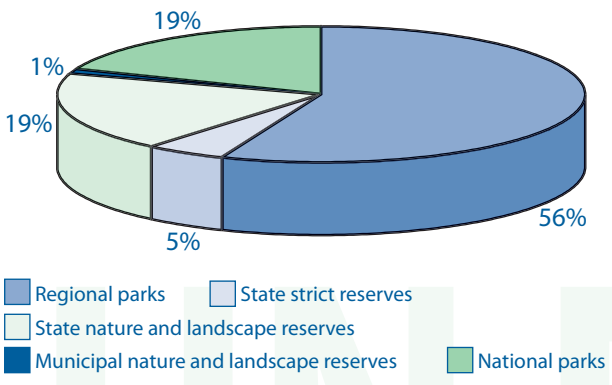
2.3. Geographic Profile

Lithuania is a country in Central Europe near the Baltic Sea. In terms of its area – 65,302 km² – Lithuania is similar to Ireland and Latvia, slightly larger than Switzerland, Denmark, Belgium or Holland, though a bit smaller than Austria.

The marginal coordinates of the present Lithuania are: in the north – 56°27' north latitude, in the south – 53°54' north latitude, in the west – 20°56' east longitude, in the east – 26°51' east longitude. The Lithuanian territory stretches for 373 km from the east to the west, and 276 km from the north to the south. The distance from the geographical centre of Lithuania to the equator equals 6,129 km, whereas to the North Pole – only 3,873 km. Lithuania borders on five countries: in the north it has a 588 km long border with Latvia, in the east and south – 660 km border with Belarus, in the southwest – with Poland (common border of 103 km), and with the Russian Federation (273 km). More than 3/4 of Lithuanian borders extend by rivers and lakes. The Lithuanian economic zone in the Baltic Sea (approximately 6,400 km²) reaches the territorial waters of Sweden. The Lithuanian coastline is as long as 90.6 km.

Lithuania is a country of lowlands. Its highest point reaches 293.6 m above sea level. The area is composed of clayey plains (55.2% of the territory), sandy plains (17.8%), moraine hills (21.2%), coastline plains (2.2%), and river valleys (3.6%).

Lithuanian land stock covers 6,530 thous ha, more than half of it being suitable for agricultural production. Farming land occupies 52% of the whole territory, and 85% of agricultural land. The Lithuanian woodland covers 2,069.1 thous ha, with forest stands in the area of 1,967.7 thous ha. The wood mass of the country makes 31.7%. Lithuanian protected areas cover 774.3 thous ha (Figure 2–1), 384.4 thous ha being occupied by forests (49.6% of protected areas, and 18.8% of the whole woodland area).



Source – State Service for Protected Areas

Figure 2–1. Proportion of protected areas by categories

Lithuania belongs to the so-called humidity excess zone; average annual precipitation is 748 mm with evaporation of only 512 mm. The rest of it – 236 mm (or 32% of the rainfall) outflow into the sea. It makes 15.4 km³ every year. Besides, 10.8 km³ of river waters inflow from the neighbour countries.

Lithuanian inland waters (rivers, lakes, ponds and the Curonian Lagoon) cover 1,903 km² that makes 2.9% of the whole territory. The area restricted by 90.6 km of the Baltic coastline, territorial waters and the marine economic zone take over about 6.5 thous km². Lithuania boasts over 17 rivers, which are more than 100 km long. The largest of them – the Nemunas – gets its start in Belarus, and, according to its length, is the 14th longest river in Europe, and the 4th – in the Baltic Sea basin. The surface area of all Lithuanian rivers is 332 km². Lithuania is abundant in lakes as well. They are estimated at about 6,000, their total area making 914 km². Small bogs (up to 50 ha) predominate, with mainly low bogs (71%), and raised bogs (22%), which are very important wetlands from a geoecological point of view.

In Lithuania, 17 sorts of natural resources have been found and investigated. At present, oil, limestone, dolomite, sand, gravel, clay, chalk, marl, peat, opoca and saprophel are being exploited. Especially important are abundant resources of building and raw materials. Nearly 600 deposits of natural resources (10 of oil among them) are sufficiently investigated and could be utilized. Due to economic conditions, in 2003, only 59% of those deposits were exploited [22].

2.4. Climate Profile

Lithuanian climate is basically conditioned by its geographical position. The country is situated in the northern part of the temperate climate zone. It is supplied with annual solar emission of approximately 3,600 MJ/m². The territorial waters of the Baltic Sea and the Atlantic Ocean, and only small land areas of the Scandinavian and Jutland peninsulas with islands expand to the west of Lithuania, while the Eurasian continent stretches for several thousand kilometres to the east. Thus, though Lithuania occurs near the sea, its climate is not typically maritime. While proceeding from the west to the east of the country: a) annual and 24-hour air temperature amplitudes increase, b) winters become colder, c) snow cover stays longer, d) air becomes drier. For instance, in eastern Lithuania, mean air temperature in January equals about -5°C, whereas by the sea – merely -1.4°C.

Some indices of the present Lithuanian climate are provided in Table 2–4.

Table 2–4. Climate indices of Lithuania (data 1971–2000)

Climate element	Numerical rate
Total solar emission per year	3,520–3,690 MJ/m^2
Amount of sunny hours per year	1,770–1,790
Temperature: average annual January April July October	 5.8–7.6 °C -1.4– -5.2 °C 5.3–6.7 °C 16.4–17.6 °C 5.9–8.9 °C
General nebulosity (average annual)	6.7–7.2
Precipitation: annual Warm period (4–10 months) Cold period (11–03 months)	 570–820 mm (approximately 44 km^3) 410–510 mm 185–325 mm
Average annual wind speed	2.7–6.0 m/s
Humidity: Partial water steam pressure: in winter in summer relative air humidity: during the day at night	 4–5 hPa 14–16 hPa 70–80% 85–90%
Days with snow cover per year	70–105
Days with thunderstorms per year	19–30
Days with drizzle per year	9–19

The warmest month in Lithuania is July (August – near the sea), and the coldest – January (February – near the sea). During three months – June, July and August – mean maximum air temperature exceeds 20°C (in July and August – near the sea). Mean minimum air temperature in April-October is positive (near the sea – till the end of November), and during the rest of the year – negative. Precipitation amount in April-October makes 60–65% of the annual precipitation. Heavy showers are quite typical in summer, when precipitation reaches 30 mm and more during 24 hours. 14–26 days a year are characterized by snowstorms. Their overall duration equals approximately 90–180 hours a year. Mean 24-hour relative air humidity per year fluctuates within 15% interval: the lowest is in May (averagely 66–77%), and the highest – in October-February (81–91%).

The May-August period is characterized by the greatest amount of sunshine (230–270 hours for each month), and in November-January – vice versa (30–45 h). The biggest amount of cloudy days is typical in November-January (averagely 17–23 days a month), whereas in summer – only 5–10 days a month. According to the data of the Environmental Information Centre, the land surface of Lithuania is reached by annual amount of 1,000 kWh/m^2 of solar energy. More than 80% of it belongs to six months (from April to September). At present, solar energy could be used for heating purposes implementing solar collectors for water heating and agricultural production drying. Solar energy could be more widely used in case new technological solutions in enhancing solar elements' effectiveness were found [12].

The strongest winds blow in November-January (in the coastal area – 6–7 m/s, elsewhere – 3–5 m/s), the weakest – in May-September (in the coastal area – 4–5 m/s, elsewhere – 2–3 m/s). Sometimes even dangerous, stronger than 15 m/s winds occur: in the coastal area – averagely 40–50 days (in some years – even 70 days), elsewhere – 10–30 days. The dominating wind direction varies during the year. Southwestern, southern and southeastern winds usually blow in autumn and winter, whereas in summer, western and northwestern winds are more frequent. Lithuanian Wind Energy Association has proved that there is no less wind in Lithuania than in Germany or Denmark. Wind measurements carried out in 1996–1997 indicated that the average annual wind speed in the height of 50 metres of the wind turbine rotor axis was 7.4 m/s. However, a wider utilization of wind energy is meant for the future, yet preparatory work being carried out for the expansion of wind energy employment [11].

2.5. Economic Profile

The last decade was the most productive in the reforms of the Lithuanian macroeconomy. Market economy and stable macroeconomic environment took their place, though not in all economic spheres. In 2004, the country's GDP reached 61.9 billion LTL, and its growth – 6.7%, comparing to 2003 (Table 2–5; Figure 2–2). In comparison to 1998, GDP and GDP per person increased 1.4 times in 2004.

Table 2–5. Gross domestic product, GDP

	1998	1999	2000	2001	2002	2003	2004
GDP in real prices, million LTL	44,377	43,359	45,526	48,379	51,643	56,179	61,898
GDP in comparative prices of 2000, million LTL	44,565	43,810	45,526	48,429	51,704	56,716	60,511
GDP in million US dollars	11,094	10,840	11,381	12,095	14,151	18,423	22,284
GDP in million EUR's	9,876	10,177	12,362	13,512	14,927	16,271	17,927
GDP per inhabitant in real prices, LTL	12,503	12,303	13,009	13,897	14,887	16,264	18,016

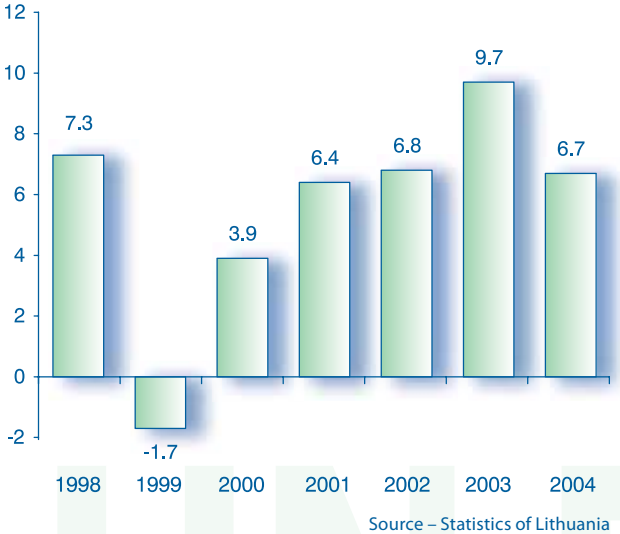
Source – Statistics of Lithuania

Table 2–6. General production and general surplus

	General production (GP)		General surplus (GS)		GP compared to 2003, %	GS compared to 2003, %
	Million LTL	%	Million LTL	%		
Total	106,157.2	100.0	55,240.3	100.0	6.7	6.7
Agriculture, hunting and forestry	5,303.2	5.0	3,154.2	5.7	-0.2	-0.2
Fishery	188.7	0.2	46.1	0.1	-19.7	2.5
Mining and quarry exploitation	576.9	0.5	317.4	0.6	-4.6	-8.3
Processing	35,103.2	33.1	11,674.0	21.1	12.3	11.4
Supply of electricity, gas and water	5,104.6	4.8	2,391.3	4.3	5.7	5.0
Construction	8,092.0	7.6	3,980.1	7.2	4.0	4.0
Domestic trade	14,697.0	13.8	10,162.4	18.4	10.4	10.4
Hotels and restaurants	1,258.9	1.2	856.7	1.6	6.1	7.0
Transport, storage and communication	12,007.5	11.3	7,428.9	13.4	8.3	7.8
Financial broking	2,052.0	1.9	1,307.5	2.4	5.0	5.1
Estate, rent and other business	7,811.5	7.4	5,477.0	9.9	2.7	2.3
State governance and defence, compulsory social insurance	4,930.0	4.6	2,907.0	5.3	0.7	4.4
Education	3,783.5	3.6	3,074.2	5.6	7.7	4.8
Health and other social insurance	2,491.6	2.3	1,584.8	2.9	2.0	1.7
Other activity	2,682.2	2.5	1,645.4	3.3	3.3	1.8
Private household activity	74.4	0.1	74.4	0.1	-3.4	-3.3

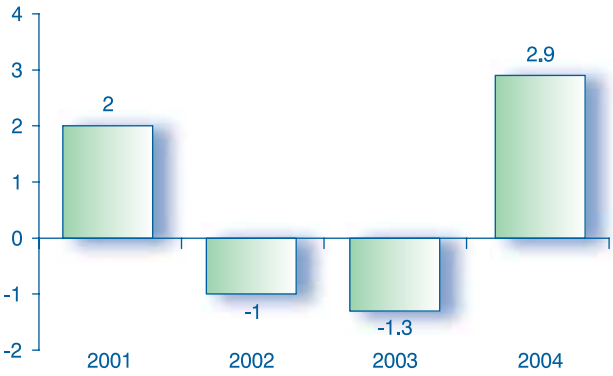
Source – Statistics of Lithuania

In 2002 and 2003, Lithuania experienced the fall in prices, thus GDP was bigger by 55.4 billion LTL according to comparative prices of 2000, and its annual change accounted for even 9.7%. Nevertheless, the prices are recently growing. Inflation equalled 2.9% in 2004, whereas in 2003 – -1.3% (Figure 2–3).



Source – Statistics of Lithuania

Figure 2–2. Real GDP changes (%)



Source – Statistics of Lithuania

Figure 2–3. Inflation per year (%)

In 2001, services sector of Lithuania accounted for 58.6% of GDP (in 1991 – 34%), while the share of industry and agriculture became smaller: in industry – from 44.4% in 1991 to 28.3% in 2001, and in agriculture – from 16.4% to 7%, respectively [12]. Economic development of recent years has been mainly determined by industry, internal trade and construction – these economic activities accounted for about half of the added value created in the country in 2004 (Table 2–6) [15].

In recent years, production needed for new construction and reconstruction has largely increased. Manufacture and export of furniture and foodstuffs has also enlarged. Due to this, production means were in great demand, thus they were manufactured in larger amounts. Constant increase is observed in the production of engine vehicles, trailers and semi-trailers (90.2% increase in 2004, compared to 2003), metal production (29.8%), refined oil products (23.7%), rubber and plastic products (12.5%), machine and equipment production (11.7%), etc. The situation in light industry is quite different. Comparing the year of 2004 to 2003, manufacture of leather and leather products decreased by 41.4%, and the production of clothing sewing, leather dressing and dyeing – by 9.78% [15].

Growth in construction volume has been determined by the rapidity of new construction and reconstruction work. In 2004, construction was carried out for 4,775.3 million LTL, which makes 4.9% more than in 2003 [15].

Lithuanian trade with foreign countries undergoes a rise as well. In 1998, goods were imported for the sum of 23,174 million LTL, while, in 2003, – for 29,968 million LTL. Simultaneously, export grew up from 14,842 million LTL to 22,062 million LTL [10]. According to export, the main foreign trade partners of Lithuania are Germany, Latvia and France (Table 2–7). In 2004, Lithuanian goods export to the EU amounted to 17,096.21 million LTL. Mineral products and vehicles make the largest share in export, whereas goods of intermediate use are most frequently imported (16,701 million LTL) (Table 2–8). The greater part of import flows from the EU (in 2004, goods imported for 21,483.38 million LTL), though Russia and the Commonwealth of Independent States remain in line with the most important import partners (Table 2–7).

2.6. Energy

Energy sector is one of the most important economic sectors in Lithuania. It owns about 14% of the whole industrial manpower. Energy sector includes subsectors of electricity, central heating, oil, natural gas, coal and local fuel, and renewable energy resources. At present, during privatization of some enterprises, energy sector is turning from centralized management to market economy. Lithuania boasts a well-developed natural gas transmission and distribution system. Moreover, a large and comparatively modern oil processing enterprise (the only in the Baltic states), and several big electric power plants, including Ignali-

Table 2–7. The main foreign trade partners of Lithuania according to the scope of export and import (million LTL)

Export

Year	EU	Germany	Latvia	France	UK	Poland	Netherlands	CIS	Russia	Other states
2004	17,096.21	2,633.65	2,588.02	1,624.22	1,369.71	1,242.23	1,242.25	4,156.36	2,342.38	4,475.39
2003	13,290.58	2,169.37	2,041.2	1,108.61	1,396.4	729.71	751.85	321,925.25	1,893.79	4,752.8

Import

Year	EU	Germany	Latvia	France	Poland	Netherlands	CIS	Russia	Other states
2004	21,483.38	5,760.3	1,295.05	1,092.24	2,579.19	1,345.43	9,238.41	7,021.04	3,374.2
2003	19,200.22	5,291.75	1,110.68	1,012.3	1,918.7	1,140.85	7,310.62	5,425.21	2,927.14

Source – Statistics of Lithuania

Table 2–8. Export and import according to merchandise groups (million LTL)

Export	1998	1999	2000	2001	2002	2003
Mineral products	2,850	1,809	3,234	4,288	3,831	4,345
Vehicles	1,208	651	1,035	1,694	3,248	3,360
Textile	2,762	2,743	2,836	2,994	3,058	2,997
Food	2,083	1,509	1,786	2,268	2,166	2,585
Wooden ware, furniture	1,092	1,238	1,544	1,734	2,096	2,543
Machines and devices	1,607	1,371	1,620	1,960	2,031	2,450
Other merchandise	3,240	2,693	3,182	3,393	3,862	3,782
Import						
Other merchandise	457	474	623	483	530	210
Cars	1,579	661	877	1,553	2,035	1,761
Intermediate products	12,510	10,967	13,505	14,924	15,809	16,701
Investment merchandise	3,723	2,889	2,736	3,589	5,245	5,977
Consumption merchandise	4,905	4,346	4,085	4,864	4,944	5,320

Source – [16]

na NPP are under operation. Electrical network, and gas and oil pipelines are connected exclusively with the energy network of Russia, and energy supplies are imported from only the CIS [5].

In 2004, the energy consumed amounted to 4,342.3 thous t oil equivalent. Transport, household and industry are the main energy consumers. Oil products, thermal energy, electrical energy and wood are the commonest sources of energy (Table 2–10).

In 2004, different economy branches utilized 1,513.5 thous t oil equivalent of oil products (liquid and non-liquid oil gas – 283.6 thous t oil equivalent, light oil products – 400.7 thous t oil equivalent, heavy oil products – 828.8 thous t oil equivalent). In Lithuania, 0.3 million t of oil is being extracted annually, thus, the sector of oil and oil products is dependent on oil volume and partly on import of oil products. For the time being, oil products will remain reserve fuel for thermal power plants and large central heating systems [4, 5].

The main electrical energy supplier is Ignalina NPP, which produces more than half of the whole electrical energy generated in Lithuania (Table 2–11). Under the EU commitments, the first unit of Ignalina NPP was closed in 2005, the second is due to be closed till 2009. The designated closure of the latter will cause additional expenditures in the electrical energy sector connected with transition from nuclear to organic fuel, increasing efficiency of the present thermal power plants, and implementation of environment protection measures by investments into construction of new electric power plants and alternative electrical energy sources, and with larger organic fuel (oil, gas) import expenditures.

Central heating covers about 60% of the Lithuanian thermal market: it satisfies up to 90% of thermal needs in cities, and 40% – in the countryside. Systems of central heating provide heat for 75% of residential houses. To generate heat, two types of fuel – natural gas and boiler oil – are being used. Heat losses remain quite big, as the network urges for renovation and equipment of the better heat insulation. In 2004, consumption of thermal energy reached 940.1 thous t oil equivalent, the major part of it being used in households (Tables 2–10, 2–12).

Table 2–9. Energy resources and their consumption, thous t oil equivalent (toe)

	1998	1999	2000	2001	2002	2003	2004
Production of primary energy	4,438.9	3,482.2	3,184.3	4,108.8	4,848.0	5,145.4	5,002.5
Crude oil	277.5	232.5	322.3	479.7	442.0	389.5	307.5
Solid fuel	593.3	644.2	638.9	640.1	679.1	688.3	715.2
Nuclear, hydro, geothermal energy	3,568.1	2,605.5	2,223.1	2,989.0	3,725.4	4,065.8	3,974.6
Liquid biofuel and biogas	–	–	–	–	1.5	1.8	5.2
Final consumption	4,444.3	4,076.5	3,768.8	3,886.0	4,069.2	4,187.5	4,342.3

Source – Statistics of Lithuania

Table 2–10. Final consumption of energy in sectors in 2004, thous t oil equivalent

	Total	Hard coal and lignite	Peat	Firewood, wood waste	Liquid biofuel and biogas	Secondary solid fuel	Natural gas	Orimulsion and shale oil	Petroleum products	Electricity	Heat
Final consumption	4,342.3	151.31	3.5	575.3	0.8	15.6	483.6	0.9	1,513.5	657.9	940.1
Industry	931.6	77.4	0.2	97.5	0.1	8.8	259.8	0.1	60.4	226.6	200.7
Construction	46.9	0.3	–	5.7	–	–	11.8	–	17.7	9.3	2.1
Transport	1,340.0	–	–	–	–	–	7.7	–	1,324.4	7.9	–
Agriculture	104.8	0.7	–	7.4	0.3	–	30.8	0.5	39.3	15.6	10.2
Services and other activities	552.3	47.0	–	31.0	0.4	1.4	51.9	0.3	7.3	220.8	192.2
Household	1,366.7	25.7	3.3	433.7	–	5.4	121.6	–	64.4	177.7	534.9

Source – Statistics of Lithuania

Table 2–11. Electricity balance, GWh

	1998	1999	2000	2001	2002	2003	2004
General production	17,631	13,535	11,424	14,737	17,721	19,488	19,274
Ignalina NPP	13,554	9,862	8,419	11,362	14,142	15,484	15,102
Thermal electric power plants	3,182	2,813	2,362	2,675	2,798	3,019	3,229
Hydropower	417	413	339	325	353	325	421
General consumption	11,549	10,853	10,088	10,773	11,234	11,958	12,079
Final consumption	6,753	6,543	6,197	6,446	6,723	7,179	7,650

Source – Statistics of Lithuania

Table 2–12. Final and general consumption of basic types of fuel and energy

	Final consumption						General consumption					
	1998	1999	2000	2001	2002	2003	1998	1999	2000	2001	2002	2003
Coal, thous t	2,004	159	118	102	199	258	219	174	130	115	211	271
Peat, thous t	29	28	14	13	15	14	61	71	40	40	40	49
Peat briquettes, thous t	15	18	10	9	11	16	15	18	10	9	11	18
Firewood, wood waste, thous m^3	2,670	2,910	2,958	2,986	3,008	3,013	2,913	3,018	3,162	3,339	3,364	3,430
Liquid fuel, thous t	255	205	152	134	86	46	1,665	1,207	661	718	598	404
Diesel fuel, thous t	696	634	566	639	665	664	704	642	571	644	670	669
Motor gasoline, thous t	631	494	381	372	361	360	634	498	383	373	363	363
Liquefied petroleum gas, thous t	104	135	185	189	211	229	108	139	189	191	213	232
Heat, GWh	10,665	9,383	8,430	8,871	9,055	9,290	15,680	13,577	11,999	12,116	12,213	12,309

Source – Statistics of Lithuania

Table 2–13. Natural gas balance, million m^3

	1998	1999	2000	2001	2002	2003	2004
Import	2,192.3	2,282.8	2,581.5	2,681.6	2,710.9	2,944.3	2,928.7
General consumption	2,192.3	2,282.8	2,581.5	2,681.6	2,710.9	2,944.3	2,928.7
Final consumption	382.7	410.6	455.0	484.7	533.1	551.0	604.5
Industry	184.5	184.4	247.4	266.3	292.4	298.1	324.7
Construction	8.6	7.7	7.9	8.3	8.8	12.2	14.7
Agriculture	8.7	15.5	30.7	34.9	34.9	32.9	38.6
Transport	–	–	–	–	–	9,6	9,6
Household	154.5	152.5	130.1	134.4	137.7	148.2	152.0
Trade and services	26.4	50.5	38.9	40.8	59.3	50.0	64.9

Source – Statistics of Lithuania

Gas covers approximately 28% of the whole primary energy balance. Lacking its own natural gas resources, Lithuania imports gas from the Russian Federation. General gas consumption in the country is constantly growing. In 2004, Lithuania consumed 2.9 billion m^3 (in 1998 – 2.1 billion m^3) of imported gas. Household and industry rank as the major consumers of natural gas (Table 2–13).

The Lithuanian National Energy Strategy designates basic strategic goals which are directly connected with saving of energy, its more effective use, and expansion and promotion of alternative energy consumption. At present, the main primary energy sources in Lithuania are imported organic and nuclear fuel. That import satisfies about 93% of the needs. Simultaneously, renewable energy accounts for 8–9% in the primary energy balance. That is virtually wood, and energy generated in Kaunas Hydro Power Plant. In 2004, produced biogas amounted to 3.4 million m^3, biodiesel – to 2.2 thous t, and bioethanol – to 1.9 thous t [4].

During a year, the surface of Lithuania is being reached by about 1,000 kWh/m^2 of solar energy. At present, only several water heating solar collectors with the total area of about 100 m^2 are being assembled. Solar power stations in Lithuania generate about 0.4 MWh of energy, which is mainly used for heating and preparation of hot water. It is projected that in 2010 this figure will reach 1.4 MWh per year [12].

Construction of small hydro power plants in Lithuania induces a number of discussions, and environmental protection specialists are strongly opposing it. Thus, over the last decade, they were being constructed only on already existing dams. Total amount of electricity generated in hydro power plants equals averagely 371 GWh per year.

Geothermal energy could be practically used in all Lithuania, however, in some places additional energy sources – gas, wood fuel energy – are indispensable for acquiring appropriate water temperature before it reaches a consumer. At present, Lithuanian geothermal power plants produce 110 MWh of energy. According to the data of the scientists of the Institute of Geology and Geography, geothermal energy potential amounts to 800 MWh per year.

In Lithuania, there are 67 operating boiler houses consuming wood fuel, with the total power of about 250 MW. Wood fuel is generally used in small central heating boiler houses, and in heating systems of private houses. At present, wood fuel burning yields 7,670 MWh of energy (8% of the total energy), and it is projected that in 2020 that index will reach the amount of 9,800 MWh [12].

In Lithuania, wind energy could be exclusively used in its coastal zone. Due to the research carried out by the Danish Energy Management A/S, by 2010 it could be attained that 290 MWh of energy per year

Table 2–14. Present and planned consumption of renewable energy

Renewable energy resources	Consumption, TWh			Potential, TWh/year
	2003	2010	2020	2020
Wood	7.81	9.5	9.8	9.8
Straw	0.05	0.5	1.5	3.59
Utility waste	0.00	0.00	0.46	0.8
Landfill gas	0.02	0.14	0.28	0.1
Biogas				0.3
Geothermal energy	0.017	0.11	0.11	0.8
Small hydro power plants	0.32	0.46	0.58	0.5
Big hydro power plants				1.00
Solar energy	0.00	0.00	0.00	1.3
Wind energy	0.00	0.29	0.85	0.85
Biofuel	0.00	0.72	0.72	2.25
Total	8.22	11.72	14.3	21.29

Source – Renewable energy

(available at http://www.avei.lt/1FCBC0B2-BDBA-45BD-9AE8-BDEB2051B3BA.W5Doc)

were generated by wind mills (2% of all electrical energy consumed in the country). Such wind mills park could save 3,500 t of oil fuel (mainly gasoline) per year preventing pollution amounting to 11,000 t of CO_2, 1,161 t of SO_2, 108 t of NO_x and 5.4 t of heavy particles. It is projected that in 2020, energy generation in wind turbines could reach 850 MWh per year (5.9% of total electrical energy) [3]. At present, 6.395 MW wind turbines are operating, 5.4 MW of which are not connected to the electrical network [11].

Lithuania owns a notable straw utilization potential for energy generation, and even 0.68 million t of straw could be used for this purpose. However, that has not been done on a larger scale so far. These days, burning of straw produces 50 MWh of energy per year, and it is projected that in 2020 this figure could reach 1,500 MWh of energy per year [3].

Lithuania has got four biogas-fuelled power plants with the power of each ranking from 0.4 to 8 MW. Their general installed power – 13.726 MW. Biogas burning power plants use technological waters (Joint-stock company "Rokiškio sūris"), pig manure and food production waste (Joint-stock company "Lekėčiai"), municipal wastewater (Joint-stock companies "Kauno vandenys", "Utenos vandenys"). Landfill gas has not been utilized in Lithuania so far [13].

2.7. Transport

Transport is a significant part of the economic and social infrastructure of the Republic of Lithuania. This sector exhibits a direct influence on economic development through international and local trade and tourism, and it strongly contributes to the creation of favourable business conditions. In recent years, Lithuanian transport and communications are enlarging their share in GDP: in 2004 – 13.5% (transport – 9.8%, communications – 3.7%), i.e. 8.4% more than in 2003, 17.3% more than in 2002, and 36% more than in 2001 [2].

During the Conference of European transport ministers held in Crete in 1994, two Trans-European Network corridors crossing Lithuania were ascertained. Railway junction in Klaipėda State seaport, International Vilnius, Kaunas and Palanga airports, inland water route Kaunas-Klaipėda are inseparable components of multimodal transport corridors forming the significant TINA network. Of four international Lithuanian airports, three (Vilnius, Kaunas and Palanga) are included into the TEN-T network [5].

Total length of roads of national importance equals 21,345 km, of which highways make 1,873.18 km, country roads – 4,873.15 km, and district roads – 14,723 km (Table 2–15). The density of national importance road network for 1,000 km² is 326.9 km, for 1,000 inhabitants – 6.13 km. At present, 8,639 km (40%) of the roads of national importance are gravelled, which increases CO_2 emission into atmosphere [3].

Total length of Lithuanian railway network equals 1,695.8 km with 648.3 km (38.1%) of two-way railways. The density of railway network amounts to approximately 26 km/1,000 km². Of all the network only 122 km of railways are electrified, and they are being used for local transportation of passengers by electric trains. The main Lithuanian railway lines of North-South and East-West directions are included into Trans-European railway network.

The northernmost ice-free port on the eastern Baltic coast – Klaipėda State seaport – is a significant

junction in IXB transport corridor, joining East-West direction roads and sea routes. Total length of Lithuanian inland water routes equals 843.3 km, 435.7 km of which are being used for passenger and freight transportation. The Nemunas river section Kaunas-Jurbarkas-Klaipėda and Kaunas river port are included into the European inland water route network of international importance (TEN-T). Furthermore, inland water route Kaunas-Klaipėda and the Curonian Lagoon water route are the UN inland water transport routes E41 and E70. However, Lithuanian inland waters do not exhibit greater importance in the general transport system because of comparatively short navigation period, insufficient depth, seasonal changes in water level, etc. [5].

In 2004, total transportation of freight in Lithuania amounted to 128.9 million t (in 1998 – 115.1 million t), and transportation of passengers – to 483.1 million people (in 1998 – 516.2 million) (Table 2–16).

Transportation by railways in 2004 amounted to 45.5 million t of freight, which is 5% more than in 2003. The transportation of black metals, oil and its products, building materials and cement, and chemical and mineral fertilizers by railways increased in 2004. However, the transportation of grain and flour, as well as coal and coke was less. The main transit flows in East-West direction occur between Klaipėda, Kaliningrad and ports of Russia and other countries of CIS. Passenger transportation by railways has been decreasing for several years: from 12.2 million in 1998 to 6.9 million in 2004.

The ratio between road transport passengers and the total number of them has been stable for the last five years – 97%, whereas the amount of freight transported by roads decreased from 54.6 million t in 1998 to 51.4 million t in 2004.

Klaipėda State seaport, comparing to 1998 (15 million t), during January-December of 2004 handled 20.2 million t of freight (4.5% less than in 2003). Būtingė oil terminal handled 7.24 million t of oil in 2004, i.e. 32% less than in 2003. In the course of 2004, Lithuanian freight in Klaipėda port made 67%, and transit – 33% of total freight. In 2002, 107.7 thous of passengers arrived and departed by sea ferries and sea navigation lines. In 2004, the number of passengers in Klaipėda port increased up to 147 thous. The number of passengers in cruise ships increased by 62%, i.e. 14 thous people more in 2004, compared to 2003 [1].

Total economic change at Palanga, Kaunas and Vilnius airports during 2004, in comparison to 2003, was as follows: the number of flights increased by 21.6%, the amount of attended passengers grew up by 40.6%, the amount of transported freight and mail decreased by 29.4%. Freight transportation by air from 1998 increased 2.35 times, and passenger transportation – 1.9 times.

Increasing number of motor vehicles poses a lot of problems in Lithuania. In 2004, the total number

Table 2–15. Length of roads at the end of the year 2004, km

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Length of operating railway lines	2,002	1,997	1,997	1,997	1,905	1,905	1,696	1,775	1,774	1,782
Motorways	62,513	66,212	69,243	72,459	73,650	75,517	76,573	77,148	78,893	79,331
Motorways with cover	54,153	58,152	61,615	66,045	67,222	68,940	69,932	69,210	70,194	69,772
Inland water routes regularly used for transportation	369	369	369	369	369	380	436	477	425	425

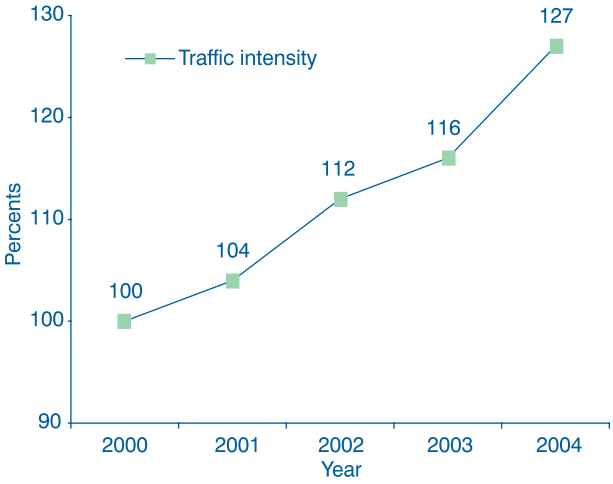
Source – Statistics of Lithuania

Table 2–16. Freight and passenger transportation in 1998–2004

	1998	1999	2000	2001	2002	2003	2004
Total freight transportation, thous t	115,135.7	101,325.6	109,076.6	115,127.8	116,563.0	132,203.2	128,989.0
Railway transport	30,911.7	28,346.6	30,711.9	29,173.7	36,649.8	43,447.3	45,554.8
Road transport	54,631.0	45,651.3	45,013.4	45,074.7	45,046.7	52,180.2	51,456.1
Pipeline	24,086.7	22,248.8	27,980.6	35,626.6	29,538.9	31,275.4	26,625.7
Sea transport	4,165.2	4,279.7	4,515.0	4,706.2	4,809.2	4,651.1	4,724.8
Inland water transport	1,338.3	796.7	852.4	543.3	515.0	645.5	621.0
Freight	2.8	2.5	3.3	3.3	3.4	3.7	6.6
Total passenger transportation, thous	516,242.7	471,929.5	383,243.0	355,874.4	358,324.8	373,563.7	483,165.5
Railway transport	12,194.6	11,527.3	8,852.1	7,718.1	7,217.2	7,004.6	6,983.2
Road transport	502,138.8	458,327.6	372,684.2	346,400.8	347,782.7	364,068.6	473,484.0
Sea transport	43.7	50.8	64.2	68.8	58.4	98.9	132.9
Inland water transport	1,563.6	1,728.3	1,299.9	1,323.6	2,890.2	1,993.6	1,973.9
Freight	302.0	295.5	342.6	363.1	376.3	398.0	591.5

Source – Statistics of Lithuania

of registered vehicles reached 1.63 million, of which 1.3 million cars, 152 thous freight vehicles, and 15 thous buses. There were 476 cars per 1,000 inhabitants (in 1998 – 312). Comparing to 1998, car number per one inhabitant increased 1.5 times (Table 2–17). Due to that, the traffic is constantly intensifying. In 2004, comparing to 2000, it increased by 27% on the main motorways of Lithuania (Figure 2–4). Increase in transport amount and in the number of passenger cars caused traffic congestion, which, in its turn, raises serious problems. As a result, pollution is constantly increasing as well.



Source – Ministry of Transport

Figure 2–4. Variation dynamics of traffic intensity, 2000–2004

The main problems accounting for environment pollution caused by transport in Lithuanian cities are: a) the density of cities' streets network is insufficient for vehicles self-regulation; b) certain sections of some main streets are not connected to the main network for 1–1.4 km, thus, transport flows concentrate in a smaller network, while vehicles cover longer distances; c) part of the existing street cover is of bad state, which greatly increases noise and emissions from vehicles; d) the main streets (especially in the largest cities) are too narrow, thus, during rush hours heavy traffic congestion is inevitable. Developing city transport infrastructure, measures for mitigation of transport concentration should be undertaken. One of them – maintenance of public transport priority in the common city transport system. However, renovation of bus parks is too slow and insufficient to ensure comfortable and fast communication. The largest cities could take advantage of ecologically friendly trolleybus lines (at present, trolleybuses exist only in Vilnius and Kaunas, and their total road length makes 277 km), still, they need to be modernized, and the trolleybus park itself should be more actively renovated [5].

Over the last decade, vehicles became more economical, causing less pollution, thus, though their number increased more than two-fold, total vehicle fuel consumption decreased by nearly 30%. Similarly, transport fuel structure markedly changed: the consumption of diesel oil is increasing (in 1998 – 531 thous t, in 2004 – 755 thous t), during recent three years, the consumption of liquid oil gas has grown three times (in 1996 – 74 thous t, in 2004 – 259 thous t). Thus, during the last decade, emission of pollutants and substances causing climate change decreased more than the consumption of fuel. However, in spite of positive trends in the transport sector, about 75% of cars in Lithuania serve more than 11 years, and their average age reaches 14 years. Freight Vehicles Park is being renewed quite rapidly, and in accordance with the strict EU requirements. Nevertheless, local freight is being transported by old vehicles of eastern make, which consume extremely big amount of fuel, contaminate the environment badly, and make a big noise [9]. The worst air pollution (transport emitted 17.3% in 1990 and 67% in 2003 of total CO_2; 35.4% in 2003 of all GHG with LUCF; 21.0% in 2003 of all GHG without LUCF) occurs in the zones of intensive motor vehicles traffic, and especially in the largest cities. Research conducted indicates that in Vilnius motor vehicles emit 88% of all pollutants found in the atmosphere.

During 1998–2002, Lithuania fulfilled the com-

Table 2–17. Variation dynamics of vehicles, 1998–2004

Year	Vehicles							
	Total	Vehicles for 1000 residents	Cars	Cars for 1000 residents	Trucks	Buses	Motorcycles	Other vehicles
1998	1,153,789	312	925,239	250	75,296	15,398	22,056	115,800
1999	1,207,451	326	957,652	258	76,486	14,660	22,190	136,463
2000	1,286,392	348	1,065,415	288	73,289	15,542	21,741	110,405
2001	1,383,724	396	1,116,473	319	142,916	16,631	25,192	82,512
2002	1,479,099	427	1,180,718	340	144,801	17,299	27,532	108,749
2003	1,580,476	458	1,260,034	365	156,326	16,881	28,775	118,460
2004	1,634,354	476	1,318,562	384	152,278	15,515	28,995	119,004

Other vehicles: house-trailers, pickups and wagons, car hitches, truck semi-trailers and hitches (Source – Ministry of Transport)

mitments to reduce the amount of sulphur and lead in fuels due to the EU regulations – from 1 January 1998, only lead-free petrol is being imported and used, while sulphur amount in diesel fuel meets the EU requirements as well. At the UN regional conference Transport and Environment held in Vienna in 1997, Lithuania signed a declaration acknowledging the importance of transport in public life, economic and social development, alongside considering it the main source of environmental pollution.

Various measures and activities for the reduction of transport contamination have been projected in national programs, the strategies of certain economy branches, and in resolutions of the Lithuanian government on reduction of air contamination by transport exhaust fumes (the Long-term Development Strategy of the State, the General Plan of the Territory of the Republic of Lithuania, the Long-term Economic Development Strategy of Lithuania until 2015), and also in the national program Transport and Environmental Protection. Different measures concerning fuel production and quality, and its control system improvement, the promotion of alternative and ecological fuel consumption, stricter regulations for pollution norms, strengthening of transport technical maintenance, optimizing the traffic in cities, and improvement of roads are in conformity with the goals of reducing transport's impact on the environment and population health [14].

2.8. Industry

The greater share of the total added value belongs to Lithuanian industry sector. According to the volume of industrial production, oil processing, food production, textile, clothing, leather and wood industries stand for the largest sectors. Lithuania possesses excess electrical energy production capacity, thus, it is an important electricity exporter in the Baltic region. This status will notably change after the closure of Ignalina NPP in the 2005–2009 period [5].

Industrial production sold in 2004 in current prices amounted to more than 35 billion LTL. The calculations in comparative prices of 2000 indicate that the production sold in 2004 increased by 10.8%, comparing to 2003. 67% of mining and quarry exploitation production was made by crude oil extraction. In the processing sector, the greatest comparative shares were taken by: food and beverages production (15.9%), clothing sewing, fur dressing and dyeing (5.3%), wood and wood products (5.2%), refined oil products (4.4%), and textile production (4.6%). There was the greatest increase in the sales of medicine industry products (90.2%), furniture (42.3%), other transport means production (33.5%), main metal products (29.8%), electrical machines and apparatus (14.4%), and rubber and plastic products (14.1%). In 2004, 60.1% of the production for sale was exported. The largest amount of export production concentrated in the following spheres of activity: metal waste and scrap processing (84.5%), electrical machines and apparatus production (81.8%), chemicals and other chemical industry production (81.7%), clothing sewing, fur dressing and dyeing production (81.3%), textile production (79.7%), refined oil products extraction (79.5%), radio, television and communications equipment and apparatus (75.7%).

