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OF THE REPUBLIC OF LATVIA UNDER UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

MINISTRY OF ENVIRONMENTAL PROTECTION
AND REGIONAL DEVELOPMENT

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Chemical symbols and abbreviations

carbon	C
carbon dioxide	CO_2
hydrofluorocarbon	HFC
liquefied propane gas	LPG
methane	CH_4

nitrogen	N
nitrogen oxides	NO_x
nitrous oxide	N_2O
non-methane volatile organic compounds	NMVOC
ozone	O_3
perfluorocarbon	PFC
sulfur hexafluoride	SF_6
sulfur dioxide	SO_2

Units of measurement

gigagram (10^9 gram)	Gg
giga joule	GJ
peta joule (10^{15} joule)	PJ
kilo watt hour (10^3 watt hour)	kWh
mega watt (10^6 watt)	MW
nanometer (10^{-9} m)	nm
hectare (10^4 m^2)	ha
Latvian lat	LVL
US dollar	USD

Abbreviations

Activities Implemented Jointly	AIJ
Central and Eastern Europe	CEE
Combined Heat and Power	CHP
Commonwealth of Independent States	CIS
Compressed natural gas	CNG
Conference of Parties	COP
Degradable Organic Carbon	DOC
District Heat	DH
Economy in Transition	EIT
Energy system optimization model (market allocation)	MARKAL
Environment Protection Fund	EPF
European Union	EU
Hydrometeorological Agency	HMA
Global Atmosphere Watch	GAW
Global Environment Facility	GEF
Global Change Human Dimensions Program	GHDP
Global warming potential	GWP
Greenhouse Gas	GHG
Gross Domestic Product	GDP
Helsinki Convention on Protection of Environment of the Baltic Sea	HELCOM
Hydro power plant	HPP
Intergovernmental Panel on Climate Change	IPCC

International Geosphere and Biosphere Program	IGBP
Joint Implementation	JI
Latvian energy company	LATVENERGO
Macroeconomic Reference Scenario	MRS
Ministry of Environmental Protection and Regional Development of the Republic of Latvia	MEPRD
Municipal Solid Waste	MSW
National Environmental Policy Plan	NEPP
Netherlands Agency for Energy and the Environment	NOVEM
Non-governmental organization	NGO
Organization of Economic Cooperation and Development	OECD
Poland and Hungary Action for Restructuring the Economy	PHARE
Polish Foundation for Energy Efficiency	FEWE
Pollution load control	PLC
Project for management of municipal solid waste in Latvia	500-
Project for water supply and sewerage in Latvia	800+
Protocol on the Long-term Financing of the European Monitoring and Evaluation Program	EMEP
Research, Development and Demonstration	RD&D
Residual fuel oil	RFO
Solid waste disposal site	SWDS
Soviet Union	SU
Statistical Classification of Economic Activities in the European Community	NACE
Supporting the Cooperative Organization of Rational Energy Use	SCORE
Swedish National Board for Industrial and Technical Development	NUTEK
United Nations	UN
United Nations Development Program	UNDP
United Nations Environment Program	UNEP
UN Framework Convention on Climate Change	UN FCCC
World Climate Research Program	WCRP
World Environmental Center	WEC
World Meteorological Organization	WMO

SUMMARY

1. INTRODUCTION

Latvia became a Party of the United Nations Framework Convention on Climate Change (UN FCCC) in 1992. Latvian Parliament ratified the UN FCCC in 1995, and since then Latvia became a Member State to the UN FCCC and undertook to fulfill a range of internationally adopted commitments.

In accordance with Kyoto Protocol to the UN FCCC on 10 December 1997, Latvia individually or jointly should ensure, that its aggregate anthropogenic CO_2 equivalent emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 in 2008—2012 should be 8% below the 1990 level.

In accordance with Article 4, Paragraph 12 of the UN FCCC, each Party, including Latvia, should submit to the Conference of the Parties the information about national GHG emissions and sinks, as well as description of policies and measures taken or envisaged to fulfill the commitments.

According to the first National Communication of the Republic of Latvia, the economic decline in Latvia in 1990—1994 due to the transition to a market economy caused a reduction of GHG emissions, and projections for the year 2000 do not envisage to exceed the level of 1990 even when no specific actions are undertaken. It is for after that year that the GHG emissions are expected to increase following the forecasted economic recovery and growth.

This document is Latvia's second National Communication under the UN FCCC. It presents the current situation in GHG emission inventories in Latvia, some corrections of data for 1990 according to IPCC 1996 Revised Guidelines, emission projections till 2020 as well as development in climate change mitigation policy. The following ministries and institutions from Latvia have contributed to the present Report:

Ministry of Environmental Protection and Regional Development,
Ministry of Foreign Affairs,
Ministry of Economy,
Ministry of Transport,
Ministry of Agriculture,
Environmental Data Center,
State Forest Service,
Latvian Development Agency,
Central Agency of Statistics,
State Hydrometeorological Agency,
Riga City Municipality,
Advisor of Prime Minister on Environmental Protection Affairs.

Foreign institutions:

Ministry of Housing, Physical Planning and Environment of the Netherlands,
Institute of Environmental Studies at Vrije University of the Netherlands,
Polish Foundation of Energy Efficiency.

2. NATIONAL CIRCUMSTANCES

Latvia's total area is 64,600 km^2 with about 2.5 million inhabitants in 1995. Of the total area about 39% is agricultural land, 45% are forests, shrubs and groves. About 3.9% of Latvia's total area are inland water systems.

Climate in Latvia is temperate with frequent cyclones, which cause fast weather changes. The average annual precipitation is 600—700 mm, and the average annual temperature in Riga, the national capital, is 6^oC.

Latvia's indigenous energy resources are biomass, peat, hydropotential and wind. At present they cover less than 20% of the primary energy supply. All the fossil fuels are imported from other countries, mainly from Russia.

As a consequence of the crisis in the economy and fast increase of prices for energy carriers, considerable drop in the energy consumption during recent years took place in Latvia. Primary energy supply has decreased from 378 PJ in 1990 to about 188 PJ in 1996.

The main mode of transport is road traffic. It uses about 77% of total transport energy consumption. The same as in other CEE countries a very rapid increase in car ownership is taking place in Latvia. The increase in 1995 was about 24% compared to 1990. The advantageous geographical position of Latvia within Europe and the location near the Baltic Sea are prerogatives for development of the transit transport.

In 1996 the decline in industrial production has stopped for the first time since the beginning of the economic reforms. The following branches of industry played an important role in the production of goods in 1996: manufacture of food products and drinks, manufacture of textiles, manufacture of wood and wood products (except furniture), manufacture of chemicals and chemical products.

Agriculture has traditionally been a developed sector in Latvian economy. Chief reasons for the decline in the 1990ies were the fast narrowing of markets (both external and domestic) and price changes with adverse effect for agriculture. In 1990 agricultural output constituted one fifth of GDP and in 1996 — only 6%.

Latvia has nearly 2.88 mill. ha forest land. Because of the very limited energetic and mineral resources in Latvia the forest sector is of great importance to the national economy. The share of forestry and its associated industries in GDP has increased remarkably and in 1995 it was about 10 % of the total.

3. INVENTORIES OF ANTHROPOGENIC EMISSIONS AND REMOVALS OF GHG

The direct GHG CO_2, CH_4, N_2O, as well as indirect GHG NO_x, CO, NMVOC and SO_2, are included into the emission inventory. The methodology used for estimating emissions is based on the IPCC 1996 Revised Guidelines for National Greenhouse Gas Inventories. In Table 1 a short summary for GHG emissions for the years 1990—1996 is presented.

Table 1

Summary of GHG emissions, 1990—1996, Gg

GHG	1990	1991	1992	1993	1994	1995	1996
CO_2	24906	19553	16461	14550	12025	12144	11065
CH_4	186	183	150	105	98	101	93
N_2O	23	20	19	17	17	16	16
NO_x	93	61	53	46	48	42	35
CO	388	733	453	528	307	454	176
NMVOC	148	97	63	98	99	70	41
SO_2	119	90	79	73	86	59	59

CO_2 emissions

The most important source of CO_2 emissions in Latvia is the combustion of fossil fuels — about 90% of the national total. The largest sources in 1995 there were Energy industries (38%), Residential (15.5%) and Transport sectors (13.6%).

CH_4 emissions

Total anthropogenic emissions of CH_4 amounted to about 101 Gg in 1995. The main sources were agriculture — enteric fermentation (38.8%) and manure management (5.2%); solid waste disposal on land (25.3%); fuel, mainly wood burning (7.4%) and leakages from natural gas transmission/distribution pipelines and facilities (21.3%) contribute to CH_4 emissions as well.

N_2O emissions

Anthropogenic emissions of N_2O almost completely (96.6%) derived from the agriculture soils in 1995. The real volume of N_2O emitted in Latvia may be higher compared to the data in Table 1 because:

— N_2O release from anaesthesia use was not accounted as there were no activity data in statistics;

— no data were available regarding the use of catalytic converters in cars.

CO_2 removals

The area of forest in Latvia is increasing and annual growth is exceeding the harvest (increment in managed forests 16.5 mill. m^3). CO_2 sequestration in 1995 was about 10600 Gg, and it means that about 87% from the total CO_2 emissions were removed by forest in 1995. The sequestration is not included in the national totals.

4. POLICIES AND MEASURES TO REDUCE GHG EMISSIONS

Climate change mitigation policy is to a large degree incorporated into other policies in Latvia. The main recently created documents related to climate policy are as follows:

— National Communication of the Republic of Latvia under UN FCCC. MEPRD, Riga, 1995 [3].

— How to Mitigate Climate Change. Summary of the Study on the Assessment of Some Policy and Technology Options in Energy and Forestry Sectors in Latvia. MEPRD, 1998. (The Study Final Report is available in the MEPRD) [5].

— National Transport Development Program (1996—2010). Summary. Riga, 1996 [14].

— Conception for Making Use of Subsidies in Agriculture and Motivation for Programs 1998—2002. Ministry of Agriculture of the Republic of Latvia, November 1997 (in Latvian) [16].

— Draft Forest Policy in Latvia. January 1998 (in Latvian) [19].

— National Environmental Policy Plan for Latvia. Riga, 1995 [20].

— National Environmental Action Program. MEPRD. Riga, 1996 (in Latvian) [21].

— Strategy for the Municipal Waste Management in Latvia. MEPRD, May 1997 (in Latvian) [26].

— National Energy Development Program for Latvia. June 1997 (in Latvian) [22].