In 2004, direct foreign investments made 14,976.1 million LTL. The greatest share of all of them is now in the processing production – 33.9%, trade – 17.1%, transport and communication services – 15.3%, and financial mediation – 15.4%. The major part of all the foreign investments of processing industry occur in foodstuffs, beverages and tobacco – 31.4%, refined oil products and chemical production – 22.2%, and in textile production – 5.1%. In 2004, direct foreign investments largely increased in rubber and plastic products manufacture – 3.4 times, furniture production – 83.5%, engine means of transport, trailers and semi-trailers, and other transport equipment manufacture – 82.5%, office equipment, computers and electrical machines and apparatus production – 42.8% in comparison to 2003. Denmark is the main investor in Lithuania (15.8% of all direct foreign investments), followed by Germany (9.6%), Estonia (8.7%), Finland (8.4%), and the USA (6.5%) [15].

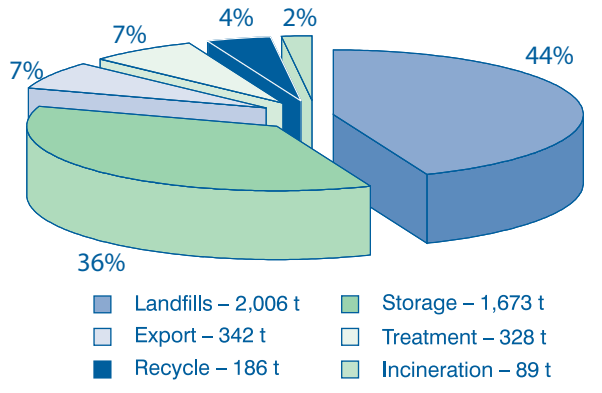
Privatisation of industrial enterprises, establishment of new market relationships, introduction of taxes on natural resources and pollution of the environment enhanced production efficiency of the majority of survived enterprises, economical utilization of natural resources, reduction of environment contamination. Industrial enterprises implement preventive measures for environmental protection, and methods of cleaner production. During the recent decade, ecological efficiency of the industry sector has largely increased, average energy consumption for a GDP unit has decreased 1.7 times, water consumption – nearly twice, emission of pollutants into the air – more than a half. In the Long-term Economic Development Strategy of Lithuania until 2015, attention is focused on the fulfilment of sustainable development regulations in the industry sector. Program of the Sustainable Development of Industry has been approved as well [5].

2.9. Waste

Lithuania has set the most important waste management goals – to create the most suitable system of hazardous and non-hazardous waste management from the economic and environmental protection point of view, to reduce waste flows, and their negative influence on the environment and human health, and to ensure its reasonable utilization for recycling and energy sector [18].

According to the data of the State waste management system and expert evaluation, in 2003, non-hazardous waste in Lithuania accounted for 4.8 million t, and hazardous waste accounted for 142 thous t [7]. The amount in the largest cities equals 300 kg, in the smaller ones (district centres) – about 220 kg, and in settlements and in the countryside – about 70 kg municipal waste per inhabitant.

The major part of non-hazardous waste is deposited in landfills. Its share in 2002 was 44% (2,006 t) of all non-hazardous waste. The greater part of it is non-classified municipal waste. A little less – 36% (1,673 t) of non-hazardous waste is stored, and it is usually wastewater treatment and other silt, as well as mineral waste. There is no appropriate equipment for the management of such waste, and the disposal of it in landfills is prohibited. Approximately 7% (342 t) of non-hazardous waste is exported or treated in other ways (328 t). About 2% (89 t) of non-hazardous waste is annually incinerated, and 4% (186 t) – recycled (Figure 2–5) [17].



Source – Ministry of Environment

Figure 2–5. Management structure of non-hazardous waste in Lithuania in 2002

The biggest part of hazardous waste (95%) is made by oil waste – oil and water mixture. The second place is taken by waste with heavy metals, e.g. used batteries and accumulators. Waste of chemical substances, used oil, ashes and slag are also hazardous waste. In 2003, 116.8 thous t of it was treated. The largest part of it is stored (49% or 89.8 t) or recycled (48% or 88.7 t), and approximately by 1% it is incinerated (1.6 t), treated in other ways (0.9 t) or exported (2.2 t) – mainly lead accumulators [17].

Management of radioactive waste and used nuclear fuel pose the most important problems. Ignalina NPP is the main generator of radioactive waste in Lithuania. Radioactive waste of other manufacturers in 2000 accounted for barely 0.15%, and in 2001 – 0.5% of all that waste [17]. The whole radioactive waste of Ignalina NPP is stored in depositories situated in its territory, which do not ensure long-term storage, and do not correspond to the long-term security criteria. Preparing for the final closure of Ignalina NPP and fulfilling the regulations of Radioactive waste management strategy, waste storage system is completely reformed, and new depositories for radioactive waste are projected [5]. Up to 2008, a new depository of used nuclear fuel should start its operation. However, Lithuania has not yet made any decisions about management of used nuclear fuel after termination of its storage in dry-type depositories [18].

In 2003, 737 landfills were identified, 42 of which were closed, liquidated or recultivated. The majority of now existing landfills do not comply with the environmental protection requirements, due to the poorly developed municipal waste treatment system, primary household waste classification, and insufficient amount of recycled secondary raw materials (25% of paper and cardboard, 18% of glass, 6% of plastic waste). More than half of secondary raw materials are imported from abroad by processing enterprises. There is lack of capacities for the recycling of some waste (glass, tires, electrical and electronic equipment, textile products, non-usable cars), as well as for the disposal and utilization of hazardous waste, and for the treatment of biodegradable waste [18]. There are enough capacities for the recycling of used paper and cardboard, but the process is hindered by the problem of waste collection. In 2002, collected paper waste constituted 58% of the total recycled amount, the rest of it – 38.5 thous t – was imported. The annual amount of plastic waste makes more than 50 thous t. In 2002, only about 5 thous t of it was collected, whereas even 11 thous t was imported [17]. In 2003, Lithuania imposed stricter parameters for transfer of hazardous waste and waste registration. The projections are made for the development of regional waste treatment systems, and for establishment of large regional landfills in separate municipalities instead of the existing ones. 10 regional landfills and one hazardous waste landfill are planned to be established till the end of 2009 [18].

Lithuania has not yet implemented waste incineration for energy generation and biogas production by

special equipment, thus, that is the reason for not collecting landfill gas, though first steps are being made in this direction. In some landfills, research is being carried out for the estimation of possible gas volume, and the projects are being designed for the landfill gas collection and utilization. In 2003, total utilization of landfill gas and biogas amounted to barely 0.02 TWh [13].

2.10. Building Stock and Urban Structure

In accordance with the Law of the Republic of Lithuania on Direct Rule of Administrative Territorial Units, all the settlements are divided into cities (compactly built-up residential localities with more than 3 thous inhabitants; more than 2/3 of the working people are occupied in the spheres of industry, business, manufacture and social infrastructure), towns (compactly built-up residential localities with the population of 500 to 3,000; more than half of the working people are occupied in the spheres of industry, business, manufacture and social infrastructure), villages (other residential localities, lacking any features of cities and towns) [20].

In Lithuania there are 106 cities (Table 2–18) and 21.5 thous villages (more than 3 thous of which had no inhabitants according to the data of the 2001 census of population). In 2004, 2,297.4 thous people resided in cities, and 1,148.5 thous – in villages [19]. The largest cities are Vilnius (541.6 thous residents), Kaunas (373.7 thous), Klaipėda (191.6 thous), Šiauliai (132.7 thous), and Panevėžys (116.8 thous). Villages with 50 to 200 inhabitants present the largest share (79.6%) in the whole villages section (Table 2–19) [14].

In 2001, in Lithuania there were about 790 thous apartments in blocks of flats, and about 420 thous of individual houses (874.5 thous of all apartments in cities, 418.5 thous – in villages) [19]. Approximately 70% of all apartments are connected to the centralized water supply, about 50% of the apartments are linked to the central heating supply. More than 60% of all blocks of flats have been built during four recent decades of the last century (approximately 25% of the total residential area (20,400 thous m^2, or roughly 8 thous houses). The construction of large-block buildings predominated at that time. Such many-flat houses are not economical in respect to the consumption of energy (lose 20–30% of supplied heat). The majority of blocks of flats and a considerable number of individual houses possess very poor thermal insulation, their windows are not modern and non-hermetic, which demands great amounts of energy for their heating (approximately 200 kJ for one degree for 1 m^2 per day) 2–2.5 times more than in most of the countries of the EU. Infrastructure of central heating is out-of-date and inefficient, the energy losses are extremely great in distribution networks, and thus, apartment heating expenditures are very high – about 20% of the average family income. At present, the problem of reasonable energy consumption is becoming more acute, as the housing resources are becoming older, energy resources are getting more expensive, besides, individual apartment owners are not able to solve the renovation problems of their houses, whereas the state budget of the Republic of Lithuania cannot cover all the costs of the modernization of all of them. Under approximation to the EU, Lithuania adopts legal acts, which liberalize the management of the apartment infrastructure, enhance responsibility and accountability. It is urgent to promote the implementation of energy-saving programmes, accelerate renovation of buildings, and the modernization of heating supply infrastructure [9]. The Lithuanian Housing Strategy states that by 2020, the present many-flat houses, as well as their engineering and technical equipment, should have been renovated and modernized in accordance with the capacities and economic expedience. It is project-

Table 2–18. Lithuanian towns according to their dimensions (2001 census of population data)

Town dimensions according to the number of residents, thous	Number of towns in certain dimensions group	Residents in towns, thous
Up to 2	27	34.3
2–5	19	53.9
5–10	21	140.6
10–20	20	266.2
20–50	13	397.8
50–100	1	71.5
100–250	3	446.6
250–500	1	378.9
500 and more	1	542.3
Total	106	2,332.1

Source – prof. S. Vaitekūnas (available at www.lietuva.lt)

Table 2–19. Villages (2001 census of population data)

Village dimensions (number of residents)	Number of villages
Up to 50	14,369
50–199	2,777
200–499	1,011
500–999	286
1000–1999	83
2000–4999	21
Without residents	3,000
Total	21,547

Source – prof. S. Vaitekūnas (available at www.lietuva.lt)

ed to reduce thermal energy relative expenditures per useful living area unit to 30% [6]. To accomplish one of the main requirements of energy and heating saving in buildings, roofs' repair and warming works are being carried out, heating junctions and equipment for hot water preparation are being modernized, windows are being hermetized or replaced, and seams between blocks are being mended [5].

The situation with public premises is also insufficient. According to the primary data, the total area of education and science institutions covers 6.6 million m². Nearly 55% of schools were built during 1960–1980, 18% – till 1940. The data obtained indicate that schools are being renovated as often as approximately 27 years. 13% of schools have been used for 40 years without any renovation. That means they are actually worn-out more than 26%. Almost all school buildings are inefficient in respect to energy consumption – thermal insulation equals 0.7–0.9 m²/kW, windows are non-hermetic, roofs are in bad condition, and heating systems are ineffective.

High consumption of energy, and inefficiency of energy systems account for the main problem of maintenance of public sector buildings (total area – 3 million m²) [5].

In 2003, as well as in 2004, households consumed a similar amount of fuel and energy. The most popular energy source in households – electrical energy, thermal energy, wood and wood waste (Table 2–10).

In 2004, the construction of modern, new-standard apartments was growing up. In 2001, new construction accounted for 40% of all building, repairing and reconstructing works. In 2004, it increased by 6% and accounted for 46% of all construction work [15]. Totally, 6,804 new-standard apartments were built (1.6 times more than in 1998) in 2004, of which 2,884 – in one/two apartment houses (individual houses), 3,920 – in blocks of flats. The number of apartments per inhabitant increased from 1.2 to 2 (Table 2–20).

Increase in the construction of public administrative buildings was evident, too. Their number grew up nearly twice: from 1,229 in 2000 to 2,444 in 2004 (Table 2–21) [19].

2.11. Forestry and Agriculture

In Lithuania, total area of agricultural land covers 3,369.3 thous ha, or 51.6% of the total territory of the country [5]. The area of forest land covers 2,069.1 thous ha, or 31.7% of the territory (Table 2–22). Since 1 January 1998, the forest land area has increased by 90.7 thous ha, and the wood mass grew up by 1.4%. The overall stand stock of wood has not increased so rapidly. During the same period, it increased by 79.8 thous ha up to 1,967.7 thous ha. The forest land area per inhabitant has risen from 0.53 ha to 0.60 ha, and the wood mass – from 93 m³ to 113 m³. That augmentation is enhanced also by the decreasing population numbers.

Conifer stands comprise the largest part of the for-

Table 2–20. New apartments

	1998	1999	2000	2001	2002	2003	2004
Total	4,176	4,364	4,367	3,696	4,470	4,530	6,804
In houses of 1–2 apartments	1,890	1,674	1,904	1,798	1,999	2,093	2,884
Apartments in blocks	2,160	2,580	2,559	1,987	2,563	2,535	3,920
Number of apartments for 1,000 residents	1.2	1.2	1.3	1.1	1.3	1.3	2

Source – Statistics of Lithuania

Table 2–21. New non-residential buildings

	Number of buildings					General area, thous m²				
	2000	2001	2002	2003	2004	2000	2001	2002	2003	2004
Total	1,229	940	883	1,348	2,444	704.1	672.5	624.6	773.7	1,193.0
Offices	49	31	26	38	59	98.7	49.3	25.4	36.6	69.5
Industrial and storehouses	152	186	173	226	236	112.4	153.5	215.4	225.4	369.7
Agricultural	270	218	213	388	1,077	55.8	56.2	72.3	85.7	167.0
Transport and communication	167	126	127	72	132	161.1	98.5	61.2	72.6	71.1
Commercial, hotels and others	250	206	188	207	204	175.0	205.4	144.6	185.9	359.0
Educational	11	19	9	14	10	13.0	21.0	30.4	22.4	13.3
Medical	17	12	9	13	11	16.8	8.4	4.0	14.2	6.5
Cultural and for sport	12	7	7	13	16	17.0	19.2	22.1	57.7	32.8
Others	301	135	131	377	699	54.3	61.0	49.2	73.2	104.1

Source – Statistics of Lithuania

ests (58.9%), followed by softwood – 36.3%, and hardwood – 4.8%. Pine woods cover an area of 716 thous ha, and it has increased by 16 thous ha comparing to 1998. Due to intensive cuttings in fir groves, their area and mass has slightly decreased during the above mentioned period. At present, they cover the area of 440 thous ha. Among softwoods, birch groves predominate, and their area has increased by 23 thous ha since 1998 and occupy 398 thous ha. Black alder areas increased by 17 thous ha up to 126 thous ha, whereas white alder areas grew up less – by 11 thous ha to occupy 123 thous ha. The slowest growing among main softwoods is demonstrated by asp groves. They increased just by 7 thous ha up to 59 thous ha.

In 2004, state-owned wood area covered 1,029.9 thous ha, and private-owned forest land area – 641.9 thous ha (31% of the total area). Average private-owned area covers 4.5 ha.

Cuttings in Lithuania over the last five years were constantly increasing. In 2003, the cuttings equalled 6.46 million m^3 or 3% more than in 2002. In state forests, the volume of cuttings stabilized around 1999, and since then has been only moderately changing. In 2003, the cuttings in state forests decreased by 4% to 3.76 million m^3. The overall increase in the total volume of cuttings was conditioned by constantly increasing cuttings in private forests. Naturally, with the growth of private forests the increased volume of cuttings is being exhibited. In 2003, about 2.7 million m^3 of wood was cut in private forests. Comparing to 2002, the increase accounted for 12.5%. The amount of annually harvested wood in private forests increased from 38% to 42% [7].

Economic forests cover 70.8% of the whole forest area; reserve forests – 1.2%, special use forests – 11.9%, and protected forests – 16.1% [10].

A decrease in agricultural production has been observed in Lithuania in recent years. In 1998, it accounted for 6,153.0 million LTL, whereas in 2003 it dropped to 4,375.6 million LTL. The greater part of the agricultural production is taken by plant growing, 1.5 times more than livestock production (Table 2–23).

Climate conditions and natural soil fertility are favourable to grow crops, fruit and vegetables, flax, rape, sugar beet, etc. (Table 2–24). Warming of climate enables larger amount of rape being grown. Since 1998, rape yields in Lithuania have increased nearly three times. Agricultural products per inhabitant in 2004 amounted to 849 kg of grain, 297 kg of potatoes, 538 kg of milk, 263 kg of sugar beet, 251 eggs, 64 kg of raw meat, 33 kg of pork, 116 kg of vegetables, and 13 kg of fruit and berries. The annual consumption of milk and dairy products per inhabitant is the highest in Lithuania (287 kg), followed by eggs (211), and potatoes (118 kg), whereas the consumption of meat and its products (59 kg), as well as fruit and berries is the lowest (61 kg). The whole crop area in 2004 amounted to 1,430.5 thous ha, with the largest portion of corn (878.5 thous ha), fodder plants in arable land (267.2 thous ha), and rape (100.6 thous ha) (Table 2–25).

Table 2–22. Land use in Lithuania, 2003

Year	1998		1999		2000		2001		2002		2003	
	Thous ha	%	Thous ha	%	Thous ha	%	Thous ha	%	Thous ha	%	Thous ha	%
Agricultural lands	3,356	51.4	3,373	51.6	3,371	51.6	3,370	51.6	3,370	51.6	3,369	51.6
Forests	1,975	30.3	1,972	30.2	1,979	30.4	1,998	30.6	1,997	30.6	2,069	31.7

Source – Activity Report of the Government, 2004

Table 2–23. General production of agriculture (in real prices, million LTL)

	1998	1999	2000	2001	2002	2003
Total production of agriculture	6,153.0	5,065.6	4,497.0	4,501.7	4,303.3	4,375.6
Plant growing	3,624.4	2,975.9	2,705.8	2,488.3	2,353.5	2,647.6
Animal husbandry	2,528.6	2,089.7	1,791.2	2,013.4	1,949.8	1,728.0

Source – Statistics of Lithuania

Table 2–24. Yields of agricultural plants, thous t

	1998	1999	2000	2001	2002	2003	2004
Cereal	2,716.8	2,048.6	2,657.7	2,345.3	2,539.1	2,631.8	2,859.4
Pulse grain	104.1	63.8	73.0	52.2	62.9	48.5	57.5
Flax	5.6	4.3	7.2	4.0	6.2	9.9	5.8
Rape	71.9	115.1	81.0	64.8	105.6	119.5	204.7
Sugar beet	949.2	869.9	881.6	880.4	1,052.4	977.4	904.9
Potatoes	1,849.2	1,708.1	1,791.6	1,054.4	1,531.3	1,445.2	1,021.4
Vegetables	436.9	325.1	329.4	322.0	290.0	549.3	379.4
Feeding roots	2,026.0	1,573.3	1,399.4	1,382.9	1,136.2	944.7	428.0

Source – Statistics of Lithuania

Table 2–25. Crops, thous ha

	1998	1999	2000	2001	2002	2003	2004
Total crops	1,833.9	1,695.4	1,557.1	1,465.3	1,446.1	1,370.7	1,430.5
Grain	1,107.5	1,012.7	979.6	935.9	918.0	864.6	878.5
Pulse grain	66.1	49.3	39.8	36.7	36.2	21.6	30.5
Flax	6.2	8.8	8.6	10.2	9.5	9.4	5.8
Rape	38.6	83.8	55.5	50.7	60.0	66.6	100.6
Sugar-beet	30.0	30.6	27.7	26.5	29.2	25.6	23.3
Potatoes	136.3	121.1	109.3	102.5	99.2	93.6	79.3
Greengrocery	28.1	24.9	21.9	21.1	20.7	27.1	20.4
Feeding roots	58.3	46.8	39.1	37.3	36.0	25.8	13.7
Fodder plants in arable land	358.4	310.2	271.3	235.9	227.4	224.5	267.2

Source – Statistics of Lithuania

Table 2–26. Number of livestock and poultry, thous

	1998	1999	2000	2001	2002	2003	2004
Livestock	1,016.3	922.8	897.8	748.3	751.7	779.1	812.1
Cows	582.8	537.7	494.3	438.4	441.8	443.3	448.1
Swine	1,200.1	1,159.0	936.1	867.6	1,010.8	1,061.0	1,057.4
Sheep	24.0	15.8	13.8	11.5	12.3	13.6	16.9
Goats	18.5	23.7	24.7	23.0	23.7	22.0	27.2
Horses	78.5	74.3	74.9	68.4	64.5	60.7	63.6
Poultry	7,423.2	6,749.3	6,372.6	5,576.5	6,576.1	6,848.1	8,066.7

Source – Statistics of Lithuania

Agriculture is one of the main emission sources. In 1990, agricultural sector emitted 48% of all methane gas, and 82.7% of all nitrous oxide/suboxide amount. In 2003, emission of methane gas decreased to 40.2%, and of nitrous oxide/nitrogen oxide – to 50.8%. Pigs (1,057.4 thous) and poultry (8,066.7 thous) are most often reared in Lithuania, sheep (16.9 thous) and goats (27.2 thous) – vice versa (Table 2–26) [19].

Most of the cattle breeding farms are small. In February 2003, of 233,480 cattle breeders, 200,687 had from one to five cattle. More than 70% of milk is supplied to the dairies by small producers (with one-five cows) [5].

The number and area of certified ecological farms in Lithuania is increasing. They are already estimated at 700 (in 2002 – 393 farms), while the land area under ecological farming reaches 24 thous ha (in 2002 – 9 thous ha). The area of certified ecological farms accounts for 0.7% of the total area of the Lithuanian agricultural land. Average size of an ecological farm equals 34 ha. Ecological as well as traditional farms are occupied with various productions. About 40% of lands are grasslands and fallows. 24% of the areas are used for cereal and pulse crops, and more than 10% – for buckwheat. Areas of ecological potatoes and vegetables constitute 1.5% of the whole ecological agricultural land, followed by berry fields – 1.0%, and gardens – 1.5%. Ecological fishery has been started to develop as well. However, the market of ecological products undergoes chaotic development because of not too attractive appearance of products, and ecological production being more expensive [23].

2.12. Sources

1. Activities of Klaipėda and Neighbouring Ports in 2004 (available at http://www.portofklaipeda.lt/lt.php/bendra_informacija/statistine_informacija/15)

2. Activity Report of the Government of the Republic of Lithuania 2004, 30 March 2005, No 337 (available at http://www.lrv.lt/13_vyr_dok/n0337.pdf)

3. Activity Report of the Ministry of Transport and Communications of the Republic of Lithuania 2004 (available at

http://www.transp.lt/Default.aspx?Element=IManagerData&TopicID=192&DL=&UL=)

4. Fuel and Energy Balance 2004 / Statistics Department with the Government of the Republic of Lithuania, Vilnius, 2005.

5. General Programming Document of Lithuania for 2004–2006, 2 August 2004, No 935 / Government of the Republic of Lithuania // *Valstybės žinios*, 2004, No 123–4486.

6. Housing Modernisation Programme, 23 September 2004, No 1213, / Ministry of Environment of the Republic of Lithuania (available at

http://www.am.lt/VI/article.php3?article_id=3201)

7. Lithuanian Forestry Statistics 2004 / Ministry of Environment of the Republic of Lithuania. State Forestry Management Service, Kaunas, 2004.

8. Lithuanian Regions: Economic and Social Development 2003 / Statistics Department with the Government of the Republic of Lithuania, Vilnius, 2004.

9. National Sustainable Development Strategy, 11 September 2003, No 1160 / Government of the Republic of Lithuania (available at http://www.am.lt/VI/files/0.658894001076396631.pdf)

10. Natural Resources and Environmental Protection / Statistics Department with the Government of the Republic of Lithuania, Vilnius, 2004.

11. Paulauskas, S. and Paulauskas. A. Lithuanian Wind Energy: Creation of Possibilities 2004 (available at http://www.eksponente.lt/vejas/Vejo%20energetika.pdf)

12. Renewable Energy / Environment Information Centre www.apicentras.lt (available at http://www.apicentras.lt/?pid=275, http://www.apicentras.lt/?pid=276, http://www.apicentras.lt/?pid=277, http://www.apicentras.lt/?pid=274, http://www.apicentras.lt/?pid=280, http://www.apicentras.lt/?pid=279)

13. Renewable Energy Resources www.avei.lt (available at http://www.avei.lt/1FCBC0B2-BDBA-45BD-9AE8-BDEB2051B3BA.W5Doc)

14. Review. 2004 / Transport Traffic Safety Department of the Ministry of Transport (available at http://www.transp.lt/Default.aspx?Element=IManagerData&DL=L&TopicID=125&ArticleID=90&Page=2&Page2=0&Action=0&SearchTXT=ap%C5%BEvalga)

15. Review of Lithuanian Economy, 2005, No 1 (available at http://www.std.lt/web/uploads/apzvalga/_Turinys.htm)

16. Review of Lithuanian Economy, March 2004, No 1 (available at http://www.nordlb.lt/files/LEA_2005_3.pdf)

17. State of Environment 2002 / Ministry of Environment of the Republic of Lithuania, Vilnius, 2003.

18. State of Environment 2003 / Ministry of Environment of the Republic of Lithuania, Vilnius, 2004.

19. Statistics Department with the Government of the Republic of Lithuania www.std.lt

20. The Republic of Lithuania Law on Territorial Administrative Units and Their Borders, 19 July 1994. No I-558 // *Valstybės žinios*, 1994, No 60–1183.

21. Traffic Intensity. General Data / Lithuanian Road Administration with the Ministry of Transport and Communications (available at http://www.lra.lt/lt.php/lietuvos_keliai/eismo_intensyvumas/542, http://www.lra.lt/lt.php/lietuvos_keliai/bendri_duomenys/30)

22. Vaitekūnas, S. Settlements (available at http://www.lietuva.lt/index.php?Lang=34&ItemId=28199)

23. Zemeckis, R. and Ribašauskienė, E. Ecological Agriculture – Future Farm Model (available at http://www.laei.lt/leid_fls/publ_fl/ekoluk.pdf)

THE REPUBLIC OF LITHUANIA

Lithuania's Third and Fourth National Communication on Climate Change

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

CHAPTER 3

Greenhouse Gas Inventory Information

VILNIUS, NOVEMBER 2005

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF LITHUANIA

INSTITUTE OF ECOLOGY OF VILNIUS UNIVERSITY

CHAPTER 3. Greenhouse Gas Inventory Information

3.1. Methodology of Preparation of Emission Inventories

The Communication contains the inventory of GHG emissions performed by the Ministry of Environment (Environmental Quality Department, Air Division) in accordance with the methodology recommended by the IPCC in its Revised 1996 Guidelines and IPCC Good Practice Guidance [33, 34, 56]. It is based on data and statistics collected from the following sources:

- Statistics of Lithuania (Statistical Yearbooks of Lithuania, Sectoral Yearbooks on energy balance, agriculture, commodities, natural resources and environmental protection) [27–30, 38–40, 42, 45–50];
- Lithuanian Statistical Yearbooks of Forestry (Ministry of Environment, State Forest Management Service) [37, 41];
- Material from the Environmental Protection Agency (waste water and waste data) [53, 54].

The UNFCCC guidelines on reporting and review have also been followed (Review of the implementation of commitments and other provisions of the Convention. National communications: greenhouse gas inventories from parties included in Annex I to the Convention, FCCC/CP/2002/8, 28 March 2003) [31].

The GHG inventory contains information on anthropogenic emissions by sources and removals by sinks for the following direct (CO_2, CH_4, N_2O) and indirect (CO, NO_x, NMVOCs, SO_2) greenhouse gases. The data on F-gases (PFCs and SF_6) are absent, only potential emissions of HFCs being presented. The GHG inventory covers the years 1990 (base year), 1998, 2001, 2002 and 2003 (NIRs submitted to the UNFCCC Secretariat).

A number of factors induce a degree of uncertainty in Lithuania's GHG emissions inventory:

- Non-existence of data collection system for this purpose (data from Statistical Yearbooks are mainly used);
- Lack of permanent group of experts for inventory and monitoring;
- 2003 is only the third year for which an inventory has been established in the CRF format, making full use of the IPCC guidelines wherever possible;
- National emission factors have been established only for fuel combustion;
- Quality Control/Quality Assurance system still has to be put into practice.

Key sources for the 2003 year GHG inventory were analyzed according to Good Practice Guidance (2000) [33, 34]. Only level assessment of the key source analysis was conducted, following the Tier 1 approach. The contribution of each source category to the national total was calculated. Any source category that met the 95% threshold was identified as a key source category. A number of 14 key sources were identified (Appendix 1).

Emissions of direct greenhouse gases CO_2, CH_4 and N_2O in the energy sector are calculated on the basis of amount and sort of fuel used and emission factors. National emission factors have been developed on the basis of international experience, to which local circumstances have been applied. Emission factors calculated apply to CO_2 and SO_2, NO_x, CO, CH_4, N_2O, non-methane volatile organic compounds (NMVOCs) and solid particles for the different sectors for the following types of fuel: coal, fuel wood, natural gas, orimulsion, heating gasoline, petrol, kerosene, other processed fuel, flammable secondary energy sources.

Emission factors were assigned to a number of energy generating facilities categories that are in line with the categories used in national fuel and energy balance. Different emission factors are set depending on the sector where fuel is used: electricity production, heat power stations, industry, small enterprises, households, transport. Moreover, different transport means are distinguished: motor cars, railways, water transport, air transport and agricultural machines.

As regards F-gases, consumption is estimated following the IPCC Guidelines Tier 1. As there is lack of data on each consumer group, aggregated data on emissions of those GHG are estimated according to potential emissions. The latter are calculated from consumption which is defined as import minus export. The import and export data are collected from the Customs Department, which is under the obligation to collect data on all halocarbons that fall under the Montreal Protocol.

Direct emissions of GHG from solvent and other products have not been estimated. Tier 1 methodology of the Revised 1996 IPCC Guidelines is used for calculation of GHG emissions in agricultural sector. A default IPCC emission factor values for each relevant livestock population is used to calculate emissions from manure and enteric fermentation. Emissions from cattle (dairy and non-dairy), horses, swine, goat and poultry were calculated. As regards nitrous oxide emissions, only total emissions from manure management could

be calculated. Direct emissions from agricultural soils are calculated using default emissions factors found in the Revised 1996 IPCC Guidelines. N_2O emissions from agricultural soils are calculated using data on nitrogen fertilizers used per hectare, and default emission factors given in the CORINAIR Guidebook, as well as emission factors from the IPPC workbook. Total N_2O emissions from agricultural soils are calculated as the sum of direct emissions and emissions from animal waste.

For calculation of carbon stocks, emissions and removals of GHG from land use, land-use change and forestry IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry [34] defaults were used. The immediate release of non-CO_2 trace gases from the burning associated with forest/grassland conversion was not calculated. There are no official statistical data on the total biomass burned "on-site", and with reference to forestry expert opinion and assumption to estimate CO_2 emissions from burning during forest/grassland conversion is not worth because burning "on-site" for that purpose does not occur in Lithuania. The basic data for CO_2 production calculation from major harvest is total timber removal (million m^3). Losses during timber harvest were not evaluated. Calculation of carbon dioxide sink by biomass augmentation was based on the detailed national inventory of wood-biomass reserve. CO_2 emissions/removals and trace gas emissions from forest and grassland conversion were not estimated because this source is absent. The calculations for CO_2 emissions from organic soils are performed using the forest land use data – agricultural land and pasture – from the State Forest Survey Service. CO_2 emissions from liming have not been calculated since lime is not applied in the forest management.

For calculation of methane in wastewater handling a maximum methane potential of the organic component of wastewater and a methane correction factor (that is relevant to the adjustment to emissions from solid waste disposal sites dependent on waste management practices) is used. Default emission factors and actual BOD and COD are used for calculation of CH_4 emissions. There are no data on amount of sludge available in the Statistics of Lithuania.

3.2. Main Changes in Inventories from the Previous Communication

When assessing GHG emissions, the National Inventory Reports (NIR) and Common Report Format (CRF) summary report data, covering the inventory of GHG emissions of Lithuania and submitted to the Secretariat of the UNFCCC were used. As GHG emissions inventories have been prepared for the years 1990, 1998, 2001, 2002 and 2003 only, the possibility for the analysis of trends is limited. However, the main tendencies can be derived. From 3 to 7 October 2005 the In-depth review of the 2005 GHG inventory submission of Lithuania by the expert review team co-ordinated by the UNFCCC secretariat was performed [52]. The report prepared under this review comprises many valuable comments, which will be taken into account compiling next GHG inventory submissions. Completion of time series and recalculations are planned for the coming years GHG inventory submissions.

Instead of the National Committee for Implementation of EU Requirements in Climate Change Area the Interministerial Committee on Climate Change being responsible for the overall coordination of the National Climate Change Strategy and Action Plan, was established in February 2004. It comprises representatives from the Ministries of Environment, Economy, Transport, Agriculture, Health Care, the Lithuanian Academy of Sciences, Institute of Ecology of Vilnius University, the Lithuanian Green Movement, the Lithuanian Confederation of Industrialists and Vilnius Municipality. At several meetings of the National Committee it was decided upon more active integration of climate policy into different fields of research, economy, enhancing capacity building, strengthening institutional arrangements, raising public awareness. Preparation of this National Communication and of the new National Climate Change Strategy and Action Plan is an outcome of the National Committee's activity.

After the submission of the Second UNFCCC National Communication including preliminary GHG emissions inventory data lacking consistency and completeness, the Ministry of Environment submitted the relevant reports (CRF and NIR) to the UNFCCC Secretariat. These reports were prepared in accordance with the UNFCCC requirements related to national inventory submission with assistance of EU PHARE project EUROPEAID/112892/D/SV/LT/4 Strengthening of Institutional Capacity to Implement EU Requirements on Chemicals, GMO, IPPC and GHG [43]. This project was implemented by national and foreign experts. The NIR contained the data on emission trends for 1990, 1998, 2001 and 2002. In 2005, this report was renewed by the data on emission trends for 2003 by experts from the Air Division of the Environmental Quality Department of the Ministry of Environment.

3.3. GHG Emissions

3.3.1. Trends of Aggregated GHG Emissions

An overview of estimated direct GHG emissions is presented in Table 3–1, which shows GHG emissions by sectors expressed in CO_2 equivalent, and based on the data for the years 1990, 1998, 2001, 2002 and 2003. Such trends as can be established from a relatively sparse time series can be deducted from these figures.

Aggregated emissions of direct GHG expressed in CO_2 equivalent without CO_2 removals/emissions from the Land-Use Change and Forestry sector decreased by 66% during the period 1990–2003. The net CO_2 emissions/removals decreased by 84%, and emissions of CH_4 and N_2O decreased by 50% and 68%, respectively (Figure 3–1). The Lithuanian emissions profile shows the clear dominance of the energy sector with CO_2 as the main GHG. Figure 3–1 presents trends of GHG in total CO_2 equivalent emissions without the contribution of the LUCF sector.

Between 1990 and 1998, GHG emissions decreased significantly as a consequence of the reconstruction of the economy: the decline in industrial production engendered a sharp decrease in fuel consumption and, as a result, in GHG emissions. The average annual reduction in GHG emissions from 1990 to 1998 was 3,574 Gg CO_2 equivalent per year. Establishment of the precise GHG emission fluctuation dynamics is impossible because of the absence of the NIR of cross-section years. Towards the mid-1990s, Lithuania's GDP began to rise and the reduction in emissions slowed down. However, the annual increase of GHG emissions between 2002 and 2003 reached only 8 Gg CO_2 equivalent per year. Once rehabilitation of the economy started, reductions were also achieved through energy efficiency and measures taken to reduce emissions.

The main sectors of the economy and their percentage share in the GDP structure according to the data of 2002 are as follows: services (57.6%), industry and construction (35.4%), and agriculture, forestry and fishery (7%) (Ministry of Finance).

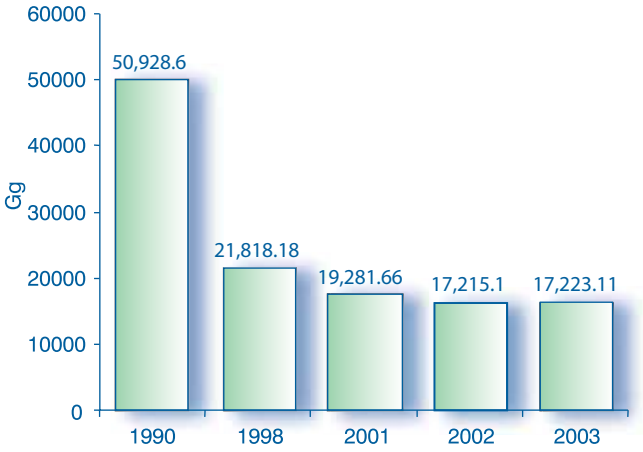


Figure 3–1. Emission trends of aggregated GHG (CO_2 equivalent; without LUCF sector) in 1990, 1998, 2001, 2002 and 2003

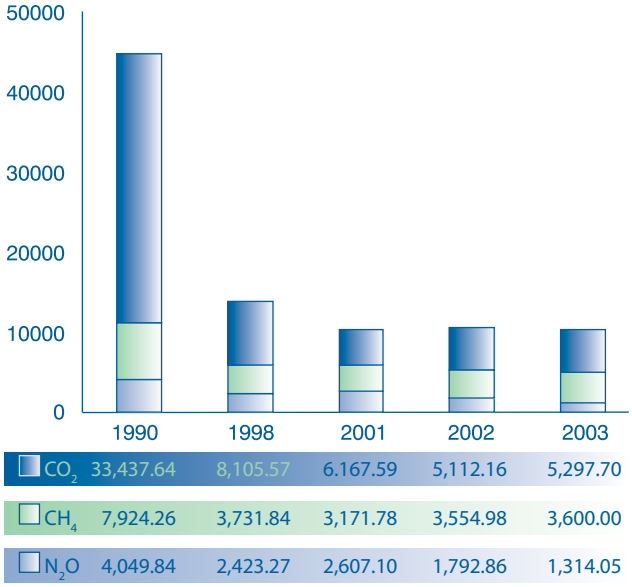


Figure 3-2. Trends of GHG emissions by gas in CO_2 equivalent, Gg (based on CRF summary; with LUCF sector)

3.3.2. Emission Trends by Gas

Decline in the emissions of the direct GHG between 1990 and 2003 with LUCF sector is presented in Figure 3–2. CO_2 and CH_4 emissions slightly increased in 2002 and 2003. This rise mainly follows the growth in industrial output as reflected by the growth of GDP (HFCs

Table 3-1. Trends of GHG emissions by sectors, CO_2 equivalent, Gg

GHG sources and categories	1990	1998	2001	2002	2003	2003/1990	2003/2002
1. Energy	37,633.53	14,885.29	12,624.50	11,556.24	12,036.60	-68%	+4
2. Industrial Processes	2,671.50	2,710.36	2,122.07	1,976.57	1,610.17	-40%	-18%
3. Solvent and Other Product Use	NE	NE	NE	NE	–	–	–
4. Agriculture	7,143.87	2,540.35	2,972.27	2,169.66	2,113.10	-70%	-3%
5. Land-Use Change and Forestry	-5,482.36	-7,557.51	-7,335.19	-6,720.60	-6,989.43	(27%)	(4%)
6. Waste	3,479.70	1,682.18	1,562.82	1,512.63	1,463.24	-58%	-3%
Total with LUCF	45,446.24	14,260.67	11,946.47	10,494.50	10,233.68	-77%	-2%
Total without LUCF	50,928.60	21,818.18	19,281.66	17,215.10	17,223.11	-66%	+0.0%

LUCF – Land-Use Change and Forestry

emissions have slightly decreased but, as they make only a minor input to total amount of GHG and were not estimated in 1990 and 1998, they are not shown in the Figure 3–2).

3.3.2.1. CARBON DIOXIDE

As shown in Figure 3–2 and Appendixes 2–6, the net CO_2 emissions/removals decreased by 84% between 1990 and 2003 due to the decline of emissions in all energy subsectors, especially in energy industries and in manufacturing industries and construction. Emissions from energy accounted for the largest share of CO_2 emissions, followed by industrial processes.

CO_2 emissions from biomass have increased more than four times since 1990 (Table 3–2). Consumption of biomass as fuel was facilitated by the government via promotion of the use of renewable energy sources. It was also regarded as a cleaner and cheaper fuel source. In addition, a number of boiler houses have switched from heavy fuel oil to biomass as a result of a programme of Activities Implemented Jointly mainly with Scandinavian countries.

3.3.2.2. METHANE

Emissions of CH_4 decreased by 55% between 1990 and 2003. The main decrease was in sources of waste management and agriculture. As shown in Figure 3–2, methane emissions have been decreasing until 2001, and then increased slightly in 2002 and 2003 due to the recent increase in coal burning and the more intensive agriculture.

3.3.2.3. NITROUS OXIDE

Emissions of N_2O decreased by 68% between 1990 and 2003. Emissions from agriculture accounted for the largest share of N_2O emissions, followed by industrial processes (nitric acid production) and energy. As shown in Figure 3–2, total N_2O emissions increased by 17% between 1998 and 2001. This increase is attributed mostly to a steep growth in emissions from agricultural soils, partly as a result of increased fertilizer application on agricultural soils. The increase of N_2O emissions from nitric acid production can be explained by increased production rates following a higher demand from export markets.

Within the fuel combustion sector, N_2O emissions originate almost equally from energy industries, transport and other sectors. The manufacturing industries and construction sector make less – about 12% of N_2O emissions from fuel combustion. As regards N_2O emissions from transport, the most important source is road vehicles.

3.3.2.4. HYDROFLUOROCARBONS, PERFLUOROCARBONS AND SULPHUR HEXAFLUORIDE

HFCs, PFCs and SF_6 are used as alternatives to chlorofluorocarbons (CFCs), ozone depleting substances being phased out under the Montreal Protocol. These substances, monitored under the UNFCCC, are not produced in Lithuania, and their national consumption is covered only by import. They are used in different industrial activities. The estimation of quantities, and therefore emissions becomes difficult to pursue due to lack of data. No aggregated data are available about the quantities of F-gases used.

3.3.3 Emission/Removal Trends by Sectors and Sources

The trends of GHG emissions by sectors were presented in Table 3–1 showing them expressed in CO_2 equivalent, not taking into account GHG emissions/removals from LUCF sector, and based on the data for the years 1990, 1998, 2001, 2002 and 2003. The major source of GHG emissions in 1990 was the energy sector responsible for 76% of all GHG emissions (in CO_2

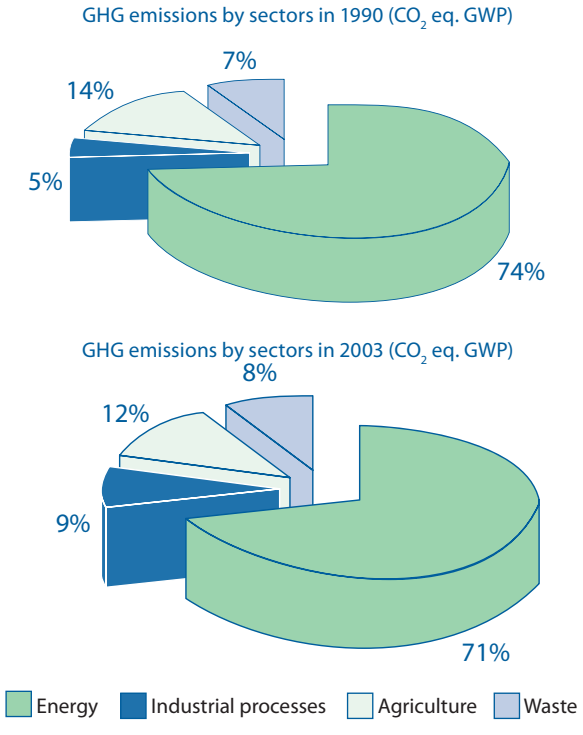


Figure 3-3. Share of GHG emissions by sectors in 1990 and 2003 in CO_2 equivalent

Table 3-2. CO_2 emissions from biomass in 1990, 1998, 2001, 2002 and 2003 (Gg)

Year	1990	1998	2001	2002	2003
CO_2 emissions from biomass, Gg	616	2,419	2,790	2,814	3,052

equivalent), not taking into account removals/emissions from LUCF sector, followed by agriculture (14%), waste (5%) and industrial processes (5%) (Figure 3–3). This pattern changed marginally in the period 1990–2003, at the end of which the energy sector accounted for 71% of emissions, followed by agriculture (12%), industrial processes (9%) and waste (8%).

As the key source analysis reveals, energy sector: fuel combustion activities are responsible for 5 key source categories of GHG emissions (CO_2), whereas fugitive emissions from oil and gas operations (CH_4) – for 1 key source.

Table 3-3. Key GHG sources in energy sector: fuel combustion and fugitive emissions

No.	Name of a source	Share of total GHG emissions, %
1.	CO_2 from stationary combustion – gas	28.7%
2.	CO_2 from mobile combustion – road vehicles	19.2%
3.	CO_2 from stationary combustion – oil	10.2%
4.	CO_2 from stationary combustion – coal	5.6%
5.	CH_4 fugitive emissions from oil and gas operations	2.7%
6.	CO_2 from mobile combustion – railways	1.3%

Four sources of GHG are identified in the industry sector, 2 of which fall within the key source categories. GHG sources from industrial processes are provided in Table 3–4.

Table 3-4. GHG sources from industrial processes and their share in total amount of GHG

No.	Name of a source	Share of total GHG emissions, %
1.	Ammonia production CO_2	4.0%
2.	N_2O from nitric acid production	2.9%

GHG emissions from agriculture category in Lithuania consist of methane and nitrous oxide emissions. Agriculture is the second largest source of GHG, accounting for 40% of all methane and 51% of nitrogen oxide emissions. Methane emissions come from animal breeding, primarily from enteric fermentation (digestive processes) and manure management, where methane is formed under anaerobic conditions. Nitrous oxide emissions are formed mainly during denitrification processes in soils, and chiefly under anaerobic conditions. The anthropogenic contribution that is determined in the national inventory of GHG is caused by nitrogenous substances derived from inorganic nitrogen-containing fertilizers, manure from animal breeding, and nitrogen contained in parts of agricultural crops that are returned to the soil.

As shown in Table 3–5, 3 sources of GHG from agriculture are among the key sources of emissions.

Table 3-5. Sources of GHG in agricultural sector and their share in total amount of GHG

No.	Name of a source	Share of total GHG emissions, %
1.	CH_4 from enteric fermentation in domestic livestock	7.3%
2.	Direct N_2O emissions from agricultural soils	2.2%
3.	N_2O from manure management	1.3%

The inventory of CO_2 from the land use, land-use change and forestry is given in Table 3–6.

In 2003, net emissions/removals made 6,989.43 Gg CO_2 and comparing to 1990 they increased to 1,507.07 Gg CO_2. During 1998–2003, the forest area expanded by 46,700 ha that made an increase in sink strength. Over the last few years, between 9,000 and 11,000 ha have been reforested annually that was an increase in sink strength as well.

Emissions of GHG from the waste sector in Lithuania originate from two major source categories: solid waste disposal on land and wastewater handling (for industrial, domestic and commercial wastewater). No managed municipal waste incineration is done at present. No emissions from other sources have been estimated. Some types of waste (hospital, plastic, waste oils) in minor amounts occur at industrial companies or within hospitals without energy production. However, there are no official statistical data on the amounts in Statistical Yearbooks. Sources from the waste sector and its contribution to total amount of GHG emissions are presented in Table 3–7.

Table 3–7. Key sources of GHG in waste sector

No.	Name of a source	Share of total GHG emissions, %
1.	CH_4 from solid waste disposal sites	5.8%
2.	Wastewater handling CH_4	2.7%

Table 3-6. Net CO_2 emissions/removals from LULUCF in 1990, 1998, 2001, 2002 and 2003, Gg

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals				
	1990	1998	2001	2002	2003
Total LUCF	-5,482.36	-7,557.51	-7,335.19	-6,720.60	-6,989.43
Changes in Forest and Other Woody Biomass Stocks Temperate Forests	-7,264.76	-6,248.73	-5,996.65	-5,302.00	-7,150.00
Abandonment of Managed Lands Temperate Forests	-930.40	-1,549.16	-1,549.16	-1,608.75	-
CO_2 Emissions and Removals from Soil Cultivation of Organic Soils	2,712.80	240.38	210.62	190.15	160.57

3.4. Sources

24. Agriculture in Lithuania 2001 // Statistics of Lithuania, Vilnius, 2002.

25. Agriculture in Lithuania 2002 // Statistics of Lithuania, Vilnius, 2003.

26. Agriculture in Lithuania 2003 // Statistics of Lithuania, Vilnius, 2004.

27. Energy Balance 1990–2003 // Statistics of Lithuania, Vilnius, 2004.

28. Energy Balance 2000 // Statistics of Lithuania, Vilnius, 2001.

29. Energy Balance 2001 // Statistics of Lithuania, Vilnius, 2002.

30. Energy Balance 2002 // Statistics of Lithuania, Vilnius, 2003.

31. Guidelines for the Preparation of National Communications by Parties Included in Annex I to the Convention. Part II: UNFCCC Reporting Guidelines on National Communications. FCCC/CP/1999/7.

32. IGES, IPCC, 2003.

33. IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, IPCC/OECD/IEA, 2000.

34. IPCC Good Practice Guidance for Land Use, Land-Use Change and Forestry, IGES, 2003.

35. Lithuania's First National Communication under the Framework Convention on Climate Change / Ministry of Environment of the Republic of Lithuania.

36. Lithuania's Second National Communication under the Framework Convention on Climate Change / Ministry of Environment of the Republic of Lithuania.

37. Lithuanian National Forest Inventory 1998–2002. Sampling Design, Methods, Results 2003 / Ministry of Environment, State Forest Survey Service, Kaunas, 2003.

38. Lithuanian Statistical Yearbook 1994–1995 // Statistics of Lithuania, Vilnius, 1995.

39. Lithuanian Statistical Yearbook 2001 // Statistics of Lithuania, Vilnius, 2001.

40. Lithuanian Statistical Yearbook 2002 // Statistics of Lithuania, Vilnius, 2002.

41. Lithuanian Statistical Yearbook of Forestry 2003 / Ministry of Environment of the Republic of Lithuania, State Forest Survey Service, Kaunas, 2003.

42. National Economy of the Lithuanian SSR during 40 Years / Lithuanian Statistical Yearbook 1980.

43. National Greenhouse Gas Emission Inventory Report of the Republic of Lithuania (Reported Inventory 2002), Vilnius, June 2004. EU PHARE project Ref.: EUROPAID/112892/D/SV/LT/4 Strengthening of Institutional Capacity to Implement EU Requirements on Chemicals, GMO, IPPC and GHG.

44. National Greenhouse Gas Emission Inventory Report of the Republic of Lithuania (Reported Inventory 2003) / Ministry of Environment of the Republic of Lithuania, Vilnius, 2005.

45. Natural Resources and Environmental Protection 2000 // Statistics of Lithuania, 2001.

46. Natural Resources and Environmental Protection 2001 // Statistics of Lithuania, 2002.

47. Natural Resources and Environmental Protection 2002 // Statistics of Lithuania, Vilnius, 2003.

48. Production of Commodities 2001 // Statistics of Lithuania, Vilnius, 2002.

49. Production of Commodities 2002 // Statistics of Lithuania, Vilnius, 2003.

50. Production of Commodities 2003 // Statistics of Lithuania, Vilnius, 2004.

51. Report on the In-depth Review of the First National Communication of Lithuania. FCCC/IDR.1/LTU. 10 May 2000.

52. Report on the In-depth Review of the Second National Communication of Lithuania. 2005. FCCC/IDR.2/LTU

53. State of Environment 2001 / Ministry of Environment of the Republic of Lithuania, 2002.

54. State of Environment 2002 / Ministry of Environment of the Republic of Lithuania, 2003.

55. The Report on Good Practice Guidance for Land Use, Land-Use Change and Forestry.

56. The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, Vol. 1–3, IPCC/OECD/IEA, 1997.

THE REPUBLIC OF LITHUANIA

CHAPTER 4

Policies and Measures

Lithuania's Third and Fourth National Communication on Climate Change

UNDER THE UNITED NATIONS
FRAMEWORK CONVENTION
ON CLIMATE CHANGE

VILNIUS, NOVEMBER 2005

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF LITHUANIA

INSTITUTE OF ECOLOGY OF VILNIUS UNIVERSITY

CHAPTER 4. Policies and Measures

This chapter presents the main policies and measures designed to mitigate GHG emissions in the field of climate change. Section 4.1 presents the main features of the policy-making process by dividing it into four parts: international agreements and conventions, EU level, national action plans and, finally, institutional arrangements, monitoring and supervision. The section refers to the existing legislative framework to which Lithuania is committed. Meanwhile, Section 4.2 provides an overview of specific national policies and measures that will be used to reach GHG emissions reduction for each activity sector: energy, transport, industry, agriculture, forestry and waste management.

4.1. Policy-Making Process

4.1.1. International Agreements and Conventions

Many international initiatives have been developed to mitigate emissions of GHG, and Lithuania has committed itself to the most significant ones. Lithuania's Seimas ratified the UNFCCC (Rio de Janeiro, 1992) on 23 February 1995. Lithuania ratified the Kyoto Protocol (Kyoto, 1997) on 19 November 2002. In this connection, the EU and Lithuania have undertaken to mitigate GHG emissions in the period 2008–2012 to, on average, 8% below the level in the so-called base year, which is 1990 for CO_2, methane and nitrous oxide and 1990 or 1995 for industrial GHG.

Lithuania has also committed itself to the following international conventions in the environment area (which does not necessarily have the limitation and reduction of GHG emissions and removals as a primary objective)[1]:

- Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992). Ratified by Seimas Law No VIII-1547 of 17 February 2000;
- Convention on the International Trade in Endangered Species of Fauna and Flora (CITES) (Washington, 1973). Ratified by Seimas Law No IX-337 of 22 May 2001;
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) (Bonn, 1979). Ratified by Seimas Law No IX-338 of 22 May 2001;
- Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus, 1998). Ratified by Seimas Law No IX-449 of 10 July 2001;
- European Landscape Convention (Florence, 2000). Ratified by Seimas Law No IX-1115 of 3 October 2002;
- Convention on Persistent Organic Pollutants (POPs) (Stockholm, 2001). Signed on 24 May 2002;
- Multilateral Agreement on the Exchange of Radiation Monitoring Data (Hamburg, 2001). Ratified by Seimas Law No IX-808 of 26 March 2002;
- Convention to Combat Desertification (Rio de Janeiro, 1992). Ratified by Seimas Law No IX-1684 of 3 July 2003;
- Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam, 1998). Ratified by Seimas Law No IX-1898 of 16 December 2003.

4.1.2. European Union Level

The Europe Agreement was signed in June 1995 (it formed the basis for trade relations between the EU and applicant states) and stated Lithuania's wish to become a member of the EU [65]. In June 2001 Lithuania presented a revised version of the National Programme for the Adoption of the *Acquis* (the so-called Lithuania's European Union Accession Programme). At the Copenhagen European Council (13 December 2002), Lithuania successfully concluded accession negotiations. Lithuania entered the EU on 1 May 2004. Being a Member State, Lithuania is bound by the EU legislation including environmental issues on climate change therefore Lithuania's climate policy is developed in interaction with the EU law.

The first step of the European Commission (EC) in the area of climate was made in 1991, when it issued the Community's first strategy to limit carbon dioxide (CO_2) emissions and improve energy efficiency. In March 2000 the Commission launched the European Climate Change Programme (ECCP) [58]. The goal of the programme is to identify and develop all necessary elements of the EU strategy to implement the Kyoto Protocol. The ECCP led to the adoption of a range of new policies and measures, including *inter alia* the EU's emissions trading scheme (it should ensure that the private sector found the most cost-effective ways to reduce CO_2 emissions). In January 2005 the European Union Greenhouse Gas Emission Trad-

[1] The international conventions in the environment area, to which the Republic of Lithuania is a party or which were signed thereby as of 1999, are mentioned here, only (conventions of earlier years are referred to in Lithuania's Second National Communication under the FCCC, section 2.10).

ing Scheme (EU GHG ETS) commenced its operation. The scheme is based on Directive 2003/87/EC, which entered into force on 25 October 2003.

A new legal basis for the compilation of the EC inventory is Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community GHG emissions and for implementing the Kyoto Protocol [60]. The goal of the Decision is to monitor all anthropogenic GHG emissions not controlled by the Montreal Protocol in the EU Member States, to transpose related requirements under the Kyoto Protocol into the EC Law, and to evaluate progress towards meeting GHG reduction commitments under the UNFCCC and the Kyoto Protocol.

On 9 February 2005 the Commission adopted the Communication on Winning the Battle against Climate Change and a more detailed Staff Working Paper. The Communication outlines the key elements for the EU's post-2012 strategy. It highlights a need for broader participation by countries and sectors not already subject to emission reductions, development of low-carbon technologies, continued and expanded use of market mechanisms, and a need to adapt to inevitable impacts of climate change.

4.1.3. National Action Plans

The measures for the implementation of the activity programme of the Government for 1999–2000 in the environment area were pursued rather heavily [63, 64]. The following draft laws were planned albeit not worked out: Law on Supplementing the Law on Pollution Taxes, Law on the Waste Management Fund, Law on Amending and Supplementing the Law on Waste Management (supplementing the Law on Waste Management with the provisions fully complying with the EU directives governing waste management). Neither was prepared the Programme for the Collection of Recycling Material.

The Ministry of Environment was in charge of the implementation of 26 measures in the environment part of the *Acquis* Implementation Action Plan (AIAP) for the year 2000 and had to draft 29 legal acts in the environment part of the Law Approximation Action Plan (LAAP) for the year 2000. 25 measures (96%) in the environment part of AIAP and 20 measures (about 70%) in the environment part of LAAP for the year 2000 were implemented in time.

The main legal act harmonising the general requirements of Lithuania in the area of air protection with those of the EU is the Law on Ambient Air Protection (1999) establishing the fundamental requirements for ambient air quality assessment and management and setting out the principles regulating ambient air pollution from mobile sources.

The general requirements for waste management have been transposed into national law with the adoption of the Law on Waste Management (1998), Order of the Minister of the Environment on the Approval of the Rules for Waste Management (1999), Government Resolution on the Outline of the National Waste Management Strategy and Action Programme (1999), Government Resolution on the National Programme for Hazardous Waste Management and Measures for the Implementation Thereof (1999), and Order of the Minister of Environment on the Approval of Procedure for the Granting of Permits to the Utilisation of Resources and for Determining Limitations on the Utilisation of Natural Resources and Permitted Levels of Environmental Pollution.

The Order of the Minister of the Environment on the Approval of the Rules for the Construction, Operation, Closure and After-Care of Landfills (2000) sets out the requirements for the disposal of waste by landfill, which are in full compliance with Directive 1999/31/EC on landfill of waste. Other legal acts transposing the requirements of Directives 89/369/EEC, 89/429/EEC, 94/67/EC, 75/439/EEC, 86/287/EEC are Orders of the Minister of the Environment on the Approval of the Fundamental Requirements for the Incineration of Waste (1999), on the Approval of Standarts for the Use of Sewage Sludge (1996) and on the Provisional Rules for the Installation and Use of Grounds Designed for the Disassembly of Road Vehicles (1998).

The following two measures were implemented in 2001 to improve the system of economic regulation of the environment: preparation and adoption of the Law on Amending the Law on Pollution Tax by setting taxes on produce waste, and the Law on Amending and Supplementing Articles 32, 33, 34 of the Law on Waste Management; approval of a legal act (Executive Order No 600/172/454 of the Ministries of Environment, Social Security and Labor, and Transport as of 18 December 2001) setting out the requirements restricting emissions of volatile organic compounds (VOC) into the ambient air to be applied to the existing petrol storage, re-filling and transportation facilities. As regards measures for the implementation of the National Programme for the Adoption of the *Acquis*, emission rates for large facilities combusting fuel were prepared and approved (Executive Order No 486 of the Minister of Environment of 28 September 2001). The latter legal act set air pollution rates and rules for the assessment of their quality parameters.

By Resolution of 11 September 2003 the Government approved the National Sustainable Development Strategy, which is one of the main documents integrating the principles of sustainable economic development, environmental protection and social policy [66]. The main objective of the sustainable development of Lithuania is by the year 2002 to reach the EU average according to the indices of efficiency of economic and social development and the use of resources, not to exceed permissive EU rates according to the indices of environmental pollution, and observe requirements of international conventions restricting environmental pollution and impacts on global climate.

The environment part setting up trends for the use of the EU structural funds for environmental protection within the General Programming Document of Lithuania for 2004–2006 was elaborated. About 35 million LTL will be allocated annually from the European Regional Development Fund for the action Improvement of Environmental Quality and Prevention of Damage to Environment. The strategy of the Cohesion Fund for environmental protection setting up trends for the use of funds of the Cohesion Fund in the sector of environment for 2004–2006 was worked out. The strategy is the basis for running investment projects intended for the creation of potable water supply and waste water treatment and regional waste management systems, as well as ambient air protection with a view to ensuring the supply of proper quality potable water to citizens and reducing environmental pollution caused by household waste and pollution emitted into the atmosphere. About 1,088 million LTL intend to be allocated for the implementation of the projects from the EU Cohesion Fund.

After the effect date (1 January 2003) of the Law on Amendment of the Law on Pollution Tax setting pollution charges on produce and package waste, the principle "polluter pays" and the principle of the manufacturer's liability, *i.e.* waste management costs are to be covered by manufacturers and importers of materials and products the use of which produce waste, started to be applied [71].

Also, the Ambient Air Quality Assessment Programme was worked out and approved, ambient air quality assessment equipment updated and data quality assurance work completed, which facilitated cooperation between institutions responsible for ambient air quality assessment, strengthening of municipal powers in taking adequate decisions on air quality management, raising public awareness, and informing relevant national and international organisations about the quality of Lithuanian ambient air.

To meet the requirements under the Kyoto Protocol and those imposed by the EU for the reduction of GHG emissions, in 2004 Lithuania's National Allocation Plan for Greenhouse Gas Emission Allowances for the Period 2005 to 2007 was prepared and harmonized with the European Commission. The GHG trade registration system is almost finished. Executive Order No D1-231 of the Minister of Environment as of 29 April 2004 On Approval of the Description of the Procedure for the Issuance and Trading in Greenhouse Gas Emission Allowances Permits approved the procedure and legitimated the system of trading.

To promote the use of renewable energy resources, reduce environmental pollution and fulfill commitments under the Kyoto Protocol to reduce GHG emissions, the Draft Law on Amending the Law on Pollution Tax of the Republic of Lithuania established tax allowances for pollution caused by use of biofuel or for the implementation of environmental measures reducing emissions of a certain pollutant by no less than 5%.

Other major legal acts adopted in 2004–2005 in the area of climate change are as follows:

- Executive Order of the Minister of Environment and Minister of Economy On Approval of Strategic Trends for the Use of the Mechanism for the General Implementation of the Kyoto Protocol of the United Nations Framework Convention on Climate Change and Division of Inter-Institutional Functions while Using the Mechanism (19 May 2004);
- The Law of the Republic of Lithuania on the Ratification of the Regional Testing Ground Agreement for Flexible Mechanisms of the Kyoto Protocol in Energy Projects of the Baltic Sea Region (28 September 2004);
- Executive Order of the Minister of Environment On Amendment of Approval of Rules for the Issue, Renewal and Cancellation of Permits concerning Integrated Pollution Prevention and Control (2004);
- The Lithuania's National Allocation Plan for Greenhouse Gas Emission Allowances for the Period 2005 to 2007 (27 December 2004).
- Executive Order of the Minister of Environment On Establishment of the Register of Greenhouse Gas Emission Allowances Permits (16 May 2005);
- Executive Order of the Minister of Environment On Approval of the Rules of Execution of Joint Implementation (JI) Projects (2005);
- Executive Order of the Minister of Environment On Establishment of the Regulations of Register of Greenhouse Gas Emission Allowances Permits (2005);
- Executive Order of the Minister of Environment On

Approval of Reimbursement Rates for Opening and Maintenance of Accounts in the Register of Greenhouse Gas Emission Allowances Permits (2005).

Strategic documents presently under preparation (year of implementation):

- Second (Updated) National Strategy for Implementation of the United Nations Framework Convention on Climate Change (2005–2006);
- Lithuania's Third and Fourth National Communication on Climate Change Under the United Nations Framework Convention on Climate Change (November, 2005);
- National GHG Emission/Removal Inventory Report (2005: Reported inventory 2004);
- Lithuania's National Progress Report on the Implementation of the United Nations Framework Convention on Climate Change (2005).

Legal documents presently under preparation:

- Executive Order of the Minister of Environment On Approval of Auction Rules of Greenhouse Gas Emission Allowances Permits;
- Executive Order of the Minister of Environment On Approval of Rules of Issue of Greenhouse Gas Emission Allowances Permits for New Facilities;
- Executive Order of the Minister of Environment On the Lithuania's National Allocation Plan for Greenhouse Gas Emission Allowances for the Period 2008 to 2012.

4.1.4. Institutional Arrangements, Monitoring and Supervision

The key institutions responsible for the formulation and implementation of policies and measures affecting GHG emissions are the Ministries of Environment, Economy, Transport, Education and Science, Social Security and Labor, as well as related bodies such as the Energy Agency and the Lithuanian Environmental Investment Fund (LEIF). The LEIF, a public enterprise under the Ministry of Environment, is responsible for the evaluation, approval and monitoring of joint implementation (JI) projects and for the EU-ETS and the National Register.

To ensure coordination of sustainable development on the highest level, the National Sustainable Development Commission headed by the Prime Minister was established in 2000 (in 2003 the commission was reorganized). The commission joins representatives of ministries, President's Office of the Republic of Lithuania, other institutions and public organizations. The Department of Statistics under the Government has to announce annually under the established procedure the main sustainable development indices in the main annual yearbooks of statistics of Lithuania, with specific indices to be issued in other publications.

The following sustainable development indices are used for the monitoring of implementation of the National Sustainable Development Strategy:

- GHG emission by CO_2 equivalent – in total (million t), per unit of area (km^2) and per GDP unit (in total and by type of economic activity);
- emission of acidifying compounds (SO_2, NO_x), surface ozone predecessors (NO_2, NMVOC) – in total (thous t), per unit of area (km^2) and per GDP unit (in total and by type of economic activity);
- city air quality (number of days per year, when concentrations of NO_2, solid particles and surface ozone exceed permissive rates), etc.

In 2004 the National Climate Change Committee was formed by Executive Order of the Minister of Environment in place of the former Committee established in 2001. The main objective of the Committee is to ensure attaining the goals related to the restriction of GHG emissions as set in the National Sustainable Development Strategy and implementing the measures for attaining such goals. The Committee also has to organize the implementation of the provisions of the UNFCCC and coordinate compliance with the requirements of the Kyoto Protocol and EU legal acts related to the UNFCCC, evaluate the efficiency of the creation of the national legal basis in this area and measures to be implemented.

However we should admit that a lot still has to be done in this field. A mechanism for the systematic monitoring and evaluation of effectiveness of policies and measures does not exist. Responsibility for the supervision of implementation of particular policies lies with relevant ministries, for example, Ministry of Economy supervises the implementation of the NEEP. The National Climate Change Committee could serve as a coordinating body provided its mandate is broadened. The national climate change focal point should be strengthened to allow for more continuous: a) development and evaluation of new or planned policies and measures, and b) monitoring and evaluation of their impacts.

4.2. Overview of Policies and Measures and Their Effects in Economic Sectors

In sections 4.2.1 to 4.2.6, policies and measures of importance in the field of emissions and removals of GHG are examined within the following six economic sectors: energy, transport, industry, agriculture, forestry and waste management. Table 4–1 below shows a summary of policies and measures and their effects.

4.2.1. Energy

4.2.1.1. POLICIES AND MEASURES ORIENTED TO THE ENERGY SECTOR

The National Energy Strategy approved by Seimas Resolution No VIII-1348 as of 5 October 1999 set the Government's key guidelines for the rearrangement and development of the energy sector up to the year 2020. In the light of Lithuania's efforts to finalize negotiations on membership in the EU in 2002 and become a member state of the EU in 2004, the Government drew up an updated the National Energy Strategy, which was approved on 10 October 2002 by Seimas Resolution.

The key issues in the Lithuanian energy sector according to the National Energy Strategy (2002) are as follows:

- terms for the final decommissioning of the Ignalina NPP;
- making Lithuania's energy supply secure;
- market liberalization;
- environmental requirements.

The long-term purposes of the National Sustainable Development Strategy (2003) are the formation of sustainable energy sector able to compete in the open international energy market and providing reliable and safe supply of energy to all branches of economy of Lithuania, increase of efficiency in energy production and distribution, extension of local renewable and waste energy resources and use of ecologically cleaner organic fuel, compliance with pollution and GHG emission rates set in international commitments.

Executive Order No 319 of the Minister of Economy as of 26 October 2001 approved the amended and updated national programme for the increase of energy efficiency. According to the calculations of the programme, upon countrywide introduction of paramount measures for saving energy resources and energy, the country could save about 25% of energy resources consumed. Energy saving potential in industry amounts to 2.3 TWh. The final energy demand in 2005 will amount to 15 TWh, and GHG emissions to 3.3 Mt. Each TWh of energy consumed generates 0.223 Mt of GHG. It is expected that in 2005, energy savings will help to reduce CO_2 emissions by 2.3 TWh×0.223 Mt/TWh = 0.51 Mt.

EC Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity (in accordance with this Directive Member States impose taxation on energy products and electricity) was implemented in Lithuania by amending the Excise Law in 2004. Excise taxes have increased since 1 April 2004 (with some exceptions, e.g. for electricity until 1 January 2010).

Table 4–2 presents the key policies and measures in energy, including the NES, NEEP and implementation of some EU directives.

Table 4–1. Summary of policies and measures and their effects

Policies and measures	Expected results of policies and measures	Responsible institution	GHG reduction, in CO_2 equivalent, Mt			
			2005	2010	2015	2020
Renewable energy sources	Promotion of electricity produced from RES (Directive 2001/77/EC) through feed in tariffs for hydro, wind and biomass	MoEcon MoE	0.235	0.302	0.379	0.451
	Increase share of RES by 2010 to 12% in TPES (set in the National Energy Strategy)	MoEcon MoE	2.89	3.200	3.500	3.800
Combined heat and power	The National Energy Strategy requires that by 2020 the share of CHP accounts for 35% of electricity generation	MoEcon	0.304	0.345	0.404	0.483
Energy efficiency improvements	Increase of energy use efficiency in the transport sector (implementation of the Energy Efficiency Programme)	MoE, MoT	0.442	0.442	0.41	0.41
	Increase of energy use efficiency in buildings		0.12	0.12	0.12	0.12
Fuel taxes	VAT exemptions for biofuel – increased use of biofuel	MoEcon MoE	0.078	0.255	0.313	0.39
	CO_2 tax under consideration					
Pollution prevention in industry	Reduction of Energy intensity in industry EMS, cleaner production	MoEcon MoE	0.51	0.48	0.44	0.42
Solid waste management	Reduction of solid waste	MoE	NE	NE	NE	NE
Fertiliser and manure management	Manure and slurry storages transported to the fields according to environmental requirements; rational fertilisation by mineral fertilisers by 2007	MoA MoE	NE	NE	NE	NE
Afforestation and reforestation	Increase by 3% (11 ha) by the year 2021	MoE MoA	NE	NE	NE	NE
International measures	AJI projects		NE	NE	NE	NE
	GEF funded projects		NE	NE	NE	NE

Abbreviations used: MoE – Ministry of Environment, MoEcon – Ministry of Economy, MoT – Ministry of Transport, NE – not estimated

Table 4–2: Summary of policies and measures in the energy sector

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entities
Decommissioning of the Ignalina NPP	Replace nuclear power by increasing the load of existing fossil fuelled power plants	CO_2, CH_4, N_2O	Regulatory	Implemented (in the framework of the NES)	Government
Promotion of renewable electricity production (Implementation of Directive 2001/77/EC)	Increase the share of renewable electricity produced to 7% by 2010 through fixed feed in tariffs for renewable electricity	CO_2, CH_4, N_2O	Economic	Implemented (since 2002 in the framework of the NES)	MoEcon, MoE, Energy Agency
Promotion of RES	Increase the share of RES in TPES to 12% by 2010 through exemption from VAT and pollution tax	CO_2, CH_4, N_2O	Fiscal	Implemented (since 2002 in the framework of the NES)	MoEcon, MoE, Energy Agency
Promotion of CHP	Increase the share of CHP in electricity generation to 35% by 2020	CO_2, CH_4, N_2O	To be determined (EU-ETS)	Planned (in the framework of the NES)	MoE, MoEcon, Energy Agency
NEEP (2001)	Identify energy savings potentials in industry	CO_2, CH_4, N_2O	Research, information	Planned	MoE, MoEcon, MoT, Energy Agency
Housing Strategy (2004) (Implementation of Directive 2002/91/EC)	Identify energy savings potential in the buildings sector, promote improvements in the energy performance of buildings	CO_2, CH_4, N_2O	Research, information	Planned	MoE
Increase of excise duties on fossil fuels (Implementation of Directive 2003/96/EC)	Increase of excise duties by April 2004. Exemptions: Coal and coke until 2007 Electricity until 2010, Orimulsion until 2016 Natural gas: remains completely exempted	CO_2, CH_4, N_2O	Fiscal	Implemented	MoEcon

Abbreviations used: MoE – Ministry of Environment, MoEcon – Ministry of Economy, MoT – Ministry of Transport

4.2.1.2. RENEWABLE ENERGY SOURCES

The promotion of renewable energy sources (RES) will be done using the following measures:

1) Programmes for the consumption of local energy resources to be updated on a regular basis;
2) Economic and financial measures (financial support to enterprises):
- feed-in prices for electricity produced using RES:
  - 5.8 EURct/kWh for hydro
  - 6.4 EURct/kWh for wind
  - 5.8 EURct/kWh for biomass
- since 1 January 2003 denaturated dehydrated ethyl alcohol and methyl and ethyl ester are exempted from VAT);
3) Projects for the use of wind, water and solar energy as well as for the consumption of other renewable and waste energy resources will be implemented;
4) Conditions provided for developing the production of biofuels (denatured dehydrated ethyl alcohol, oils of biological origin, ethyl and ethyl ester). Legal and natural persons using biofuels and documenting such use are exempt from tax for pollution from mobile pollution which is based on fuel consumption and is levied per t of fuel consumed.

Energy saving measures as well as implementation of projects for the use of local, renewable and waste energy resources will be supported by the Special Programme for the Implementation of Energy Saving Measures.

According to the National Energy Strategy (2002), part of local, renewable and waste energy resources, except for the local crude oil (hereinafter, the local energy resources) accounted for about 9% in the general primary energy balance in 2000. The goal is to consume about 2 million t of such resources per year (about 430 thous t of which being waste energy).

4.2.1.3. NUCLEAR ENERGY

The first reactor of the Ignalina NPP was decommissioned on 31 December 2004. Lithuania has committed to the EU to decommission the second reactor in December 2009. According to the National Energy Strategy (2002), to ensure the lowest expenses of the development and functioning of electric energy and centralized heating supply systems and higher reliability of electricity supply after the decommissioning of the two units of the Ignalina NPP, the following has to be done [75]:

- Modernisation of Lietuvos Elektrinė (the Lithuanian Power Plant) as the main source of electric energy as well as Vilnius and Kaunas thermal power plants: installation of new burners, modern control and management equipment and combustion products' treatment facilities;
- Renovation of the Kaunas Hydro Power Plant until 2007;
- Construction of thermal power plants in Klaipėda, Šiauliai and Panevėžys, a combined cycle gas turbine condensation-type power plant and additional thermal power plants in other cities provided that new powers are necessary and it is economically feasible;
- Rehabilitation of existing boiling houses: installation of gas turbines and generators or small thermal power plants using local fuel provided that their installation is economically feasible with regard to local conditions and they could compete with the rehabilitated large power plants.

According to a recent study by the International Atomic Energy Agency, after unit 2 of Ignalina NPP is decommissioned, CO_2 emissions will increase by 4.0 Mt if replacement capacity comes from a new combined cycle gas turbine or by 5.5 Mt if it comes from the modernisation of the Lithuanian thermal power plants (basic economic growth scenarios).

4.2.1.4. RESIDENTIAL AND BUILDING SECTOR

In 1997, the district heating sector was split off from AB Lietuvos Energija (Stock Company Lithuanian Energy), and local heating services companies were handed over to municipalities. About 75% of the area of residential buildings in Lithuanian cities is heated from the centralized heating supply systems (Section 2.6). Due to various economic, technical and social reasons, the centralized heating supply is not effective enough therefore it should be rearranged. The centralized heating supply should be combined with decentralized sources of heating so that benefits of both ways of heating would be effectively used. The creation of modern housing infrastructure providing good and hygienic living conditions, increase of energy efficiency in buildings, assurance of modern high quality and widely accessible public services, mitigation of a negative housing effect upon environment – such are long-term objectives under the National Sustainable Development Strategy.

Population itself will continue financing the renovation of residential houses and public buildings and modernisation of their energy sector in the country, by using preferential loans administered by the public institution Housing and Urban Development Facility and applying other possible sources of financing. The Housing and Urban Development Facility is formed from the funds allocated from the State Treasury, as well as loans of the World Bank and foreign countries (National Energy Strategy).

The National Energy Efficiency Programme estimated the energy saving potential in residential buildings and in the buildings of commercial and servicing sector at 0.52 TWh, or 45% of all final energy consumption in the sectors [61]. Such data provides basis for the calculation of mitigation of GHG emissions within one year after implementing measures to increase energy efficiency in household and service sectors at 0.456 Mt CO_2 potential per year.

The Government Resolution No 60 as of 21 January 2004 approved the Lithuanian Housing Strategy [67]. The goal of the strategy is to set up long-term housing policy aims and priorities which would serve as the basis for the perfection of legislation in the sphere of housing, governing system and the system of informing the public, for the preparation and implementation of programmes and measures for the development, renovation and modernisation of housing, for financial and social support to the population, paying due regard to the current housing situation in Lithuania and the EU housing policy principles, as well as the State Long-term Development Strategy by Resolution No IX-1187 approved of the Seimas on 12 November 2002 [69]. One of the objectives of the Lithuanian Housing Strategy is to ensure effective use, maintenance, renovation and modernisation of buildings, including the rational use of energy resources. The following is to be done to attain this objective by the year 2020:

- Renovation and (or) modernisation of the heating systems of most condominiums, renovation and heat insulation of roof constructions, change or renovation of windows and doors;
- Elimination of defects in wall joints of precast concrete residential houses and reduction of heat conduction of walls of such houses;
- Reduction by no less than 30% of relative costs of heat energy and fuel, as calculated per unit of usable area;
- Increase in household expenses (investments) for housing needs to constitute from 20 to 30% of all expenses.

These measures will make it possible to achieve an up to 30% reduction in relative heat and fuel costs calculated per one unit of area by 2020. This also reduces sulphur dioxide emissions generated due to household activities.

4.2.2. Transport

4.2.2.1. MAIN OBJECTIVES OF TRANSPORT POLICIES

The state strategic documents, such as the State Long-term Development Strategy, Master Plan of the Territory of the Republic of Lithuania and Long-term Economic Development Strategy of Lithuania until 2015, focus on the implementation of sustainable development principles in the transport sector. In Lithuania, engines of motor vehicles consume the largest part of energy. The fuels used are: light oil products (petrol, diesel fuel, kerosene) and liquid gas. The highest energy saving effect may be achieved by perfecting the road transport. In accordance with the National Energy Efficiency Programme (Ministry of Economy, 2001), energy efficiency potential in the transport sector is 1.7 TWh or 0.15 Mtoe per year on average. Due to the introduction of energy efficiency measures in

the transport sector, the reduction in GHG emissions will amount to 0.442 Mt per year.

As indicated in the Sustainable Development Strategy, long-term objectives include an increase in the use of less polluting fuels (liquid oil gas and compressed natural gas, low sulphur heavy fuel oil for ships) and alternative fuels. One goal is to ensure that biofuel (biodiesel, bioethanol) comprises not less than 15% of fuel used by road transport by 2020. The use of more environment-friendly transport means is emphasized, as well as the creation of multi-modal transport systems.

The measures for the implementation of long-term objectives are as follows:

- Promote modernization of transportation means with the help of economic and legal measures by giving priority to the means that are less fuel consuming and less polluting the environment;
- Ensure economical promotion of the development of a network of petrol stations selling less polluting and biological fuels;
- Implement measures for the development of the infrastructure for different types of transport and for improving their interaction, as well as programmes for the development of a network of bicycle tracks as provided for in the Long-term Economic Development Strategy of Lithuania until 2015.

Table 4–3 shows the policies and measures within the transport sector.

4.2.2.2. MEASURES TO MITIGATE POLLUTION FROM VEHICLES

The Law on Biogases, Biofuels and Biooils of the Republic of Lithuania (2004) is intended to ensure the European Parliament and Council Directive 2003/30/EB of 8 May 2003 on the promotion of the use of biofuels and other renewable fuels in transport [72]. One of the objectives of the law is to mitigate emissions of GHG and pollution. Manufacturers and users of biogases, biofuels and biooils are subject to statutory exemptions. The government or institutions authorized thereby elaborate measures to ensure that by 31 December 2005 biofuels account for no less than 2% of the total amount of petrol and diesel fuel intended for transportation in the home market; and by 31 December 2010 – 5.75%. Thus, by 2010, when energy consumption comes up to 17 TWh, it will be possible to achieve a 0.255 Mt reduction in CO_2 emissions per year.

4.2.3. Industry

4.2.3.1. POLICY CONTEXT IN THE INDUSTRY SECTOR

The Long-term Economic Development Strategy of Lithuania until 2015 gives a great focus on the implementation of the sustainable development principles in the industry sector [69]. The Industry Sustainable Development Programme has been prepared. Long-term objectives under the National Sustainable Development Strategy are: to develop industry based on the introduction of new technologies having a less adverse effect upon environment, increase both economic and ecological efficiency of enterprises, use resources in a more cost-efficient way and mitigate negative impacts upon environment. To attain the above objectives, the following measures are to be taken:

- Promote (using economic and legal measures) the development of industry which needs research and knowledge rather than natural resources, update the production process, introduce possibly more modern technologies and cleaner production methods;
- Develop research and consultancy activities promoting creation and introduction of new manufacturing technologies with lower negative impact upon environment, make such technologies more state-of-the-art, and use energy and other natural resources in a more cost-efficient way;
- Promote economically the branches of industry based on knowledge and high technologies;
- Carry out the programme for the replacement of production materials hazardous to the environment and human beings with safer ones.

The Strategy of Economic Factors of Environmental Protection is a part of the Long Term Economic Development Strategy of Lithuania until 2015 and includes the reform of pollution charges with a view to strengthening their incentive character, introduction of a pos-

Table 4–3: Summary of policies and measures in the transport sector*

Name of policy or measure	Objective and/or activity affected	GHG affected	Type of instrument	Status	Implementing entities
NEEP (2001)	Identify potential for energy savings in transport	CO_2, CH_4, N_2O	Research, information	Planned	MoE, MoEcon, MoT, Energy Agency
Promotion of biofuel use in transport (Implementation of Directive 2003/30/EC)	Increase the share of biofuels to 12% of total transport fuels by 2010 through tax exemptions and preferential market access (Law on Biofuels)	CO_2	Fiscal, regulatory	Implemented (since 2003, in the framework of the NES)	MoE, MoEcon

* Only policies and measures with a potential direct impact on GHG emissions were included
Abbreviations used: MoE – Ministry of Environment, MoT – Ministry of Transport, MoEcon – Ministry of Economy

sibility of emissions trading via the transferability of pollution permits, implementation of an efficient waste management system accompanied and promoted by a wider application of product charges and deposit-refund systems, initiation of the "green budget reform" and establishment of the "green procurement" rule for public procurements, promotion of the subsidiary principle by extending municipal rights and responsibilities in the area of local environmental control.