— Conception for Agricultural Development. Ministry of Agriculture of the Republic of Latvia. Riga, 1998 (in Latvian) [29].

— Draft National Program "Production and Use of Biofuels in Latvia". Ministry of Agriculture of the Republic of Latvia. Riga, 1996 (in Latvian) [23].

— Latvia Forestry Sector Masterplan. Final Report. State Forest Service, Latvia; Swedforest International AB, Sweden. January, 1995 [25].

— Forestry Development Program for Latvia. 1992 (in Latvian) [24].

— Republic of Latvia. Draft Municipal Solid Waste Management Project. Document of the World Bank. November 1997 (in Latvian) [27].

— Draft National Program for Construction. MEPRD, 1997 (in Latvian) [33].

— Riga Development Plan 1995—2005 (in Latvian) [28].

The above mentioned documents envisage following measures which are relevant to climate change mitigation in different sectors of economic activities (more detailed information is presented in Annex 1).

Energy industries:
increase of fuel prices,
fuel switching,
improvement of energy efficiency,
increased use of CHP production,
increased use of biomass in DH production,
reconstruction of small HPPs,
increased use of wind energy.
End-use sectors:
fuel switching,
heat energy conservation in buildings,
electricity conservation,
implementation of the system for analysis and checking of energy consumption.
Transport:
improved public transport system,
maintenance of existing vehicles,
engine power reduction for cars,
road vehicle with alternative fuels,
speed limits,
improved drivers' behavior.
Fugitive emissions from fuels:
reduction of natural gas leakages,
reduction of gasoline losses in filling stations.
Industrial processes:
implementation of up-to-date technologies,
replacement of old equipment and hazardous substances.
Agriculture:
improved management of ruminant live-stock,
improved management of live-stock manure,
elaboration of scientifically sound recommendations on N-fertilizer use efficiency.
Forestry:
forest and forest land area conservation,
purposeful afforestation of abandoned agricultural land,
silviculture practices in young stands,
sustainable forest management,
forestry certification.
Waste:
establishment of separate waste collection systems,
waste reuse,
waste minimization in landfills,
biological treatment of waste,
clean-up of old landfills,
development of waste management infrastructure.

5. PROJECTIONS AND EFFECTS OF POLICIES AND MEASURES

MRS

Two cases for economy development for 1995—2020 with different growth rates of GDP has been discussed — a lower one and a higher one. Only the higher growth rate case was assumed for MRS, because a higher economic growth usually leads to a higher level of GHG emissions.

Other assumptions for creating MRS:
— number of population in Latvia is not increasing;
— integration of the state in the EU is one of the most important objectives of the Government;
— the Government plans to finalize privatization till the end of 1998 (including also big companies).
— liberation of prices and tariffs, and reduction of inflation is going on.

SECTORAL SCENARIOS AND GHG EMISSIONS

To create the Energy sector development scenarios and calculate future GHG emissions the MARKAL model — bottom-up dynamic optimization model for Energy sector was used. Modeling was carried out by experts from the Energy department of the Latvian Development Agency. The analysis of the Transport sector GHG mitigation possibilities was based on experts' judgement only. For creating the Forestry sector projections the methodology developed by experts from State Forest Service were used to make all the calculations. The GHG emission projections for the Industry, Agriculture and Waste sectors were carried out making use of the Long-term Economic Forecast till 2020 elaborated by experts of the Ministry of Economy of the Republic of Latvia.

Energy

Economy in Latvia undergoes transition, which means that considerable changes will occur in the Energy sector. Therefore a "business-as-usual" scenario cannot be used here. An "efficient" Energy sector Reference Scenario was elaborated, and a lot of economically profitable, cost-effective energy efficiency improving options were included in it, resulting at the same time in GHG emission reduction.

Results of model calculation for high energy efficient Reference Scenario CO_2 emissions show that emissions from Energy sector in the year 2020 may be about 18% below the level of 1990. It means that if economic growth is not higher than assumed in MRS and Energy sector Reference Scenario is realistic, which means — if there is rather high level of investments available in Latvia's economy to introduce modern, resources saving technologies and to implement appropriate economic and fiscal instruments, then according to the Kyoto Protocol to the UN FCCC the GHG reduction targets can be reached without any additional effort on behalf of Latvia because Energy sector is the main to emit GHG into atmosphere.

If efficiency improvements included in the Energy sector Reference Scenario are not fully implemented, aggregated GHG emissions after the year 2012 might be only some 10% below the 1990 level and it does not seem easy to fulfill the commitments under the UN FCCC in coming years. Therefore additional measures should be envisaged.

MARKAL model calculations for the Energy sector Scenario "with measures" show that the combined effect of implementation of all CO_2 reduction measures in an integrated approach could be about 30% emissions reduction till the year 2020 compared to the Reference Scenario case. A lot of policy instruments is necessary in Latvia to reach the emission reduction, including CO_2 tax.

Transport

As a result of the sharp increase in the number of vehicles and development of transit traffic the annual CO_2 emissions from transport in 2020 will exceed the level of 1995 considerably in the Energy sector Reference Scenario case, but they will not reach the level of 1990. Other experts yet are of the opinion that just after 2010 CO_2 emissions from transport will start to exceed the level of 1990. Some additional researches should be performed to clear up the problem.

Effect of implementation of GHG mitigation measures considered in the given Communication was not included in the Energy sector Scenario "with measures".

Forestry

Because of the increase of the forest area, and because of the fact that forests in Latvia will be on average composed of relatively young classes as they recover from the past harvesting and abandonment of agricultural land, they will remain net C sink during 1995—2020. CO_2 sequestration will increase in the Forestry sector Reference Scenario case by about 14% in comparison to the year 1990 level.

As there was no model for Forestry sector assessment, no integrated approach was possible in the Forestry sector Scenario "with measures". Therefore only one partial scenario was evaluated for the purpose of this document. In that case CO_2 removals will begin to increase after the year 2000, and will reach about 2.5% annual incremental CO_2 removal starting the year 2020 in comparison with the Reference Scenario case. Full benefits (economical and social) could be observed only over some period of 50—60 years.

Waste

The amount of waste in solid waste disposal sites in Latvia and related CH_4 emissions are going to grow after the year 2000 though the number of population will continue to decrease. If nothing is done (Waste sector Reference Scenario case), in 2020 the amount of CH_4 produced in landfills could exceed the level of 1990 by about 70%. Waste incineration is on a pilot project scale in Latvia presently.

The Strategy for the Municipal Waste Management [26] was worked out in 1997, one of the main targets of it being to reduce the negative environmental impact of landfills in Latvia. "Getliņi" waste disposal site reconstruction has been started. Combined effect of proposed measures (Waste sector Scenario "with measures"), such as decrease in landfilling by about 20% from 2005 due to waste reuse, and recovery of biogas after the year 2000, will result in the CH_4 emission reduction till 2020 by about 46% in comparison with the Reference Scenario. In this case CH_4 emissions will remain 6% below the level of 1990.

Summary of GHG emissions

A summary of the forecast for CO_2, CH_4 and N_2O emissions for all sectors for Reference scenarios and Scenarios "with measures" is shown in Table 2.

Table 2

GHG emissions for the period of 1990—2020, Gg

GHG	1990	1995	2000	2005	2010	2015	2020
CO_2	24906	12144	12273 12274	15118 11067	17884 12566	19612 13248	20573 13936
CH_4	186	101	104 95	110 100	119 114	123 128	135 143
N_2O	23	16	15 15	15 15	17 17	18 18	18 18
NO_x	93	42	56 56	70 59	81 67	88 72	93 76
CO	388	454	273 273	294 320	330 359	364 388	382 408
NMVOC	148	70	96 96	118 120	204 207	365 369	627 630
SO_2	119	59	77 77	114 43	157 60	187 57	190 52

Note:

GHG	According Sectoral Reference scenarios According Sectoral Scenarios "with measures"

6. VULNERABILITY ASSESSMENT OF THE ECOLOGICAL SYSTEMS AND ADAPTATION TO THE IMPACTS OF CLIMATE CHANGE

Till now no vulnerability assessment of the ecological systems has been carried out, and no national programs or plans created regarding adaptation measures in these systems in Latvia because of the lack of financial resources. However, there is some earlier started research work on the variability of regionally important tree species in response to changes in climate and on the degree and rate of evolutionary processes and adaptation by means of genetic changes.

7. RESEARCH AND SYSTEMATIC OBSERVATIONS

An elaborated planning and use of best available technologies would ensure sustainable development possibilities for Latvian economy. However, national resources that could be assigned for these objectives are limited. There is a need for more active practical international co-operation in order to implement the requirements of the Article 4 (c) of the UN FCCC on transfer of technology and knowledge. The climate change mitigation related international cooperation projects in Latvia mainly are orientated towards energy efficiency improvements and waste management.

Following the Berlin meeting (COP 1, 1995), pilot projects now are being undertaken on AIJ by a number of countries, and this work should be finished in 2000. In 1997 the MEPRD has signed two climate change mitigation-related international agreements on AIJ (with the Netherlands and with Canada). These agreements include cooperation in the increase of energy efficiency, and increased use of the alternative and renewable energy resources. Similar agreements are expected to be signed with Sweden and Germany.

Pursuant to the requirements of the UN FCCC, the Hydrometeorological Agency of Latvia has provided for systematic pollution observations and climate monitoring, thus creating a data base for the evaluation of climate-related factors and the study of tendencies. Information about anthropogenic pollution load is necessary to assess reasons of changes in the environmental quality. At the Environmental Data Center of the MEPRD such statistical reports are filed in the database.

8. EDUCATION, TRAINING AND PUBLIC AWARENESS

Feasibility of Latvia to support education on environmental issues from the state budget is restricted; the present level in environmental education is achieved by virtue of activities of informed part of general public, as well as owing to support of governmental and non-governmental organizations of Nordic countries and EU.

Efforts should be made to expand the ideas of the latest scientific findings on global warming, to promote environmental education and public awareness. Public awareness is a necessary pre-requisite for the implementation and development of climate policy, since its efficiency is directly dependent on the level of knowledge, understanding of situation and sense of responsibility of all the persons involved.

1. INTRODUCTION

For some time scientists have drawn attention to the phenomenon of accelerated climate change as a result of human activities. An increase in GHG concentrations leads to an additional warming of the Earth's surface and its atmosphere and leaves a negative impact on climate. According to the Second Report of the IPCC [1], the global mean surface air temperature has increased by 0.3 to 0.6°C over past 100 years. In its modeling of possible climate changes to come, the IPCC envisages future temperature increase using a number of scenarios with varying assumptions as to population, economic growth and energy supplies. A "business-as-usual" scenario may lead to 1—3°C temperature increase by 2025 and to 2—4°C increase by the end of the next century, in comparison with the present state. The likely global consequences of this increase are as follows.