4.2.3.2. PREVENTIVE ENVIRONMENTAL PROTECTION AND OTHER MEASURES

The preventive environmental protection measures and cleaner production methods are also widely introduced. During the last decade a number of bilateral technical assistance projects on training and implementation of cleaner production; waste minimization and environmental management were carried out. Introduction of the best available technologies as part of the requirements for the Integrated Pollution Prevention and Control (IPPC) will, to a certain extent, reduce GHG emissions from IPPC installations.

Despite the progress there is still room for improvement. There are no methods yet for Lithuanian industries to use a life cycle analysis or to design environment-friendly products. Very few enterprises use recycled materials and the ones that do import them from foreign countries. There is a lack of economic mechanisms promoting broader use of local secondary raw materials.

4.2.3.3. LIMITATION OF EMISSIONS OF VOLATILE ORGANIC COMPOUNDS

The management and information on solvents used in Lithuania largely depends upon the implementation of the provisions of EC directive 1999/13/EC on the limitation of emissions of volatile organic compounds (VOC) due to the use of organic solvents in certain activities and installations [59]. The Directive covers emissions of organic solvents from stationary commercial and industrial sources and thereby complements the auto-oil programme (Directives on emissions into atmosphere from cars and lorries with internal combustion engines) and Directive 94/63/EC on VOC emissions resulting from the storage of petrol and its distribution from terminals to filling stations.

Executive Order No 620 (as of 5 December 2002) of the Minister of Environment approved The Procedure for the Limitation of Emissions of Volatile Organic Compounds Due to the Use of Solvents in the Installations of Certain Activities (the procedure entered into force as of 1 January 2004) [62]. The document is intended to mitigate a direct and indirect impact of VOC (separated from dye, solvents, glue and other preparations) on environment, most frequently on ambient air, and possible hazard to human health, as well as prescribes measures and procedures to be implemented in respect of types of activity specified in the document in case any such activity is pursued exceeding the threshold amounts for the use of solvents specified in the document. Annex 3 of the document approves the Pollution Mitigation Plan affording a performer of activities a possibility to reduce, by using other measures, the amount of VOC emitted into atmosphere to the same degree it would decrease if marginal values of VOC emitted into atmosphere were applied.

4.2.4. Agriculture and Forestry

4.2.4.1. CONTEXT OF THE ACTION POLICY IN AGRICULTURE

The main measures include the application of agro-environmental schemes, implementation of the EC Nitrate Directive as well as the Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (the IPPC directive). The Seimas by its resolution as of 13 June 2000 approved the Agricultural and Rural Development Strategy, which aims at setting up agricultural and rural development trends for 2000-2006 [74].

The application of mineral fertilisers and manure together with husbandry are the main sources of GHG in the agricultural sector. Therefore the same factors are important when designing measures to achieve mitigation of N_2O and CH_4 emissions in this sector, e.g. development of plant-growing agriculture, intensive, protective and organic agriculture, plants with longer vegetation period and intermediate plants, mechanical soil cultivation, using appropriate types of organic fertiliser, their characteristics, nutrient substances in the manure, application of organic fertilisers and maximal recommended density of animals, etc.

Highly important is the State Programme for the Reduction of Waters' Pollution from Agricultural Sources approved by Government Resolution No 1076 as of 26 August 2003 [70]. The Programme is drawn up based on the European Parliament and Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources. A summary of the action programme from the State Programme for the Reduction of Waters' Pollution from Agricultural Sources is provided in Table 4–4.

To meet the requirements under Directive 91/676/EEC, Code of Good Agricultural Practice (CGAP) had

to be worked out. CGAP was prepared in 2000 under the guidance of the Water Management Institute of Lithuania and the Danish Agricultural Consultancy Centre and is a compendium of compulsory and recommended measures for the management of agricultural production. In the nitrate vulnerable zones CGAP is compulsory, whereas in other areas it is optional. CGAP sets requirements for farm management that have an impact on emissions of N_2O and CH_4 from fertiliser application and manure management. Capacity building and raising awareness of farmers about environmental requirements in farming (following CGAP) is one of the indirect measures to mitigate emissions of GHG in the agricultural sector.

4.2.4.2. CONTEXT OF THE ACTION POLICY IN FORESTRY

The Lithuanian Economic Development Strategy until 2015 (drawn up in 2002) is a constituent part of the State Long-term Development Strategy. The principal actions in the forestry strategic development policy are as follows:

- Increase the area of forests in the country by planting forests in *inter alia* wastelands and barren lands;
- Improve the species structure of forests;
- Satisfy common social needs of the society;
- Ensure the variety of ownership forms of forests and their equality;
- Develop the competitive private forestry sector based on the principles of sustainable and subordinate forestry;
- Increase productivity and healthiness of forests.

During 1998–2002, Lithuania's forest area expanded by 66,900 ha (1%), the total growing stock volume of forests increased from 347,600 m^3 to 382,600 m^3, and the average age of forest stands increased from 51 to 53 years [57]. According to the data of the Lithuanian Forest Research Institute, natural afforestation makes about 4–5 ha annually on non-forest land. Thus, until the year 2020 about 6,000–7,000 ha should be afforestated. Having stated the nationally accepted principles related to the development of natural resources – both in terms of increase and consumption – it is expected that the measure Afforestation of Agricultural Land within the Rural Development Plan together with the investment instruments related to forestry, processing and use of wood within the EAGGF Guidance Section will contribute to the implementation of the Lithuanian Forest Increase Programme 2003–2020 and further to the obligations related to the reduction/absorption of carbon dioxide emissions.

The Lithuanian Forest Research Institute is responsible for forest monitoring activities. The Lithuanian Forest Fund provides financial support for the development of forestry, national and regional parks.

4.2.5. Waste Management

4.2.5.1. MAIN OBJECTIVES OF THE WASTE MANAGEMENT POLICY

The State Strategic Waste Management Plan was approved by Government Resolution No 519 as of 12 April 2002 [68]. The Ministry of Environment together with other ministries carries out measures for the implementation of the State Strategic Waste Management Plan. The plan is drawn up with regard to the legal acts regulating the EU waste management.

The main objectives of the plan are as follows:

- Protect nature and human health from the impact of pollution caused by waste through maximal though rational use of material and energy resources;
- Create the rational waste management system meeting public needs, ensuring sound quality of the environment and complying with the principles of market economy;
- Set waste management targets, measures and actions ensuring implementation of the EU directives on waste management in the near decade.

4.2.5.2. SOLID WASTE MANAGEMENT

About 4 million t of non-hazardous waste are produced in Lithuania annually. Municipal solid waste (MSW) constitutes 1 million t, ranging from 300 kg per capita in larger cities to 70 kg in rural areas. The organic content in MSW constitutes about 32%. Recycling and reuse policies are constantly developing. Paper and cardboard waste, glass and plastic waste are being recycled. The amount of paper and cardboard waste formed in Lithuania accounts for 25%, glass waste 18%, and plastic waste merely 6% of the total recycled amount, the rest being imported for the purpose of recycling. The remaining part of waste is taken to landfills.

The EU directive as well as national regulations set a target to reduce biodegradable waste by 50% by the year 2005 and further by 25% by the year 2010 (as compared to the level of biodegradable waste in 1993). Methane has to be collected and used or burnt in all new and existing waste landfills. After the fulfillment of such requirements, methane gas emissions in waste landfills will be reduced.

The waste sector is currently under reorganization and modernization for the purpose of meeting the EU requirements. More than 700 existing landfills and dumpsites will be rearranged into 10 regional waste

Table 4–4: Measures for the implementation of the State Programme for the Reduction of Waters' Pollution from Agricultural Sources

Title of the measure	Objectives	Implementation period	Responsible institutions	Expected result
I. Competence building				
1. To create training system and to organise training	To develop training programmes on the CGAP and to organise training with a particular attention given to the problem with nitrates in the private dug wells.	2004	MoA, MoE, MoES, MoH	Specialists administrating EU support for environmental protection in agriculture will be introduced to the requirements for reduction of water pollution from agriculture; farmers will be trained how to store and use manure, slurry and mineral fertilizers without harm to the environment, how to balance nutrients used by plants, to choose the best crop structure, how to increase economic and nature protection effect, how to implement all measures set in this Programme; methodical material regarding protection of dug wells from pollution will be developed.
	To organise establishment of demonstration farms in which pollution preventive measures would be implemented and the effect of those measures investigated	2005	MoA, MoE, MoES, physical and legal entities	In demonstration farms the mandatory measures from the Nitrate directive will be implemented, also impact of those measures on the environment will be observed. Based on this research the recommendations on how to minimize pollution from agricultural sources will be prepared, the most effective measures will be demonstrated during the field days and seminars; information will be provided about planning of manure storages, slurry and effluent tanks, about the requirements for those installments and possible suppliers of material for construction.
2. To prepare legal acts and technical regulations	To prepare new and to improve the existing legal acts and technical regulations according to the EU requirements related to the installment of manure storages and slurry tanks.	2004	MoA, MoE	Legal acts will be prepared, technical regulations will be improved, conditions for the development of the technical projects for manure storages and slurry tanks meeting EU requirements will be created.
II. Measures related to the elimination of pollution from livestock farms				
3. To eliminate pollution caused by big livestock farms	First of all to install manure storages, slurry and effluent tanks in big farms with more than 300 LU	2007	MoA, MoE, physical and legal entities	Manure and slurry storages will be installed according to the defined environmental requirements.
	To foresee that in the farms having more than 300 LU the manure would be applied on the fields by special equipment	2007	MoA, MoE	Manure and slurry will be transported to the fields and applied with special equipment, which ensures that environmental requirements are followed.
4. To reduce pollution from small livestock farms	To create conditions to install manure storages, tanks for slurry or other waste water, to use special equipment for application of mineral and organic fertilizers which are in line with defined requirements	2007	MoA, MoE	There will be conditions created for smaller livestock farms to install manure storages, to procure slurry application equipment meeting the defined requirements; in all farms undergoing reconstruction it will be mandatory to install manure storages and slurry tanks meeting the defined technical requirements.
III. Implementation of the sustainable agricultural system				
5. To reduce run-off of nitrogen, especially of nitrates from agricultural fields	To define that organic fertiliser is only used in the right periods	2005	MoA	Fertilisation with manure and slurry will be performed during the defined period, organic fertiliser will be incorporated into the soil within defined time.
	To limit fertilisation on steep slopes	2007	MoA, MoE,	Fertilisation on steep slopes will be performed according to the defined requirements based on the vegetation cover, slopes, and soils condition.
	To limit fertilisation of waterlogged, flooded soils	2007	MoA, MoE	Lowlands (sinks) where surface water may accumulate will not be fertilised; waterlogged soils will be fertilised according to defined requirements.
	To limit animal grazing close to water courses	2007	MoA, MoE	Animals in the protection zones of water bodies will be grazed according to the defined requirements; protective zones of water bodies will not be damaged.
	To organise rational fertilisation by manure and mineral fertilisers	2007	MoA	There will be requirements set so that fertilisation with manure and other fertilisers will be done in the periods when plants can absorb most of nutrients based on the balance between the plants' need of nitrogen and nitrogen which plants get from soil and fertilisers, in accordance with the amount of nitrogen in soil in the moment when the plants start absorbing most of nitrogen; the fertilisation plans will be developed for each farm, the ongoing registration of the use of fertilisers will be carried out.
	To organise land use management according the balance between perennial and annual crops	2007	MoA	There will be defined requirements that farms would develop land use plans and would define land area for perennial and annual crops.
	In all farms which have more than 300 LU to limit the amount of manure applied on the soils	2007	MoA	Having defined requirements it will be achieved that having incorporated all manure accumulated in the farms, including manure applied on the land while grazing animals, the limit of the allowed application norm of 170 kg of nitrogen per ha of agricultural land will not be exceeded.

Title of the measure	Objectives	Implementation period	Responsible institutions	Expected result
IV. Pollution from agricultural sources monitoring				
6. To implement monitoring for pollution by nitrates from agricultural sources	To monitor land use, animal density, manure storage and fertilisation in characteristic agroecosystems; to analyse and prognose changes	2007	MoE, MoA	Monitoring of agroecosystems will be carried out in all main natural-geographical regions; there will be established GIS with the database for diffused pollution to be defined and prognosed.
7. To implement water pollution monitoring	To continuously monitor ground and surface water status	2007	MoE	Improved (expanded) according to coordinated programmes water pollution monitoring will be implemented in the entire territory of Lithuania, nitrate concentration showing the extent of water pollution from agricultural sources will be monitored in surface and ground water.
V. Collection of information, scientific research				
8. To collect information	To create a system for collection of information about pollution by nitrate sources and applied measures	2005	MoE, MoA	There will be an information system created, which will include data about pollution by nitrates and the implementation of the measures of this programme and evaluation.
9. To implement scientific and applied research	To define the environmental and economic effectiveness of the implemented measures, to provide proposals regarding application of science and technical novelties	2007	MoE, MoA, MoES	The impact on the environment of the implemented measures will be investigated, most suitable measures will be identified, further recommendations regarding implementation of the measures in applying the novelties of science and technique will be developed.

Abbreviations used: MoE – Ministry of Environment, MoA – Ministry of Agriculture, MoES – Ministry of Education and Science, MoH – Ministry of Health

management systems meeting the EU standards. As a result all landfills will be considered managed landfills. Improvement of waste collection, recycling, reuse and disposal are the main preconditions for the reduction of GHG. In 2000, a new modern landfill with bottom insulation, collection and treatment of filtrate was completed in the city of Kaunas. The landfill complies with the requirements of the EU and Lithuanian legislation as other three landfills already constructed or under construction. The monitoring system is installed in the majority of large landfills that are currently in use, and the control over the waste accepted in such landfills is stricter. Systems for the collection and use of landfill gas are not functioning, yet. According to expert calculations based on the Environmental Impact Assessment Report for the Kaunas Regional Landfill (Center for Environmental Policy, 2003), the improved collection, incineration and use of landfill gas will result in the reduction of methane emissions in Lithuania to 153 million m^3 of landfill gases by 2012. It makes 0.475 Mt CO_2 potential by 2012 or a 0.1 Mt yearly reduction.

On 25 September 2001 the Seimas adopted the Law on Package and Package Waste Management (in force as of 1 January 2003) [73]. The aim of the law is to set general requirements for the inventorying, labeling, collection and use of packages and package waste manufactured in and imported into the Republic of Lithuania, with a view to avoiding an adverse effect caused by packages and package waste upon environment and human health, as well as to establish the rights and duties of manufacturers, importers, sellers, consumers, product users and waste managers in managing packages and package waste. The law established the principle "polluter pays" as well as the principle of the manufacturer's responsibility.

On 22 January 2002, the Law on Amendment to the Law on Pollution Tax of the Republic of Lithuania was adopted. The aim of the law is to promote (by sue of economic measures) pollutants to mitigate environmental pollution, carry out waste prevention and management, not to exceed set emission rates, as well as to use proceeds from the pollution tax for the implementation of environmental measures.

4.2.5.3. SEWAGE SLUDGE MANAGEMENT

In 2003, 38% of all waste water was fully treated (i.e. with phosphorus and nitrogen removal); 47% underwent mechanical and biological treatment; 14.4% was treated mechanically and the remaining 0.6% was discharged without any treatment. Since 2001, the amount of treated waste water has doubled.

During the last decade, most of sewage sludge has been stored on waste water treatment sites. Only a minor part of sludge has been used for composting and application on fields for fertilization purposes. From 1991 to 1999, 724 thous t of sewage sludge was stored in ponds, 110 thous t were spread on fields and more than 60 thous t were composted. The amount of sludge used for the fertilizing of agricultural fields ranged from 2,000 t to almost 40,000 t per year. The biggest amounts of sludge applied on the fields were registered in 1994 (39,409 t) with 22,400 t in 1991 and 13,400 t in 1999. Since 2000, approximately 200,000 t of sludge is produced every year. The sludge management situation is presented in Table 4–5.

Table 4–5. Sludge management during the period of 2000–2002, t per year

	2000	2001	2002
Amount of sludge produced	244,271	240,161	230,027
Amount received from previous year	899,561	1,010,443	1,097,100
Total amount of sludge untreated	978,216	1,083,857	1,212,806
Amount of sludge treated	165,616	166,747	114,321
Amount of sludge applied on fields	0	2,085	0

Data source: Environmental Protection Agency

In 2002 the biggest amounts of untreated sludge were stored in Panevėžys, Alytus and Klaipėda cities. In 2000 and 2002 no sludge was used for fertilization of fields, in 2001 a total of 2,085 t of sludge was applied in fields, which is 1% of the total amount of sludge treated. All sludge produced was applied on the fields in Vilnius County, 2,080 t of which was used in Ukmergė district, the rest in Vilnius district.

4.3. Sources

57. Activity Report of the Government of the Republic of Lithuania (available at website of the Seimas of the Republic of Lithuania http://www3.lrs.lt/pls/inter/DBA_INTRA.W3_VIEWER.ViewTheme?p_int_tv_id=959&p_kalb_id=1&p_org=0)

58. Communication from the Commission to the Council and the European Parliament on EU policies and measures to reduce greenhouse gas emissions: towards a European Climate Change Programme (ECCP). COM/2000/0088 final.

59. Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations. O. J. L 085.

60. Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol. O. J. L 049.

61. Executive Order of the Minister of Economy of the Republic of Lithuania "On Approval of Amended and Updated National Programme for the Increase of Energy Consumption Efficiency and Basic Measures for the Implementation of the Programme in 2001–2005" // *Valstybės žinios*, 2004, No 59–2094.

62. Executive Order of the Minister of Environment of the Republic of Lithuania "On Approval of the Procedure for the Limitation of Emissions of Volatile Organic Compounds Due to the Use of Solvents in the Installations of Certain Activities" // *Valstybės žinios*, 2003, No 15–634.

63. National Greenhouse Gas Emission Mitigation Measures by Economy Sectors (Reported Inventory No 29) in PHARE project 2001 "Strengthening of institutional capacity to implement EU requirements on chemicals, GMO, IPPC and climate change" (available at website of the Ministry of Environment of the Republic of Lithuania www.am.lt/VI/files/0.903565001109324317.pdf)

64. Report on the In-depth Review of the Second National Communication of Lithuania (Draft 31 May 2005).

65. The EU Relations with Lithuania (available at the EU portal http://europa.eu.int/comm/enlargement/lithuania/)

66. The Republic of Lithuania Government Resolution "On Approval and Implementation of the National Sustainable Development Strategy" // *Valstybės žinios*, 2003, No 89–4029.

67. The Republic of Lithuania Government Resolution "On Approval of the Lithuanian Housing Strategy" // *Valstybės žinios*, 2004, No 13–387.

68. The Republic of Lithuania Government Resolution "On Approval of the State Strategic Waste Management Plan" // *Valstybės žinios*, 2002, No 40–1499.

69. The Republic of Lithuania Government Resolution "On Lithuanian Long-term Economic Development Strategy until 2015" // *Valstybės žinios*, 2002, No 60–2424.

70. The Republic of Lithuania Government Resolution "On State Programme for the Reduction of Waters' Pollution from Agricultural Sources" // *Valstybės žinios*, 2003, No 83–3792.

71. The Republic of Lithuania Law on Amending the Law on Pollution Tax // *Valstybės žinios*, 2002, No 13–474.

72. The Republic of Lithuania Law on Biofuel, Biogas and Biooil // *Valstybės žinios*, 2004, No 28–870.

73. The Republic of Lithuania Law on Package and Package Waste Management // *Valstybės žinios*, 2001, No 85–2968.

74. The Republic of Lithuania Seimas Resolution "On Approval of the Agricultural and Rural Development Strategy" // *Valstybės žinios*, 2000, No 50–1435.

75. The Republic of Lithuania Seimas Resolution "On Approval of the Energy Strategy" // *Valstybės žinios*, 2002, No 99–4397.

THE REPUBLIC OF LITHUANIA

Lithuania's Third and Fourth National Communication on Climate Change

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

CHAPTER 5

Projections and the Total Effect of Policies and Measures

VILNIUS, NOVEMBER 2005

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF LITHUANIA

INSTITUTE OF ECOLOGY OF VILNIUS UNIVERSITY

CHAPTER 5. Projections and the Total Effect of Policies and Measures

5.1. Projections of GHG Emissions and Effects of Policies and Measures in Fuel Combustion Sector

Energy projections include climate change mitigation measures because forecasts of final energy demand include energy saving potential evaluated in the National Energy Efficiency programme, and primary energy demand includes all other climate change measures foreseen in National Energy Strategy (2002; measures to promote utilization of renewable energy resources, promotion of CHP, implementation of emission ceilings, fuel standards, etc). These projections should be assumed as GHG emission projections „with measures" because they are based on final energy demand and primary energy supply projections developed in mentioned strategy. Total GHG emissions projections according scenarios "without measures" are presented only for energy sector. Lithuania, however, still lacks projections for GHG emissions regarding three scenarious: „without measures", „with measures" and „with additional measures".

This chapter was prepared using technical reports No 28–1 and 28–2 of the project EUROPAEAID/112892/D/SV/LT/4 (Ministry of Environment of Lithuanian Republic, contract No LT01.06.01.01.0003) [76, 77].

5.1.1. Projections for Primary and Final Energy

Forecast of final energy and electricity demand is primary and very important information used in primary energy demand forecast carried within the scope of National Energy Strategy. 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 fertilizers and other non-energy production), and external, such as the volume of power surplus export. General growth of economy and income has a significant impact on the introduction of new technologies and on a possibility to reduce energy consumption. Thus, three scenarios of economic growth were selected: 1) fast economic growth (annual growth rate of 7% up to 2010, and 3% from 2010 to 2020, 2) baseline scenario (4.7% up to 2010, and 3% from 2010 to 2020), and 3) slow economic growth (2% up to 2010, and 3% from 2010 to 2020) (Figure 5–1) [76].

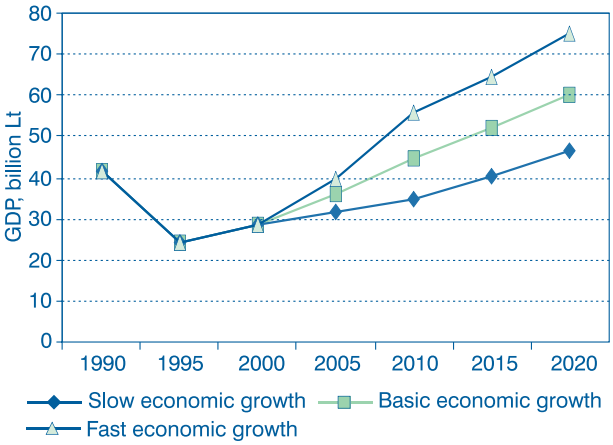


Figure 5–1. Scenarios of economic growth in 2005–2020

Final energy consumption has been presented by: 1) economic sectors (industry and its sectors, agriculture, transport, services and household sector), 2) industrial processes, 3) branches of transportation, and 4) social needs of the population. 2000 was taken as the base year. Projections of final energy demand have been presented in detail according to the sectors of economy and energy sources. Final energy demand has been predicted by estimating energy saving potential in particular economic sectors in accordance with the executive summary of the National Energy Efficiency program revised and updated in 2001. It has been estimated that 20–50% of the currently consumed energy resources may be saved in particular economic sectors of Lithuania.

The total increase in energy efficiency has been predicted by taking into account a reduction in energy intensity, i.e. a decrease in the final energy consumed per GDP unit. Final energy is directly consumed by final consumers (industrial and agricultural enterprises, enterprises in transport and services sectors, individual consumers, etc.) in their equipment. Thorough analysis shows that in all cases the final energy demand in 2020 would not exceed the demand in 1990. At the end of the forecasting period, the consumption of fuel and energy in the basic scenario would be 6.2 million t of oil equivalent, or 71% of the amount in 1990. In this case, the energy intensity index in 2020 would constitute only 49% as against 1990, while energy efficiency according to this indicator would be close to the current average level of the EU. Over the period up to 2020, final energy intensity of GDP in Lithuania could be expected to converge to the EU level.

On the basis of the available information and the technical-economic analysis carried out in National Energy Strategy (2002), it can be stated that upon the closure of both Units of Ignalina NPP certain measures will be necessary in order to ensure the least costs of the development and operation of power and district heating systems, modernization of the existing combined heat and power plants and construction of new ones (of about 400 MW capacity). All of it will facilitate the solution of the problem relating to the growing demand.

Information of primary energy consumption forecast for electricity and heat generation according to fuel structure, and primary energy consumption for Mažeikiai Refinery own needs according to fuel structure was used to evaluate GHG emissions from fuel combustion in electricity and heat production and refinery sector which use primary energy sources. In other sectors (transport, manufacturing, trade, agriculture and household) GHG emissions from fuel combustion were evaluated based on final energy demand forecast in these sectors.

Total primary energy supply forecast is presented in Figure 5–2, and primary energy consumption in energy production sector – in Figure 5–3.

5.1.2. Projections for CO_2 Emissions

Projections of CO_2 emissions generated from fuel combustion (based on forecasted perspective energy supply and final energy consumption balances within the scope of National energy strategy (2002) and taking into consideration IPCC guidelines (1999) and emission factors are presented in Table 5–1. Sensitivity analysis indicated that the biggest impact on energy demand was caused by GDP growth rates, structural changes of economy and energy intensity decrease.

5.1.3. Projections for N_2O Emissions

Forecasted N_2O emissions from fuel combustion in different sectors of economy carried out on the basis of primary energy consumption for electricity and heat generation and Refinery own needs and final energy consumption in sectors of economy are presented in Table 5–2.

5.1.4. Projections for CH_4 Emissions

Forecasted CH_4 emissions from fuel combustion in different sectors of economy carried out on the basis of primary energy consumption for electricity and heat

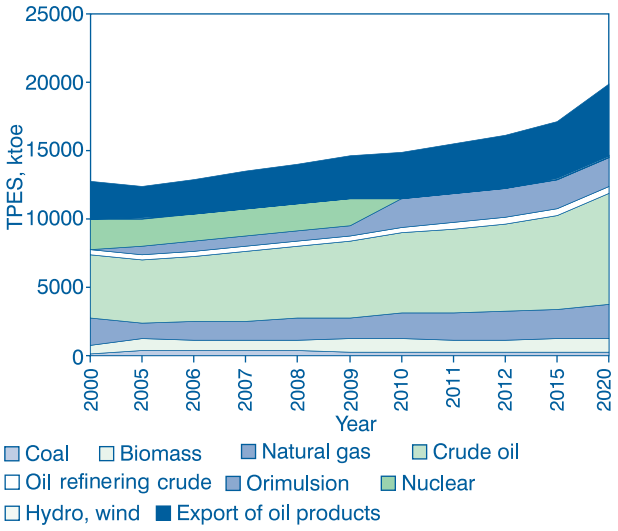


Figure 5–2. Total primary energy supply (TPES) forecast

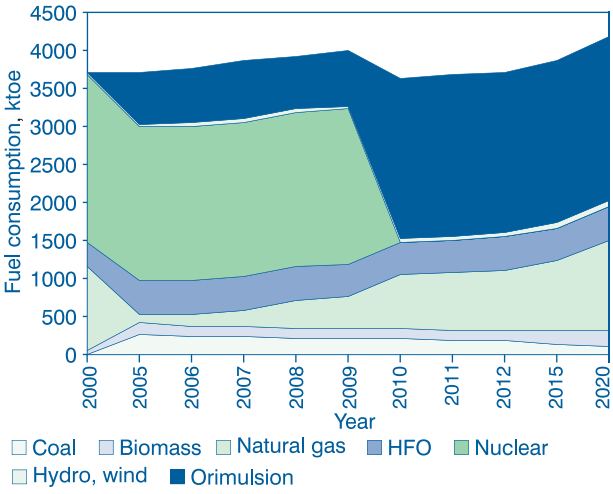


Figure 5–3. Primary energy consumption forecast in energy production sector according to fuel structure

Table 5–1. Forecasted CO_2 emissions from fuel combustion in sectors of economy 2005–2015 and inventory data for 2001–2002, Mt

Sectors	Year											
	2001	2002	2005	2006	2007	2008	2009	2010	2011	2012	2015	2020
Oil refinery	1.5	1.4	1.00	1.00	1.05	1.16	1.19	1.22	1.28	1.35	1.43	1.68
Electricity and heat	4.4	3.9	5.10	5.29	5.42	5.52	5.67	11.00	11.10	11.17	11.35	11.7
Industry	1.7	1.09	3.3	3.44	3.54	3.59	3.59	3.65	3.68	3.71	3.80	3.95
Service	0.4	0.31	0.41	0.43	0.44	0.45	0.45	0.46	0.46	0.47	0.48	0,5
Transport	3.48	3.6	3.6	3.65	3.77	3.87	3.99	4.11	4.20	4.29	4.56	5.06
Agriculture	0.18	0.2	0.23	0.24	0.25	0.26	0.26	0.27	0.27	0.28	0.29	0.31
Household	0.56	0.598	0.60	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.62	0.63
Total	12.2	11.1	14.20	14.66	15.02	15.36	15.76	21.31	21.61	21.87	22.53	23.8

Table 5–2. Forecasted N_2O emissions from fuel combustion in sectors of economy for 2005–2020 and inventory data for 2001–2002, Gg

Sectors	2001	2002	2005	2006	2007	2008	2009	2010	2011	2012	2015	2020
Oil refinery	0.04	0.03	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.09
Electricity and heat	0.10	0.09	0.45	0.5	0.55	0.46	0.47	0.79	0.78	0.78	0.77	0.75
Industry	0.15	0.04	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.17
Service	0.01	0.01	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06
Transport	0.14	0.15	0.26	0.27	0.27	0.28	0.29	0.29	0.3	0.3	0.32	0.35
Agriculture	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Household	0.09	0.09	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.055
Total	0.54	0.42	1.02	1.09	1.1	1.07	1.15	1.42	1.43	1.43	1.45	1.49

Table 5–3. Forecasted CH_4 emissions from fuel combustion in sectors of economy for 2005–2020 and inventory data for 2001–2002, Gg

Sectors	2001	2002	2005	2006	2007	2008	2009	2010	2011	2012	2015	2020
Oil refinery	0.33	0.07	0.29	0.3	0.32	0.33	0.35	0.37	0.38	0.4	0.43	0.49
Electricity and heat	0.50	0.24	1.58	1.65	1.72	1.69	1.72	3.58	3.61	3.63	3.68	3.78
Industry	0.3	0.26	0.233	0.237	0.242	0.246	0.25	0.254	0.256	0.259	0.268	0.283
Service	0.6	0.42	0.57	0.58	0.6	0.61	0.63	0.64	0.65	0.67	0.71	0.788
Transport	1.49	1.44	3.6	3.64	3.71	3.74	3.8	3.86	3.9	3.94	4.06	4.24
Agriculture	0.11	0.14	0.36	0.37	0.38	0.4	0.41	0.41	0.43	0.44	0.47	0.539
Household	8.59	8.2	8.79	9.05	9.30	9.55	9.8	10.4	10.5	10.57	11.04	11.72
Total	11.93	10.77	15.42	15.87	16.27	16.56	16.96	19.51	19.73	19.9	20.66	21.84

Table 5–4. Projections of total GHG emissions from fuel combustion in CO_2 equivalent, Gg CO_2

	2001	2002	2005	2006	2007	2008	2009	2010	2011	2012	2015	2020
Oil refinery	1,507.3	1,410.8	1,021.6	1,026.3	1,080.1	1,185.5	1,215.9	1,249.5	1,309.7	1,380.1	1,463.8	1,718.2
Energy production	4,449.9	3,932.9	5,270.6	5,463.2	5,664.4	5,838.8	5,839.4	11,320	11,417.6	11,488	11,665.9	12,011.9
Industry	1,752.8	1,026.9	3,351.4	3,535.6	3,588.6	3,641.7	3,644.9	3,704.9	3,734.9	3,765	3,855.2	4,008.6
Service	412.7	311.92	454.4	460.9	467.5	473.3	478.7	488.9	489.2	499.6	510.4	535.2
Transport	3,554.7	3,676.7	3,693.7	3,812.6	3,927.0	4,155.3	4,159.7	4,280.9	4,374.9	4,465.7	4,744.5	5,257.5
Agriculture	185.4	206.04	2,393	250.8	259.1	274.5	275.8	284.8	285.2	294.4	306.1	327.5
Household	768.2	780.1	804.2	811.1	818.14	826.1	832.3	845.9	846	847.4	867.3	893.2
Total	12,631	11,345	14,835.2	15,357	15,806	16,395.3	164,468	22,175.1	22,455.5	22,737.2	23,413.3	24,752.1

generation and Refinery own needs and final energy consumption in sectors of economy are presented in Table 5–3.

5.1.5. Projections for All GHG Emissions from Fuel Combustion

Forecasted total GHG emissions in CO_2 potential from fuel combustion are presented in Table 5–4. For evaluation of CO_2 potential the following GWP factors were used: CO_2 – 1; CH_4 – 21; N_2O – 310.

5.2. Impacts of Policies and Measures in Fuel Combustion Sector

5.2.1. Impact of Measures in Energy Sector

Under Directive 2001/77/EC on the promotion of electricity production from renewable energy resources in the internal electricity market, Lithuania has committed itself to increase the share of such electricity to 7% by 2010. Electricity and the share of renewables in electricity production forecast presented in Economic analysis of electricity sector [4] (11.4 TWh in 2000, 18 TWh in 2005, 15.5 TWh in 2010, 17 TWh in 2015, and 18 TWh in 2020), and procedures for promotion of production and purchase of electricity produced from renewables and by-product energy provide a basis for determining the reduction in GHG emissions brought about by wider use of renewable energy resources for electricity generation by implementing requirements of the above mentioned Directive 2001/77/EC (through a reduction in the use of fuel oil). Significant reduction in GHG emissions will be achieved by (Table 5–5):

- 2000 – (11.4 TWh×3.6 GJ/TWh×0.03)×10^6×77.4 kg/GJ = 95 thous t;
- 2005 – (18 TWh×3.6 GJ/TWh×0.047)×10^6×77.4 kg/GJ = 235 thous t;
- 2010 – (15.5 TWh×3.6 GJ/TWh×0.07)×10^6×77.4 kg/GJ = 302 thous t;
- 2015 – (17 TWh×3.6 GJ/TWh×0.08)×10^6×77.4 kg/GJ = 379 thous t;

- 2020 – (18 TWh×3.6 GJ/TWh×0.09)×10^6×77.4 kg/GJ = 451 thous t.

Implementation of National Energy Strategy requires the share of renewable energy resources to account for 12% of all primary energy structure by 2010. Primary energy and the share of renewables in TPES (83.9 TWh and 9.2% in 2000, 90.3 TWh and 11.5% in 2005, 95.0 TWh and 12% in 2010, 101 TWh and 12.5% in 2015, and 106 TWh and 13% in 2020) forecast presented in National Energy Strategy provides a basis for determining the reduction in GHG emissions brought about by the increased use of renewable energy resources provided by National Energy Strategy (through a reduction in the use of fuel oil, as the main trend in renewable energy resource utilization is the conversion of boilers from HFO to biomass). Significant reduction of GHG will be achieved by (Table 5–5):

- 2000 – (83.9 TWh×0.092)×3.6×10^6×77.4 kg/GJ = 2.15 Mt;
- 2005 – (90.3 TWh×0.115)×3.6×10^6×77.4 kg/GJ = 2.89 Mt;
- 2010 – (95 TWh×0.12)×3.6×10^6×77.4 kg/GJ = 3.2 Mt.
- 2015 – (101 TWh×0.125)×3.6×10^6×77.4 kg/GJ = 3.5 Mt;
- 2020 – (106 TWh×0.13)×3.6×10^6×77.4 kg/GJ = 3.8 Mt.

Implementation of National Energy Strategy also requires the share of CHP to account for 35% of electricity generation by 2020. Electricity generation forecast presented in Economic analysis of electricity sector [4] (11.4 TWh and 18% in 2000, 18 TWh and 22% in 2005, 15.5 TWh and 29% in 2010, 17 TWh and 31% in 2015, and 18 TWh and 35% in 2020), and the factor of difference between GHG emissions generated by natural gas and by fuel oil provides a basis for determining the reduction in GHG emissions as a result of co-generation development provided in National Energy Strategy. The reduction of GHG emissions as a result of switching from fuel oil to natural gas makes 21.3 kg/GJ (77.4–56.1 = 21.3 kg/GJ). Therefore, the reduction in CO_2 emissions resulting from the increase of the share of CHP in electricity production will cause a considerable decrease of GHG emissions by (Table 5–5):

- 2000 – (11.4 TWh×3.6 GJ/TWh×0.18)×10^6×21.3 kg/GJ = 157 thous t;
- 2005 – (18 TWh×3.6 GJ/TWh×0.22)×10^6×21.3 kg/GJ = 304 thous t;
- 2010 – (15.5 TWh×3.6 GJ/TWh×0.29)×10^6×21.3 kg/GJ = 345 thous t;
- 2015 – (17 TWh×3.6 GJ/TWh×0.31)×10^6×21.3 kg/GJ = 404 thous t;
- 2020 – (18 TWh×3.6 GJ/TWh×0.35)×10^6×21.3 kg/GJ = 483 thous t.

5.2.2. Forecast of GHG Emissions and the Impact of Policies and Measures in Industry and Residential and Service Sector

According to the National Energy Efficiency programme, the total energy saving potential makes 20–50% of the total energy consumed in 2000. Energy saving potential in industry makes 2.3 TWh. Final energy demand in 2005 will make 15 TWh in manufacturing sector, and CO_2 emissions will amount to 3.3 Mt in the same year. Each TWh of energy consumed in manufacturing caused 0.223 Mt of CO_2. Energy saving will help to reduce CO_2 emissions by 2.3 TWh×0.22 Mt/TWh = 0.51 Mt in 2005 (Table 5–6). The same assumptions were applied in defining GHG reduction in 2010, 2015 and 2020. The same energy saving potential was multiplied by CO_2 intensity of en-

Table 5–5. Impact of GHG reduction policies and measures in the energy production sector

Name of policy or measure	Objective	Type of instrument	Status	Estimated mitigation impact for particular year, in CO_2 equivalent				
				2000	2005	2010	2015	2020
Under Directive 2001/77/EC on promotion of electricity from renewable energy sources Lithuania has committed itself to increase the share of electricity produced from renewable energy sources to 7% by 2010	Increase the use of renewables for electricity generation	Feed-in prices for renewables: • 5.8 EURct/kWh for hydro; • 6.4 EURct/kWh for wind; • 5.8 EURct/kWh for power plants using biomass	2002	0.095 Mt	0.235 Mt	0.302 Mt	0.379 Mt	0.451Mt
Implementation of National Energy Strategy which requires that by 2010 the share of renewable energy sources account for 12% of all primary energy structure	Increase the use of renewable energy sources	Feed-in prices for electricity generated from renewables; VAT exemptions for biofuels; Exemptions of biofuel using entities from the pollution tax from mobile sources levied per t of fuel consumed.	2003	2.150 Mt	2.89 Mt	3.200 Mt	3.500 Mt	3.800 Mt
Implementation of the National Energy Strategy which requires that by 2020 the share of CHP accounts for 35% of electricity generation	Increase the share of CHP in electricity generation	EU emission trading scheme	2005	0.157 Mt	0.304 Mt	0.345 Mt	0.404 Mt	0.483 M
Total in energy production				2.402 Mt	3.429 Mt	3.847 Mt	4.283 Mt	4.734 Mt

ergy consumption in industry in 2010 (0.21 Mt/TWh), 2015 (0.19 Mt/TWh) and 2020 (0.18 Mt/TWh).

According to the National Energy Efficiency program, energy saving potential in residential and commercial sectors makes 1.2 TWh. Final energy demand in 2005 will make 12 TWh, and emissions of CO_2 will amount to 1.16 Mt. One TWh of energy consumed would result in 0.097 Mt of CO_2 emissions. Energy saving will help to reduce GHG emissions by 1.2 TWh×0.097 Mt/TWh = 0.12 Mt in 2005 (Table 5–7). The same assumptions were applied for the evaluation of GHG emission reduction in 2005, 2010, 2015 and 2020. Forecasted GHG emissions per TWh in household and service sector were the same during 2005–2020.

5.2.3. Forecast of GHG Emissions and the Impact of Policies and Measures in Transport Sector

Directive 2003/30/EC of the European Parliament and the European Council on the promotion of the use of biofuels for transport will be implemented in accordance with the requirements of the Law on Biofuel, Biogas and Biooil of the Republic of Lithuania. Article 4 of that law regulates the production of biofuels from locally available raw materials, and establishes the procedure of promotion of such biofuels. Tax laws and other legal acts provide concessions and guarantees applicable to biofuel producers, users and investors in its production.

The National Energy Efficiency program states that energy efficiency potential in transport sector is averagely 1.7 TWh or 0.15 Mtoe per year. Perspective energy balances show that average GHG emissions in transport sector in the period from 2005 to 2007 will amount to 3.9 Mt CO_2 potential per year. The forecast for the final energy consumption in transport sector indicates that its consumption in 2005–2007 will amount to approximately 15 TWh per year. This means that one TWh results in 0.26 Mt of CO_2 potential emissions. These data make it possible to calculate the reduction (0.44 Mt) in GHG emissions within one year as a result of introduction of energy efficiency measures in transport sector (Table 5–8).

According to perspective energy balances, final energy demand in transport will make 18.68 TWh in 2015 and 20.8 TWh in 2020, and CO_2 emissions from transport sector during the same years will make 4.56 Mt and 5.06 Mt, respectively. Therefore, saving of 1 TWh in 2015 and 2020 will reduce GHG emissions by 0.24 Mt in respective years. Realization of energy saving potential of 1.7 TWh will correspond to 0.41 Mt of GHG emission reduction (Table 5–8).