— Planetary climate change will make weather patterns erratic and increasingly hard to predict. Droughts, storms, floods and hurricanes are likely to be more frequent and more severe than in past. Ice, snow and glaciers will be reduced.

— A 20—50 cm increase in the level of the oceans is envisaged for 2050; it may reach 30—100 cm by the end of the 21st century. Coral reefs and other aquatic ecosystems will be disrupted.

— Effects on agriculture, mainly due to changes in rainfall patterns and predictability, will be uneven but substantial. Desertification will be enhanced. Hydrological changes will be disruptive not only for agriculture but for hydroelectric power generation.

— Changed climate conditions will place stress on forests, grasslands and other ecosystems, especially where species are already close to their biological limit with respect to moisture and temperature.

The IPCC points to uncertainties that affect its predictions of the timing, the magnitude and regional patterns of climate change. These are because of inadequate knowledge of such factors as the functions of the oceans in determining climate, the interaction of the clouds with GHG buildup, the response of the polar ice sheets to climate change, and other possible feedback mechanisms [2].

Alongside with many other countries worldwide Latvia signed the UN FCCC during the United Nations Conference on Environment and Development in Rio de Janeiro in June 1992. FCCC came into force on 21 March 1994, and its ultimate aim is countering irreversible climate change caused by anthropogenic activities. The Saeima of Latvia ratified FCCC on 23 February 1995, and since then Latvia became a Member State to the UN FCCC and undertook to fulfill a range of internationally adopted commitments.

In accordance with Article 4, Paragraph 12 of the UN FCCC, each Party, including Latvia, should submit to the Conference of the Parties the information about national GHG emissions and sinks, as well as description of policies and measures taken or envisaged to fulfill the commitments.

This document is Latvia's second National Communication under the UN FCCC. It presents the current situation of the GHG emission inventories, emission projection as well as development in climate change mitigation policy. The first National Communication [3] was prepared in 1995. The in depth-review of this Communication by experts from

OECD was carried out in 1996 in Riga. In the first National Communication it was possible to give the complete GHG emissions inventory only for the base year 1990. Since then the inventories of emissions have been done annually and they became more precise. The emission calculation in this document was carried out in accordance with the IPCC 1996 Revised Guidelines for National Greenhouse Gas Inventories [4]. It means that emissions for the year 1990 were recalculated.

As stated in the first National Communication, the economic decline in Latvia in 1990—1994 due to the transition to a market economy caused a reduction of the GHG emissions also, and projections for the year 2000 do not envisage to exceed the level of 1990 even when no specific actions are undertaken. It is for after that year that the GHG emissions are expected to increase following the forecasted economic recovery and growth. But it was assessed that rapid economic development already started in Latvia after 1995 (annual average increase of GDP was projected to be about 4.6—5.8% in 1995—2000 period) will cause a gradual increase in emissions. It will not be possible to stabilize before the year 2000 the achieved emission reduction level of 1995.

To assist Latvia to meet requirements of the Convention on stabilization of GHG concentrations in the atmosphere at a level preventing dangerous anthropogenic interference with the climate system the joint Latvian-Poland-Dutch Study [5] was carried out. Its objective was to scientifically identify and evaluate feasible measures in Energy and Forestry sectors to mitigate climate change and to propose a strategy for the stabilization and reduction of GHG emissions in the future. The Study was financed by Dutch Government with technical and training support by experts from the Netherlands, Poland and Norway, and it was very useful in preparing the second National Communication.

The following ministries and institutions from Latvia have contributed to the present Report:

— Ministry of Environmental Protection and Regional Development,
— Ministry of Foreign Affairs,
— Ministry of Economy,
— Ministry of Transport,
— Ministry of Agriculture,
— Environment Data Center,
— State Forest Service,
— Development Agency,
— State Committee of Statistics,
— Hydrometeorological Agency,
— Riga City Municipality,
— Advisor of Prime Minister on Environmental Protection Affairs.

Foreign institutions:

— Ministry of Housing, Physical Planning and Environment of the Netherlands,
— Institute of Environmental Studies at Vrije University of the Netherlands,
— Polish Foundation of Energy Efficiency.

2. NATIONAL CIRCUMSTANCES

2.1. Geographic conditions, climate and demography

Latvia is located on the edge of the East European plane near the Baltic Sea between 55°40' and 58°05' north and from 20°58' to 28°14' east. The length of the coastline with the Baltic Sea and Riga Gulf is 0.5 thous. km. With an area of 64,600 km^2 the Republic of Latvia is one of the smallest countries in Europe. Of the total surface area about 39 % is agricultural land and 45 % is covered by forests, shrubs and groves. About 3.9% of Latvia's territory are inland water systems [6,13].

Climate in Latvia is temperate. It is determined by Latvia's geographical location near the Baltic Sea and Riga Gulf. To a large extent climate is influenced by flows of marine air from Atlantic Ocean and frequent cyclones, which bring about considerable changes in weather 190—200 days during a year. This results in lower summer temperatures and higher winter temperatures in comparison with the average temperature at medium degrees of latitude for inland areas. Annual mean air temperature in Riga is +6° C; in January –4.9 °C and in July +16.9 °C [7]. Long-term observations made at hydrometeorological stations in Latvia show that annual average temperature over recent 100-year period has increased slightly. During the first 50 years annual air temperature became 0.2°C higher on the average, in the second half nearly by 0.5°C.

The annual precipitation in Latvia is ranging from 600 to 700 mm, and it has become more abundant over the last 50 years. The process was more evident in districts, where prevailing winds and relief fostered ascending of air masses. During a year, the increase was more evident early in the cold period.

The average number of hours with sunshine in Latvia is 1660—1880 a year. Total cloud amount in Latvia has remained unchanged during observation period. Notwithstanding this fact the analysis shows that the sunshine duration has become shorter.

The winds are usually from south-west and south directions with mean speed 3—6 m per sec.

The hydrological observations in the Riga Gulf and the Baltic Sea areas adjacent to Latvia's coast testify to gradual water level rise. Analysis of trends of observations shows that during the last 100 years the mean annual water level in the Riga Gulf (Daugavgrīva station's data) has increased by 16 cm, in the Baltic Sea (Liepāja station's data) — by 4 cm.

The population in Latvia amounts to nearly 2.5 mill. inhabitants, out of whom 32.9% lives in the capital city Riga. During the years 1945—1990 the number of population in Latvia grew very fast due to immigration flow from Russia, Byelorussia and Ukraine. The estimated population for 1990 was 2.67 millions. After that year the number of inhabitants has started to decrease both because of decreasing natural growth and because of some population leaving Latvia. Demographic projections do not predict any growth of the number of population during the next 20 years. It is forecasted to be 2337.3 thousands in 2015 [8]. The changes of number of population are presented in Table 2.1.

Table 2.1.

Changes in number of population

	1990	1995
Total population (thous.)	2673.4	2529.5
Population, % from which		
— urban	69.3%	69.1%
— rural	30.7%	30.9%

Source: [13].

2.2. Economic conditions

General

After regaining independence in 1991 Latvia was one of the first CEE countries to start the process of the transition to a market economy. With its very poor mineral deposits (gravel, sand, dolomite, limestone, peat) Latvia has experienced remarkable economic decline during the last five years. Dynamics of its GDP during 1990—1995 is shown in Fig. 2.1.

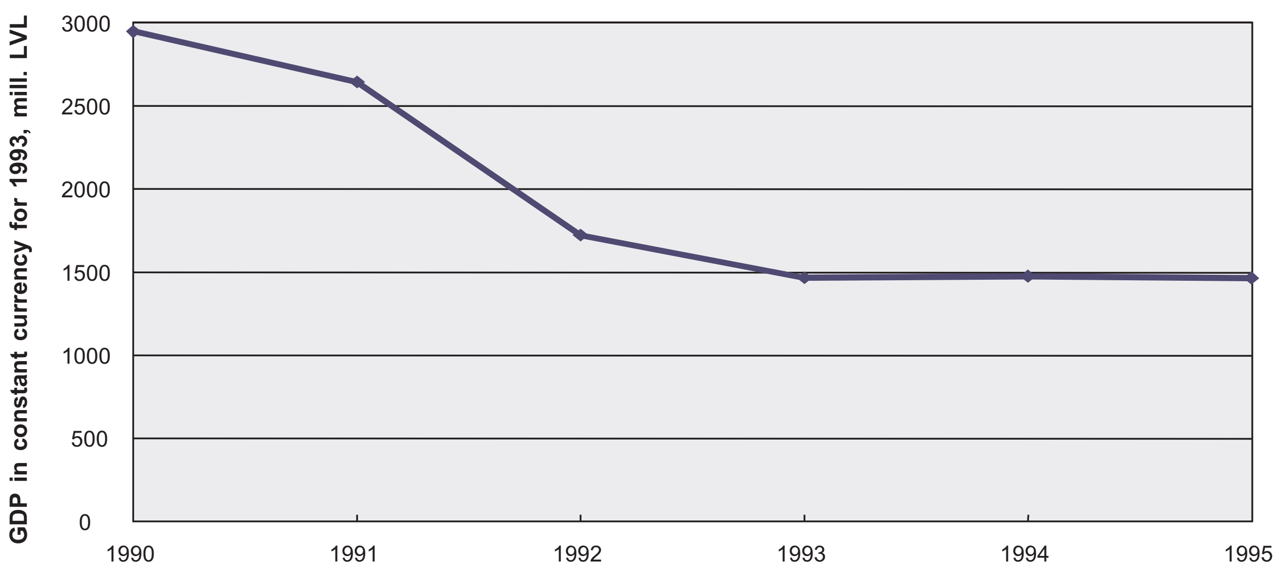

Fig. 2.1. GDP dynamics, 1990—1995, mill. LVL

Results of the economic development in 1996 show that situation in the state is beginning to stabilize [9]:
— GDP has increased,
— inflation rate has gone down,
— interest rate on loans has fallen,
— output of manufacturing industry has increased,
— transit activity has rapidly grown,
— exports of goods has grown.

Integration of Latvia into the EU is one of the most important objectives of the government. It proceeds in accordance with the National Program for Integration into the EU, which covers legislation approximation methods and sequence for participation of Latvia in the European internal market.

Energy

Latvia's indigenous primary energy resources are biomass (wood), peat, hydro- and wind energy. In 1995 they covered less than 20% of the primary energy supply. Latvia has no resources of gas and coal, and till now it had no explored oil-wells. These fossil fuels are imported from other countries, mainly from Russia.

Seismic research done in the Baltic Sea during the 80ies shows that accumulation of oil is possible in several underground structures. A portion of these structures is located in the territory owned by Latvia. Latvian Government has signed licence agreement with AMOCO, USA and Oljeprospectering AB, Sweden on research and possible extraction activities there. The contract has been ratified in Saeima in 1996 [10]. The possible amount of oil resources is too small to develop oil industries here in Latvia, therefore potentially obtained oil should be exported as crude product, and it will not have any influence on the amount of the imported oil products in Latvia.

As a consequence of the crisis in the economy, particularly the collapse in industrial production as well as the fast increase of prices for energy carriers, a considerable drop in the energy consumption during recent years took place in Latvia. Primary energy supply has decreased from 378 PJ in 1990 to about 187 PJ in 1995. The primary energy supply is shown in Fig. 2.2.

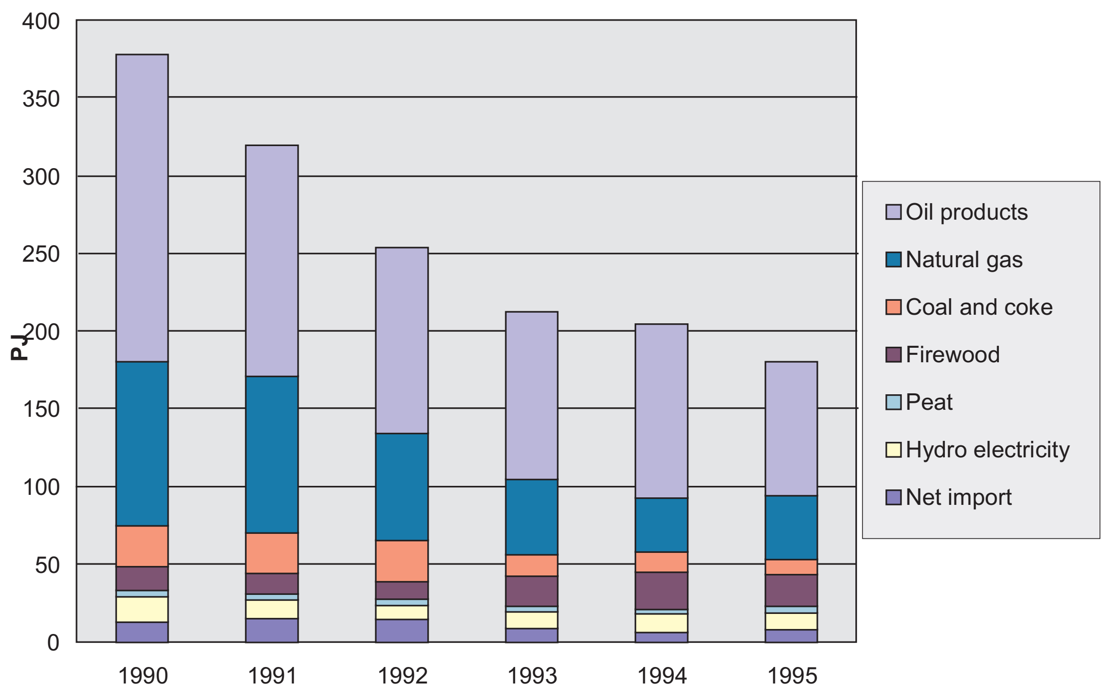

Fig. 2.2. Primary energy supply, 1990—1995, PJ

The low prices of fossil fuels (oil, gas) in the former USSR had very negative effects on the energy system in Latvia, inducing ineffective use of energy and restraining the development of renewable resources. Fig. 2.3. shows the changes in primary energy consumption per unit of GDP in 1990—1995 [5].

Following the economy decline in Latvia, final energy demand has decreased considerably during 1990—1995 (see Fig. 2.4.).

To-be-privatized state joint-stock company LATVENERGO is the nucleus of the power supply system in Latvia. It incorporates three HPPs on the River Daugava and cogeneration plants CHP-1 and CHP-2 in Riga in which natural gas,

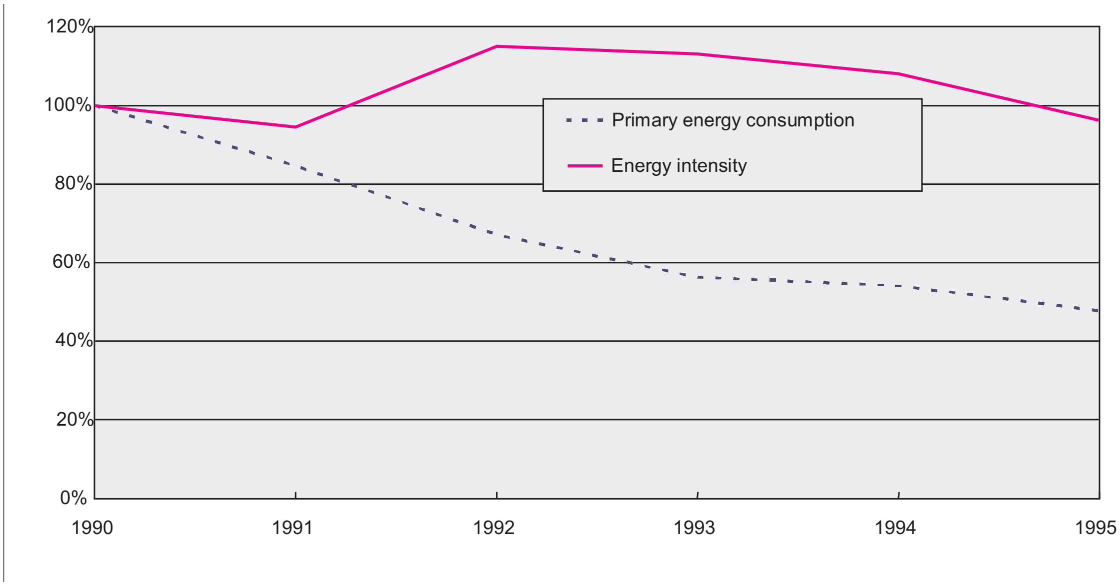

Fig. 2.3. Primary energy consumption per unit of GDP, 1990—1995, %

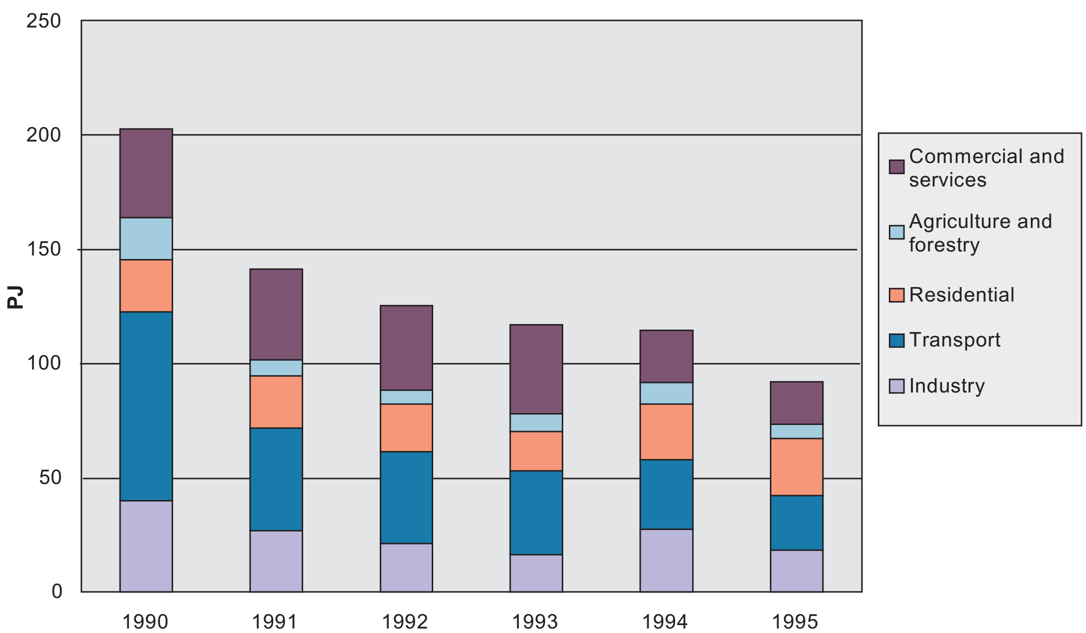

Fig. 2.4. Final energy demand by sectors, 1990—1995, PJ
(without electricity and district heat)

RFO and a small amount of peat are being burnt. Several small HPPs were rehabilitated and operating till 1995. Their owners are either joint-stock companies or individuals, and their total installed capacity in 1996 was 2.6 MW, generation 2.52 GWh.

Heat energy for the district heating is produced in Riga cogeneration plants CHP-1 and CHP-2 and regional district heating boiler houses. In 1996 there were 10 small and medium size cogeneration plants with total installed electricity capacity about 68 MW, their owners basically being industrial enterprises — joint-stock companies. Of all the heat energy produced by district heating system only about 21 % were produced by cogeneration plants in 1994 [10, 12].

Current situation in Transport

Transport is a sector of national economy, which develops very dynamically. In 1996 it yielded 14.3% of GDP. Fast development was ensured mainly by transit carriage and port services [9].

In Latvia the main mode of domestic transport is road traffic. It uses about 77% of total transport energy consumption. The number of vehicles registered in Latvia is presented in Table 2.2.

Table 2.2.

Number of vehicles, 1994—1996
(data refers to the end of a year)

Vehicles	1994	1995	1996
Ships	345	317	312
Trucks	59386	68668	72908
Buses	14160	16465	17275
Cars	251593	331837	379895
Locomotives	369	349	322

Source: [13].

The condition of roads depends on the financing allocated to their maintenance and construction. Due to the general economic situation, since 1992 allocation for road financing constitutes only a small part of the sum necessary to keep roads up to certain standards. Because of inadequate financing the wear of roads grows, and their general condition is rather critical [9].

Considering the Western experience that the environmental problems caused by transport are growing very rapidly, due attention should be paid to a transport development policy, improvement of transport infrastructure and service. The advantageous geographical position of Latvia within Europe and the location near the Baltic Sea are prerogatives for development of the transit transport that is going to be a permanent element of the Latvia growth potential. Tourism in Latvia will also promote transport development. Table 2.3. shows that the most popular type of vehicle for crossing Latvia's border are motor-cars.