Since the EU Directive 2003/30/EC on biofuels that has been transposed into the Law on Biofuels provides an increase in the share of biofuels consumed in transport sector of 2% in 2005 and of 5.75% by the end of 2010, it is possible to calculate the reduction in CO_2 emissions achieved through implementation of the above-mentioned Directive: 0.3 TWh×0.26 Mt/TWh = 0,078 Mt in 2005. By 2010, when energy consumption will grow to 17 TWh, this would make it possible

Table 5–6. Impact of GHG reduction policies and measures in the industry sector

Name of policy or measure	Objective	Type of instrument	Status	Estimated mitigation impact for particular year, in CO_2 equivalent				
				2000	2005	2010	2015	2020
Implementation of National Energy Efficiency Programme	Reduction of energy intensity in industry		2001		0.51 Mt	0.48 Mt	0.44 Mt	0.42Mt
Total in industry					0.51 Mt	0.48 Mt	0.44 Mt	0.42Mt

Table 5– 7. Impact of GHG reduction policies and measures in the household sector

Name of policy or measure	Objective	Type of instrument	Status	Estimated mitigation impact for particular year, in CO_2 equivalent				
				2000	2005	2010	2015	2020
Energy Efficiency Programme, Housing Strategy	Increase of energy use efficiency in buildings		2001		0.12 Mt	0.12 Mt	0.12 Mt	0.12Mt
Total in households					0.12 Mt	0.12 Mt	0.12 Mt	0.12Mt

Table 5–8. Impact of GHG reduction policies and measures in the transport sector

Name of policy or measure	Objective	Type of instrument	Status	Estimated mitigation impact for particular year, in CO_2 equivalent				
				2000	2005	2010	2015	2020
Implementation of National Energy Efficiency Programme	Increase of energy use efficiency in the transport sector		2001		0.442 Mt	0.442 Mt	0.41 Mt	0.41 Mt
Implementation of EU directive on biofuels 2003/30/EC	Increase of the share of biofuels in fuel consumed in the transport sector	VAT exemptions for biofuels	2002		0.078 Mt	0.255 Mt	0.313 Mt	0.39 Mt
Total in transport					0.52 Mt	0.697 Mt	0.723 Mt	0.8 Mt

Table 5–9. GHG emission projections "with measures" and "without measures" in energy sector, Gg

	1990	1998	2001	2002	2005	2010	2015	2020
CO_2	37,332	16,103	12,207	11,100	14,239	21,314	22,533	23,820
CH_4	5.25	7.9	11.93	10.77	15.42	19.51	20.66	21.84
N_2O	0.95	0.19	0.54	0.42	1.02	1.43	1.45	1.49
Total GHG emissions in CO_2 potential	37,737	16,328	12,631	11,345	14,835	22,175	23,413	24,741
Impact of GHG reduction measures	–	–	–	–	-4,456	-5,143	-5,562	-6,074
GHG emissions without measures	37,737	16,328	12,631	11,345	19,291	27,318	28,975	30,815

to achieve a 0.255 Mt reduction in CO_2 emissions per year (Table 5–8).

In 2015 and 2020, energy consumption in transport will increase further (to 18.68 and 20.8 TWh, respectively). The share of renewables would also increase further in transport sector, and would make 7% and 8% in 2015 and 2020, respectively. This would decrease GHG emissions by 1.3 TWh×0.24 Mt/TWh = 0.313 Mt in 2015, and by 1.66 TWh×0.24 Mt/TWh = 0.39 Mt in 2020 (Table 5–8).

5.2.4. GHG Emissions in Energy Sector „With Measures" and „Without Measures"

GHG emission projections "with measures" and „without measures" are available only for energy sector and according to GHG gases are given in Table 5–9.

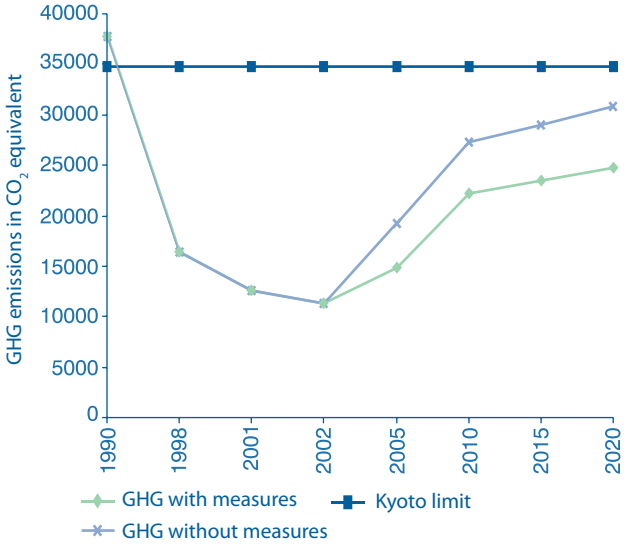


Figure 5–4. GHG emissions projections according to "with measures" and "without measures" scenario in energy sector

Table 5–10. Projected development of livestock, population size (1,000 head)

	2005	2010	2015	2020
Cattle:	984	839	818	804
Dairy cattle	569	481	481	481
Non-Dairy cattle	415	358	337	323
Sheep	15	15	15	15
Goats	25	25	25	25
Horses	65	65	65	65
Swine	1,047	1,144	1,146	1,146
Poultry	8,185	7,888	8,283	8,623

Total GHG emissions projections according scenarios "with measures" and "without measures" are presented in Figure 5–4.

5.3. Projections of GHG Emissions and Effects of Policies and Measures in Non-Energy Sector

Projections of GHG emissions from non-energy sector were conducted for industry, agriculture, land-use change and forestry and waste [77].

5.3.1. Projections of GHG Emissions in Agriculture

Calculation projections of emissions of GHG from agriculture were based on the European Union's Clean Air for Europe (CAFÉ) Program. The baseline agricultural scenario was developed by IIASA and local experts. The calculation of CH_4 emissions projections took into account the impact of enteric fermentation as well as processes occurring in management of manure. Projections of emissions from enteric fermentation and manure management were derived on the basis of trends in the total number of farm animals (Table 5–10). Projections of N_2O emissions from agricultural soils were calculated on the basis of application of manure only. Based on these calculations, the projections up to 2020 will result in a slight decrease in CH_4 and N_2O emissions, as it is indicated in the Table 5–11.

5.3.2. Projections of GHG Emissions from the Industrial Processes Sector

In Lithuania, industrial and technological processes are the second significant generators of GHG emissions. Cement, lime and ammonia production are the main generators of GHG. GHG emissions in the industrial sector decreased two-fold between 1990 and 2000. This is mainly due to the decrease in cement production.

Projections of trends in emissions of GHG from industrial processes were based on activity data calculated for EU the Clean Air for Europe (CAFÉ) programme Baseline scenario developed by IIASA and

Table 5–11. Projections of CH_4 and N_2O emissions in agriculture, Gg

	2005	2005	2010	2010	2015	2015	2020	2020
	CH_4	N_2O	CH_4	N_2O	CH_4	N_2O	CH_4	N_2O
Total agriculture	82.33	0.83	71.76	0.74	70.54	0.73	69.73	0.73
Enteric fermentation	72.31		62.14		60.97		60.18	
Manure Management	10.01	0.78	9.62	0.69	9.58	0.68	9.55	0.68
Agricultural soils		0.05		0.05		0.05		0.05

Table 5–12. Projected CO_2 emissions from cement and lime production, Gg

Activity and emissions	2005	2010	2015	2020	2025	2030
Cement production, kt	630	690	790	860	910	980
Lime production, kt	80	90	110	120	120	130
CO_2, Gg from cement production	315	345	395	430	455	490
CO_2, Gg from lime production	63.2	71.1	86.9	94.8	94.8	102.7

local experts. The projections were carried out only for CO_2 emissions from cement and lime production. Production of cement in Lithuania has been constantly decreasing since 1990. Projection of further development is based on the assumption of a more marked recovery of investment construction and cement production in Lithuania after 2005. The same emission factor, taken from the IPCC methodology, i.e. 0.5 t CO_2/t cement, was employed in the projection. The situation with lime production is very similar. CO_2 emissions from lime production were calculated using the emission factor 0.79 t CO_2 taken from the IPCC methodology. Projected CO_2 emissions from cement and lime production are shown in Table 5–12.

5.3.3. Projections of GHG Emissions from LUCF Sector

Increase in national forest cover arising from the implementation of the State forest policy has resulted in a more intense absorption of atmospheric carbon by the biomass of the forest ecosystem. Moreover, forests perform many other important functions as well, therefore, the scope of the State forest policy is much wider, and it also covers: limitation of wind and water erosion phenomena, surface and underground water protection, increasing retention capacity of the country, improvement in ecological and landscape system, as well as improvement in climate conditions.

During 1998–2002 forest area expanded by 66,900 ha from 30.3% to 31.3% and the trend of recent years is expected to continue. The Lithuanian Afforestation program has been developed for the period of 2004–2020. This program is divided into two phases:

- Preparatory phase (2004–2006) – afforestation of 5,000 ha per year (4,000 ha of agricultural land, and 1,000 ha of new forests);
- Phase of sustaining forest resources (2007–2020) – afforestation of 7,000 ha per year.

Up to now, annual cuttings during the past decade in Lithuania amounted to 3.0–6.3 million m^3. As the forest volume is increasing, a number of cuttings grows accordingly, and reached 6.3 million m^3 in 2004, with the total increment of forest amounting to 11.7 million m^3. It is forecasted that a number of forest cuttings will reach 6.5 million m^3 per year in 2005–2010, and will continue to grow. Timber harvesting production will not increase. In contrast, there should be a gradual increase in CO_2 sinks in forest management, and the trend of recent years is expected to continue.

For calculating projections of CO_2 emissions and removals from forestry, a method from Revised IPCC Guidelines was used. The calculation based on forecasted forestry data is submitted in the Table 5–13, Figure 5–5.

Table 5–13. Calculated projections of CO_2 emissions and removals, Gg

	2005	2010	2015	2020
CO_2 emissions	5,448	5,178	5,058	5,120
Removals	-11,269	-11,595	-11,933	-12,270
Net CO_2 emissions/removals	-5,821	-6,417	-6,875	-7,150

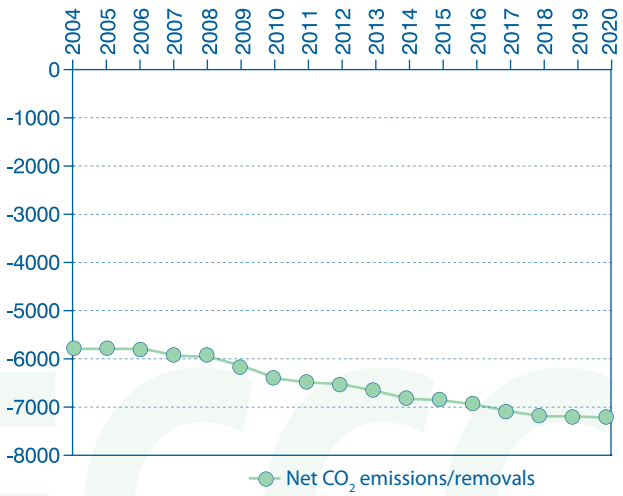


Figure 5–5. Forecasted net CO_2 emissions/removals in 2004–2020, Gg.

Therefore, it is assumed referring to the Lithuanian forestry augmentation programme that the average annual increase in CO_2 sinks will be approximately 1% and higher in relation to the potential higher volume of available funds for forestry policy implementation for afforestation and forest maintenance.

5.3.4. Projections of GHG Emissions from the Waste Sector

Management of solid municipal waste is one of the most important activities that generates GHG. CH_4 emission projections from municipal solid waste disposal were calculated taking into account the future trends in waste management in Lithuania, and particularly the impact of the implementation of Directive 99/31/EC on waste, which limits the amount of biodegradable waste disposed in landfills. Projections of GHG emissions from combustion of municipal waste and other activities were not calculated, as there is no combustion of municipal waste at the moment, and forecasts are not available. The National Strategic Waste Management plan sets limits for municipal biodegradable waste as follows:

- Until 2010 – not more than 75% of the amount in 2000;
- Until 2013 – not more than 50% of the amount in 2000;
- Until 2020 – not more than 35% of the amount in 2000.

For assessing GHG, a mono-variant scenario was elaborated taking into account possible trends in production and management of municipal waste up to 2020. The provisions of the National Strategic Waste Management plan were taken into account, as were the economic development trends (which have been provided in the forecasts of macroeconomic indices for the years 2001–2015 (Table 5–14, Ministry of Finance).

Table 5–14. Forecasts of macroeconomic indices of Lithuania

Index	Forecasts		
	2001–2005	2006–2010	2011–2015
	Average annual		
Real annual change of GDP, %	5.2	6.8	6.5
Number of residents at the beginning of the year, thous of people	3,460	3,440	3,430

Calculations of CH_4 emissions from solid waste disposal were carried out using a simplified approach employing the EXCEL tabular processor, based on projections of trends in accordance with IPCC methodology for inventories of GHG. Emissions data calculated in CRF for 2001 were taken as a reference year.

It is anticipated that the amount of biodegradable waste deposited in landfills will decrease by about 65% by the year 2020, compared to 2000. This will correspond to a decrease in CH_4 emissions to 19.1 Gg (Table 5–15).

Table 5–15. Projected CH_4 emissions (Gg/year) generated in landfills

	2001	2010	2013	2020
Landfilled biologically degradable waste	1,046	784.5	523	366.1
CH_4 emissions from landfills	52.3	40.95	27.3	19.1

Decrease in biodegradable waste corresponds to decrease of CH_4 emissions mainly due to the implementation of waste minimization, separation and recycling tasks, and improved waste collection and management.

5.4. Methodology

Projections of final energy demand were made according to the new version (2000) of simulation model MAED (Model for Analysis of Energy Demand). For the primary energy supply forecast, a mathematical model was developed at Lithuanian Energy Institute for modeling the energy sector development for 25–30 years. This model was based on the Message mathematical model that was originally elaborated by the International Institute of Applied System Analysis (IIASA), and its enhanced version was distributed by the International Atomic Energy Agency (IAEA). The mathematical model prepared for the analysis of the Lithuanian energy system development represents the whole energy system of the country including all the processes from primary energy extraction or import to the supply of final energy in different end-use sectors along the energy conversion chain. The model is a flexible instrument for energy and environmental analyses. It was adjusted to specific Lithuanian conditions in order to represent correct peculiarities of the energy system. The mathematical model uses linear programming. It is energy supply model, representing energy conversion and utilization processes, and their environmental impact on exogenously given demand of final energy. It is also an optimization model which from the set of existing and possible new technologies selects the optimal one in terms of selected criteria mix of technologies able to cover the country's demand for various energy forms. Representation of the energy system in the model is based on a network concept. Activities and relationships of the energy system are described

as an oriented graph, depicting the energy chain starting from extraction or supply of primary energy, passing through several energy conversion processes in order to satisfy the demand for final energy in industry, household, transportation and other sectors of economy. The optimization criterion or the objective function of the programme is minimization of the present value of the cumulated energy system costs in the planning period. The model is applied by defining scenarios. They represent different hypotheses on important parameters, like future fuel prices, the market penetration by new technologies, the market penetration by renewable energy resources, and political decisions. The model allows to include environmental restrictions: emission ceilings for the emissions of SO_2 and NO_x based on Directive 2001/81 requirements, emission ceilings for GHG emissions based on the Kyoto Protocol requirements, minimal part of electricity produced with renewables based on requirements of Directive 2001/77/EC, minimal part of electricity produced by CHP, and minimal use of renewables in primary energy supply based on requirements of National Energy Strategy.

5.5. Uncertainties

Projections of CO_2 emissions generated from fuel combustion (based on forecasted perspective energy supply and final energy consumption balances within the scope of National Energy Strategy (2002)) were calculated according to IPCC guidelines (1999). However, there are a lot of uncertainties in energy, as well as GHG emission projections:

- Forecast of GDP growth rate includes some uncertainties;
- Final energy demand forecast is related with uncertainties in foreseen energy efficiency improvement;
- The future prices of energy resources are very uncertain, and they are one of the major driving force in selection of generation sources in least cost power sector development plan;
- The level of primary energy demand is based on internal factors (GDP growth rate, growth of energy efficiency, losses in fuels and energy, own use of the energy sector, fuel consumption for production of fertilizers and other non-energy use), as well as the volume of surplus electricity used for export.

Sensitivity analysis indicated that the biggest impact on energy demand was caused by GDP growth rate, structural changes of economy and decrease in energy intensity.

5.6. Sources

76. Greenhouse Gas Projections. Fuel Combustion Sector (Reported Inventory No 28–1) in Strengthening of Institutional Capacity to Implement EU Requirements on Chemicals, GMO, IPPC and Climate Change, Lithuania // Ministry of Environment of the Republic of Lithuania, Vilnius, 2004.

77. Greenhouse Gas Projections – Other than Energy Sectors (Reported Inventory No 28–2) in Strengthening of Institutional Capacity to Implement EU Requirements on Chemicals, GMO, IPPC and Climate Change, Lithuania" // Ministry of Environment of the Republic of Lithuania, Vilnius, 2004.

THE REPUBLIC OF LITHUANIA

Lithuania's Third and Fourth National Communication on Climate Change

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

CHAPTER 6

Climate Change Impact, Vulnerability Assessment, Adaptation and Mitigation Measures

VILNIUS, NOVEMBER 2005

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF LITHUANIA

INSTITUTE OF ECOLOGY OF VILNIUS UNIVERSITY

CHAPTER 6. Climate Change Impact, Vulnerability Assessment, Adaptation and Mitigation Measures

6.1. Climate Change Impact

6.1.1. Changes in Climate

Climate change trends observed in Lithuania have been described in a series of publications [Chapter 7, Sources: 94–101]. Due to climatic and geographic features, Lithuania falls into a group of countries highly vulnerable to climate change. According to daily air temperature measurements in Vilnius, temperature has been rising throughout the past 200 years (Figure 6–1). A particularly sharp increase in annual air temperature was recorded during the last 15 years. Like in Northern Europe the highest temperature rise rates were observed in winter, whereas changes in summer were insignificant. During the past 200 years, trend values of air temperature in Vilnius show a strong temperature rise in December and January (Figure 6–2), whereas in August and September a small air temperature decrease was observed.

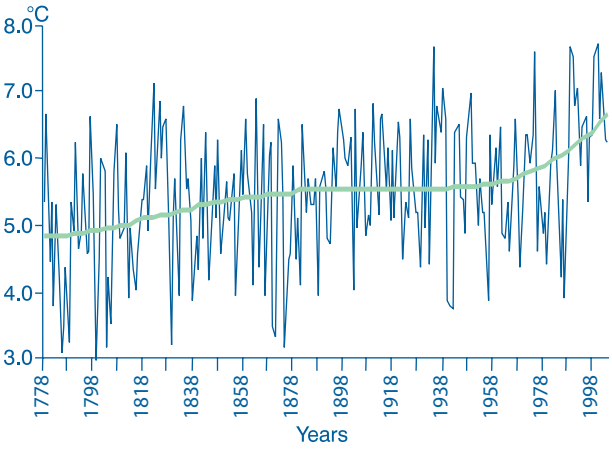


Figure 6–1. Average annual air temperature change (°C) in Vilnius in 1778–2004

Over the past two hundred years not only the average air temperature but also the extremity of thermal conditions has changed. During the 19th–20th centuries, the average annual air temperature in Lithuania increased by 0.6°C, average air temperature in the cold season went up by even 1.0°C; thermal period of the summer season shortened by 8 days (because dates of usual temperature rise over 15°C above zero became earlier in autumn and later in spring); thermal period of the winter season (time span when air temperature falls below 0°C) shortened by as many as 29 days (because dates of air temperature rise above 0°C became earlier in spring). Moreover, at the end of the 20th century, the number of extremely cold days ($T_{min} \leq -20$ °C) decreased whereas hot days ($T_{max} \geq 25$ °C) became more frequent.

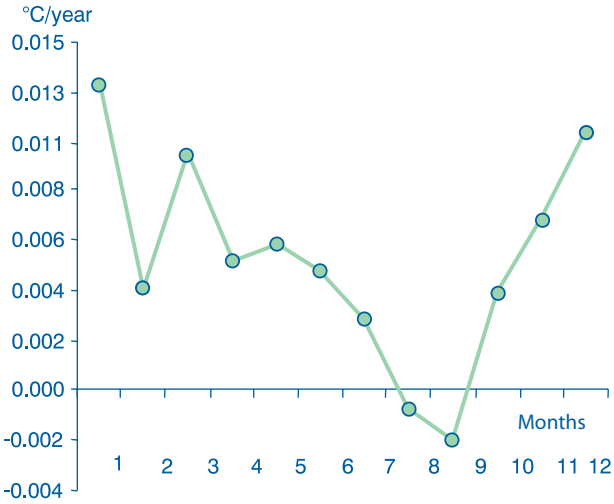


Figure 6–2. Average monthly air temperature change trends (°C/year) in 1778–2004

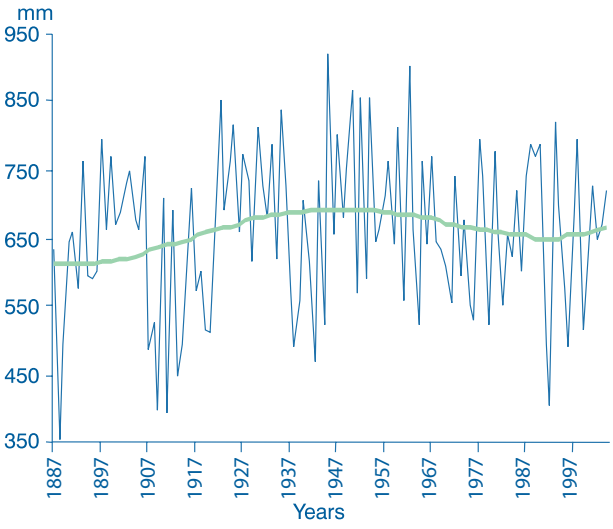


Figure 6.3. Change in the sum of the annual precipitation amount (mm) in Vilnius in 1887–2004

Short-term fluctuations in the 20th century developed into a tendency for precipitation in cold season to increase and in the summer season to decrease, which is related to more frequent advection of warm and humid air masses in winter (Figure 6–3). The number of days with precipitation events in winter also increased. With air temperature and a share of rainfall in winter increasing, the duration of snow cover be-

comes shorter. The last decade of the 20th century distinguished by a unique climatic phenomenon of several successive warm winters (1988/1989–1994/1995). During the past two hundred years, Eastern Europe has never evidenced such a long series of exceptionally warm winters [79]. In the year 1989, Lithuania's mean air temperatures were by 1.9°C higher than the long-term average of 1900–2000 (in 1999 by 1.7°C, in 2000 by 1.9°C, and in 2002 by 1.6°C, on average) [79]. Climate changes reveal an increasing tendency for unusual meteorological phenomena to appear. The last decades of the 20th century were characterized by a greater per cent of the recurrence of prevailing western winds, which was related to the global process, i.e. strengthening of western flows. Regional differences in the frequency of recurrence of winds of nearly all directions have increased in Lithuania, which evidences increase in frequency of macro-circulation processes all over the territory of Lithuania and strengthening of wind under conditions of such processes (decrease in significance of local factors affecting wind direction). In the second half of the 20th century, frequency of recurrence of medium strength winds was gradually increasing, whereas frequency of recurrence of weak and strong winds decreasing.

The character of climate variations in Lithuania greatly depends on the processes of atmospheric circulation, i.e., cyclonic and anticyclonic formations and different nature air mass advection. Beginning with the fourth decade of the 20th century, a number of deep cyclones visiting Lithuania in cold seasons (September-March) was recorded to be increasing, whereas the number of anticyclonic formations was decreasing. Moreover, the analysis of the air masses direction and velocity in the middle troposphere revealed that since the middle of the 20th century the transport from west and north above Lithuania was also strengthening. The changing patterns of atmospheric circulation entailed changes in other climatic indices: thermal season duration shift, fainting seasonal differences in air temperature and precipitation amount, declining snow cover indices (Figure 6–4). In characterising the climate of Lithuania, we have to state that it is increasingly losing its territorial specificity and can be described as reflecting global climate phenomena observed in large areas and regions.

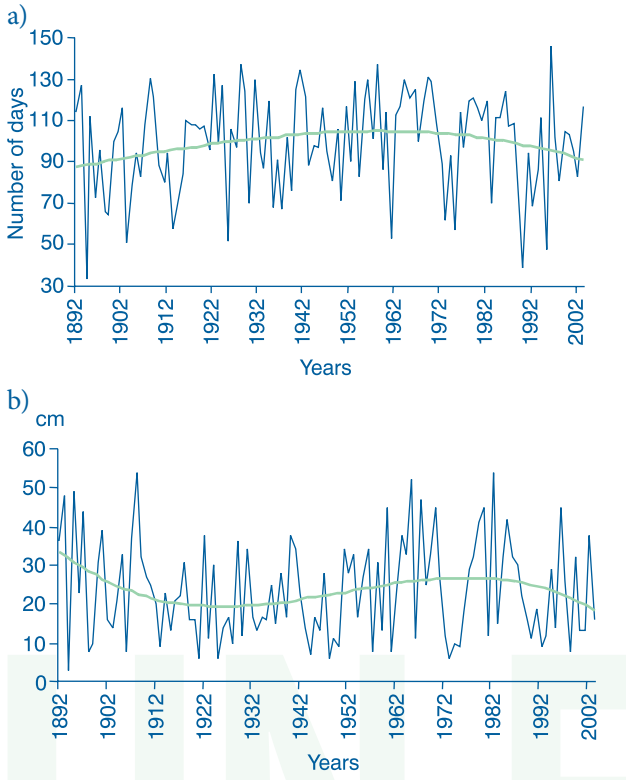


Figure 6–4. Number of days with snow cover (a) and maximal snow cover depth (b; cm) in Vilnius in 1892–2003

6.1.2. Impact on Agriculture

Different research programmes and works carried out in the country during the recent decade resulted in the compilation of facts revealing the scope of climate change impacts upon social and economic development of the country, projections of such impacts and effects upon certain branches of economy. Temperature and precipitation amounts as well as their regimes are of particular importance for crops of agricultural cultures, therefore, the currently observed climate change already has a marked impact upon the country's agriculture [79]. Data of research pursued in Lithuania show the dependency of phytomass resources, CO_2 removal, productivity of agricultural cultures, abundance of pests and spread of diseases upon climatic characteristics and changes in climate. Due to climate warming, vegetation of most plants starts earlier, species of dryer climate start spreading, and farmers begin applying drier climate technologies, including those of fertilizing. It has been established that agricultural cultures are affected by increase of active air and soil temperature sums during vegetation, longer duration of the vegetation period, change in wintering conditions of biennial and perennial cultures, spread of local pests, arrival of new pests and diseases from the south due to a northward shift of their distribution ranges. We have to point out that many species of fauna and flora have their own limits of dispersal in Lithuania and Eastern Baltic region, and a northward shift is registered for different species. Not all alien species are equally welcome, particularly in agriculture, forestry or horticulture. So far the impact upon agricultural production technologies

is not clear enough, therefore, new special investigations are necessary and already planned in Lithuania.

6.1.3. Impact on Forest Ecosystems

Trees serve as bioindicators of susceptible environmental changes (both induced by anthropogenic activity and climate) [102]. In the course of the last two decades, we have already registered climate warming impact upon forests in Lithuania. Mass drying out and degradation of spruce forests caused by spread of secondary pests is the beginning of great forestry problems expected in Lithuania. Such impact upon spruce forests can be related to the southern range of the distribution of this tree species in Lithuania. Changes observed evidence a clear tendency for the distribution range of this tree species to shift – upon change in temperature and hydrological regime, conditions in Lithuania become more and more unfavourable. Climate change impact can also be observed in defoliation of trees, which is lower in Lithuania compared with southern countries and higher compared with northern areas. Currently, the Lithuanian Forest Research Institute carries on research with a view to investigating tree reactions to mineral soil water regime changes caused by climate warming. The models developed allow forecasting climate change impacts upon productivity of forests as well as upon forest ecosystems, forests in protected areas and forest habitats.

6.1.4. Impact on Terrestrial, Freshwater and Wetland Ecosystems and Their Components

Recent changes in climate have impact on various ecosystems and their components – habitats, species, communities and populations. An increase of eutrophication of water basins, marshes and wetlands has been registered [93]. In addition, investigations carried out by the Institute of Ecology of Vilnius University revealed new data on climate change impacts upon biological diversity, timing of spring arrival of birds, periods, dynamics, distances and directions of bird migration, breeding timing of birds, shifting of birds breeding distribution areas and ranges, changes in bird selection of wintering areas and changes in wintering populations, restructuring of the composition of bird species breeding in Lithuania and Eastern Baltic Region, changes in Important Bird Areas and Habitats, insect development cycle, flying timing, population abundance and dynamics. Research investigations demonstrated marked shifts in migratory flyways in many waterfowl populations. Due to sustained warming of winter seasons, wintering grounds of several species shifted east- and northward; the main stop-over areas of migrating populations changed; the number of resident birds in different populations is increasing rapidly; the degree of migratoriness is changing (from long-distance to medium- and short-distance migrant categories); species composition of various groups of breeding birds and their populations changed. As water organisms are highly adapted to temperature conditions in water ecosystems, the factor of temperature is very important in fish spawning grounds, especially of stenobionts. As the most valuable migrating fishes return from sea waters to spawn in selected rivers, the change of conditions in rivers may lead to irrevocable losses of separate populations and decrease in fish supplies. Acting upon animals and plants, climate change affects economy through losses in fishery, forestry and hunting resources [92].

Investigations performed in the Institute of Ecology of Vilnius University show different response to global climate warming by different bird ecological groups, different categories of migrants and residents breeding in peripheral and central parts of their species' ranges. Global warming impact is more dramatic for water birds and birds of wetland complexes rather than for terrestrial birds. The analysis showed that in Lithuania ranges of many bird species, populations of which are on the edges of their distribution areas, move eastwards or north-eastwards. Investigations indicate that most of all categories of migrants and residents breeding in the central part or northern periphery of their distribution areas benefit from the position. Results obtained support a hypothesis that short- and medium-distance migrants and residents benefit from climate warming in southern peripheries of their species' ranges, whereas the population status of long-distance migrants becomes worse, which implies that alterations in the composition of bird communities in the Eastern Baltic region occur at the expense of long-distance migrants breeding in the southern periphery of the species' range. Such finding puts forward a new viewpoint on threat to birds and bird conservation problems in the region and all over Europe. In order to design effective conservation measures, it is important to know the migratory status of breeding birds, population's location in the species' distribution range as well as trends and scope of climate change in the region. Results obtained can be applied in biodiversity risk assessment and in species conservation [91].

6.1.5. Impact on Biological Diversity, Ecosystems and Their Components in Conditions of Increasing Anthropogenic Pressure

Impact of climate and large-scale habitat degradation due to human activities constitutes the main threats to ecosystem and habitat degradation and species extinction process on the planet. Diagnosis of the impact of climate change on biological diversity, ecosystems and their components becomes more complicated due to the increasing anthropogenic pressure on all ecosystems, especially where natural resources are intensively exploited, including protected and strictly protected territories and forests. For a long time, most authors indicated a negative anthropogenic effect manifesting through habitat degradation, land reclamation, urbanisation, as well as through cultivation of natural areas, direct extinction of species, forest felling and fragmentation as one of the main factors deciding the status of ecosystems in Lithuania. Only in recent decades, the global climate change impact was recognized as a very important factor alongside with anthropogenic effect. However, the scope of climate change impact is not sufficiently investigated as yet. In addition we have no clear understanding of the balance between the climate impact and anthropogenic effect and change of such balance, or which of the impacts above is more relevant to date, how it changes in time and space and how it acts upon the status of habitats or species. Besides, we have to recognize considerable land use differences between Western and Eastern Europe during two last decades, which have different effects upon the status of ecosystems. The most significant differences between Western, Central and Eastern Europe were observed in intensively managed land surfaces, when in the course of land privatization and redistribution in Eastern Europe intensity of land use decreased, large areas started wasting, industrial and agricultural pollution decreased with its negative impact upon wildlife decreasing and areas of protected territories expanding (NATURA 2000 network). Therefore, the ratio between climate impact and anthropogenic effect may vary in different parts (western and eastern) of Europe. It is likely that the impact of climate warming might be greater than the effect of man-induced activities in Lithuania.

6.1.6. Impacts on Groundwater Regime and Chemical Composition, on Hydrological and Hydrophysical Indices of the Baltic Sea, Curonian Lagoon, Lakes and Rivers

Investigations carried out in three integrated monitoring stations in the last decade of the 20th century showed that the amount of precipitation was by 19–37% less compared with the norm [79]. Groundwater level went down in all stations irrespective of how deep it was. Climate may be taken as one of the factors directly responsible for the chemical composition of groundwater as it determines not only the trend of hydrochemical processes but also the intensity of soil formation, weathering and activity of microorganisms as well as the character of vegetation. The closer the bedding depth of groundwater to the surface the stronger is the interaction between groundwater and meteorological conditions. The analysis of groundwater chemical composition revealed that shallow groundwater contains smaller concentrations of most chemical elements. However, in agrarian territories groundwater mineralization is strongly affected by the use of organic and mineral fertilisers. No special research works on climate change impacts have been performed therefore no exhaustive conclusions or recommendations can be drawn.

Climatic variations greatly affect ice formation in rivers and lakes [79]. Long-term variations in dates of ice cover formation in the Nemunas River (at Smalininkai settlement) in the 20th century revealed a tendency for the ice cover formation to become later and shorter in duration. It was the first time over the past four decades when due to climate warming up to 90% of the Baltic Sea area remained ice-free in winter (Bukantis, personal report). Analysis of long-term data on the duration and maximum yield of spring flood in the lower reaches of the Nemunas River indicates a significant decrease in both above parameters during the last 10 years [90]. However, no clear regularities showing climate change impacts on hydrological and hydrophysical indices of lakes and rivers have been found due to the lack of long-term research, therefore, no detailed conclusions or recommendations can be elaborated.

6.1.7. Wind Erosion

Detailed analysis of wind and precipitation parameters helped to determine the scope of wind erosion in Lithuania. Favourable conditions for wind erosion occur in dry weather periods when wind velocity reaches 5.5–6 m/s. 9–10 m/s wind velocity causes dust storms. Precipitation reduces the number of deflation winds by 20–30%. Thus, wind velocity and precipitation must be viewed in complex [79]. Since 1991, reduction in the area of arable lands and belated sowing works reduced a probability of wind erosion under deflation-favourable meteorological conditions. Further investigations are necessary in this sphere.

6.1.8. Socio-Economic Importance of Climate Change Impacts

Changes in ecosystems, their constituent parts and in biological resources due to climate warming have a marked effect on various branches of economy and environmental protection, therefore, they must find place in environmental and economy strategies of the country. These changes reveal new urgent practical ecological problems on the science-policy interface basis. They are the audit of the net of old strictly protected areas, establishment of new protected areas, optimisation of the use and protection of biological diversity and biological resources, land privatisation and use practices, new commitments in relation to international conventions, revision of environmental conservation strategies, action plans and programmes. However, no serious efforts to include climate change impacts into strategies of branches of economy have been noticed as yet. Observed and predicted changes in ecosystems, biological resources, different cycles and processes of bird life may exert effects upon different branches of economy: energy, agriculture, forestry, fishery, hunting, civil and military aviation, and environmental protection. Knowledge of such changes has a direct influence on the prospect of agriculture, technologies, creation of new sorts of cultures and their adaptation to the country's climate, development of forestry, planting of new forest areas, adaptation of tree species and varieties to the country's conditions, success in managing and solving bird strike problems, applicability of concrete measures, their effectiveness, etc. Furthermore, a decrease in snow cover in the recent decade considerably reduced winter tourism, eliminated possibilities for winter sports in the country, whereupon the geography of winter tourism has narrowed – admirers of winter tourism increasingly choose active winter relaxation in other countries, which brings losses to the country's tourism industry. On the other hand, the summer season is becoming noticeably longer in holiday resorts near the Baltic Sea – one can enjoy rest from May to September. The period of heating in cities, towns and settlements is becoming considerably shorter, which allows saving fuel and conditions reduction of GHG emissions.

6.2. Vulnerability Assessment

For the lack of concrete information supported by countrywide investigations, this national communication presents only several aspects regarding vulnerability to climate change. The following communications will expose these issues in other fields, including different sectors of economy, health and well-being of people, and environmental protection.

6.2.1. Forecast of Climate Situation according to General Circulation Models for the 21st Century

According to the results of calculations based on five climate change models designed and used worldwide (HadCM2, UK; ECHAM4, Germany; CGCM1, Canada; GFDL-R30, USA, CSIRO-Mk2, Australia; and CCSR/NIES, Japan), air temperature should further increase in Lithuania in the 21st century (Figure 6–5) [79]. In the first half of the new century, December-March temperatures should increase at the highest rate, whereas in the second half, December temperature increase rates will slow down, but mean temperature in February will increase – at the end of the century it should be by 4.0–6.0°C higher (Figure 6–6). So, the highest temperature change rates will occur in the second half of this century. It is predicted that air temperature in cold seasons (December-March) will increase in particular. In warm seasons of the year, air temperature will not go up so quickly.

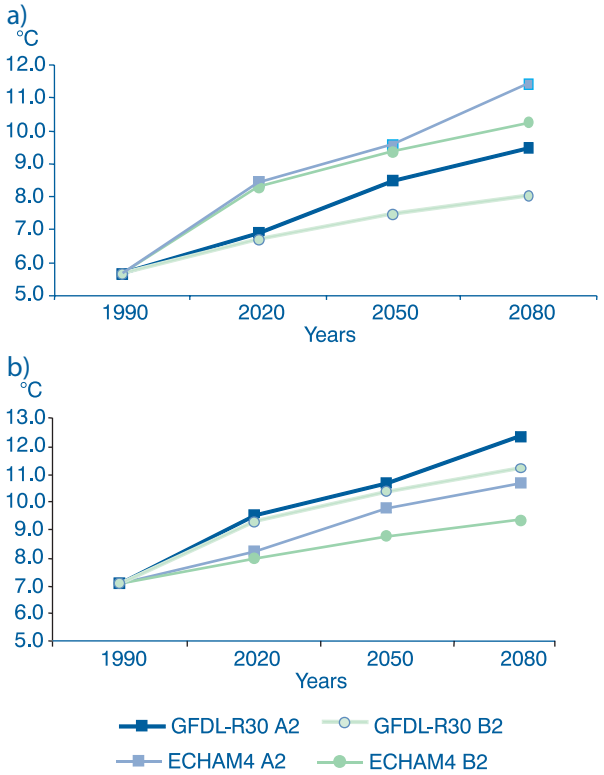


Figure 6–5. Forecasted air temperature trends (°C) in the 21st century in Vilnius (a) and Klaipėda (b) based on the GFDL R30 climate model predicting the smallest changes and the ECHAM4 model predicting the greatest changes according to A2 and B2 GHG emission scenarios

A decrease in the annual air temperature shows that the recently observed increase of ocean influence upon Lithuanian climate will continue throughout the century.

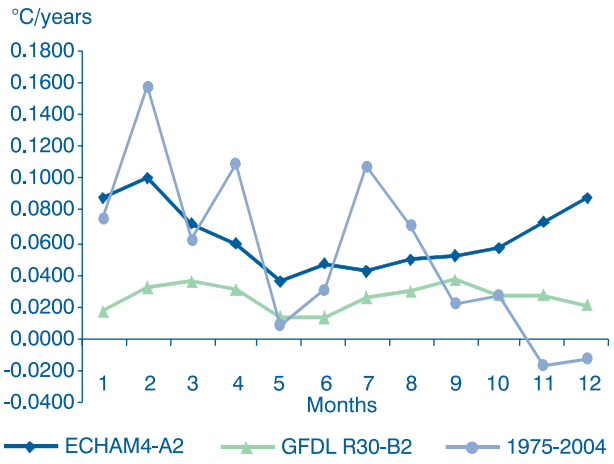


Figure 6–6. Forecasted air temperature trends in Vilnius (°C/year) in the 21st century based on the models predicting the greatest (ECHAM4 A2 scenario) and smallest (GFDL R30 B2 scenario) changes, and air temperature trends within the past 30 years (1975–2004)

Forecasts coincide with the current climate change tendencies in Lithuania and show increasing tendencies for the Lithuanian climate to become more marine-type. In separate months an increase in air temperature during the past 30 years was even greater compared with the data of the most pessimistic scenarios. Especially great changes were recorded in February-April and July-August. Therefore, we can state that results of the application of modern climate models rather precisely reflect change trends. Air temperatures in November and December were the only to slightly go down though based on change trends throughout the period of measurements (1778–2004) a rather marked increase in temperature was recorded in said months, too.

Climate change models designed by climate research centres give rather different forecasts for precipitation amount trends in Lithuania in the 21st century (Figure 6–7). The only common trait is the increase in precipitation by the end of the 21st century. However, the forecasted speed and nature of changes in precipitation amounts differ greatly. In summarizing the above forecasts, we can state that precipitation in cold seasons should increase more rapidly than in warm ones. Difference between seasonal amounts of precipitation will be less, which once again evidences that Lithuanian climate is becoming more marine-type.