Table 2.3.

Persons crossing Latvia's border and share of types of transportation in 1996

Types of transportation	Outgoing Latvian tourists, thous.	Type of transport, %	Incoming foreign tourists, thous.	Type of transport, %
Total, out of which	1798	100,0	1750	100,0
— by motor-cars	1359	75,6	1301	74,4
— by rail	291	16,2	235	13,4
— by air	105	5,8	112	6,4
— by sea	43	2,4	102	5,8

Source: [9].

Industry

Industrial sector played an important role in Latvian economy until 1990, though only 40 % of total industrial production was supplied with raw materials from local sources. During 1991—1995 changes in political and economical situation created a crisis in the state sector of industry in Latvia. Companies have considerably decreased their industrial manufacturing, some of them are on the verge of bankruptcy, privatization process is governed by indefiniteness, investment interests of foreign investors are lower than expected. Industrial production was only 36% of the level of 1990. This is linked with the technological level of the sector, which does not allow to make high-quality products in adequate quantities and sell them in markets that are able to pay.

Change in privatization policy was determined by the Government Declaration of 1994. Implementing the law “On Privatization of State and Municipal Equity Units”, a profit-free state joint-stock company — Latvian Privatization Agency — was founded which at present carries out the process of privatization of state equity units, attraction of direct foreign investments to companies under privatization, creation of capital market, public share offering, capitalization of state budget debts of enterprises and statutory companies and privatization of land under state property units. In 1996 the decline in industrial production has stopped for the first time since the beginning of the economic reforms and an increase of 5% has been reached (see Table 2.4.). Foreign investments in sector in 1996 increased by 20%, still this increase was substantially slower than totally in national economy where foreign investments increased by 35% [9, 13, 15].

Table 2.4.

Gross industrial output indices, 1990—1996
(as per cent of previous year)

Year	Industry, total
1990	100.8
1991	99.4
1992	66
1993	68
1994	90
1995	96
1996	105

Source: [13].

The following branches of industry played an important role in the production of goods in 1996: manufacture of food products and drinks, manufacture of textiles, manufacture of wood and wood products, manufacture of chemicals and chemical products.

The output of cement and lime, which is a source of CO_2 emissions, is shown in Table 2.5.

Table 2.5.

Output of cement and lime, 1990—1996, thous. t

Year	Cement	Lime
1990	744	156
1991	720	183
1992	340	95
1993	114	46
1994	244	26
1995	204	21
1996	325	19

Source: [13].

Agriculture

Agriculture has traditionally been a developed sector in Latvian economy. The decline of agricultural production after 1990 was determined by several factors — those influencing the total national economy and those that were particularly unfavorable to agriculture. Chief reasons there were the fast narrowing of markets (both external and domestic) and price changes with adverse effect for agriculture [7]. In 1990 agricultural output constituted 20% of GDP and in 1996 — only 6% [7]. The agricultural output indices are shown in Table 2.6.

Table 2.6.

Agricultural output indices, 1990—1996
(as per cent of previous year)

Year	Agricultural output	Crop production	Live-stock production
1990	90	80	94
1991	96	105	92
1992	84	89	82
1993	78	99.8	66
1994	80	76	82
1995	94	93	94
1996	89	94	87

Source: [13].

In 1997 the 5 tax exemptions were granted to farmers by the law in order to stimulate the process of restructuring peasant farms on their way to production intensification and competitiveness. In 1997 the total sown area in peasant farms, household plots and private subsidiary farms increased to about 4.5% [17]. Changes in number of live-stock, area of cultivated organic soils, use of synthetic and organic fertilizers and volume of crops are presented in Table 2.7.

Table 2.7.

Changes in agricultural production

Agricultural production	1990[1)]	1995 [2,3)]	1996 [2,3)]	2010 [4)]	2020 [4)]
Live-stock, thousands					
Cattle	1439	537	509	624.3	755.1
of which dairy cattle	535	292	277	318.3	373.7
Sheep	165	72	56	67.6	72.6
Goats	5.4	8.9	8.4	11	11
Horses	31	27	26	23.7	23.7
Swine	1401	553	460	581.8	879.8
Poultry	10321	4198	3791	4413	5290
Area of cultivated organic soils (at the beginning of year), thous. ha	1687.4	1712.6	no data	1428	1372
Use of synthetic fertilizer (N input), thous. t	131.4 [5)]	11.5 [5)]	9.0 [5)]	46	78
Use of organic fertilizer, thous. t	14400	5145.7	5843.1	6499.1	7248.8
Crops, th. t					
Wheat	371.8	243.7	357.5	442.1	523.5
Barley	697.0	284.0	371.5	614.9	712.2
Oats	176.1	73.2	101.4	401.4	604.7
Rye	323.6	71.3	112.9	223	260.7
Pulses	22.7	4.7	7.8	11.7	15.5
Potatoes	1016.1	863.7	1081.9	1121.3	1256.6
Fodder roots	188.4	432.7	399.1	717.4	803.3
Sugar beets	439.1	250.0	257.8	439.9	554.6

Notes:
1) data from [3];
2) data from [13];
3) data from [17];
4) long-term economic forecast till 2020;
5) data from State Scientific Production Enterprise "Ražība".

Forestry

Forests are the largest natural resources in Latvia. The share of forestry and its associated industries in GDP has increased remarkably and in 1994 it was about 10 % of the total. Latvia has nearly 2,88 mill. ha actual forest land (about 44,6% of the country's land surface), which is classified as high or boreal latitudinal belt (approximately 55.5—58.0 N latitude). The main tree species covered area is following: pine — 39,7%, spruce — 20,6% and birch — 28,4%. Total growing stock for 1995 was 489 mill. m^3, the net annual increment being 16,5 mill. m^3 [18].

Under climatic circumstances in Latvia forest is a dominant ecosystem, and it would have occupied about 90% of the total country's area unless man had not transformed it. From the beginning of 1920ies up to now the forest area has increased to about 1 mill. ha. To ensure the conservation of the area of existing forests, the main tasks in the forestry today are [19]:

— to restrict the transformation of forest land into other land-use systems;

— to promote the afforestation of abandoned agricultural lands through different kinds of state's instruments.

Consideration of these principles would allow the forest area in Latvia to be increased to about 48—52% of the total country's area till 2020.

The state's institutions specify the volume for sustainable forest cuttings in Latvia. It means that planned volume of harvesting should be balanced with increase of the growing stock. For 1995—1999 the cutting volume was estimated to be 8.3 mill. m^3 per year. An increase of the area of mature stands and increase of their productivity will allow to increase forest harvesting after 2000 (see Table 2.8.).

Table 2.8.

Forest harvesting volume, 1990—2020, mill. m^3

Year	Harvesting
1990	5,76
1995	6,89
2000	8,5 (forecast of the State Forest Service)
2010	10,0 (forecast of the State Forest Service)
2020	12,0 (forecast of the State Forest Service)

Source: [5, 18].

2.3. Environmental policy and sustainable development in Latvia

The common environmental policy principles, and activities in energy conservation and efficiency increasing both in energy production and end-use sectors forced by economical reasons, are resulting in GHG emission reduction as well. The most noteworthy recently created documents in Latvia related to environmental policy issues are as follows:

* National Communication of the Republic of Latvia under UN FCCC. MEPRD, Riga, 1995 [3].

* National Environmental Policy Plan for Latvia. Riga, 1995 [20].

* National Environmental Action Program. MEPRD, Riga, 1996 (in Latvian) [21].

* How to Mitigate Climate Change. Summary of the Study on the Assessment of Some Policy and Technology Options in Energy and Forestry Sectors in Latvia. MEPRD, 1998. (The Study Final Report is available in the MEPRD) [5].

* National Energy Development Program. EU PHARE. Riga, June 1997 (in Latvian) [22].

* National Transport Development Program (1996—2010). Riga, 1995 (in Latvian) [14].

* Draft National Program “Production and Use of Biofuels in Latvia.” Ministry of Agriculture of the Republic of Latvia. Riga, 1996 (in Latvian) [23].

* Conception for Agricultural Development. Ministry of Agriculture of the Republic of Latvia. Riga, 1998 (in Latvian) [29].

* Conception for Making Use of Subsidies in Agriculture and Motivation for Programs 1998—2002. Ministry of Agriculture of the Republic of Latvia, November 1997 (in Latvian) [16].

* Draft Forest Policy in Latvia. January 1998 (in Latvian) [19].

* Forestry Development Program for Latvia, 1992 (in Latvian) [24].

* Latvia Forestry Sector Masterplan. Final Report. State Forest Service, Latvia; Swedforest International AB, Sweden. January, 1995 [25].

* Strategy for the Municipal Waste Management in Latvia. MEPRD, May 1997 (in Latvian) [26].

* Republic of Latvia. Draft Municipal Solid Waste Management Project. Document of the World Bank. November 1997 [27].

As stated in the National Environmental Policy Plan for Latvia [20], at present, there are two groups of environmental problems to be solved in Latvia. The first group is connected with the heritage of the so-called controlled and centrally planned economy:

— an attempt to achieve maximum production without any regard for the environment as well as an excessively high energy demand and non-economical use of raw materials in state-owned industries; restructuring of this sector which started after 1990, has not stopped yet;

— the agriculture, energy and transport sectors are presently being restructured;

— the public utility sector is not developed.

The second group of problems is connected with the privatization and restructuring of the national economy towards a market economy. Lack of clear direction in the development of branches of the national economy hinders the implementation of preventive environmental policy. An unfavorable legal environment exists due to the contradictory nature and insufficient number of laws.

At the same time, the significant benefits of the present situation should be stressed. In the course of production restructuring, it is possible to change the outdated production base with modern, environment-friendly technologies. There is a high biodiversity level in Latvia and relatively low environmental pollution in rural areas. The active support and assistance of developed countries is a fact that can be counted on. Global experience can be drawn upon to devise and implement most effective national environmental policy. At present, there is a unique opportunity to renew the national economy using a strategy of sustainable and balanced development.

Riga City Municipality together with other institutions has worked out the Riga Development Plan 1995—2005 [28], in which a lot of environment problems in Riga have been discussed including air protection:

— reduction of air pollution from transport through better structure of urban area, traffic control, economic, information and education instruments;

— elaboration of long-term strategy in energy production, transportation and demand;

— the building development program, including heat energy saving principles;

— fuel use, which produce less harmful emissions, and promotion of the implementation of flue gas refinery systems using economic instruments (charges, investments etc.);

— tree planting campaign promotion.

During 1997—1998 the elaboration of the "Climate Change Mitigation Policy Plan for Latvia" was carried out by authorities from different institutions under the guidance of the Ministry of Environmental Protection and Regional Development of Latvia. There is no special action program in Latvia to mitigate climate change.

3. INVENTORIES OF ANTHROPOGENIC EMISSIONS AND REMOVALS OF GHG

3.1. Introduction

The chapter presents the emission inventory in Latvia for 1995. The classification of sectors of economic activities and methodology used for estimating emissions is based on the IPCC 1996 Revised Guidelines for National Greenhouse Gas Inventories [4]. The GHG CO_2, CH_4, N_2O, as well as indirect GHG NO_x, CO, NMVOC and SO_2, are included. Halocarbons such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6) were not produced or used in Latvia during the period and are not included. Reports of GHG emissions, compiled according to the IPCC 1996 Revised Guidelines [4] are presented in Annexes 4 and 5.

Contribution of CO_2, CH_4 and N_2O to the present Latvia's emission balance in Gg CO_2-equivalent based on GWP values for a time horizon of 100 years [1], is presented in the chapter as well.

3.2. CO_2 emissions and removals

The most important source of CO_2 is the combustion of fossil fuels — about 90% of the total in Latvia. In 1995 the largest sources of them were Energy industries (38%), Residential (15.5%) and Transport sectors (13.6%). Other anthropogenic sources are industrial processes and emissions from agricultural soil management and liming. Removals of CO_2 take place due to the growth of vegetation through the process of photosynthesis. At present forests in Latvia are significant carbon sink, about 89% of CO_2 emitted by fuel combustion being removed by forests (see Table 3.1.).

Sectoral reports for CO_2 emissions for 1995 in accordance with [4] can be found in Annexes 4 and 5. Below more detailed information about CO_2 emissions in each sector is provided.

3.2.1. Fuel combustion activities (1A) (see Table 3.2.)

CO_2 emission values from fuel combustion are based on the information about fuel consumption by sectors of economy from the energy balances statistics. The emission factors employed were taken from [4]. Emissions from centralized heat production in DH and CHP plants are accounted for in Energy industries sector (1A1). Data on fuel combustion in industry on branch level are not reliable therefore it is calculated for the total sector 1A2.

Table 3.1.

Total CO_2 emissions and removals in 1995, Gg

Sectors	Emissions/Removals
1. Energy 1A. Fuel combustion activities	11899.91 11899.91
2. Industrial processes 2A. Mineral products	127.42 127.42
5. Land use change and forestry 5D. CO_2 emissions and removals from soil 5D1. Intensively managed organic soils 5D2. Liming of agricultural soils	116.45 116.45 111.83 4.62
Total emissions	12143.79
5. Land use change and forestry 5A. Changes in forest and other woody biomass stocks	10600.00 10600.00
Total removals	10600.00

Table 3.2.

Energy related CO_2 emissions in 1995, Gg

Sectors	Emissions
1A. Fuel combustion activities, total	11899.91
1A1. Energy industries 1A1a. Losses	4922.94 129.52
1A2. Manufacturing industries and construction	1205.21
1A3. Transport	1748.79
1A4. Other sectors 1A4a. Commercial/Institutional 1A4b. Residential 1A4c. Agriculture/Forestry/Fishing	3893.45 1388.00 1980.00 525.45

3.2.2. Industrial processes (2) (see Table 3.3.)

There are two kinds of the industrial activities in Latvia not related to energy where CO_2 is emitted:

1) the production of clinker, an intermediate product from which cement is made,

2) the production and use of lime, which involves a series of steps comparable to those used in the production of cement clinker; the emission factor is taken from [4].

Table 3.3.

CO_2 emissions from industrial processes in 1995, Gg

Sectors	Activity, Gg	Emission factors, t CO_2/t	Emissions, Gg
2. Industrial processes, total			127.42
2A. Mineral products 2A1. Cement production (26.5) 2A2a. Lime production (26.5) 2A2b. Lime use	 204.0 20.9 20.9	 0.498 0.79 0.44	127.42 101.59 216.59 9.24

Note: in brackets the statistical classification group according [11] is given.

3.2.3. CO_2 emissions and removals from soil (5D) (see Tables 3.4. and 3.5.)

Emissions result from organic soils which are currently under intensive use for crop production (drainage, mechanical tillage, fertilizing, liming) [4].

Table 3.4.

CO_2 emissions from intensively managed organic soils in 1995, Gg

Agricultural use of organic soils	Land area, thous. ha	Annual C loss rate, mg/ha [4]	C loss, Gg	CO_2 emissions, Gg
5D1. Intensively managed organic soils (Cool temperate)	30.5	1.0	30.5	111.83

Table 3.5.

CO_2 emissions from liming of agricultural soils in 1995, Gg

Type of lime	Total annual application, Gg	C conversion factor [4]	C emissions, Gg	CO_2 emissions, Gg
5D2. Liming of agricultural soils (Limestone)	10.5	0.12	1.26	4.62 4.62

3.2.4. Changes in forest and other woody biomass stocks (5A) (see Tables 3.6.—3.8.)

As forest area in Latvia is increasing and annual growth is exceeding the harvest from the point of view of preventing climate change annual increase of forest area means that forests are sequestrating more and more carbon from atmosphere. Net CO_2 sequestration in 1995 was about 10600 Gg and it was decreased a bit compared to 1990 10960 Gg because of higher rates of harvesting. It should be mentioned that recalculation of the CO_2 fluxes for 1990 according [4] gave values which differ from those presented in the first National Communication [3]. The information from Latvian State Forest Service data base was used for all the calculations. The increment of wood in products and buildings as well as wood import is not included in the calculations because documentation was not available. Forests regrowing on the abandoned agricultural land are managed forests in Latvia, therefore they are classified into "Changes in forest and other woody biomass stocks" category also.

Table 3.6.

Growing stock increment in 1995
(sheet 1 according to [4])

Forest land type	Area, thous. ha	Annual increment of growing stock, thous. m^3 (stemwood volume)	Carbon uptake increment in whole tree biomass, thous. t
Managed forest	2829	16500	6680
Other wooded land	112	112	50
Total	2941	16610	6730

Table 3.7.

Amount of removed biomass in 1995
(sheet 2 according to [4])

Type of removed biomass	Annual amount, thous. m^3	Annual amount of whole tree biomass, thous. t dry biomass	Carbon release, thous. t
Forest harvesting	6890	5581	2790
Natural die-off	2800	2268	1130
Total	9690	7849	3920

Table 3.8.

Net CO_2 removals in 1995, Gg
(sheet 3 according to [4])

Annual C increment in the whole tree biomass	6730
Annual C increment in soil of newly afforested land	80
Annual C release from natural forest die-off	1130
Annual C release from harvesting	2790
Net annual C uptake	2890
Net annual CO_2 removals	10600

The assumptions and calculations to get results for the Tables 3.6.—3.8. are given in Annex 2.

3.3. CH_4 emissions

The main sources of CH_4 emissions in Latvia are agricultural sector (enteric fermentation, manure management) and solid waste disposal on land. The leakages from natural gas transmission/distribution pipelines and facilities and biomass (wood) burning also contribute to CH_4 emissions. Total CH_4 emissions are provided for 1995 in Table 3.9.

Table 3.9.

Total CH_4 emissions in 1995, Gg

Sectors	Emissions
1. Energy	29.10
1A. Fuel combustion activities	7.50
1B. Fugitive emissions from fuels	21.60
4. Agriculture	44.63
4A. Enteric fermentation	39.31
4B. Manure management	5.32
5. Land use change and forestry	
5A. Changes in forest and other woody biomass stocks	2.00
6. Waste	25.60
6A. Solid waste disposal on land	
6A1. Managed waste disposal on land	21.74
6A2. Unmanaged waste disposal sites	3.86
Total emissions	101.33

Sectoral reports for CH_4 emissions for 1995 according to [4] can be found in Annexes 4 and 5. Below more detailed information about CH_4 emissions in each sector is provided.

3.3.1. Fuel combustion activities (1A)

The main source of CH_4 emissions in the sector is biomass (wood) burning. CH_4 is produced in small quantities from fuel combustion due to incomplete combustion of hydrocarbons in fuel. The highest rates of emissions occur in residential applications (small stoves and open burning). Results see in Table 3.9.

3.3.2. Fugitive emissions from fuels (1B)

Emissions from natural gas transmission/distribution pipelines and facilities are estimated according to the IPCC 1996 Revised Guidelines [4] from the amount of country's gas consumption per year and emission factor for former USSR 0,5 Gg/PJ. Results see in Table 3.9. The emissions from the Inčukalns underground natural gas storage were taken from its Annual Report.

3.3.3. Enteric fermentation and manure management (4A, 4B)

CH_4 from animals is produced in the processes of enteric fermentation and manure management under anaerobic conditions. Results see in Table 3.10. Course of calculations see in Annex 5, Table A5-4.

3.3.4. Changes in forest and other woody biomass stocks (5A)

On-site burning of biomass (wood) residues after harvesting produces non-CO_2 trace gases CH_4, CO, N_2O, NO_x. Amount of CH_4 released — 2.0 Gg. Results see in Table 3.9. The detailed calculation of CH_4 emissions from Forestry sector see in Annex 2.

3.3.5. Solid waste disposal on land (6A)

CH_4 is produced in solid waste disposals during anaerobic decomposition of organic matter. Results are given in Table 3.9. Course of calculations see in Annex 5, Table A5—6a. As there are only few wastewater anaerobic treatment pilot plants in Latvia, CH_4 emissions from wastewater treated were not accounted.

3.4. N_2O emissions

The main N_2O emission sources in Latvia are agricultural soils and fuel combustion activities. Total N_2O emissions for 1995 are provided in Table 3.10. It should be noted that the real volume of N_2O emitted may be higher in comparison with the data in the table because:

— N_2O release from anaesthesia use was not accounted as there were no activity data in statistics;

— no data were available regarding the use of catalytic converters in cars.

Table 3.10.

Total N_2O emissions in 1995, Gg

Sectors	Emissions
1. Energy	
1A. Fuel combustion activities, in which	0.26
1A1. Energy industries	0.06
1A3. Transport	0.11
1A4b. Residential	0.05
4. Agriculture	
4D. Agricultural soils	15,73
5. Land use change and forestry	
5A. Changes in forest and other woody biomass stocks	0.01
6. Waste	
6B. Wastewater handling	
6B2. Domestic and commercial wastewater	0.25
Total emissions	16.25

Sectoral reports for N_2O emissions for 1990—1995 can be found in Annexes 4 and 5. Below more detailed information about N_2O emissions in each sector is provided.