Only minor changes in wind velocity are forecasted with mean seasonal values presumably increasing by no more than 0.2 m/s throughout the 21st century. In cold seasons, wind velocity should increase more compared with warm seasons. The average number of days with snow cover should decrease by 15–25

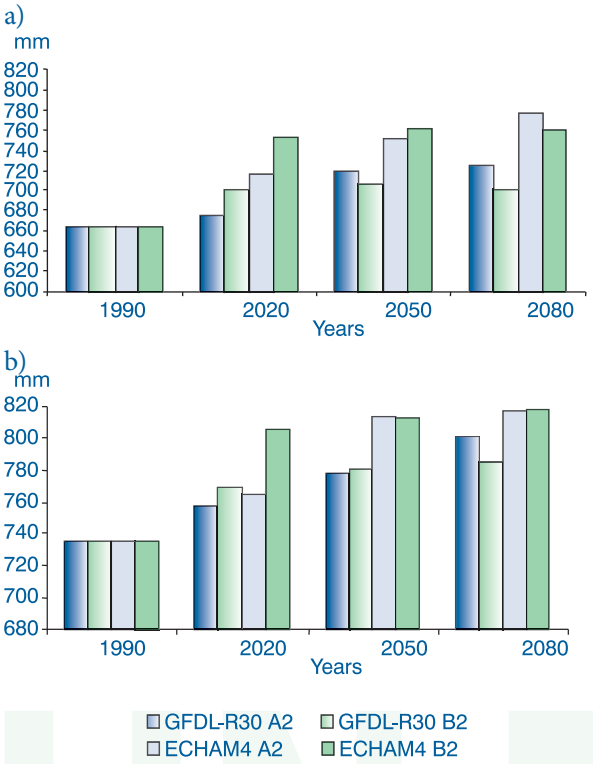


Figure 6–7. Forecasted precipitation amount (mm) trends in the 21st century in Vilnius (a) and Klaipėda (b) based on GFDL R-30 climate model predicting the smallest changes and ECHAM4 model predicting the greatest changes according to A2 and B2 GHG emission scenarios

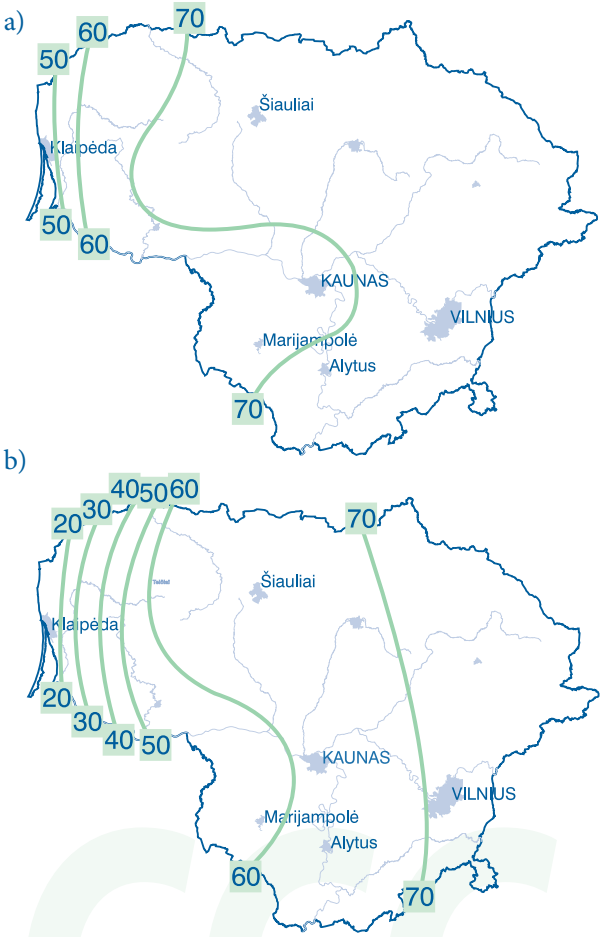


Figure 6–8. Forecasted number of days with snow cover (a) and probability (%) of permanent snow cover formation in Lithuania (b) in the middle of 21st century

days in Lithuania in the 21st century (Figure 6–8). The greatest changes are expected in the eastern part of Lithuania, where snow cover should hold for no more than 80 days, *cf.* in 1961–1990 snow cover in Vilnius and Utena was holding for more than 100 days. The period of snow cover by the seaside is predicted to hardly reach 50 days.

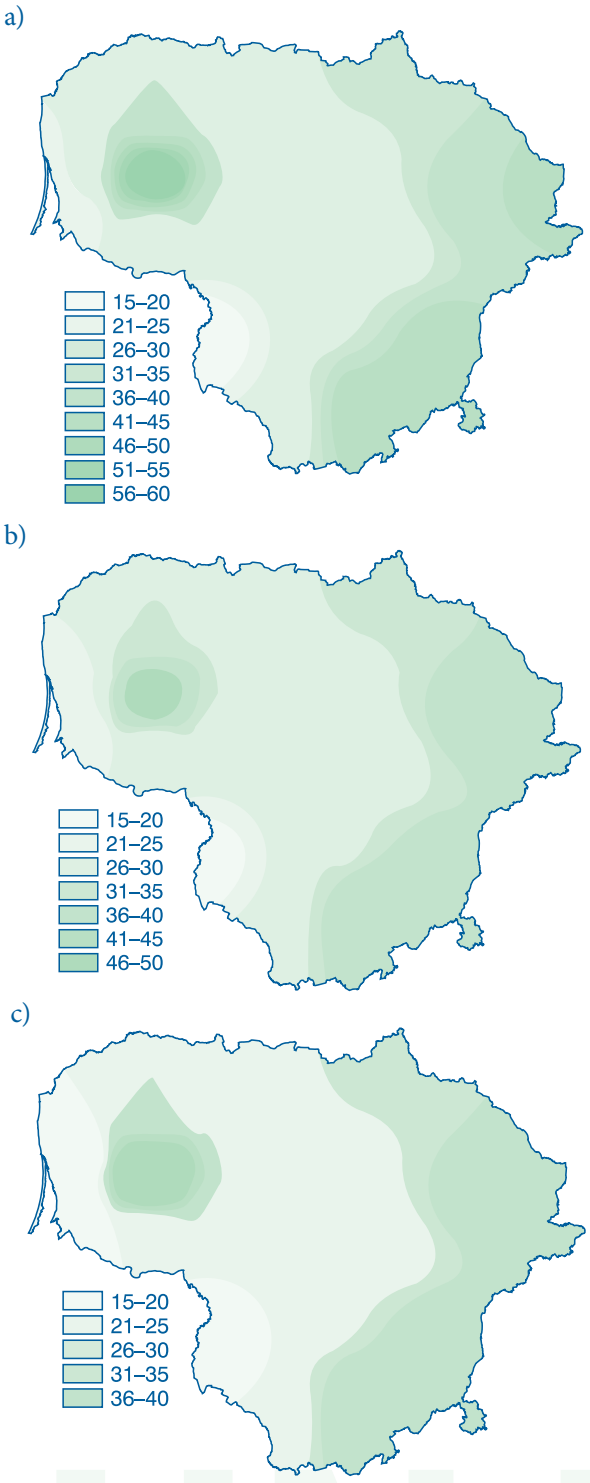


Figure 6–9. Average maximum snow water equivalent (mm) in Lithuania: a) in 1961–1990 b) when average temperature increases 1.5°C and amount of precipitation – 8 mm during snow accumulation period; c) when average temperature increases 3°C and amount of precipitation – 14 mm during snow accumulation period

One of the main snow cover indices is maximal water accumulation in snow. The index in significant part reflects the nature of river feeding. The forecast of snow water equivalent in the Lithuanian territory is based on two predictions: 1) mean temperature in the accumulation period will rise by 1.5°C, and precipitation amount by 8 mm (this is expected around the year 2040); 2) mean temperature will rise by 3.0°C, and precipitation amount by 14 mm (this is expected around the year 2065). If changes in the accumulation period are the same as forecasted, the regional features of spatial distribution will remain.

The average maximum snow water equivalent will decrease to 34 mm in case b) (compared with 40 mm in the control period), and to 28 mm in case c) (Figure 6–9). Such changes will also predetermine the feeding character of rivers in Lithuania. If in 1961–1990 feeding by melting snow in the annual runoff of rivers in Lithuania came to 31%, according to future forecasts snow-based feeding would come to 26% in 2040 and to 21% in 2065. The character of the annual hydrography of rivers influenced by snow-based feeding will change mostly.

6.2.2. Agriculture and Forestry

Climate change impacts cover not merely agroclimatic resources and plant productivity in Lithuania, but also soil hydrochemical processes, spread of plant and animal diseases and pests in the country as well as social consequences caused thereby:

- Predicted increase in active air and soil temperature sums in the vegetation period in Lithuania;
- Predicted lengthening of the vegetation period (in particular when mean 24-hour air temperature is above 0°C);
- Change in wintering conditions of biennial and perennial plants: shorter in duration and irregular snow cover due to air temperature balancing about 0°C, crop saturation and suffocation caused by frequent thaws, spread of fungous diseases, early vegetation of winter crops, fruit shrubs and fruit trees exposed to a high probability of frosts (frosts of -10°C, -15°C can make harm);
- Increase in precipitation in the form of strong storms, which intensifies soil weathering, increase haymaking and rye harvest costs, impair crop quality and causes loss of some part of crop;
- Increase in negative effects of acid rains causing soil acidity, decrease in soil productivity, decline of soil microflora and microfauna;
- Alternations between wet and dry periods caused by increase in annual precipitation amount fluctuations and irregular humidity. Possibilities of oc-

currence of elemental droughts can especially increase in southern and southeastern sandy areas, therefore effective irrigation and drainage systems would be necessary to mitigate adverse effects of such phenomenon;

- Air temperature increase would not only favour reproduction and development of local pests, but also would cause the coming of new organisms from the south;
- In modeling impacts of various combinations of air temperature and CO_2 concentration in air upon wheat productivity it was determined that rapid temperature rise can lower productivity because the period of flowering and ripening becomes shorter and grains fail to grow in full. Simultaneous increase in air temperature and CO_2 concentration causes more intensive productivity of photosynthesis, with 5–10% productivity increase under excess humidity, and higher productivity increase (15–20%) in years of optimal humidity;
- As global climate change will affect economy of other countries, changes in the structure of imports and exports of agricultural products and in the domestic market are possible.

Forecasts for the main agroclimatic indices (vegetation period duration, sum of active temperatures and hydrothermal index) were made based on ECHAM4 and GFDL-R30 global climate models according to A2 and B2 GHG emissions scenarios (ECHAM4 is used to forecast the greatest changes, GDFL-R30 the smallest).

The duration of thermal seasons (with mean 24-h temperature exceeding 5°C or 10°C above zero), which is the best characterizer of vegetation conditions, is forecasted to increase significantly. Particularly marked changes are predicted for the seaside where the season with mean temperature exceeding 5°C above zero will last 20–60 days in the middle of the century, and 30–100 days around the year 2080. According to ECHAM4 A2 model predicting the most extreme changes, the duration of the thermal season will reach as many as 309 days at the end of the century (the mean of 1961–1990 constitutes 207 days). In Eastern Lithuania, the duration of the thermal season will not increase so rapidly: 4–9 days per decade (Figure 6–10). In the territory of Lithuania, the duration of the period with mean air temperature exceeding 10°C above zero will grow gradually, but not so quickly. In

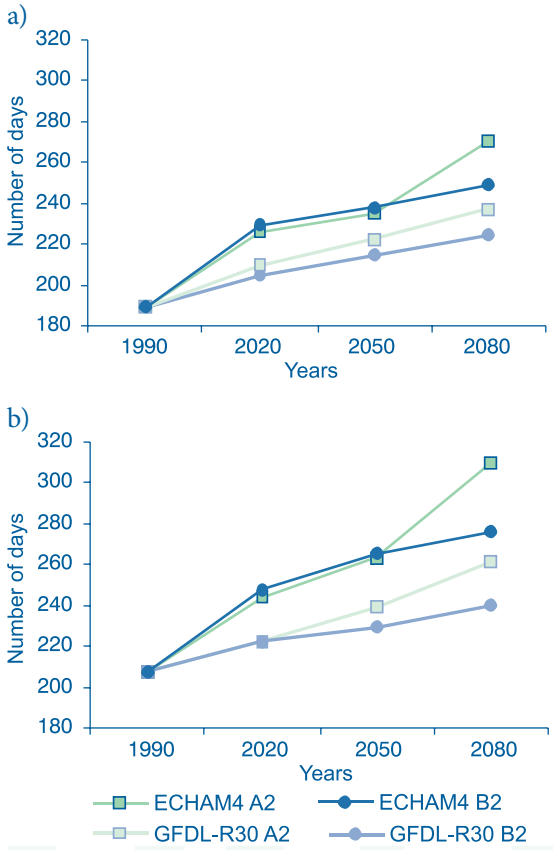


Figure 6–10. Forecasted changes in the duration of the period with mean air temperature exceeding 5°C above zero in the 21st century in Vilnius (a) and Klaipėda (b), based on GFDL R–30 climate model predicting the smallest changes and ECHAM4 model predicting the greatest changes according to A2 and B2 GHG emission scenarios

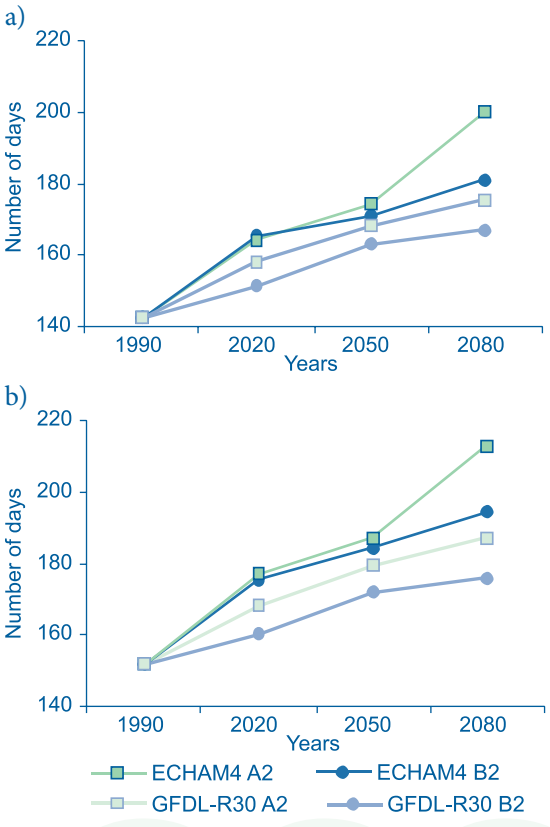


Figure 6–11. Forecasted changes in the duration of the period with mean air temperature exceeding 10°C above zero in the 21st century in Vilnius (a) and Klaipėda (b), based on GFDL R30 climate model predicting the smallest changes and ECHAM4 model predicting the greatest changes according to A2 and B2 GHG emission scenarios

Vilnius, the duration of such period will increase from 142 days in the years 1961–1990 to about 180 days in the year 2080 (160 days in 2020 and 170 days in 2050), whereas in Klaipėda from 152 to 190.

Another important agroclimatic index is the sum of active temperatures, which is calculated by summing up mean 24-h temperatures of the period with air temperature exceeding 10°C above zero (Figure 6–11). Changes in such index can be used for forecasting vegetation conditions of agricultural cultures. Climate modeling results show rather marked increase in the values of the index. In Vilnius, sums of active temperatures will go up by 10–20% in the coming 20–30 years, and by 30% (GFDL R30 B2) to 60% (ECHAM4 A2) by the end of the century (Figure 6–12). Very similar changes are forecasted for the seaside.

Hydrothermal (Selianinov's) coefficient is one more complex index describing conditions of the vegetation period. The values of Selianinov's coefficient will decrease in Lithuania in the course of the 21st century (Figure 6–13). Though on average they will be attributed to optimal irrigation, dry periods will be recorded more often. The more so as changes in coefficient values will be different in separate stages of the vegetation period: at the beginning of the period (May-June) irrigation conditions will change relatively little whereas at the end (July-September) the coefficient value will go down sharply due to decrease in precipitation against the background of increasing air temperature. Such increasing dryness would be particularly unfavourable for late grain crops, root vegetables and pastures' vegetation.

Wintering conditions of plants will also change: snow cover duration should markedly decrease, snow layer will become considerably thinner, and part of precipitation of phasal composition and in the form of rain will increase. Thus wintering cultures would be more often exposed to unfavourable agrometeorological phenomena: saturation, heaving, suffocating. Thin, dense and irregular snow cover would not provide safe protection for plants from low temperatures, especially unexpected frosts.

To sum up, changes in temperature and precipitation regimes will further affect production of agricultural cultures, production quality, and will require increasing financial investments in agriculture and its separate fields. Threat of increased contamination

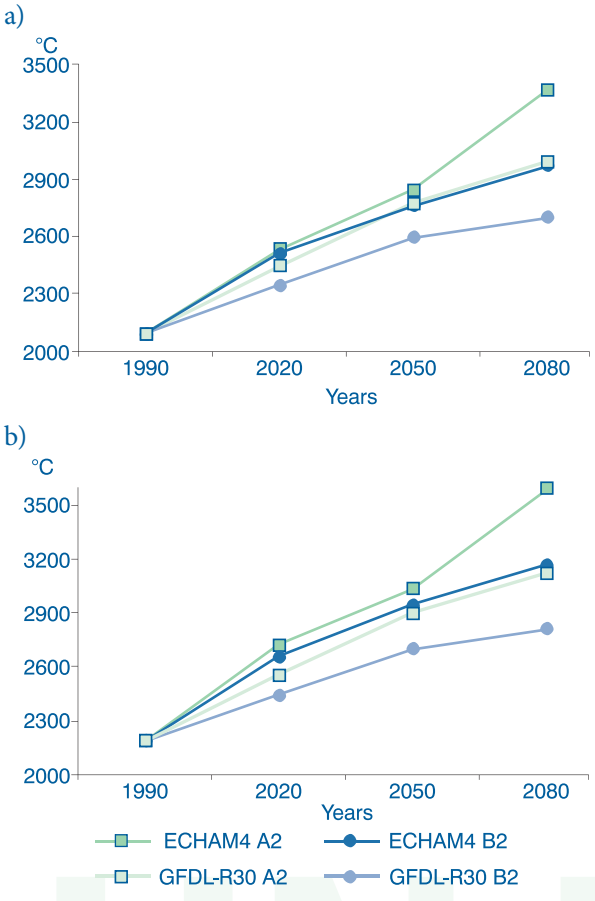


Figure 6–12. Forecasted changes in the sum of active temperatures (>10°C) in the 21st century in Vilnius (a) and Klaipėda (b), based on GFDL R30 climate model predicting the smallest changes and ECHAM4 model predicting the greatest changes according to A2 and B2 GHG emission scenarios

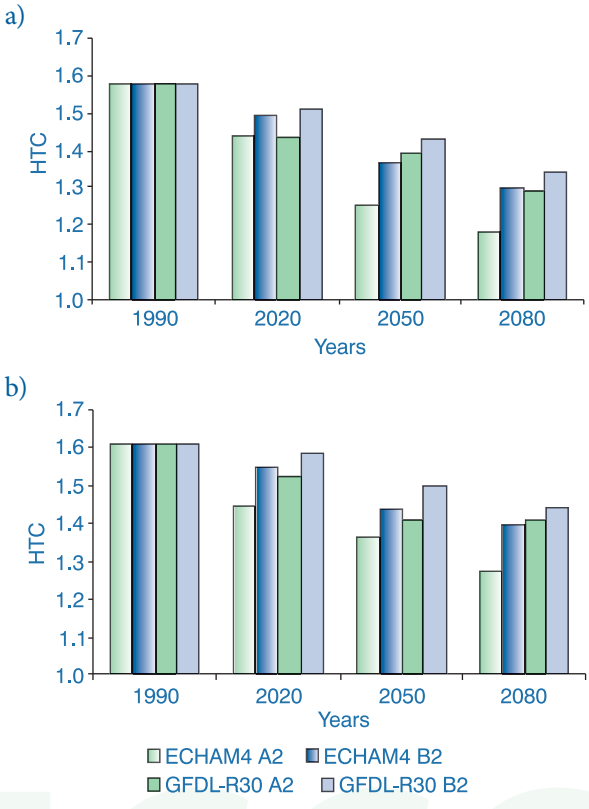


Figure 6–13. Forecasted changes of the hydrothermal coefficient (HTC) in the 21st century in Vilnius (a) and Klaipėda (b), based on GFDL R30 climate model predicting the smallest changes and ECHAM4 model predicting the greatest changes according to A2 and B2 GHG emission scenarios

of soil with chemical substances will emerge. A need to combine sorts, change and adapt cultures or their arrangement in the country to the ever-changing climate conditions will further remain. Impacts upon productivity of forests, especially those in protected territories and forest habitats, productivity and quality of minor forest goods will become stronger. Upon change of conditions, a need to change and modify growing technologies trying to get them adapted to new climatic conditions will emerge. Spread of new diseases and pests will increase investment costs. Attention will have to be paid to new research trends and investigations requiring greater investments.

6.2.3. Ecosystems, Biodiversity and Protected Areas

Increasing climate change impacts are expected in natural ecosystems and their components, including biodiversity, biological resources, system of protected areas, and the Baltic Sea coasts. As to biological diversity, further degradation of ecosystems and habitats, extinction of species due to their shifts northward, arrival of new species, loss of part of values of protected areas due to changes in species distribution areas and northward and northeastward shifts (species will leave protected areas because of changed conditions) will occur [91]. Therefore new threats and obstacles for the realisation of conservation of protected species will emerge. Many usual species protection and management measures applicable in environmental protection will lose their efficiency, which will necessitate new concepts, ways and measures for their conservation for future generations. A need for international co-operation and transboundary protection will particularly increase, as well as a necessity of co-operation between countries in creating new common systems or networks of protected territories. 20-year-long research at the Institute of Ecology of Vilnius University showed that along with anthropogenic loading climate warming is one of the potential factors changing our ecosystems, causing rapid changes in their components (habitats, species and community composition). Impacts upon ecosystems manifest through their eutrophication, drying, change of habitats, acceleration of changes in natural succession, unbalancing of ecosystems. Research done in recent years allows predicting that in Lithuania global warming can affect northern species more than anthropogenic load. Research into biological diversity of wetlands as the main strict reserves of the country performed within the framework of GEF/UNDP project Conservation of Inland Wetland Biodiversity in Lithuania [91] showed that upon elimination of adverse human effect the impact of global warming upon the wetland ecosystem, with which separate species are associated, is not eliminated. As a result, conservation of biological diversity will not be efficient enough because strict reserves, protected areas in Lithuania are established based on the current situation of values, without taking into consideration future climate change scenarios and natural succession processes. Such areas are attempted to be conserved through great monetary contributions however not always expected results are attained. Species extinction in the process of climate change is an inevitable process to be taken into consideration in the process of selection and designation of protected areas. Under conditions of climate warming, current reserve-selection methods might yield solutions inadequate to ensure species' long-term persistence within strict reserves, which is highly urgent in creating a new network of European protected areas NATURA 2000. The existing network is rather conservative, its creation is not harmonised with climate change processes, with research on climate change impacts, long-term monitoring either in Lithuania or other EU countries.

6.2.4. Coastal Zone

The Lithuanian coastal zone is relatively short, about 90.6 km in length. The coastline is exposed to heavy anthropogenic load. It has a large Klaipėda seaport with several oil and other material loading terminals operating. The seaside contains the main holiday resorts of the country. The Curonian Spit is included into the UNESCO natural heritage list; several protected areas are designated as NATURA 2000 sites both on the coast and in the sea. Great part of population living in the coastal area engages in fishing and recreation activities. Researchers worldwide declare that climate warming causes the rise of the level of the world ocean. It is forecasted that the water level in the Baltic Sea may rise by 0.3–0.6 m throughout the 21st century. Sea water level by Lithuanian coasts rises by 6.5 mm per year. If such water rise rate persists, sea water level by Klaipėda at the end of the 21st century would be by 0.65 m higher than the level to date [79]. Theoretical conclusions, experience of other regions of the world and analysis of the status of Lithuanian coasts show that upon rise of water level by 9 cm, the transverse profile of our coasts will gradually start changing, and when water level jumps up to 0.3 m, essential transformation of coasts will begin. With water level rise by 0.6 m or more, the coastline will start changing drastically and part of the territory

will be flooded. Such conclusions can be confirmed by investigations into changes of coast formation processes under conditions of surge during different-strength storms. The rise of the Baltic Sea water level would mostly affect Lithuanian coastal areas by Nida, Pervalka-Juodkrantė, Palanga-Būtingė. General coast degradation would firstly embrace coastal areas which already now are short of sediments because of natural reasons or anthropogenic activity. The Klaipėda seaport impact zone as well as other coastal areas suffering negative effects of hydrotechnical settings can primarily be designated as such areas. From the perimeter of the Curonian Lagoon, coastal areas situated north of Dreverna and Kintai settlements as well as the Nemunas delta part belonging to Lithuania are the lowest and most hazardous areas in the face of flooding. The Curonian Spit's coast of the Curonian Lagoon will become exposed to all active coast formation processes and eastern contours of the spit would be evened and become straight. Water level rise will stimulate more frequent salty water invasions in the Curonian Lagoon and gradual change of ecosystem of its northern part, which will be increasingly inhabited by plant and animal species adapted to dwell under salty conditions. Water level rise, more frequent storms and mighty coast washouts in recent decades pose threat to resort sites. This is especially notable in Palanga beaches, which lose sand and are catastrophically narrowing. Increasing water level, greater frequency of hurricanes and storms will greatly affect Baltic coasts, beaches and will necessitate new coast management ways and investments. If no planned actions are taken, water level rise can cause serious socioeconomic problems.

6.2.5. Human Health and Well-Being of Society

Climate warming has a clear direct and indirect impact upon human health and well-being of society. Disregarding shortage of special investigations, certain phenomena observed in the recent decade deserve greater attention [78]. Wide spread of ticks transmitting tick-born encephalitis and Lyme disease is registered all over the territory of Lithuania, Eastern Baltic region and Scandinavia. Furthermore, vector-borne diseases could emerge with invasion of, for example, malarial mosquitoes. Parasitological investigations show rapid spread of malaria agents in birds during their migration through Lithuania. Rapidly spreading bloodsucking insects in recent decades cause great problems in South Lithuania, in particular Druskininkai health resort. The resort is becoming unattractive for persons undergoing treatment. Bloodsucking insects are a great problem in animal husbandry: lots of animals die and farmers incur losses. Similar situation was observed in Northern Lithuania in the year 2005. Many animals died from mosquitoes in South Latvia. Rapidly increasing numbers of bloodsucking insects, spread of diseases transmitted by ticks, outbursts of parasites and diseases will affect human health and consequently health and well-being of the whole society. Pollen spread timing and change cause new problems for prophylaxis and therapy of allergic diseases. New additional studies as well as methods and ways of treating such diseases are necessary. Greater frequency of extreme air phenomena brings about new problems and losses for the society. Shorter and irregular snow cover will have negative effect upon winter sport, tourisms and recreation in Lithuania.

6.2.6. Rivers, Floods and Their Possible Impacts

In forecasting river runoff changes in the 21st century, ECHAM4 (predicting the greatest changes) and GFDL-R30 (predicting the smallest changes) global climate models have been relied upon. Distribution of river runoff in the course of the year will alter with climate change. Changes depend both upon climate model and geographical position of the basin. The greatest changes are forecasted for the hydrological area of Žemaičių highlands. The runoff of autumnal flood will increase in particular. It will start later and reach maximal values in December. The values of water level drop in winter will also increase and the whole water-level-drop period will hardly last a month or two. It is forecasted that by the end of the 21st century, autumnal flood will nearly merge with spring flood in some rivers. Thus, only two periods will be left in the annual regime of such rivers – cold period characterized by great runoff and warm period with less abundance of water [79]. Moreover, it is forecasted that mean values of autumnal flood in some rivers will be higher than those of spring floods. Spring floods will also start earlier with maximum runoff moving from April back to March or even February. In the warm season of the year, runoff will hardly change. June-July runoff values are expected to be slightly above the mean long-term value, whereas in the second part of the warm season runoff will decrease.

Hydrological changes were not so expressed in the hydrological area of middle Lithuania. According to ECHAM4 and GFDL-R30 climate models, runoff during spring floods will even increase in most rivers of the area. With changes in climate, the cold season of the year will be characterized by a continu-

ous greater runoff period: water level rise starting in November will drag through January and February up to the maximum runoff in March related to earlier snow thawing and increasing precipitation. In the warm season of the year, runoff will slightly increase in the first half and decrease in the second half of the season likewise in Žemaičių highlands (Figure 6–14). Due to the reasons already mentioned above, duration of the lowering of water level in the warm season will slightly increase.

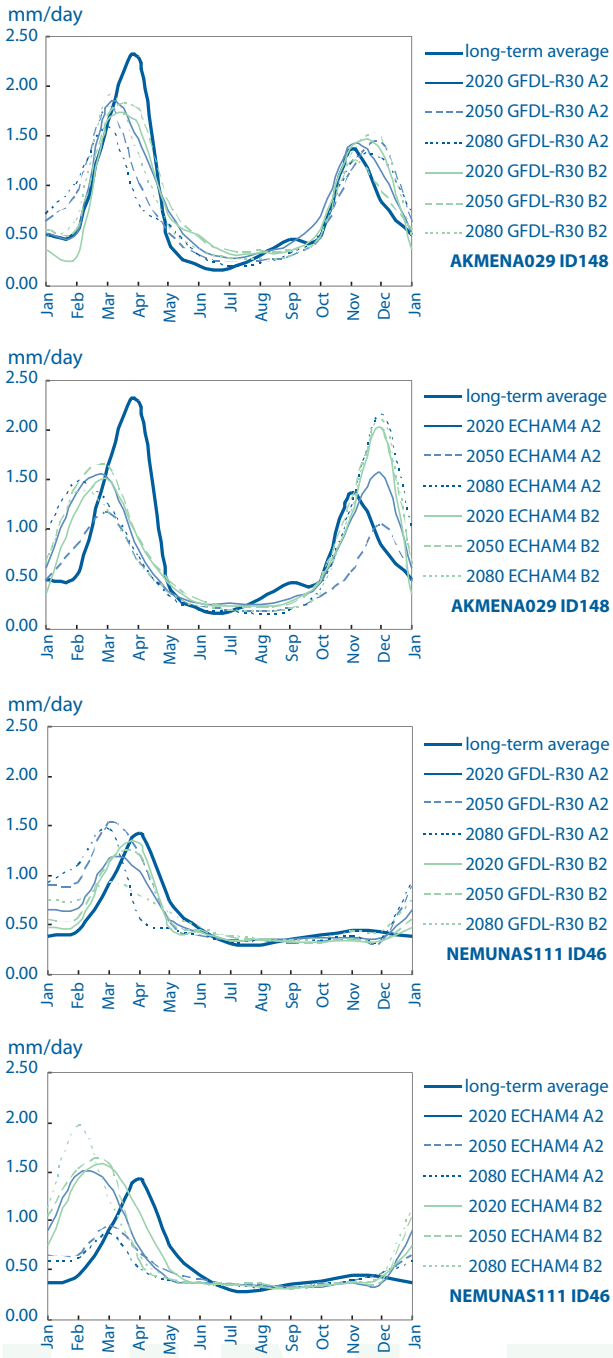


Fig. 6–14. Forecasted seasonal runoff changes in rivers of Žemaičių highlands (the Akmena river near Paakmeniai settlement) and the largest rivers of Lithuania (the Nemunas near Smalininkai) based on ECHAM 4 and GFDL-R30 climate models (according to A2 and B2 GHG emission scenarios) in 2020, 2050 and 2080

Runoff changes in rivers of the hydrological area of Southeast Lithuania are forecasted to be very diverse and dependent both upon the size of the basin and the number of factors regulating runoff. For example, in river basins teaming with lakes the volume of flooding should decrease still further and by the end of the 21st century runoff seasonality will nearly disappear due to a lower possibility of the formation of constant snow cover. As to river basins with considerable part of light ground, their runoff values are expected to even increase during floods.

The largest rivers of Lithuania (Nemunas, Neris) will exhibit features common to all hydrological areas. January-February runoff will increase markedly therefore even if the volume of flood slightly increases its wave will not be as well expressed as it is now, which can be due to the marked increase in precipitation in the cold season and decreasing water accumulations in snow. Some climate models forecast a sharp decrease in spring floods by the end of the 21st century, which again can be related with a lower possibility of the formation of constant snow cover and shortening of the accumulation period due to drastic increase in air temperature in winter. The latter factor will also condition the shifting of spring floods back to March and February. In the warm season, runoff fluctuations will be insignificant and will scarcely differ from runoffs today.

The greatest river runoff changes are expected in middle Lithuania, where it will increase by 20–40% by the end of the century. Whereas in other hydrological areas annual runoff fluctuations will be insignificant – in such areas climate change will be mostly reflected in the seasonal runoff distribution.

Changes in the degree of extremeness of atmospheric phenomena and precipitation regime cause increase in the frequency and volume of floods and, consequently, amounts of material losses incurred in connection therewith. In most European regions, including Lithuania, precipitation amount extremes are expressed better than the average tendency. Since the year 1976, increase in the number of extremely rainy days was observed in central and northern Europe, and decrease in southern Europe. It is forecasted that cases of intensive precipitation will be more frequent in Lithuania therefore a risk of floods will increase. Besides, due to temperature rise precipitation in winter will increasingly fall in the form of rain, which will cause rapid water flow and increase a risk of floods. It is forecasted that climate change and increasing showers can make such floods even more frequent in Lithuania. In particular, sudden, severe and local-

ized floods in unexpected places will become more frequent, which can increase numbers of injured, e.g. floods of August 2005 in western and southeastern Lithuania, which brought about considerable losses for the residents (flooded residential areas, evacuation of local residents). In the future, flood frequency and intensity tendencies will be closely related with precipitation changes, changes in river debit models and, at the same time, with long-term climate change. Although most forecasts still contain lots of obscurities, researchers are more and more relying upon climate models as possible tools to evaluate future situation. However, such investigations are still not a priority in our country.

6.3. Adaptation and Mitigation Measures

Measures for adapting to climate change and mitigating climate change impacts are various, among which the global reduction of GHG emissions should be pointed out in the first place. For the purpose of reduction of GHG emissions, the Government of Lithuania set a number of measures complying with the UNFCCC requirements such as energy saving, rational and efficient energy use, cutting of losses, development of alternative energy (solar, wind, water), wider use of biotransport, etc. [90]. Furthermore, the Government is making steps towards amendment of the legal basis and initiation of joint transboundary projects. Measures for the implementation of the UNFCCC are included into a number of strategies, namely, National Strategy for Implementation of the UNFCCC, State Long-term Development Strategy, National Sustainable Development Strategy, Long-term Economic Development Strategy of Lithuania until 2015, National Communication on Implementation of the UNFCCC and draft amendments to the National Strategy approved by the Government of the Republic of Lithuania in 1996. Considerable measures are taken to carry out research into climate change impact upon different spheres, create scenarios of possible impacts, define ways of mitigation of impacts, and raise public awareness. For more details see special Chapters 4, 5, 6, 7 and 8 of the present Communication. This Chapter describes adaptation and mitigation measures applicable to certain branches of economy (energy, agriculture, forestry, and health protection) and environmental protection.

6.3.1. Agriculture

Promotion of environmental protection and ecological farming fostering biological diversity and landscape is one of three key strategic goals of the Ministry of Agriculture for 2005–2007 [81]. One of special programmes of the ministry is the Programme for Promotion of the Development of Biofuel Production. According to the programme, 30,000 t of rape grain and 30,000 t of triticale and rye produced in the country in 2005 should be used otherwise than for food, market of agricultural products should be expanded, 7.2 thous t of bioethanol and 10 thous t of rape methyl ester should be produced. Until 31 December 2005 biofuel should account for no less than 2% of the aggregate amount of petrol and diesel fuel intended for transport in the domestic market; and until 31 December, 5.75%. 7,799 thous LTL are allocated for the implementation of the programme in the year 2005. The Ministry of Agriculture pointed out to the following activities related to the UNFCCC: afforestation of uncultivated land; use of agricultural waste for the production of energy, cultivation of new energetic plants for alternative energy (source: Infrastructure and Reclamation Department of the Ministry of Agriculture).

The Ministry of Agriculture is seeking to develop technologies enabling better and more efficient use of renewable local energy sources and mitigation of hazardous emissions. Therefore it is important to implement the principles of sustainable farming in the country as soon as possible. Mitigation of pollution caused by nitrates from agricultural sources is an important part of such farming. The ministry has prepared the State Programme for Mitigation of Pollution Caused by Nitrates from Agricultural Sources. The purpose of the programme is to ensure sustainable development of agriculture in harmony with environment. The objective of the programme is – through application of scientific research – to select and recommend the most efficient measures for mitigation of pollution by nitrates from agricultural sources, standardize the use of nitrogen fertilizers, including manure and other organic fertilizers balanced according to the needs of plants, to involve research and education institutions and consultancy services in the monitoring of pollution from agricultural sources.

In the 2005–2007 strategic action plan, the Lithuanian Institute of Agriculture indicates close relationship of research pursued by the institute with climate change impact. Institute's research works into global climate change impact upon agriculture, vegetation and environment show an increasing use of species of drier climate and farmers' initiatives to apply agricultural technologies of drier climate. Another research trend of the institute is to carry out investigation of

ecologically sustainable multifunctional legume and gramineous and search for renewable energy resources for agriculture. Another important research trend is ecological agricultural production. The measures for implementation of the trend are set in the action plan projected by the Government and in the Law on Agriculture and Rural Development. Since 1997, the number of ecological production farms and certificated areas has increased by about 35% per year on average. Upon increase of payouts in 2004, the number of certificated farms and areas increased by about 80%. It is forecasted that certificated areas will increase by about 40–50% per year on average until 2010. Ecological farming should be further expanded and promoted.

6.3.2. Forestry

To enhance the country's adaptation to climate change, CO_2 removal is being increased by planting new forest areas and by carrying out afforestation in barren and unused agricultural land [80, 82, 83, 87–89]. Changes in forest and other woody biomass stocks in Lithuania reduced total CO_2 emissions by 40.6% in 2003 (by 10.8% in 1990). Forestry is subsidised by the EU funds provided according to the General Programming Document and Rural Development Plan. In 2004–2006, a total of 113 million LTL is intended for planting new forests and for the development of forestry. The total amount of support during 2004–2006 would allow planting 12 thous ha forest, or 4 thous ha forest per year. Agricultural land is also used for afforestation.

6.3.3. Environmental Protection, Rivers, Lakes and Coastal Zone

If climate warming forecasts come true, most of the country's natural ecosystems will become vulnerable. Therefore a need arises to intensify special investigations with a view to determining the scope of impact and possible means and measures for reduction and mitigation. A shortage of such measures is primarily felt in conservation of protected territories (including NATURA 2000 areas), red-listed species and communities, certain ecosystems (wetlands, in the first place) and habitats. So far, no strategy or vision to protect the above-mentioned values and to respond to the ongoing processes and expected changes has been designed, nor have the principles and ways to designate protected areas and protect species been changed in the face of climate change impact.

The Government and Palanga Resort Municipality have already paid attention to climate change impacts upon the Baltic Sea coasts and coastal resorts, by designing special protection and management programmes intended to stop the beach degradation process, which requires special research and great investments. The coast management project will be financed from the EU funds (5.6 million LTL) and funds allocated by the Government. Solely for coast reinforcement and protection from erosion, 0.5 million LTL was spent in Palanga in 2004.

Water fluctuation amplitudes must be taken into account in developing different land and water management projects in relation to distribution of beaches, camp sites for rest, boat landing stages and pumping stations in areas surrounding lakes and rivers.

6.3.4. Human Health

No adequate attention is paid to human health protection under climate change conditions [86]. Special investigations on the scope of climate change impacts are missing, little attention is paid to prophylaxis of certain diseases and illnesses, educating the public and raising its awareness. The Government is annually allocating significant amounts for the extermination of bloodsucking insects in the Nemunas River however the problem is not so far finally settled.

6.4. Guidelines for Further Work

One of the key objectives in carrying out the UNFCCC is consistent implementation of the already created national and adapted EU legal basis, designed strategies, action plans, Government resolutions and acts, regulations and plans of adopted programmes. It is important to make designed projects and created mechanisms work and fully implement them.

Greater attention should be paid to the search for alternative energy sources and to the readiness to fulfill commitments to the EU. So far the Government does not have any clear vision about prospects of alternative energy development. Furthermore, inadequate legal basis hinders investments in this area.

It is highly important that the UNFCCC implementation would cover a possibly wider array of problems and spheres, all branches of economy and all environmental areas where climate change impacts are felt or probable, though not ascertained. Special attention should be paid to agriculture and forestry, health protection and environmental protection, in particular – principles of designing the system of protected areas, management of such areas under variable climate conditions, impacts upon red-listed species and communities, NATURA 2000 territories and habitats.

Of great importance is the conservation of the band of sea coast dunes in the Baltic Sea part belonging to Lithuania, protection of beaches from degradation, which is currently very intensive due to increasing sea water level, more frequent storms, improper use of marine landscape and protection infringements.

Great focus should be put on educating the public and building its awareness. So far the level of informing the public is inadequate. All possible measures should be used for the spread of information – popular publications especially in the Lithuanian language, posters, booklets, TV and radio programs, inclusion of appropriate information into school textbooks, promotion of preparation and issue of other publications related to the UNFCCC issues on climate change impacts, vulnerability assessment, adaptation and mitigation possibilities. Popular information should both present current climate change impacts upon society and the country and demonstrate what will happen to all of us on the Earth if climate change is not slowed down. Such publications and programmes should explain how each member of society should behave in order to mitigate climate change impacts or adapt to such impacts. All levels of society should be educated – from kindergarteners and schoolchildren to the Seimas and Government members. Everybody must know what is happening on the Earth, how serious the problem is and what we can expect in this century.

6.5. Sources

78. Action Plan 2002–2005 for Implementation of the Lithuanian National Public Health Care Strategy // *Valstybės žinios*, 2002, No 12–426.

79. Bukantis, A., Gulbinas, Z., Kazakevičius, S., Kilkus, K., Mikelinskienė, A., Morkūnaitė, R., Rimkus, E., Samuila, M., Stankūnavičius, G., Valiuškevičius, G., Žaromskis, R. The influence of Climatic Variations on Physical Geographical Processes in Lithuania // Institute of Geography, Vilnius University, Vilnius, 2001.

80. Conservation and Sustainable Management of Forests in Central and Eastern European Countries. The European Union's PHARE Programme, 1999.