3.4.1. Fuel combustion activities (1A)

The main source of N_2O emissions in the sector are transport and biomass (wood) burning in Energy industries and Residential sectors. Results see in Table 3.10.

3.4.2. Agricultural soils (4D)

N_2O emissions from agricultural soils include [2]:

— direct emissions from soils (which result from the synthetic fertilizer use, manure used as fertilizer, nitrogen input from N-fixing crops and crop residues and emissions from cultivation of histosols),

— emissions due to grazing animals,

— indirect emissions (due to atmospheric deposition of NH_3 and NO_x and due to nitrogen leaching). Results for 1995 are presented in Table 3.11.

Table 3.11.

N_2O emissions from agricultural soils 1995, Gg

Type of emissions from soils	Emissions
4D. Agricultural soils, total	15,7
4D1. Direct emissions	14.62
4D1a. Synthetic fertilizers use	0.20
4D1b. Manure use as fertilizer	0.75
4D1c. N input from N-fixing crops	0.01
4D1d. N input from crop residues	0.20
4D1e. Cultivation of histosols	13.46
4D2. Emissions due to grazing animals	0.23
4D3. Indirect emissions	0.88
4D3a. Atmospheric depositions of NH_3 and NO_x	0.17
4D3b. N leaching	0.71

3.4.3. Changes in forest and other woody biomass stocks (5A)

On-site burning of biomass (wood) residues after harvesting produces non-CO_2 trace gases CH_4, CO, N_2O, NO_x. The detailed calculation of N_2O emissions from Forestry sector see in Annex 2. Amount of N_2O released — 0.014 Gg. Results see in Table 3.10.

3.4.4. Domestic and commercial wastewater (6B2)

A negligible amount of N_2O is released from discharge of human sewage to aquatic environments. To make the estimation annual per capita protein intake was assumed to be 0.11 kg/person/day (stated by Latvia's scientists questioning in 1991). Results see in Table 3.10. Course of calculations see in Annex 5, Table A5—6b.

3.5. Indirect greenhouse gases and SO_2

Total emissions of the indirect GHG and SO_2 for 1995 are provided in Table 3.12.

Table 3.12.

Total indirect GHG and SO_2 emissions in 1995, Gg

Sectors	Emissions			
	NO_x	CO	NMVOC	SO_2
1. Energy	41.80	436.17	48.70	59.07
1A. Fuel combustion activities	41.80	436.17	46.56	59.07
1B2. Fugitive emissions from fuels			2.14	
2. Industrial processes		0.00	8.37	0.11
2A. Mineral products				
2A1. Cement production (26.5)				0.06
2A2. Lime production (26.5)				
2A6. Road paving with asphalt (45.23)		0.00	6.47	
2D. Other production				
2D1. Pulp and paper (21.1)				0.05
2D2. Food and drink (15.9)			1.90	
3. Solvent and other product use			12.54	
3A. Paint application			12.54	
5. Land use change and forestry	0.50	17.50		
5A. Changes in forest and other woody biomass stocks	0.50	17.50		
Total emissions	42.30	453.67	69.61	59.18

Note: in brackets the statistical classification group according to [11] is given.

Sectoral reports for indirect GHG and SO_2 emissions for 1990—1995 can be found in Annexes 4 and 5. Below more detailed information about these emissions in each sector is provided.

NO_x

Nitrogen oxides are indirect GHG. Fuel combustion activities were the main source of all the NO_x emissions in Latvia in 1995, which resulted in total of 41.80 Gg. 52% of it came from Transport sector. On-site burning of biomass (wood) residues after harvesting produces non-CO_2 trace gases CH_4, CO, N_2O, NO_x. The detailed calculation of NO_x emissions from Forestry sector see in Annex 2. Amount of NO_x released — 0.5 Gg. Results see in Table 3.12.

CO

Carbon monoxide is an indirect GHG. From the total of 453.67 Gg emitted, 25% came from motor vehicles and 52% from Residential sector small combustion equipment. On-site burning of biomass (wood) residues after harvesting produces non-CO_2 trace gases CH_4, CO, N_2O, NO_x. The detailed calculation of CO emissions from Forestry sector see in Annex 2. Amount of CO released — 17.5 Gg. Results see in Table 3.12.

NMVOC

NMVOC are volatile organic compounds — all hydrocarbons, including those where hydrogen atoms are partly, or fully, replaced by other atoms [4]. In 1995 about 69.61 Gg NMVOC were emitted in Latvia. The main sources were fuel combustion activities (transport and biomass burning in Residential sector). Fugitive emissions from oil products storage and handling include only those from gasoline. Results see the Table 3.12.

SO_2

SO_2 is not a GHG, but its' being a sulfate aerosol precursor in the atmosphere may influence climate. In 1995 99,8% of the total 59.18 Gg SO_2 emissions in Latvia arose from fuel combustion. About 72% from this amount came from residual fuel oil and 25% — from coal combustion. Results see in Table 3.12.

3.6. Aggregated emissions of GHG

The emissions of individual GHG can be expressed in an aggregated form using their GWP values for a time horizon of 100 years, based on data from [1] (see Table 3.13.).

Table 3.13.

Aggregated CO_2, CH_4 and N_2O emissions in 1995

	CO_2	CH_4	N_2O	Total
Emissions, Gg	12143.66	101.33	16.25	
GWP factors [1]	1	21	310	
Aggregated emissions, Gg CO_2-eq.	12143.66	2127.93	5037.50	19309.09
Share of individual GHG, %	62.89	11.02	26.09	100

Table 3.14.

Sectoral share of total aggregated CO_2, CH_4 and N_2O emissions in 1995, %

Sectors	Emissions, %
1. Energy	65.2
2. Industrial processes	0.7
4. Agriculture	30.1
6. Waste	3.2

Table 3.14. shows the large contribution of the Energy and Agricultural sectors to aggregated emissions of GHG.

4. POLICIES AND MEASURES

In this chapter an overview of climate change-related policies and measures for the period 1990—2020 is provided. However, no detailed information on policy implementation can be provided yet.

4.1. Climate change policy as a part of other policies in Latvia

Since climate change is not a priority for Latvia, the measures developed should not be completely new initiatives — they address additions or changes to current programs, policies or plans. In addition, measures should achieve multiple objectives (e.g. reducing GHG emissions while also decreasing emissions of other air pollutants and promoting economic development). Climate change policy is to a large degree incorporated into other policies in Latvia. The policy areas addressing the issue of climate change are presented in Table 4.1.

The summary of recently published and forthcoming documents describing policies that affect climate change or provide background information is presented in section 2.3.

4.2. Overview of sectoral reduction strategies

In accordance with recommendations from [30] only those sectors are included in this chapter where there are specific policies or measures to reduce GHG emissions introduced or considered for introduction. Most of the measures are introduced primarily as a part of the current economic transformation or as a part of the NEPP [20].

4.2.1. Measures to reduce CO_2 emissions

About 98% of CO_2 emissions in Latvia came from fuel combustion in 1995, in which 41% — from Energy industries sector, 15% — from Transport, 17% — from Residential sector (calculated from Tables 3.1. and 3.2.).

Table 4.1.

Policy areas that address climate change

Policy area	Goal
Environmental policy	Objectives of national environmental policy were formulated in NEPP [20] in 1995 with the following environmental problems being designated as priorities: — transboundary transfer of pollution, — eutrophication of water basins, degradation of water ecosystems, — risks related to anthropogenic activities, — problems connected with waste, — decreasing of biological diversity, — degradation of landscapes, — irrational utilization of natural resources, — poor quality of drinking water. The plan [20] proposes principles and means for solution of the above problems.
Energy policy	The main goal of Energy sector in Latvia is an increase of energy efficiency, switching to the local energy resources where possible and supply of the necessary amount of energy to the consumers at the possibly low price level, at the same time providing reconstruction and development of the energy systems and reduction of their environmental impact [22].
Industry policy	The main goal of industry sector in Latvia is manufacturing of the competitive industrial output for the local consumers as well as for export, at the same time minimizing its environmental impact [15].
Transport policy	The main goal of the transport policy is to ensure the development of the efficient transport system in order to satisfy the constantly growing demand of the national economy and people for quantitative and qualitative transport that demonstrates safety, strict guaranties and reasonable costs [14].
Agricultural policy	The main goal of the agricultural sector policy in Latvia is to develop the agriculture production capable of integrating into common European market and corresponding to the world market's demands, as well as capable of competing with other countries' agricultural production in the area of quality and costs [29].
Forestry policy	The main goal of forestry in Latvia is sustainable development which means the forest and forest land management and use in such a way, which retains its biodiversity, productivity, renewability, vitality as well as its present and future potential to contribute to ecological, economical and social sphere in local, national and global level, and which is not hazardous to other ecosystems [19].
Waste management policy	The main goal of the waste management is to prevent the deterioration of the environment quality in Latvia and to develop at the same time waste stream reuse and recycling [26].

4.2.1.1. Energy (1A1, 1A2, 1A4)

The data on the Energy sector measures which result in GHG emission reduction were taken from the Study carried out during 1996—1997 in the MEPRD [5], National Energy Development Program [22], National Environmental Action Program [21] and Report on the Economic Development of Latvia, 1997 [9]. Following measures have been proposed in these documents.

Overall improvement of energy efficiency in Latvia the same as in other EIT countries should be the cornerstone of any GHG emission reduction strategy. The process is regarded inevitable if Latvia is willing to continue to build its market economy and join EU. The necessary actions to improve the energy efficiencies have been analyzed in all the lately developed programs and plans connected with energy supply or demand side problems (see sect. 4.2.1.3.). Therefore these already partially implemented actions have been regarded in the Study [5] and in this document as the necessary part of the national economy's future development (see sect. 5.2.1., key assumptions for Energy sector Reference Scenario) and not considered as the options for GHG mitigation assessment. These actions aimed to increase energy efficiency are given below.

In the energy conversion sector (1A1):
* increase of fuel prices;
* switching to environmentally less hazardous fossil fuels and technologies;
* increase of the share of cogeneration in heat production from 21 % in 1994 up to 31 % till 2020;
* improving the average efficiency of CHP plants from 75—80% in 1994 up to 84—86% till 2020;
* improving the efficiency of regional (small and medium) DH plants by 3—9% till 2020;
* reduction of heat energy losses in DH network from 20—25 % in 1994 up to about 8 % till 2020;
* reduction of power transmission losses from 21% in 1994 up to about 12% till 2020;
* optimization of the energy supply system in Latvia including
— privatization of main energy companies (LATVENERGO, Latvijas Gāze, Ventspils Nafta etc.),
— licensing of energy enterprises,
— cooperation of Baltic states in the energy supply.