81. Ecological Agriculture Programme // *Valstybės žinios*, 2002, No 115–5177.

82. Forests of Lithuania / Ministry of Forestry of the Republic of Lithuania // *Baltijos aras*.

83. Lithuanian Forest Increase Programme // *Valstybės žinios*, 2003, No 1–10.

84. Lithuanian Renewable Energy Server: Solar Energy, Hydro Power, Biomass, Geothermal, Wind Power, Renewable Energy: Who? Where? When? (available at http://saule.lms.lt/main/hidro_e.html; solar_e.html; biomass_e.html; geo_e.html; wind_e.html; edu_e.html; progr_e.html)

85. Lithuanian National Public Health Care Strategy // *Valstybės žinios*, 2001, No 66–2418.

86. Lithuanian Statistical Yearbook of Forestry 2003 // Ministry of Environment of the Republic of Lithuania, State Forest Survey Service, Kaunas, 2003.

87. Lithuanian Statistical Yearbook of Forestry 2004 // Ministry of Environment of the Republic of Lithuania, State Forest Survey Service, Kaunas, 2003.

88. Ministry of Environment – the European Union Financial Support to Forestry (available at http://www.am.lt/VI/article.php3?article_id=2085)

89. Paulauskas, S., Paulauskas, A. Lithuanian Wind Energy: Creation of Possibilities (available at http://www.eksponente.lt/vejas/vejo%20energetika.pdf)

90. Švažas, S. Possible Impacts of Climatic Conditions on Changes in Numbers and in Distribution of Certain Breeding and Staging Wildfowl Species in Lithuania // Acta Zoologica Lituanica, Vol. 11 (2), 2001. P. 163–182.

91. Žalakevičius, M. Wildlife Response to Climate Warming: Evidence, Future Research and Co-operation Prospects // Acta Zoologica Lituanica, Vol. 15(2), 2005. P. 199–203.

92. Žalakevičius, M. (Ed.) Fauna and Climate Change: Part I, II // Acta Zoologica Lituanica, Vol. 11, 2001.

93. Žalakevičius, M., Švažas, S. Global Climate Change and Its Impact on Wetlands and Waterbird Populations // Acta Zoologica Lituanica, Vol. 15(3), 2005. P. 211–217.

THE REPUBLIC OF LITHUANIA

Lithuania's Third and Fourth National Communication on Climate Change

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

CHAPTER 7

Research and Systematic Observation

VILNIUS, NOVEMBER 2005

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF LITHUANIA

INSTITUTE OF ECOLOGY OF VILNIUS UNIVERSITY

CHAPTER 7. Research and Systematic Observation

7.1. General Policy on Research and Systematic Observation

The system of research and higher education was reformed in Lithuania after the restoration of independence of the State in 1990 [104]. The Lithuanian higher education system joins 21 higher education institution (6 of which are non-public) in the university sector and 27 higher education institutions (11 of which are non-public) in the non-university sector [109]. There are 35 state research institutes in Lithuania, 18 of which are university research institutes. The Law on Science and Studies (1991) and the Law on Higher Education (2000) constitute the legal basis for universities and research institutions. The above statements clearly show that the Lithuanian research and higher education system focuses on the basic research and educational function of research [104]. State research establishments carry out applied research and experimental development (R&D) activities. However research capacities of such establishments are least developed than those of other two types of research institutions.

The major part of Lithuanian science and development capacity is concentrated in universities and research institutes. There are three types of research institutions in Lithuania, whose mission is stated in relevant legal acts, namely:

- University research institutes established to carry out research of high international quality. They focus mainly on basic research and provide research basis for university education, doctoral studies and improvement of scientific qualification of university personnel;
- State research institutes established to carry out long-term research of international quality important for the Lithuanian economy, culture and international cooperation. Research activities that state research institutes perform involve groups of specialized scientists and require data collection and specialized experimental instruments. State research institutes together with higher education institutions help to train specialists;
- State research establishments aiming at carrying out R&D activities important for the Lithuanian economy and culture, for the development of industry, state government and other institutions.

The majority of higher education and research institutions are within the jurisdiction of the Ministry of Education and Science. The Science Council of Lithuania assists the Seimas and the Government. The Lithuanian Universities Rectors' Conference represents universities of Lithuania and the Lithuanian Research Institutes Directors' Conference stands for Lithuanian research institutes. The independent Higher Education Quality Evaluation Centre carries on quality assessment of research and higher education. The Lithuanian Academy of Sciences acts as an expert of Lithuanian science and higher education. Nearly all research and higher education institutions are concentrated in four largest cities: Vilnius, Kaunas, Klaipėda, and Šiauliai.

Lithuanian Science and Technology White Paper document, published in 2002, drew up the long-term development strategy and general policy in science and technologies. The initiative of the Lithuanian Academy of Sciences to compile the White Paper was supported by the academic community. It was discussed by scientists, Lithuanian Confederation of Industrialists, Ministries of Agriculture, Environment and Economy.

The document concluded that transparent and active Government policy in the areas of higher education, research and innovation is missing. Lithuania still has no effective institution, which could prepare well-formulated decisions on the policy of higher education, research and technologies. In strategic issues, the opinion of the Ministry of Education and Science is not always taken into consideration by more influential ministries, such as the Ministry of Economy or the Ministry of Finance, which prevents from preparing proposals for the strategy of the Lithuanian innovation system on a more professional level (including applied research in the scope of the UNFCCC). Consequently, the potencial of Lithuanian science is not appropriately employed for the implementation of UNFCCC requirements and country's obligations. Moreover, a lack of co-operation between scientific institutions is one of weak points.

Projections for state research and systematic observation are provided for in the 2003 National Sustainable Development Strategy with the following long-term objectives: develop well-educated, independent, active and responsible members of society and enhance intellectual society potential so that knowledge and science would ensure sustainable implementation of economic, social and environmental goals. To succeed in the above long-term objectives, it is necessary

inter alia to ensure continuous development of research and technologies allowing building the knowledge society based on science, newest low-environmental-impact technologies, and innovations.

The total amount of expenses for R&D in Lithuania remains rather low (merely 0.68% of GDP) though the European Council has established that by 2010 such index in the European countries should reach 3%. Lithuania is still characterized by low R&D potential in the private sector, insufficient cooperation between researchers conducting state-aided investigations and the private sector.

R&D in Lithuania is mainly subsidized from the state budget. Though the network of research and higher education institutions is rather well developed, the base of research and higher education has not actually changed since the restoration of independence of the State and has become rather out-of-date, which limits possibilities of doing research according to the needs of economy, environmental protection, etc. Human aspect in the context of R&D is also of great importance. In 2001, R&D activities comprised 14,980 people, including 5,130 researchers (34% of all employees). By the official index of the total number of researchers (full-time equivalent), Lithuania nearly reaches the average of EU countries. However two problems exist. First, researchers are basically concentrated in the sector of higher education (71%) and in the public sector (27.7%) whereas the private sector, NGOs and non-profit research organisations have merely 0.8% of all researchers. In the recent decade, our scientific society aged considerably, cf. 55% of researchers were more than 50 years old in 2000, whereas to date more than 60% of researchers are over 50 and 25% are over 60. According to estimations, 300–400 young researchers should start working in the R&D sphere to satisfy minimal regeneration needs. However, merely 200 doctors are prepared in Lithuania; moreover a great part of young researchers emigrate to Western countries because salaries in Lithuania are still very low. In addition, great problems exist with the experimental base and funding, which is only partial. Research institutions must search for additional funding in order to survive. Meanwhile the Lisbon Summit March 2000 formulated the main strategic goal: until the year 2010, the knowledge-based EU economy has to become the most competitive and the most dynamic all over the world.

Currently, the main problems we encounter are: the absence of research strategy, the failure to formulate state orders with respect to research, partial funding of research, out-dated and inflexible system for the assessment of research institutions and researchers, which does not stimulate performance of works necessary for the state and fulfillment of state orders, lack of co-operation between scientific institutions. Too little attention is paid to research by ministries failing to place orders for research works, whereupon international projects and orders of foreign foundations and institutions dominate in state research institutions.

Research in the field of climate change and climate systems represents only a minor share in R&D, which is a consequence of a small number of organisations working in this field, existing national priorities in this field of R&D, and poor co-operation between institutions of all levels.

7.2. Research

7.2.1. State of Research

Upon signing by Lithuania of the UNFCCC in 1992 and upon ratification thereof in 1995, the National Strategy for the Implementation of the UNFCCC and the action programme providing for a number of research works was developed. The requirements of the UNFCCC for special research investigations are also reflected in other environmental strategies created by the Ministry of Environment, namely, the Biological Diversity Protection Strategy, Strategy on Raising Environmental Awareness of the Society (Training, Educating, Informing). The state complex research programme ECOSLIT and the State Ecological Monitoring launched in 1992 (since 2005 it is performed according to the programme meeting the EU requirements) played a certain role in implementing the requirements under the UNFCCC. The latter programme was created with participation of experts from different research institutions representing various branches of research.

Although the level of research and technologies in Lithuania in certain research trends is high, a number of problems still remain unsettled such as inadequate level of application of research in practice and in strengthening economy, insufficient research funding, inadequate use of knowledge and achievements in separate sectors of economy and in environmental protection. Nevertheless, research in Lithuania is actively integrating into the international research network and becoming a sound part thereof. Under the financial support of the U.S. Department of State, the researchers of the Institute of Ecology of Vilnius University carried out two research projects related to the

creation of a long-term ecological research network in 2004–2005 [110]. With participation of other research institutions (Vilnius University, Institute of Botany, Institute of Geology and Geography, Klaipėda University, etc.) the Long-term Ecological Research Network (LTER) was designed on the base of the Institute of Ecology of Vilnius University and crowned by a conference on research conducted under the network. In November, 2005 during the international conference of parties in Mexico the Long-term Ecological Research Network of Lithuania was incorporated into the International Long-term Ecological Research Network (ILTER). The following areas have been chosen as thematic priorities of the network: global climate change and its impact on the nature and society of the country, biological diversity and its conservation, environmental quality assessment and enhancement. The following territories that in the best way meet the requirements of the network have been chosen as LTER polygons: the Baltic Sea coastal area, Lake Drūkšiai area, Čepkeliai and Kamanos Strict Nature Reserves. In co-operation with researchers of other neighbouring countries (Latvia, Russia, Belarus, Ukraine, Poland) and researchers working in the ILTER network, it is intended to initiate a number of research projects and obtain new results in the areas of the impact of climate change on ecosystems, society and certain branches of economy and environmental protection, to determine susceptibility, possible vulnerability and adaptation of separate ecosystems in the country.

Having taken into consideration thematic priorities under the EU Framework Programme for Research, in 2002 the Government approved the underlying national research priorities, including financial support in 2003–2006 in the area Changes in Ecosystems and Climate, which complies with the thematic priority Global Change and Ecosystems under the EU 6th Framework Programme and remains urgent in the scheduled projects under the EU 7th Framework Programme for Research. To promote projects of underlying research priorities, in 2003 the Lithuanian State Science and Studies Foundation organized a public tender. The project Impact of Global Climate Change and Human Activities on Ecosystems: Sensitivity, Vulnerability, Adaptation and Evolution designed by seven Lithuanian and foreign partners was submitted for the tender. Researchers from Latvia, Russia, Belarus, Ukraine, Max Planck Institute for Ornithology of Germany, M. & P. Curie University in France agreed to be partners to the project. In spite of the support by the Ministry of Environment and high priorities and urgency of the project on the national scale, the project did not win the tender, whereupon a possibility to collect unique material necessary for the National Communication, for the updating of the UNFCCC strategy and preparation of regular National Inventory Reports (NIR) was lost. In 2005, the Lithuanian State Science and Studies Foundation invited for a new tender within this thematic priority. However, the project Regional Indicators of Climate and Anthropogenic Activity upon Ecosystems designed by three strongest research institutions of the country (Vilnius University, Institute of Ecology of Vilnius University, and Institute of Botany) in cooperation with foreign partners did not get financing, and investigations into the impact of climate change upon ecosystems were not started though again supported by the Ministry of Environment.

In spite of the above difficulties, the main research related to the fulfillment of commitments under the UNFCCC is carried out in Vilnius University, Institute of Ecology of Vilnius University, Lithuanian Energy Institute and, partially, in state research institutes (Institute of Geology and Geography, Lithuanian Institute of Agriculture, Institute of Agriculture Engineering of Lithuanian University of Agriculture, and Institute of Botany).

The Department of Hydrology and Climatology in the Faculty of Natural Sciences of Vilnius University performs analyses and forecasts of Lithuanian climate, prepares climate change future scenarios [95–102]. The department cooperates with the Lithuanian Hydrometeorological Service under the Ministry of Environment. In 2000–2003, Vilnius University participated in the project European Flood Forecasting System (EEFS) under the 5FP of the European Commission. Currently, Vilnius University is running the project Origin of Organic Substances in Aerosol and Interaction with Climate Parameters with the Institute of Physics and National University of Ireland, the project Impact of Climatic Fluctuations on Geographical Processes in Lithuania with the Institute of Physics and the Institute of Geology and Geography, the international project European Climate Assessment & Dataset coordinated by the Netherlands Royal Meteorological Institute and executed in Lithuania by Vilnius University, Institute of Geology and Geography, Lithuanian Hydrometeorological Service. Vilnius University is running projects Climate Change and Quantitative and Qualitative Fluctuations of Lithuanian Water Resources, Responses of the Hydrosphere to Climate Fluctuations at Different Time-Scales, etc.

Vilnius University in co-operation with other institutions arranged a number of different-level con-

ferences and seminars directly related to the implementation of the UNFCCC, namely the seminar European Flood Forecasting System and its Applicability in Lithuania; international video conference Climate Change and Citizenship organized by the British Council; international conference Solar Energy: Possibilities and Perspectives for Northern Countries; international conference Problems on Coastal Management of the Baltic Sea; conference Meteorology and Hydrology in Lithuania: Development and Prospects.

With respect to the commitments of Lithuania under the UNFCCC, in 2003 the Institute of Ecology of Vilnius University changed its research trends. Three new research priorities have been approved by the Government and are financed by the state. Each year, the institute carries on research to obtain new results on the impact of global warming upon ecosystems, habitats, animal communities, species and populations, as well as on their abundance, change in distribution areas, as well as the state and change trends of populations. Furthermore, within a period from the submission of the UNFCCC NC2 to the Secretariat of the UNFCCC, researchers of the institute implemented a number of projects directly and indirectly related to the fulfillment of the UNFCCC commitments.

Researchers of the Institute of Geology and Geography carry on research on the dynamics of Baltic coasts with a view to determining possible impact of global warming and other related phenomena – hurricanes, sea level change – on the state of coasts, recreation, tourism and the only seaport of the country.

Researchers of the Lithuanian Energy Institute focus their research activities on several areas, some of them being directly related to the implementation of the UNFCCC – trends and potential of the development of alternative energy, technologies, problems and possible ways to mitigate GHG emissions.

The Institute of Agriculture Engineering of Lithuanian University of Agriculture pursues research in the area Research on Conversions of Renewable Energy Sources and Plant Products and Their Waste to Obtain Non-nutrient Substances.

In order to increase the efficiency of the use of solar energy and make equipment cheaper, relevant researches are conducted at the Semiconductor Physics Institute, Institute of Physics, Kaunas University of Technology, Vilnius University, research on solar and wind energy is pursued at the Institute of Agriculture Engineering of Lithuanian University of Agriculture [94, 113, 114].

Applied research conducted at the Lithuanian Institute of Agriculture is intended for the maintenance of soil richness, slowing down soil degradation, improvement of soil tillage and cropping technologies, which save energy and resources, under the conditions of climate change and change in market demands, as well as enhancement of production quality. Besides, research is done to protect cultures from diseases and pests, the distribution and dynamics whereof depend upon climate and its change.

Lithuanian researchers carried out investigations into climate impact on water volume of Lithuanian rivers, relationship between the water level of rivers and swamps and climate change, climate impact on tree radial increment formation. However, all said works are only indirectly related to the implementation of the UNFCCC and may serve as models adapted under Lithuanian conditions.

Not all ministries are planning research works related to climate change though this is declared in their strategic plans. For example, the Ministry of Agriculture does not take into consideration the designed climate change forecasting scenarios in adapting plant species and sorts to agroclimatic conditions of Lithuania. The ministry does not observe the UNFCCC requirements, nor order any special research, including research how to use agricultural methane gas in the production of energy. It is not clear so far how the country will increase the part of alternative energy and fulfill related commitments. The Ministry of Economy has not made a resolve yet as to what alternative the country should choose in the sector of energy. A wish of the private sector to develop wind energy is still not supported; the intent to expand water energy in the country of flatlands fails to meet environmental requirements and requirements of signed and ratified international conventions as well as possibilities to markedly increase the part of alternative energy due to low efficiency of hydro power plants. Actually, the country hardly has any other efficient alternatives; special research works are not funded.

NGOs play an important role in the process of implementation of the UNFCCC in Lithuania. They seek to use all available national scientific potential and lobby state officials for attaining common purposes. One of such organisations is the Regional Environmental Center (REC) for Central and Eastern Europe in Lithuania. The organisation is running the project of the UNDP and the Ministry of Environment National Capacity Self-Assessment for Global Environmental Management. The project covers climate change impacts upon ecosystems, registration of GHG, introduction of gas technologies and different tools, including international instruments. The project

concluded that the interaction between R&D and state institutions in implementing the convention is inefficient, officials responsible for the strategic planning do not take part in designing state orders in the area of developing research and technologies, applied research does not enjoy adequate financial support – the greatest part of research related to the implementation of conventions in Lithuania was carried out according to international projects, which proves that the care of the state for the performance of international commitments is far from being sufficient.

7.2.2. Impacts on Ecosystems and Their Components

Climate change created ideal conditions for the natural experiment in the nature allowing observation of natural regularities, which seemed to be clear, ecologically defined and recognized, from a new perspective. Most of relations established in ecosystems in the course of evolution under more or less stable environmental conditions were found to be within amazingly narrower ranges of their possible variations compared with the potential adaptation possibilities acquired in the course of evolution. Climate fluctuations allowed looking at the natural phenomena anew, adjusting and establishing the entirety of natural phenomena on an array wider than usual conditions, which is very important in modeling wildlife processes – models created under specific conditions can not always adapt to other natural conditions. A wider spectrum and the occurrence of extreme conditions sometimes overstepping the limits of possibilities allow observing natural phenomena in their new quality. This is one of the reasons why an interest in climate change impact mechanisms has arisen in ecology, biology, environmental protection. Nevertheless there is still a shortage of such type investigations. Different climate change trends in time and space also determine a necessity of such investigations: climate change trends in Lithuania are different from those in Western and Central Europe.

The national research programme Ecological Sustainability of Regional Development in the Historical Context: Lithuanian Example (ECOSLIT, 1992–1998) carried out a decade ago was devoted to the interaction of all components of the regional system: atmosphere, soil, water, fauna and society under the impact of anthropogenic pollution [103]. Unfortunately, the programme was poorly related to climate change problems and possible impacts on ecosystems, including vulnerability, sensitivity, adaptation or mitigation.

Research investigations currently pursued at the Institute of Ecology of Vilnius University suggest climate change impacts both on individual ecosystems and on their components – species, communities and habitats. After the preparation of UNFCCC NC2, new data have been obtained on the impact of climate change upon [108, 115–120]:

- Biological diversity;
- Spring arrival of birds;
- Periods, dynamics, distances and directions of bird migration;
- Breeding timing of birds;
- Shifting of birds breeding ranges;
- Selection of birds wintering areas and changes in wintering populations;
- Restructuring of the bird species composition breeding in Lithuania;
- Changes in Important Bird Areas and habitats;
- System of protected areas and their values.

7.2.3. Research and Development of Technologies for Adaptation to and Mitigation of Climate Change Consequences

By conducting planned scientific research, researchers and laboratories of Lithuanian Energy Institute, the Institute of Agriculture Engineering of Lithuanian University of Agriculture are solving the issues of the use and development of alternative energy sources in the country. The Lithuanian Energy Institute is engaged in creating GHG emission reduction technologies. Research on the increase of efficiency of the use of solar energy and making equipment cheaper in Lithuania are conducted at the Semiconductor Physics institute, Institute of Physics, Kaunas University of Technology and Vilnius University. Researchers of the Institute of Agriculture Engineering of Lithuanian University of Agriculture, Lithuanian Institute of Agriculture are creating soil tilling and cropping technologies saving energy and resources, technologies to improve production quality under climate change conditions. Besides, research is pursued on the protection of cultures from diseases and pests, the distribution and dynamics whereof largely depend upon climate and climate change. In agriculture, a need to adapt species to the changing climate conditions of the country has emerged. Higher temperatures would increase a risk of pests and plant diseases resulting in an increased demand of pesticides. At the same time, increased production would require more fertilisers, which would increase the risk of nitrate leaching. The Institute of Ecology of Vilnius University has prepared methodical recommendations to increase efficiency of conservation of biological diver-

sity in the protected areas. The problems arising will require involvement of new research activities, additional financing and human resources.

7.2.4. Socio-Economic Analysis

The country still lacks information about climate change impact on society – human health, spread of new diseases and increase of sickness rate, recreation and tourism, economic indices. With the change of the environment and its components new problems rise in implementing the principles of sustainable development in transport, industry, energetic, fishery and other sectors of economy. Change in biological diversity (separate species or distribution ranges of communities) gives rise to new environmental problems, which can be resolved only with the help of new financial resources for research and, consequently, redistribution of state subsidies, new unplanned expenses having an effect upon society.

In spite of difficulties, in recent years the GHG emission reduction has become among priority objectives in Lithuania. Numbers of participants in the process of implementation of the UNFCCC are increasing, all spheres regulated by the convention try to be covered, and all commitments of the state attempt to be fulfilled. In order to forecast projections on GHG emissions, society, gross domestic product, growth of industry and various sectors of economy influencing the use of energy and affecting GHG emissions, first steps in research have been made.

7.3. Systematic Observations

7.3.1. Meteorological and Atmospheric Observations

The main tasks of the Lithuanian Hydrometeorological Service under the Ministry of Environment are meteorological, hydrological and agrometeorological observations and forecasts. The service provides hydrometeorological information to the Lithuanian institutions, takes part in the international projects and programmes, prepares and publishes manuals, annals and reviews. The observation network covers the entire country. Meteorological observations in Lithuania have originated at Vilnius University in 1770. In 1945 Lithuania launched its first radiosonde and started agrometeorological observations. A meteorological observation network covers all the territory of the country and includes 18 meteorological stations, 3 aviation meteorological stations, including 9 climatological stations. A water-gauging network consists of 59 stations. The oldest one was established in 1811.

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 BALTMET system is in operation.

A strong scientific centre is the Department of Hydrology and Climatology at the Faculty of Natural Sciences of Vilnius University, being the main climatological scientific centre in the country. The main research trends of the Department are related to the preparation of climate reviews, future climate forecasts and creation of future climate scenarios and modeling. Scientists of the Department have prepared several books, monographs and papers on climate status and trends in Lithuania and in the Baltic region. Close co-operation with different international research centers on the UNFCCC research trends is maintained. A number of climatologists and climate researchers are working in other research institutions: Institute of Ecology of Vilnius University, Vilnius Pedagogical University, Institute of Physics, Klaipėda University, etc.

The Environmental Protection Agency (EPA) being a subsidiary institution of the Ministry of Environment is responsible *inter alia* for environmental quality monitoring, gathering and storing environmental data and information as well as for the assessment and prognosis of environmental quality [106, 107]. One of the main tasks of the Environmental Protection Agency is managing, processing and reporting of information related to the UNFCCC issues. So far the development and preparation of the GHG inventory has been a responsibility of the Air Division in the Ministry of Environment.

The following types of climate monitoring are carried out in Lithuania: atmospheric, water, soil, wildlife, ecosystem and landscape monitoring. All existing types of observing the climate system are essentially satisfying our basic demands for climate variability analysis. However, taking into consideration the prevailing global trends in this respect, it is necessary to proceed to observations on an hourly basis by automating our meteorological network, increasing precipitation-gauge density, upgrading instruments, better interinstitutional coordination, following unified methods and ensuring better data accessibility through a single database. Also, radar observations may be considered a very important component of specific meteorological observations; unfortunately,

currently we have no weather radars operating in Lithuania.

Alongside with fixed stationary observations, mobile observations should be organized in order to obtain more detailed data, e.g. efficient soil moisture in spring and summer periods in view of impeding drought conditions as well as other environmental and natural emergencies, etc. Recently in Lithuania we are lacking phenological observations.

7.3.2. Marine Observations

Marine observations are concentrated in the Baltic Sea and Curonian Lagoon. The main research centers are the Marine Research Centre under the Ministry of Environment, the Institute of Ecology of Vilnius University, Institute of Geology and Geography, Klaipėda and Vilnius Universities. Research related to the UNFCCC implementation issues are concentrated on the circulation and transformation of water masses, water pollution, impacts on coastal ecosystem, dynamics of coasts, biological diversity, wise use of biological resources and their protection strategies and measures. Investigations are carried out according to both national and international (HELCOM) monitoring programmes. A special USA-Lithuanian symposium was organized in the country embracing climate change issues in 2004, the next is announced to be held in 2006. Recently in Lithuania we are lacking observations on the Baltic Sea currents, water level fluctuations and change in the chemical composition of sea water. Also, we need to expand seaside wind observations.

7.3.3. State Environmental Monitoring

In Lithuania the monitoring in the area of observing the state of ambient air was launched in 1967. In the largest cities and industrial centers, concentration of basic and some specific pollutants (common dust, sulphur dioxide, carbon monoxide, sulphates, formaldehide, fenol, sulphur hydrogen, fluorine hydrogen, nitrogen oxides, metals and benzapirene) characteristic of a particular area have been measured. In 1999–2004 the network of the municipal ambient air quality monitoring was updated. In 2004, it joined 13 automatic air quality assessment stations carrying out uninterrupted measurements of the concentration and meteorological parameters of nitrogen oxides, sulphur dioxide, carbon monoxide, solid particles, ozone, benzene and toluene. Concentration of common dust, polycyclic aromatic hydrocarbons and metals in the surface air layer was measured in a semi-automatic way.

The system of background air monitoring stations allows analysing transboundary air pollution, general (background) pollution level in the country's air basin, its changes and factors causing such changes. The first station was equipped in Preila settlement in 1980. In 1993–1994 three more stations were equipped. Since 2004, a network of 3 stations is operating to measure concentrations of ozone, sulphur and nitrogen dioxides, sulphates, heavy metals, nitrates and ammonium that most intensively get into the territory of Lithuania with transboundary air flows, as well as chemical composition of precipitation. The station in Preila is operating under the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP) and the Baltic Marine Environment Protection Commission (HELCOM) Programme, other stations for evaluation of natural ecosystems according to International Cooperative Programme on Integrated Monitoring (ICP IM). The latter stations already belong to the system of international stations, their observations being strictly regulated and customary to Europe.

The Ecosystem Status Monitoring was initiated by the Convention on Long-range Transboundary Air Pollution signed by the EU countries in 1979. In 1988, 6 international co-operation programmes, including the ICP IM programme aimed at determining, evaluating and forecasting the status of relatively natural ecosystems and their long-term trends with regard to long-range transmissions of air pollutants (in particular, sulphur and nitrogen compounds), impacts of ozone and heavy metals, regional peculiarities and climate change, were initiated on the basis of the Convention. The results of the ICP IM programme allowed implementing the requirements under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes, United Nations Framework Convention on Climate Change, Convention on Biological Diversity, Vienna Convention on Protection of Ozone Layer and Kyoto Protocol. Lithuania together with other Baltic countries participates in the ICP IM programme since 1993. In implementing the ICP IM programme, the stations of complex monitoring of relatively natural ecosystems have been established in the main Lithuania's landscapes, sites of minimal anthropogenic impact and reserve zones of national parks. Within the last 10 years, the greatest focus in this global background monitoring network was put on the chemical composition of air pollutants and precipitates, soil, ground and surface waters, as well as accumulation of elements in biota, and leaching. Observations on the status of relatively natural ecosystems carried out on the national scale

provide data on the impact of pollutants brought into Lithuania from Western and Central Europe with long-range air flows and climate change upon the quality of waters and soil of territories with low anthropogenic load, biological diversity and status of forests. Moreover, such data allow recording of a possible trend of the impact of national pollution sources upon environment.

Until the year 1988, more systematic observations were carried out only on the status of forests according to the ICP Forests programme, whereas observation of other components of wildlife was rather fragmentary until 1993. Systematic observations of separate wildlife components initiated according to the first Ecological Monitoring Programme in 1993 were not representative on the national level; they merely covered an insignificant part of habitats and biological diversity with the major traditional focus on forests. Parameters of observations were oriented to the impact of pollution upon wildlife, part of wildlife components were observed only for the purpose of supplementing physical and chemical indices of the status of other spheres of environment. The programme of the State Environmental Monitoring of 1999–2004 has already mentioned separate measures for the evaluation of the status of plants and animals, i.e. observations of the status of forests, meadows, swamps, waters, sandy areas and fields as well as rare plants, mammals, birds, fish, rare amphibians and invertebrates. However the programme did not make any records on the impact of climate change upon ecosystems or their constituent parts.

A new State Environmental Monitoring Programme was drawn up based on the EU legal acts and directives, international conventions both signed and ratified, protocols, State Long-term Development Strategy, National Sustainable Development Strategy, Law on Environmental Monitoring, Law on Environmental Protection and other legal acts, plans and programmes of the Republic of Lithuania such as the State Public Health Observation Programme, National Environmental Healthiness Action Programme 2003–2006, etc. The State Environmental Monitoring Programme in significant part started to be implemented from 2005.

The key long-term objective of the new State Environmental Monitoring Programme is to provide conditions for furnishing responsible state and international institutions and the public with reliable information on the status of and man-induced changes in natural environment having regard of the current international commitments and national needs, which will be the basis for the objective management of quality of the Lithuanian natural environment and add to the improvement of the EU environment status. The nearest (short-term and medium-term) objectives and tasks of the programme in the area of observation of the status of ambient air have been formulated: *inter alia* to obtain data which would allow to reasonably mitigate pollution and GHG emissions, negative impact of global climate change, acidification and eutrophication processes as well as ozone-depletion substances upon human health and ecosystems, and forecast air quality. It is necessary to evaluate ambient air pollution level in agglomerations and mostly urbanized territories of the zone, forecast the quality of ambient air, and evaluate climate change in the country. The programme provides measures for its implementation, the system of funding and necessary funds. The new State Environmental Monitoring Programme covers impacts upon ecosystems, wildlife and protected areas however it does not include any climate change and anthropogenic impact balance research. The programme only partially reflects the UNFCCC requirements and country's obligations.

7.4. Sources

94. Balčiūnas, P., Židonis, V., Adomavičius, V., Linkevičius, Z., Norkevičius, P. Results of Thermoelectric Micro-chip Research and Development // North Sun 2005 – 10th International Conference on Solar Energy at High Latitudes. Abstract Book, May 25–27, Vilnius, 2005. P. 62–63.

95. Bukantis, A. Application of Factor Analysis for Quantification of Climate-forming Processes in the Eastern Part of the Baltic Sea Region. Climate Research 20. 2002. P. 135–140.

96. Bukantis, A. (2001) Climatic Fluctuations in Lithuania against the Background of Global Warming // Acta Zoologica Lituanica, Vol. 11, 2001. P. 113–120.

97. Bukantis, A. Extreme Winters in the Baltic Sea Area. In: Pauliukevičius, G. (Ed) Geographical Yearbook 28: 179–193 / Institute of Geography, Lithuanian Geographical Society, Vilnius, 1994.

98. Bukantis, A. et al. Daily Dataset of 20th-century Surface Air Temperature and Precipitation Series for the European Climate Assessment. Int J Climatol 22(12). 2002. P. 1441–1453.

99. Bukantis, A. The Variability of Climatic Elements on the Lithuanian Territory (a Monograph) // Institute of Geography, Vilnius, 1998.

100. Bukantis, A., Rimkus, E. Extreme Natural Phenomena in the World and in Lithuania in 1998. In: Geographical Yearbook XXXII // Institute of Geogra-

phy, Lithuanian Geographical Society, Vilnius, 1999. P 365–367.

101. Bukantis,A. Rimkus, E. The Extreme Natural Phenomena in the World and in Lithuania in 1999. In: Geographical Yearbook XXXIII(1) // Institute of Geography, Lithuanian Geographical Society, Vilnius, 2000. P. 480–483.

102. Bukantis A, Rimkus, E. Extreme Weather Events in the World and Lithuania in 2000. In: Geographical Yearbook XXXIV(1) // Institute of Geography, Lithuanian Geographical Society, Vilnius, 2001. P. 201–230.

103. Ecological Sustainability of Lithuania in the Historical Context. Eds: Kairiūkštis, L., Rudzikas, Z. // Lithuanian Branch of the International Center of Scientific Culture – World Laboratory, Academy of Sciences of Lithuania, Vilnius, 1999.

104. Education and Science of the Republic of Lithuania, Vilnius, 2004.

105. Education with the Ministry of Education and Science // Justitia, Vilnius, 2002.

106. Environmental Monitoring Regulations // *Valstybės žinios*, 2002, No 40–1514.

107. Environmental Monitoring Works in Lithuania: Informational Publication // Ministry of Environment of the Republic of Lithuania, Joint Research Center, Vilnius, 1994.

108. Lehikoinen, E, Sparks, T, Žalakevičius, M. Arrival and Departure Dates. In: Møller, AP, Fiedler, W., Berthold, P. (Eds) Advances in Ecological Research 35 (Birds and Climate Change), 2004. P. 1–31.

109. Lithuanian Science and Technology: White Paper // Department of Science and Higher Research and Experimental Development in Lithuania: Directory (Ministry of Statistics Department www.std.lt – about higher education)

110. Long-term Ecological Research Network in Lithuania // Institute of Ecology of Vilnius University, Vilnius, 2004.

111. State of Environment 2002 // Ministry of Environment of the Republic of Lithuania, Vilnius, 2002.

112. State of Environment 2003 // Ministry of Environment of the Republic of Lithuania, Vilnius, 2004.

113. Šateikis, I., Lynikienė, S. Feasibility Study of Single Family House Heating by Sun and Wind Energy // North Sun 2005 – 10th International Conference on Solar Energy at High Latitudes. Abstract Book, May 25–27, Vilnius, 2005. P. 25–26.

114. Šuksteris V., Perednis, E. Monitoring of Operation of Renovated Heat Production, Distribution and Consumption Systems at Kačerginė Children Sanatorium // North Sun 2005 – 10th International Conference on Solar Energy at High Latitudes. Abstract Book, May 25–27, Vilnius, 2005. P. 62.

115. Žalakevičius, M. Biophysical Impacts of Climate Change on Bird Populations and Migration in Lithuania // GeoJournal Vol. 57, 2002. P. 191–201.

116. Žalakevičius, M. Bird Migration and Climate Change // Acta Zoologica Lituanica: Ornithol., Vol. 6, 1997. P. 20–30.

117. Žalakevičius, M., Bartkevičienė, G., Raudonikis, L.,and Janulaitis, J. Spring Arrival Response to Climate Change in Birds: a Case Study from Eastern Europe // Journal of Ornithology, 2005 (Online DOI: 10.1007/s10336–005–0016–6)

118. Žalakevičius, M, Švažas, S. Global Climate Change and Its Impact on Wetlands and Waterbird Populations // Acta Zoologica Lituanica Vol. 15(3), 2005. P. 211–217.

119. Žalakevičius, M., Švažas, S. (1997) The Impact of Global Climate Change on Wildlife in Lithuania: Theoretical and Practical Aspects // Acta Zoologica Lituanica: Ornithol., Vol. , 1997. P. 14–19.

120. Žalakevičius, M, Žalakevičiūtė, R. Global Climate Change Impact on Birds: a Review of Research in Lithuania // Folia Zoologica, 2001. P. 50: 1–17.

THE REPUBLIC OF LITHUANIA

Lithuania's Third and Fourth National Communication on Climate Change

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

CHAPTER 7

Education, Training and Public Awareness Raising

VILNIUS, NOVEMBER 2005

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF LITHUANIA

INSTITUTE OF ECOLOGY OF VILNIUS UNIVERSITY

CHAPTER 8. Education, Training and Public Awareness Raising

8.1. Introduction

Public environmental awareness needs to be raised to create a broader base of support for environmental activities related to UNFCCC issues, encourage individuals to make more sustainable choices in their private lives and work, and support environment-friendly decision-making in political life. Unfortunately, in spite of several actions recently initiated by NGOs, scientific institutions, media, etc., public knowledge of causes and consequences of climate change as well as possibilities of their mitigation is still not sufficient in Lithuania. Currently, Lithuania is living through a period of fundamental changes not only in its economic and political life, but in the level of public environmental awareness too [123]. The society does not know yet how to change the lifestyle and habits so as to reduce its share in GHG emission. Much needs to be done in this sphere to make people realize their responsibility for the preservation of natural and unpolluted environment for future generations. After the UNFCCC ratification, the previously run training projects, implemented educational measures and public awareness raising tools were somewhat neglected for some reasons. Firstly, their further development was interrupted. Secondly, the general public-oriented information on future environmental threats and hazards as well as that (in Lithuanian in particular) on the fulfillment of UNFCCC commitments in the country was lacking. Since climate change affects us all, efforts to prevent or at least mitigate these effects must be increased. The Government with all necessary tools and financial levers at its disposal should perform a more active role here. The Government cannot be replaced by any NGO in this field as the primary task of the latter is to highlight the topicality and scale of the problem. However, at present the Government and responsible ministries seem to have no systematic approach to the problem of extending public knowledge of global climate change. To change the current situation, the Government should adopt a novel approach to the aforesaid problem and a new environmental awareness campaign should be launched. So far, climate change issues have been dealt with mainly by the Ministry of Environment, whereas other Ministries (Transport, Agriculture, Economy, Education and Science), which must be the key actors in the Kyoto Protocol enactment, have been less active. It was not until 2004 that work with the general public was given more attention and became more vigorous. However, despite the increased effectiveness of environmental education and recent co-operation with NGOs, improvement of public environmental awareness should be continued.

8.2. Education

The system of science and higher education in Lithuania was reformed in the last decade to answer the needs of an Independent State. This period also saw the adoption of the legislation on the development of the national system of education and vocational training which was in line with the Lisbon Summit Council Conclusions, Employment Increase Programme for 2001–2004 and Lifelong Learning Strategy. Thus, it is possible to assert that Lithuania has appropriate legislation for the development of modern educational system and social partnership. The sector of global climate change is integrated into long-term goals in the sphere of education and science, which are set out in the National Strategy for Sustainable Development [145]. They are to build a society of educated, self-dependent, active and responsible members, to develop its intellectual potential and thus ensure the coherent and harmonious implementation of economic, social and environmental aims.

Global climate change and related topics (vulnerability and sensitivity of ecosystems, global climate change impacts on economy, ecosystems and society, adaptation, mitigation measures) are covered in study programmes offered by the following higher educational institutions of Lithuania: Vilnius University, Vilnius Pedagogical University, Klaipėda University, Šiauliai University, Vilnius Gediminas Technical University, Vytautas Magnus University, Kaunas University of Technology, and Lithuanian University of Agriculture. These issues are included in Bachelor and Master courses in Biology, Ecology, Ecology and Environment, Environmental Engineering, Geography, Geology, etc. The UNFCCC implementation-related subjects offered by higher educational institutions of Lithuania are as follows: Agroecology, Atmospheric Chemistry, Fundamentals of Global Circulation Modeling, Climatic Fluctuations and Hydrospheric Changes, Climatology, Coastal Research and Fundamentals of Coastal Management, Fundamentals of Meteorology, Microclimatology, Problems of Global Ecology, Climate and Environmental Protection,

Atmospheric Control and Protection, Extreme Atmospheric Phenomena, Climate and Water Circulation, Climatic Forecasts, Coastal Zone Management/ Project Management, Coastal Management Methods, Methods and Equipment for the Removal of Atmospheric Pollutants, Cleaner Production, Agro-environmental Planning, the EU Environmental Policy, etc.

The interdisciplinary university study programme in Ecology and Environment at the Environmental Studies Centre of Vilnius University covers all relevant areas of environmental studies, e.g., air, water and soil pollution, ecotoxicology, medical ecology, nature protection, environmental impact assessment, global ecology and global ecological problems, environmental sociology, environmental economics, environmental law, GIS technologies. This Centre offers doctoral training in ecology and environment. Several doctoral degree holders, trained at the abovementioned Centre over the last decade, are currently working in the system of environmental protection of Lithuania, Environmental Protection Agency, State Service for Protected Areas, Lithuanian Universities. They are in charge of environmental monitoring, climate change-related issues and topics, are responsible for education of environmentalists.

Problems of climate change trends and impacts were raised at several different level conferences (international, regional and republican), organized by the Ministry of Environment, the Institute of Ecology of Vilnius University, Vilnius University, Lithuanian Academy of Sciences, Klaipėda University, Vilnius Gediminas Technical University, etc.

Despite these efforts, the population of the country is still insufficiently informed about local and global environmental problems and methods of environmental protection. One of the reasons of the situation is the insufficient education programme in the secondary school of the country. Presently the issues of global change and climate change suffer a loss of their priority the focus being shifted on biochemistry, genetics or biotechnology. As separate fragments the problems of climate change are presented on such subjects as Geography, Nature and Human Being, and Biology. The subject of Ecology previously studied in secondary schools now became merely a small part of Biology. To improve environmental awareness of the population and the implementation of UNFCCC requirements, the GEF Small Grants Programme (SGP) established under the UNDP branch in the country is being carried out. Under the GEF SGP project Reflection of Environmental Projects in TV Programme „Stop – tai gamta" (Stop – Nature), 25 minute-long educational TV broadcasts on climate change mitigation initiatives in the country were made. Under the Programme, there were nine climate change projects on bicycle transport development and promotion as well as energy efficiency enhancement carried out in Lithuania over the last 3 years [137]. Environmental awareness raising and education of the public were important aspects of each project. Even 236 educational events, such as seminars, conferences and special actions were organized for target groups with the number of participants approximating 50,000. The training programme in housing energy management, enabling communities to play a more active role in the field of climate protection, was drawn up and applied. In addition, 14 leaflets of educational character (35,500 copies), 19 brochures and books (215,000 copies) were published, 32 stands and posters, 6 presentations on CD were prepared. 7 more publications were issued after the fulfilment of the projects. The information about the projects was presented in 74 articles, various internet sites and 20 TV broadcasts.

8.3. Environmental Information Accessibility and Public Participation in Decision-Making on Environmental Issues

In a democratic society the implementation of effective decisions on environment protection is guaranteed by the right of free access to information and public participation in decision-making. At present Lithuania enjoys an appropriate legal basis which guarantees its citizens the right of free access to environmental information and participation in decision-making. These rights are also ensured by the UN European Economic Commission Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention) which was ratified by Lithuania, EU Directives (the European Council Directive 90/313/EEC on Free Access to Environment-Related Information, EU Directive on Environmental Impact Assessment) and laws of the Republic of Lithuania.

The main rights to environment-related information access and participation in decision-making on environmental matters for citizens, NGOs, legal and private persons are provided for by the Law on Environmental Protection of the Republic of Lithuania. Implementation of these rights is regulated by other laws and legal acts, e.g.: Laws on Environmental Impact Assessment, Provision of Information to the Public (2000), Right to Receive Information from

State and Municipal Institutions (2000), Territory Planning, Environment Monitoring, etc., resolutions of the Government and ministries, orders, ordinances. One of the main documents that regulate accessibility of environmental information is the Government Resolution On the Procedure for the Provision of Information on the Environment to the Public. The chief aim of this resolution is to guarantee the general public the possibility to use information on the environment in the Republic of Lithuania, make information access easier and set out terms for this information provision. All relevant institutions with environmental information in their possession were instructed by the Government to submit summary reports on environmental information to the Ministry of Environment by June 1, 2000. On the basis of the information obtained, the Ministry of Environment drew up a comprehensive summary report on environmental information possessed by ministries, state institutions and local municipalities which is available on the website of the Ministry of Environment http://www.am.lt.

One of the main institutions responsible for the accessibility of environment-related information, implementation of EU and Lithuanian laws as well as other documents is the Ministry of Environment. In addition to special legal acts guaranteeing environmental information provision, general laws and legal acts guaranteeing the right of citizens to get all information about activities and decision-making of state institutions are also of great importance. The main of these are the Republic of Lithuania Laws On the Provision of Information to the Public and On the Right to Obtain Information from State and Local Government Institutions. In addition, there is a great number of national legal acts, Government resolutions, orders and resolutions of authorities of various institutions.

The Ministry of Environment has the Public Information Division (in Public Information and Public Relations Department) the functions of which are to frame and pursue the policy of public education and information on issues within the ambit of the ministry; ensure provision of environmental information and its dissemination to the public; promote activities of state institutions and NGOs as well as enhance their cooperation in public environmental education, draw up and coordinate projects on environmental education.

The Ministry of Environment implements its policy of public information and environmental education in the following ways:

- Citizens submit inquiries to the Ministry of Environment and receive information from the spokesman of the Ministry by telephone or by directly contacting the people concerned by electronic or ordinary mail;
- The Ministry of Environment coordinates projects on environmental education on its initiative and presents information to the public via its press service and spokesman. Information dissemination is carried out through press, internet, various publications, library resources, projects on environmental education and information, exhibitions, special events, etc.;
- The website of the Ministry of Environment has special web pages designed for UNFCCC issues. They contain currently adopted and valid convention-related legal acts, information on fulfiled and underway projects, project reports, draft laws and draft Government resolutions.

8.4. Training and Participation of the Society

Public participation in environmental problem solving mainly depends on the timeliness of accumulation, processing and presentation of appropriate information on environmental issues. Great progress in this sphere has been made in recent years. However, environmental monitoring capacities in ten districts are still too low. As a result of harmonization of Lithuanian legal acts containing regulations for environmental protection with those of the EU, requirements for executive and surveillance organizations have become much stricter. Especially strict requirements have been imposed on the qualification and technical training of municipality and enterprise specialists and environmental protection inspectors. The majority of these organizations still do not meet present-day requirements. To remedy this situation, by 2006 it is necessary to raise the qualification of these specialists, adopt new information technologies, introduce advanced disaster prevention and mitigation methodologies.

The problem yet unsolved is a want of competent specialists to improve the quality of work to be carried out and ensure the timely submission of draft documents to the UNFCCC secretariat. To solve this problem, it is necessary to train specialists for the compilation of GHG inventories and build a team of executives from different branches of economy who would be in charge of GHG emissions monitoring and expert assessment of GHG emission/removal, preparation of NIRs and national UNFCCC Communications, attendance of international training courses, master-

ing and employment of effective working methods, planning and fulfilment of necessary investigations and assessments. The main impediment for this work is the shortage of funds, the position of the Ministry of Environment and approach to the requirements set out by the Convention to the country.

Several educational campaigns aimed at increasing public interest in environmental issues have been conducted recently. However, these events showed that awareness and participation level of communities, especially of those in rural areas of Lithuania, is still too low. North Sun 2005 – the 10th International Conference on Solar Energy in High Latitudes: Possibilities and Prospects was one of such campaigns. The conference was organized by the Center for Renewable Energy, Vilnius Gediminas Technical University, the Academy of Applied Sciences of Lithuania, Kaunas University of Technology, Lithuanian Energy Institute, Lithuanian Scientific Society, Institute of Agriculture Engineering of Lithuanian University of Agriculture.

It must be admitted that over the last decade Lithuania has failed to raise the level of public environmental awareness and develop a more responsible and caring approach to nature. Among the reasons behind this failure it is necessary to point out a lack of funds as well as indifference and the previous low-level environmental stewardship culture of our society.

8.5. Public Awareness

Issues of public environmental education and information about climate change-related problems and ways to address them are included into the National Strategy and Action Programme for Environmental Education, Information and Public Awareness of Society, drawn up by the Ministry of Environment in 1998 [154], in the National Strategy and Action Plan for the Implementation of UNFCCC. Regretfully, due to the shortage of funds quite a number of measures projected in the above documents were not implemented. It was not until 2004, when the Ministry of Environment increased its attention to public environmental education and awareness raising, that the fulfilment of measures set in the above-mentioned documents became more active. Public attention to climate change in Lithuania has considerably increased in recent years due to special publications in press (daily and weekly newspapers, popular magazines), TV and radio reports and interviews or nationally popular special TV broadcasts „Negali būti" (It cannot be true) and „Gamta visų namai" (Nature is everybody's home). 5–6 TV broadcasts and 4–5 radio broadcasts (LTV, LNK, TV1, LRT) on climate change issues are made yearly by Lithuanian climatologists and specialists in environment protection. In 2002 scientists of Vilnius University organized the academic reading The Impact of Anthropogenic Activities on Climate Fluctuations at the Lithuanian Academy of Sciences.

A series of climate change-related events organized in 2005 by the Embassy of the United Kingdom in Lithuania and the British Council received a strong response in press and generated great interest of the public. The photo exhibition NorthSouthEastWest presenting a special photo album and featuring photos of all climate change aspects recorded in all the continents of the world deserves a special mention. The exhibition was opened by the Ambassador of the UK to Lithuania and the Minister of Environment of the Republic of Lithuania. The press conference devoted to this event was attended by representatives of public organizations and scientists involved in climate change investigations. The follow-up round-table discussion Climate Change: Promotion of Closer Cooperation and international videoconference Climate Change and Citizenship focused on the enhancement of cooperation among the Government, scientists, businessmen, NGOs and mass media in the areas of public informing and search for effective solutions to climate change-related problems. The discussion was attended by the Ambassador of the UK in Lithuania. Reports were made by the world famous environmentalist Tom Burke, representatives of the Ministry of Environment, science and education institutions, NGOs. Participants of the discussion concluded that to highlight climate change-related problems, educate the society and develop publishing activities, it is necessary to team up all the interested organizations of the country.

NGOs aiming at environmental education of the society perform a significant role in the implementation of Convention commitments. At present there are over 80 environmental NGOs in Lithuania, a Coalition of Environmental NGOs being established in 2005. The GEF Small Grants Programme in Lithuania (SGP), as the main contributor to public environmental education and public awareness raising (educational events such as seminars, conferences and special actions organized for target groups; housing energy management training programmes; leaflets of educational character, brochures and books; articles; TV shows; internet sites; regular electronic circular News of Climate Change), should be mentioned among the leaders in this sphere. The UNDP and Global Envi-

ronment Fund (GEF) Small Grants Programme (SGP) currently supports six environmental protection projects with the total value amounting to 303 thous LTL. SGP support the biodiversity society „Gamtos namai“ (Nature's home), the ecological society „Liepija“ (A Lime-tree Stand), the community of Dusetos, the Marijampolė society „Pilietis“ (A Citizen), Baltic Environmental Forum and the local initiative group of Kelmė. These organizations are engaged in practical environmental improvement activities: they protect and improve habitats of endangered animal and plant species, manage natural territories of European significance in Žemaitija and Dzūkija national parks, adjusting them to purposes of cognitive tourism, destroy vegetation sites of the non-native detrimental to human health plant *Heracleum Sosnowsky* in the district of Marijampolė, inform people about dangerous water pollutants in the transboundary Lielupė-Mūša river basin, promote co-operation and marketing of ecological agriculture in Kelmė district.

The Lithuanian Bureau of the Regional Environmental Centre for Central and Eastern Europe (REC) attempting to summarize UNFCCC-related problems in the country and speed up the process of Convention implementation has started great activities in this field.

The portal site *http://www.aplinkosauga.lt/* devoted to environmental issues is available in Lithuania. Its aim is to present the latest environmental protection-related information and provide environmentalists with the opportunity to publicize information by themselves, comment on it, initiate discussions and participate in them. This portal was created in 2004 within the framework of the UNDP Small Grants Programme Project on Recruitment of Informational and Environmental NGOs. Implementation of the project is carried out by a non-governmental organization Baltic Environmental forum. Despite all the work that is being carried out, the information on UNFCCC, its implementation commitments, climate change, its present-day and future impacts is still lacking. The public is still unaware of the topicality, scale and seriousness of the problem and therefore it cannot participate in decision-making on Convention-related problems. A new approach and actions are needed to change the situation in the country, achieve the level of the EU public environmental awareness, shape awareness and concern of the public about the quality of life and fate of the present and future generations.

8.6. Sources

121. Bičkus, A., Rastenienė, V., Suveizdis, P. Use of Geothermal Energy in the Country, 2004.

122. Braziulis, R., Jansson, R. Hydropower and Environment // Ecological Club "Žvejonė", Lithuanian Green Movement, 2003.

123. Bubnienė, R., Dundulienė, Z., Greimas, E., Kubilius, I., Lenkaitis, R., Mačiūnaitė, J., Raulinaitis, M., Semėnienė, D., Taločkaitė, E., Vainius, L., Valatka, S. The European Union Environmental Policy and Its Implementation in Lithuania // Environmental Policy Centre, Vilnius, 2002.

124. Burneikis, J., Jablonskis, J. Possibilities of the Use of Small Hydropower in Lithuania, 1998.

125. Climate Change News (Circular), 2005, No 1–6.

126. Dagys, L. J., Jarmokas, J. R. Possibilities of Local Fuel Use in Lithuania, 1998.

127. Declaration by the Ministers of Environment of the Region of the United Nations Economic Commission for Europe (UN/ECE). Directives on Dissemination of Information about the State of Environment and Public Participation in Environmental Decision-making // Ministry of Environment of the Republic of Lithuania, Vilnius, 1996.

128. Efficient Energy (Leaflets), 1999–2004.

129. Environmental Protection in Vilnius: Current Situation and Prospects // Department of Environment of the Vilnius City Municipality, Vilnius, 2004.

130. Implementation of the Main Measures and Works to Implement the National Energy Use Efficiency Increase Programme // Ministry of Economy of the Republic of Lithuania, 2003.

131. Janulis, P., Makarevičienė, V. Use of Biofuel and Biooils in Lithuania, 2004.

132. Juodvalkis, S., Zabarauskas, R. Efficient Heating Energy Use in Houses, 2003.

133. Katinas, V., Tumosa, A. Possibilities of Wind Energy Use in Lithuania, 1995.

134. Kavolėlis, B. Self-production Sun Collectors for Water Heating, 1996.

135. Kyoto Protocol of the United National Framework Convention on Climate Change // *Valstybės žinios*, 2002, No 126–5735.

136. Leaflets about Energy Saving in Household and Industry, 1997–2005.

137. Linking the Interests of the Environment and Society: GEF SGP Three Years in Lithuania. The GEF Small Grants Programme. UNDP GEF SGP, Vilnius, 2004.

138. Lithuanian Environmental Strategy and Action Programmes // Ministry of Environment of the Republic of Lithuania, Vilnius, 1996.

139. Lithuanian R&D Thematic Priorities // *Valstybės žinios*, 2002, No 74–3180.

140. Long-term Strategy for Development of Economy of Lithuania until 2015 // *Valstybės žinios*, 2002, No 60–2424.

141. National Energy Consumption Efficiency Increase Programme // *Valstybės žinios*, 2001, No 82–2856.

142. National Energy Strategy // *Valstybės žinios*, 2002, N 99–4397.

143. National Environmental Health Action Programme 2003–2006 // *Valstybės žinios*, 2003, No 8–288.

144. National Strategy for Implementation of the United Nations Framework Convention on Climate Change // *Valstybės žinios*, 1996, No 105–2409.

145. National Sustainable Development Strategy: Efficient Economy, Healthy Environment, Prosperous Society // Ministry of Environment of the Republic of Lithuania, UNDP, Vilnius, 2003.

146. National Tourism Development Programme // *Valstybės žinios*, 1999, No 63–2061.

147. Paulionis, K., Linkevičius, V. L., Bačauskas, A. How to Save Energy and Money at Home, 1997.

148. Regional Development Law of the Republic of Lithuania // *Valstybės žinios*, 2000, No 66–1987; 2002, No 123–5558.

149. Republic of Lithuania Biodiversity Conservation Strategy and Action Plan // World Bank, Ministry of Environment of the Republic of Lithuania, 1998.

150. Republic of Lithuania Regions Development Programme and Its Implementation Measures 2003–2005 // *Valstybės žinios*, 2002, No 117–5259.

151. Savickas, J., Vrubliauskas, S. Possibilities of Biogas Production and Use in Lithuania, 1997.

152. State Education Strategy Regulations 2003–2012 // *Valstybės žinios*, 2003, No 71–3216.

153. State Long-term Development Strategy // *Valstybės žinios*, 2002, No 113–5029.

154. Strategy and Action Programme of Public Environmental Education (Training, Teaching, Raising Awareness) of the Republic of Lithuania // Ministry of Environment of the Republic of Lithuania, Vilnius, 1997.

155. Šuksteris, V., Kiveris, R. Possibilities of Solar Energy Use in Lithuania, 1996.

156. Žaltauskas, A. Straw Use for Fuel in Lithuania, 2002.

157. http://saule.lms.lt/lindex.html [alternative energy in Lithuania]

158. http://saule.lms.lt/lnsp/lnsp_atsinauj.html [Lithuanian national solar programme 2000–2005]

159. http://www.ekostrategija.lt [renewable and local energy sources RIES]

160. http://gstudija.tinklapis.lt/ltma/lindex4.htm [solar, wind, hydro, biomass energy]

161. http://www.avei.lt/?language=da [renewable energy resources of Lithuania]

THE REPUBLIC OF LITHUANIA

ABBREVIATIONS

Lithuania's Third and Fourth National Communication on Climate Change

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

VILNIUS, NOVEMBER 2005

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF LITHUANIA

INSTITUTE OF ECOLOGY OF VILNIUS UNIVERSITY

Abbreviations

AEI – Alternative Energy Implementation
AIAP – *Acquis* Implementation Action Plan
BOD – Biochemical Oxygen Demand
CAFE – European Union Clean Air for Europe Programme
CGAP – Code of Good Agricultural Practice
CH_4 – Methane
CHP – Combined Heat and Power Plant
CIS – Commonwealth of Independent States
CO – Carbon Monoxide
COD – Chemical Oxygen Demand
CO_2 – Carbon Dioxide
CRF – Common Report Format
EC – European Commission
ECCP – European Climate Change Programme
EPA – Environmental Protection Agency
ETS – Emission Trading Scheme
EU – European Union
EUR – Euro (European Union Currency)
F-gases – Hydrofluorocarbons (HFC), Perfluorocarbons (PFC), and Sulphur Hexafluoride (SF_6)
GDP – Gross Domestic Product
GEF – Global Environment Facility
GHG – Greenhouse Gas
GIS – Geographical Information System
GMO – Genetically Modified Organisms
HCFCs – Hydrochlorofluorocarbons
HELCOM – Helsinki Commission
HFCs – Hydrofluorocarbons
HFO – Heavy Fuel Oil
IAEA – International Atomic Energy Agency
ICP IM – International Co-operative Programme on Integrated Monitoring
IIASA – International Institute of Applied System Analysis
JI – Joint Implementation
ILTER – International Long-Term Ecological Research
IPCC – Intergovernmental Panel on Climate Change
IPPC – Integrated Pollution Prevention and Control
LAAP – Law Approximation Action Plan
LEIF – Lithuanian Environmental Investment Fund
LPG – Liquified Petrol Gas
LTER – Long-Term Ecological Research
LTL – Lithuanian Republic Currency
LU – Livestock Unit
LUCF – Land-Use Change and Forestry
MAED – Model of Analysis of Energy Demand
MoA – Ministry of Agriculture
MoE – Ministry of Environment
MoEcon – Ministry of Economy
MoES – Ministry of Education and Science
MoH – Ministry of Health
MoT – Ministry of Transport
MSW – Municipal Solid Waste
NC – National Communication
NE – Not Estimated
NEEP – National Energy Efficiency Programme
NIR – National Inventory Report
NMVOC – Non-Methane Volatile Organic Compounds
NO – Not Occurring
NO_x – Nitrogenoxide (NO and NO_2) Expressed as NO_2
N_2O – Nitrous Oxide
NPP – Nuclear Power Plant
PFCs – Perfluorocarbons
POPs – Persistent Organic Pollutants
REC – Regional Environmental Centre
RES – Renewable Energy Source
R&D – Research and Development
SF_6 – Sulphur Hexafluoride
SGP – Small Grant Programme
SO_2 – Sulphur Dioxide
TPES – Total Primary Energy Supply
UN – United Nations
UNDP – United Nations Development Programme
UNFCCC – United Nations Framework Convention on Climate Change
VAT – Value-Added Tax
VOC – Volatile Organic Compounds

Units and Exchange Rate

g – gramme
h – hour
km – kilometre
km^2 – square kilometre
t – tonne
toe – tonne of oil equivalent
J – joule
ha – hectare
K, k – kilo (10^3)
M – Mega (10^6)
G – Giga (10^9)
T – Tera (10^{12})
W – Watt
Wh – Watt-hour
1 EUR = 3.4528 LTL (official exchange rate)

THE REPUBLIC OF LITHUANIA

APPENDIXES

Lithuania's Third and Fourth National Communication on Climate Change

UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

VILNIUS, NOVEMBER 2005

MINISTRY OF ENVIRONMENT
OF THE REPUBLIC OF LITHUANIA

INSTITUTE OF ECOLOGY OF VILNIUS UNIVERSITY

APPENDIXES

Appendix 1. Key Source Analysis

Key Source Description	Direct GHG	Level Assessment, %	Cumulative Level Assessment, %
Stationary Combustion: Gas	CO_2	28.7	28.7
Mobile Combustion: Road Vehicles	CO_2	19.2	47.8
Stationary Combustion: Oil	CO_2	10.2	58.0
Enteric Fermentation in Domestic Livestock	CH_4	7.3	65.3
Solid Waste Disposal Sites	CH_4	5.8	71.1
Stationary Combustion – Coal	CO_2	5.6	76.7
Ammonia Production	CO_2	4.0	80.7
Nitric Acid Production	N_2O	2.9	83.6
Wastewater Handling	CH_4	2,7	86,4
Fugitive Emissions: Oil & Gas Operations	CH_4	2.7	89.1
Direct N_2O Emissions From Agricultural Soils	N_2O	2.2	91.2
Cement Production	CO_2	2.0	93.2
Mobile Combustion: Railways	CO_2	1.3	94.6
Manure Management	N_2O	1.3	95.8

Appendix 2. Summary Table of GHG Emissions in 1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES CO_2 equivalent (Gg)	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Total (Net Emissions) (1)	33,437.64	7,924.26	4,049.84	34.50	NE	NE	45,446.24
1. Energy	36,717.00	648.69	267.84				37,633.53
A. Fuel Combustion (Sectoral Approach)	36,717.00	100.59	267.84				37,085.43
1. Energy Industries	16,352.00	15.33	112.84				16,480.17
2. Manufacturing Industries and Construction	5,379.00	9.24	43.40				5,431.64
3. Transport	5,791.00	29.82	58.90				5,879.72
4. Other Sectors	6,313.00	46.20	52.70				6,411.90
5. Other	2,882.00	NO	NO				NO
B. Fugitive Emissions from Fuels	NE	548.10	0.00				548.10
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	NE	548.10	NE				548.10
2. Industrial Processes	2,203.00	NE	434.00	34.50	NE	NE	2,671.50
A. Mineral Products	2,203.00	NE	NE				2,203.00
B. Chemical Industry	NE	NE	434.00	NE	NE	NE	434.00
C. Metal Production	NO	NO	NO		NO	NO	NO
D. Other Production	NE						NE
E. Production of HFC's, PFC's and SF_6				NO	NO	NO	NO
F. Consumption of HFC's, PFC's and SF_6				34.50	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	0.00
3. Solvent and Other Product Use	NE		NE				NE
4. Agriculture	NE	3,795.87	3,348.00				7,143.87
A. Enteric Fermentation		3,303.87	L				3,303.87
B. Manure Management		492.00	0.00				492.00
C. Rice Cultivation		NO					NO
D. Agricultural Soils (2)	NE	NE	3,348.00				3,348.00
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other							
5. Land-Use Change and Forestry (1)	-5,482.36	NE	NE				-5,482.36
6. Waste	NE	3,479.70	NE				3,479.70
A. Solid Waste Disposal on Land	NE	3,402.00					3,402.00
B. Wastewater Handling		77.70	NE				77.70
C. Waste Incineration	NE	NE	NE				NE
D. Other	NE	NE	NE				NE
7. Other	NE	NE	NE	NE	NE	NE	NE
Memo Items:							
International Bunkers	0.00	0.00	NE				0.00
Aviation	NE	NE	NE				NE
Marine	NE	0.00	NE				0.00
Multilateral Operations	NE	NE	NE				NE
CO_2 Emissions from Biomass	616.00						616.00

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry (LUCF)	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	2,935.17	-10,199.93	-7,264.76			-7,264.76
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE
C. Abandonment of Managed Lands	NE	-930.40	-930.40			-930.40
D. CO_2 Emissions and Removals from Soil	2,712.80	NE	2,712.80			2,712.80
E. Other	NE	NE	NE	NNE	NNE	NE
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	5,647.97	-11,130.33	-5,482.36	NNE	NNE	-5,482.36
Total CO_2 Equivalent Emissions without LUCF						50,928.60
Total CO_2 Equivalent Emissions with LUCF						45,446.24

NE – not estimated; NO – not occurring

Appendix 3. Summary Table of GHG Emissions in 1998

GREENHOUSE GAS SOURCE AND SINK CATEGORIES CO_2 equivalent (Gg)	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Total (Net Emissions) (1)	8,105.57	3,731.84	2,423.27	14.04	NE	NE	14,260.67
1. Energy	14,465.01	249.07	171.21				14,885.29
A. Fuel Combustion (Sectoral Approach)	14,465.01	249.07	171.21				14,885.29
1. Energy Industries	6,807.66	8.40	62.00				6,878.06
2. Manufacturing Industries and Construction	2,286.64	3.78	18.60				2,309.02
3. Transport	3,933.09	44.53	47.21				4,024.83
4. Other Sectors	1,437.62	192.36	43.40				1,673.38
5. Other	NE	NE	NE				NE
B. Fugitive Emissions from Fuels	NE	NE	NE				NE
1. Solid Fuels	NE	NE	NE				NE
2. Oil and Natural Gas	NE	NE	NE				NE
2. Industrial Processes	1,198.07	0.42	1,511.87	NE	NE	NE	2,710.36
A. Mineral Products	447.32	NE	NE				447.32
B. Chemical Industry	750.75	0.42	1,511.87	NE	NE	NE	2,263.04
C. Metal Production	NO	NO	NO		NO	NO	NO
D. Other Production	NE						NE
E. Production of HFC's, PFC's and SF_6				NO	NO	NO	NO
F. Consumption of HFC's, PFC's and SF_6				NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	NE
3. Solvent and Other Product Use	NE		NE				NE
4. Agriculture	NE	1,800.16	740.19				2,540.35
A. Enteric Fermentation		1,574.60					1,574.60
B. Manure Management		225.56	271.78				497.34
C. Rice Cultivation		NO					0.00
D. Agricultural Soils (2)	NE	NE	468.41				468.41
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NO	NNO				NNO
5. Land-Use Change and Forestry (1)	-7,557.51	NE	NE				-7,557.51
6. Waste	NE	1,682.18	NE				1,682.18
A. Solid Waste Disposal on Land	NE	1,544.55					1,544.55
B. Wastewater Handling		137.63	NE				137.63
C. Waste Incineration	NE	NE	NE				NE
D. Other	NE	NE	NE				NE
7. Other	NE	NE	NE	NE	NE	NE	NE
Memo Items:							
International Bunkers	0.00	0.00	NE				0.00
Aviation	NE	NE	NE				NE
Marine	NE	0.00	NE				0.00
Multilateral Operations	NE	NE	NE				NE
CO_2 Emissions from Biomass	2,419.44						2,419.44

NE – not estimated; NO – not occurring

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry (LUCF)	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	4,493.50	-10,742.23	-6,248.73			-6,248.73
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE
C. Abandonment of Managed Lands	NE	-1,549.16	-1,549.16			-1,549.16
D. CO_2 Emissions and Removals from Soil	240.38	NE	240.38			240.38
E. Other	NE	NE	NE	NE	NE	NE
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	4,733.88	-12,291.39	-7,557.51	NE	NE	-7,557.51
Total CO_2 Equivalent Emissions without LUCF						21,818.18
Total CO_2 Equivalent Emissions with LUCF						14,260.67

NE – not estimated; NO – not occurring

Appendix 4. Summary Table of GHG Emissions in 2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES CO_2 equivalent (Gg)	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Total (Net Emissions) (1)	6,167.59	3,171.78	2,607.10	14.04	NE	NE	11,946.47
1. Energy	12,206.57	250.53	167.40				12,624.50
A. Fuel Combustion (Sectoral Approach)	12,206.57	250.53	167.40				12,624.50
1. Energy Industries	5,948.34	17.64	43.40				6,009.38
2. Manufacturing Industries and Construction	1,733.01	6.30	46.50				1,785.81
3. Transport	3,480.54	31.29	43.40				3,555.23
4. Other Sectors	1,044.68	195.30	34.10				1,274.08
5. Other	NE	NE	NE				NE
B. Fugitive Emissions from Fuels	NE	NE	NE				NE
1. Solid Fuels	NE	NE	NE				NE
2. Oil and Natural Gas	NE	NE	NE				NE
2. Industrial Processes	1,296.21	1.26	824.60	NE	NE	NE	2,122.07
A. Mineral Products	307.97	NE	NE				307.97
B. Chemical Industry	988.23	1.26	824.60	NE	NE	NE	1,814.09
C. Metal Production	NO	NO	NO		NO	NO	NO
D. Other Production	NE						NE
E. Production of HFC's, PFC's and SF_6			N	NO	NO	NO	NO
F. Consumption of HFC's, PFC's and SF_6				14.04	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	NE
3. Solvent and Other Product Use	NE		NE				NE
4. Agriculture	NE	1,357.17	1,615.10				2,972.27
A. Enteric Fermentation		1,177.47					1,177.47
B. Manure Management		179.70	204.60				384.30
C. Rice Cultivation		NO					0.00
D. Agricultural Soils (2)	NE	NE	1,410.50				1,410.50
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NO	NO				NO
5. Land-Use Change and Forestry (1)	-7,335.19	NE	NE				-7,335.19
6. Waste	NE	1,562.82	NE				1,562.82
A. Solid Waste Disposal on Land	NE	1,142.19					1,142.19
B. Wastewater Handling		420.63	NE				420.63
C. Waste Incineration	NE	NE	NE				NE
D. Other	NE	NE	NE				NE
7. Other	NE	NE	NE	NE	NE	NE	NE
Memo Items:							
International Bunkers	312.09	0.42	NE				312.51
Aviation	NE	NE	NE				NE
Marine	312.09	0.42	NE				312.51
Multilateral Operations	NE	NE	NE				NE
CO_2 Emissions from Biomass	2,790.61						2,790.61

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry (LUCF)	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	5,016.00	-11,012.65	-5,996.65			-5,996.65
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE
C. Abandonment of Managed Lands	NE	-1,549.16	-1,549.16			-1,549.16
D. CO_2 Emissions and Removals from Soil	210.62	NE	210.62			210.62
E. Other	NE	NE	NE	NNE	NNE	NE
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	5,226.62	-12,561.81	-7,335.19	NNE	NNE	-7,335.19
Total CO_2 Equivalent Emissions without LUCF						19,281.66
Total CO_2 Equivalent Emissions with LUCF						11,946.47

NE – not estimated; NO – not occurring

Appendix 5. Summary Table of GHG Emissions in 2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES CO_2 equivalent (Gg)	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Total (Net Emissions) (1)	5,112.16	3,554.98	1,792.86	34.50	NE	NE	10,494.50
1. Energy	10,783.49	645.83	126.92				11,556.24
A. Fuel Combustion (Sectoral Approach)	10,782.20	224.69	126.92				11,133.82
1. Energy Industries	5,086.13	6.42	36.13				5,128.68
2. Manufacturing Industries and Construction	1,086.25	5.46	12.40				1,104.11
3. Transport	3,501.70	28.99	45.27				3,575.96
4. Other Sectors	1,108.12	183.83	33.12				1,325.06
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	1.29	421.13	0.00				422.42
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	1.29	421.13	NE				422.42
2. Industrial Processes	1,049.27	NE	892.80	34.50	NE	NE	1,976.57
A. Mineral Products	346.51	NE	NE				346.51
B. Chemical Industry	702.76	NE	892.80	NE	NE	NE	1,595.56
C. Metal Production	NO	NO	NO		NO	NO	NO
D. Other Production	NE						NE
E. Production of HFC's, PFC's and SF_6				NO	NO	NO	NO
F. Consumption of HFC's, PFC's and SF_6				34.50	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	NE
3. Solvent and Other Product Use	NE		NE				NE
4. Agriculture	NE	1,396.52	773.14				2,169.66
A. Enteric Fermentation		1,209.94					1,209.94
B. Manure Management		186.59	210.80				397.39
C. Rice Cultivation		NO					NO
D. Agricultural Soils (2)	NE	NE	562.34				2,060.26
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other							
5. Land-Use Change and Forestry (1)	-6,720.60	NE	NE				-6,720.60
6. Waste	NE	1,512.63	NE				1,512.63
A. Solid Waste Disposal on Land	NE	1,092.00					1,092.00
B. Wastewater Handling		420.63	NE				420.63
C. Waste Incineration	NE	NE	NE				NE
D. Other	NE	NE	NE				NE
7. Other	NE	NE	NE	NE	NE	NE	NE
Memo Items:							
International Bunkers	442.51	0.48	NE				351.02
Aviation	91.97	NE	NE				NE
Marine	350.54	0.48	NE				351.02
Multilateral Operations	NE	NE	NE				NE
CO_2 Emissions from Biomass	2,813.71						2,813.71

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry (LUCF)	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	5,775.00	-11,077.00	-5,302.00			-5,302.00
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE
C. Abandonment of Managed Lands	NE	-1,608.75	NE			-1,608.75
D. CO_2 Emissions and Removals from Soil	190.15	NE	190.15			190.15
E. Other	NE	NE	NE	NNE	NNE	NE
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	5,965.15	-12,685.75	-5,111.85	NNE	NNE	-6,720.60
Total CO_2 Equivalent Emissions without LUCF						17,215.10
Total CO_2 Equivalent Emissions with LUCF						10,494.50

NE – not estimated; NO – not occurring

Appendix 6. Summary Table of GHG Emissions in 2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES CO_2 equivalent (Gg)	CO_2 (1)	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Total (Net Emissions) (1)	5,297.70	3,600.00	1,314.05	21.93	NE	NE	10,233.68
1. Energy	11,205.91	689.28	141.41				12,036.60
A. Fuel Combustion (Sectoral Approach)	11,205.9	224.93	141.41				11,572.25
1. Energy Industries	5,359.67	8.73	41.19				5,409.59
2. Manufacturing Industries and Construction	1,155.22	5.04	12.40				1,172.66
3. Transport	3,550.17	29.36	45.57				3,625.10
4. Other Sectors	1,140.85	181.79	42.25				1,364.90
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	1.29	464.35	0.00				464.35
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	1.29	464.35	NE				464.35
2. Industrial Processes	1,081.22	1.72	505.30	21.93	NE	NE	1,610.17
A. Mineral Products	388.25	NE	NE				388.25
B. Chemical Industry	692.97	1.72	505.30	NE	NE	NE	1,199.99
C. Metal Production	NO	NO	NO		NO	NO	NO
D. Other Production	NE						NE
E. Production of HFC's, PFC's and SF_6				NO	NO	NO	NO
F. Consumption of Halocarbons and F_6				21.93	NE	NE	21.93
G. Other	NE	NE	NE	NE	NE	NE	NE
3. Solvent and Other Product Use	NE		NE				NE
4. Agriculture	NE	1,445.77	667.34				2,113.10
A. Enteric Fermentation		1,254.12					1,254.12
B. Manure Management		191.65	218.15				409.79
C. Rice Cultivation		NO					NO
D. Agricultural Soils (2)	NE	NE	449.19				449.19
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NE	NE				NO
G. Other							
5. Land-Use Change and Forestry (1)	-6,989.43	NE	NE				-6,989.43
6. Waste	NE	1,463.24	NE				1,463.24
A. Solid Waste Disposal on Land	NE	992.63					992.63
B. Wastewater Handling		470.61	NE				470.61
C. Waste Incineration	NE	NE	NE				NE
D. Other	NE	NE	NE				NE
7. Other	NE	NE	NE	NE	NE	NE	NE
Memo Items:							
International Bunkers	450.80	0.95	4.92				456.67
Aviation	99.55	0.74	0.69				100.99
Marine	351.25	0.21	4.22				355.68
Multilateral Operations	NE	NE	NE				NE
CO_2 Emissions from Biomass	3,051.76						3,051.76

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions/ removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry (LUCF)	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks						
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE
C. Abandonment of Managed Lands	NE					
D. CO_2 Emissions and Removals from Soil		NE				
E. Other	NE	NE	NE	NNE	NNE	NE
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry				NNE	NNE	-6,989.43
Total CO_2 Equivalent Emissions without LUCF						17,223.11
Total CO_2 Equivalent Emissions with LUCF						10,233.68

NE – not estimated; NO – not occurring

Appendix 7. GHG Emissions from Fuel Combustion by GHG Emission Sources and Greenhouse Gases

Total GHG Emissions from Fuel Combustion in CO_2 Equivalent, Gg CO_2 in 2005

	Total Gg CO_2 equivalent	CO_2 Gg	CH_4 Gg	N_2O Gg
Oil refinery	1,021.59	1,000	0.29	0.05
Electricity and Heat Production	5,270.57	5,097.89	1.58	0.45
Industry	3,351.39	3,300	0.233	0.15
Service	454.44	426.97	0.57	0.05
Transport	3,693.71	3,537.51	3.6	0.26
Agriculture	239.26	228.6	0.36	0.01
Household	804.23	604.14	8.79	0.05
Total	14,835.19	14,195.11	15.42	1.02

Total GHG Emissions from Fuel Combustion in CO_2 Equivalent, Gg CO_2 in 2006

	Total Gg CO_2 equivalent	CO_2 Gg	CH_4 Gg	N_2O Gg
Oil refinery	1,026.32	1,004.52	0.30	0.05
Electricity and Heat Production	5,478.67	5,289.02	1.65	0.5
Industry	3,490.787	3,439.31	0.237	0.15
Service	460.87	433.19	0.58	0.05
Transport	3,812.03	3,651.89	3.64	0.27
Agriculture	250.76	236.79	0.37	0.02
Household	811.11	605.56	9.05	0.05
Total	15,330.547	14,660.28	15.827	1.09

Total GHG Emissions from Fuel Combustion in CO_2 Equivalent, Gg CO_2 in 2007

	Total Gg CO_2 equivalent	CO_2 Gg	CH_4 Gg	N_2O Gg
Oil refinery	1,080.1	1,054.78	0.32	0.06
Electricity and Heat Production	5,611.12	5,420	1.72	0.5
Industry	3,,542.872	3,491.29	0.242	0.15
Service	467.52	439.42	0.60	0.05
Transport	3,927.63	3,766.02	3.71	0.27
Agriculture	259.11	244.93	0.38	0.02
Household	818.14	607.34	9.3	0.05
Total	15,706.492	15,023.78	16.272	1.1

Total GHG Emissions from Fuel Combustion in CO_2 Equivalent, Gg CO_2 in 2008

	Total Gg CO_2 equivalent	CO_2 Gg	CH_4 Gg	N_2O Gg
Oil refinery	1,185.53	1,160	0.33	0.06
Electricity and Heat Production	5,698.09	5,520	1.69	0.46
Industry	3,641.666	3,590	0.246	0.15
Service	473.31	445	0.61	0.05
Transport	4,045.34	3,880	3.74	0.28
Agriculture	274.6	260	0.40	0.02
Household	826.05	610	9.55	0.05
Total	16,144.586	15,465	16.566	1.07

Total GHG Emissions from Fuel Combustion in CO_2 Equivalent, Gg CO_2 in 2009

	Total Gg CO_2 equivalent	CO_2 Gg	CH_4 Gg	N_2O Gg
Oil refinery	1,215.95	1,190	0.35	0.06
Electricity and Heat Production	5,851.82	5,670	1.72	0.47
Industry	3,644.85	3,590	0.25	0.16
Service	478.73	450	0.63	0.05
Transport	4,159.7	3,990	3.8	0.29
Agriculture	275.81	261	0.41	0.02
Household	832.3	611	9.8	0.05
Total	16,459.16	15,762	16.96	1.1

Total GHG Emissions From Fuel Combustion in CO_2 equivalent, Gg CO_2 in 2010

	Total Gg CO_2 equivalent	CO_2 Gg	CH_4 Gg	N_2O Gg
Oil refinery	1,249.47	1,220	0.37	0.07
Electricity and Heat Production	11,320.08	11,000	3.58	0.79
Industry	3,704.934	3,650	0.254	0.16
Service	488.94	460	0.64	0.05
Transport	4,280.96	4,110	3.86	0.29
Agriculture	284.81	270	0.41	0.02
Household	845.9	612	10.4	0.05
Total	22,175.094	21,322	19.514	1.43

Total GHG Emissions From Fuel Combustion in CO_2 equivalent, Gg CO_2 in 2011

	Total Gg CO_2 equivalent	CO_2 Gg	CH_4 Gg	N_2O Gg
Oil refinery	1,309.68	1,280	0.38	0.07
Electricity and Heat Production	11,417.61	11,100	3.61	0.78
Industry	3,734.976	3,680	0.256	0.16
Service	489.15	460	0.65	0.05
Transport	4,374.9	4,200	3.9	0.30
Agriculture	285.23	270	0.43	0.02
Household	846	610	10.5	0.05
Total	22,457.546	21,600	19.726	1.43

Total GHG Emissions from Fuel Combustion in CO_2 Equivalent, Gg CO_2 in 2012

	Total Gg CO_2 equivalent	CO_2 Gg	CH_4 Gg	N_2O Gg
Oil refinery	1,380.1	1,350	0.40	0.07
Electricity and Heat Production	11,488.03	11,170	3.63	0.78
Industry	3,765.039	3,710	0.259	0.16
Service	499.57	470	0.67	0.05
Transport	4,465.74	4,290	3.94	0.30
Agriculture	295.44	280	0.44	0.02
Household	847.47	610	10.57	0.05
Total	22,741.389	21,880	19.909	1.43

Total GHG Emissions from Fuel Combustion in CO_2 Equivalent, Gg CO_2 in 2015

	Total Gg CO_2 equivalent	CO_2 Gg	CH_4 Gg	N_2O Gg
Oil refinery	1,463.83	1,430	0.43	0.08
Electricity and Heat Production	11,665.98	11,350	3.68	0.77
Industry	3,855.228	3,800	0.268	0.16
Service	510.41	480	0.71	0.05
Transport	4,744.46	4,560	4.06	0.32
Agriculture	306.07	290	0.47	0.02
Household	867.34	620	11.04	0.05
Total	23,413.318	22,530	20.658	1.45

Total GHG Emissions from Fuel Combustion in CO_2 Equivalent, Gg CO_2 in 2020

	Total Gg CO_2 equivalent	CO_2 Gg	CH_4 Gg	N_2O Gg
Oil refinery	1,718.19	1,680	0.49	0.09
Electricity and Heat Production	12,011.88	11,700	3.78	0.75
Industry	4,008.643	3,950	0.283	0.17
Service	535.148	500	0.788	0.06
Transport	5,257.54	5,060	4.24	0.35
Agriculture	327.519	310	0.539	0.02
Household	893.17	630	11.72	0.055
Total	24,752.09	23,830	21.84	1.495

ISBN 9986-443-31-8