In the energy demand-side sectors (1A2, 1A4):
* heat energy conservation in buildings;
* efficiency improvement in electricity demand-side;
* implementation of system for analysis and checking of energy consumption, including
— installation of heat meters and multi-tariff electric power and natural gas meters,
— the audit of energy consumption and analysis of production processes in the industrial and agricultural enterprises.

The following GHG mitigation measures were evaluated in the Study [5] and in this Communication (see sect. 5.2.1., key assumptions for Energy sector Scenario "with measures"):

*** INCREASED USE OF CHP PRODUCTION AND FUEL SWITCHING**

The objective of the measure is to build up the installed capacities of CHP plants and to increase the share of CHP in 2020 to about 40% from total amount of DH production in comparison with 21% in 1994 and 31% in 2020 in Energy sector Reference Scenario. Natural gas will be used instead of coal.

Increase in the prices of imported electricity and state's policy to support the development of cogeneration in Latvia makes it economically reasonable to reconstruct the medium-size boiler houses into the CHP plants in the towns with high enough heat load and well developed DH network. Conversion of non-efficient, poorly maintained boiler houses to cogeneration plants would allow to solve some environmental problems in towns and to use fuels more efficiently (to about 20—30%). Fuel savings would lead to the direct and indirect GHG savings, too.

*** INCREASED USE OF BIOMASS FOR DISTRICT HEAT PRODUCTION**

The objective of the measure is to increase the share of wood in total amount of conversion fuel use in 2020 to about 35% in comparison with 8% in 2020 in Energy sector Reference Scenario.

Wood fuel is the most significant domestic fuel in Latvia. Because of technical and economical reasons not all the available amount of biomass has been used presently. The main problem to make the use of wood energy resources more efficient is price policy. Taking into consideration the wood fuel's low average calorific value and its labor-intensive production and high delivery costs, the usefulness of wood fuel today is restricted by distance between the producer and user of this energy resource. It can be mentioned that costs of the fuelwood's harvesting, handling and transportation constitute about 90% from its total price [22]. Another drawback is the fact, that burning equipments in DH plants are not suitable for burning wood and wood-wastes. Number of wood fuelled DH plants was:

706 in 1995,
870 in 1996,
1022 in 1997.

There is available locally produced equipment of good quality for wood chips preparation and burning in Latvia. In 1997 about 36 boiler houses were converted to be fuelled by wood chips and/or sawdust.

*** RECONSTRUCTION OF SMALL HPPs**

The objective of the measure is to build up the installed capacities of the small HPPs and to increase the power generation in 2020 to about 0.22 PJ (0.7% from total amount of self-produced electricity).

Since the beginning of the 1990ies intensive reconstruction of regionally important small scale HPPs have been started in Latvia as well as manufacturing of the equipment for the small HPPs. In 1995 total installed capacity of small HPPs was 1.85 MW, generation — about 0.016 PJ (0.11% from total amount of power energy produced in Latvia) [22].

*** INCREASED USE OF WIND ENERGY**

The objective of the measure is to build up the installed capacities of the wind turbines and to increase the power generation by wind in 2020 to about 1.21 PJ (3.1% from total amount of self-produced electricity) compared to 0.0006 PJ in 1994 and 0.005 PJ in 2020 in Energy sector Reference Scenario.

From the beginning of the 1990ies wind energy has been restored in Latvia, based on international know-how and technologies in this field. Wind cadastre was elaborated in 1990. In 1996 there were 12 wind farms in Latvia with total capacity 1.333 MW. They generated 0.033% of the total electrical energy generated in Latvia. The biggest were Ainaži wind farm, where 2 modern turbines with capacity 0.6 MW each were installed. The manufacturing of small wind generators has been started in Latvia [22].

Geothermal energy in Latvia is on the scientific research and pilot project scale. Results of geological exploration testify that in the central and southwestern part of Latvia there are geothermal anomalies where the temperature of rock and underground water in depth of 1300—1950 m is 30—65^{o}C. Thermal water of such temperature is classified as low potential water, nevertheless it is possible to use such water as a source of heat for heating and balneological purposes. Latvia geothermal data base has been created by means of Danish financial support. The first experimental projects for geothermal heat plants in Dobele — 4 MW and Liepāja — 8 MW basic load are under development. Costs show that it will not be possible to use geothermal energy on commercial basis in the nearest future [10]. Reduction of CO_2 emissions in Liepāja could be about 12.6 Gg/year and in Dobele about 6.5 Gg/year.

4.2.1.2. Transport (1A3)

The data on Transport sector measures which result in GHG emission reduction were taken from the Study [5], National Transport Development Program [14] and Riga Development Plan [15]. Following measures have been proposed in these documents.

*** IMPROVED PUBLIC TRANSPORT SYSTEM**

This measure was not assessed because no studies have been carried out up to now and large uncertainties still exist regarding what would be locally defined priorities in large cities in Latvia in future. In other studies it was calculated that when implemented, this measure would have an indirect positive effect for energy efficiency of transport in general, and could lead to the reduction of CO_2 emissions up to 5% [31].

Riga Development Plan for 1995—2005 [28] envisages the maintenance and further development of public transport. Promotion of bicycle transport will be one of the local government priorities in coming years.

*** MAINTENANCE OF EXISTING VEHICLES**

The EU standards regarding vehicle technical standards will be introduced in Latvia. The test centers will be opened in the whole state in coming years causing some fuel and emission savings. It could be at the range of 1—3 % in Latvia. According other studies it was calculated that due to improved maintenance it should be possible to save 2—10% of fuel immediately after engine tuning and to reduce CO_2 emissions to 5 % [31].

*** ENGINE POWER REDUCTION FOR CARS**

The objective of the technical option is to reduce the fuel consumption and CO_2 emissions via reduction of the number of unnecessary powerful engines in cars in Latvia.

The data base of Latvian Road Safety Directorate does not contain the information about engine size or power output, therefore it was not possible to review the current situation and to forecast the future development. According [31] up to 5% total CO_2 emission reduction for the Transport sector is possible due to implementation of the option.

*** ROAD VEHICLES WITH ALTERNATIVE FUELS**

Conversions of existing engines to run on alternative fuels are done on two levels: 1) simple conversion — adjusting engine for alcohol or esterizated vegetable (rapeseed) oil to improve viscosity and ignition quality, 2) reconstruction — in case of engines driven by hydrogen or electricity from renewable power sources. Operating on gasoline-biofuel mixture is less effective but does not require great modifications in the existing engines. There is certain experience of using gasoline-bioethanol (95:5) mixture in Latvia in the 1930ies, and several experiments are still going on. The real implementation of the use of biofuels in Latvia seems to be the question of the time beyond or at the very end of the period under study therefore there were no attempts to do any calculations or assumptions. According to other studies LPG and CNG can offer 10—30 % CO_2 emission reduction and are already cost-effective for small urban buses and delivery vans [31].

*** SPEED LIMITS**

It is assumed that the speed limits will be established on majority of the roads. This option can result in fuel savings and CO_2 emission reduction at about 1—2 % in Latvia. In other studies [31] it was estimated that moderate reductions in average road vehicle speed (e.g., from 90 km/h to 85 km/h) can lead to energy savings of about 5—10%.

*** IMPROVED DRIVERS' BEHAVIOR**

As there were not enough data, the effect of implementation of a measure in Latvia regarding CO_2 emission reduction possibilities could not be calculated properly in this study. The experts' opinion is that the implementation of the measure could lead to an overall reduction of CO_2 emissions to about 1—3 %**.**

4.2.1.3. Policy instruments

The supporting measures for the efficiency improvements should be adopted such as regulatory measures, market-based incentives, various programs, RD&D etc.

Below some of the main existing or future policy instruments in Latvia are given related to the implementation of CO_2 reduction options in Energy sector in period 1990—2020.

Regulations

The current legislation needs to be perfected to ensure carrying out the actions necessary to improve energy efficiency in Latvia [9, 22]:

— harmonization of laws and regulatory documents with the requirements of the EU, such as on transparency of electricity and gas prices, ensuring transit of energy materials and products via networks, quality of oil products etc.;

— preparation of new laws and documents in compliance with the government declaration and policy, requirements of external and domestic markets and development of power supply in the state.

At present the only policy instrument for energy efficiency improvement really implemented in Latvia is “Law on Regulation of Entrepreneurship Activities in Energy Industries” accepted by Latvian parliament in 1995. According to this Law the licensing of energy supply enterprises have been started, which means that among others the task for annual reduction of energy losses shall be determined. Law states that surplus electricity from small HPPs (with capacity up to 2 MW) and wind farms shall be purchased on the national scale at higher tariffs for eight years from the starting day of operation of the power plant. After that the purchase price shall correspond to the average sale tariff of power.

“Law on Regulation of Monopolies” has been prepared. The draft law provides for establishment of a single industry regulator institution in Latvia and defines its competence in different sectors including energy supply.

“Law on Nature Resources Tax” and “Regulations on Application of Law on Nature Resources Tax” limit uneconomical use of nature resources and pollution of environment and reduce sale of products causing environment pollution. Tax rates for polluting atmosphere, water, soil and underground water and water beds determined by law are applied to energy utilities.

The draft of “Law on Energy” is being elaborated. Its aim is to define the role of energy within the national economy of the Republic of Latvia in compliance with the European Agreement signed on June 12, 1995 and requirements of the Energy Charter Treaty. The State control and supervision of all energy utilities dealing with energy supply in the public interest, i.e. supplying the necessary energy to consumers regardless of the type of ownership and entrepreneurship will be provided for.

Market-based incentives

Some additional market-based instruments, e.g. C or CO_2 taxes, tax privileges, low interest rate loans and others shall be necessary to encourage adoption of new energy efficient technologies in Energy sector. Rise of prices of carbon-based fuels by imposing a tax would make them less competitive and encourage the energy industries to develop new production methods based on renewable fuels. Rising energy prices would make previously non-viable energy conservation investments more attractive.

Public Investment Program (PIP) is the aggregate of infrastructure related investment projects which annually receive or are planned to receive government financing. It is annually worked out by the Ministry of Economy for the following three years taking into consideration priorities outlined in the government declaration, financial strategies and development directions of the national economy. At present priority sectors for PIP are the power sector, transport, environment protection. The most important power sector projects envisage improvements in the heating system and reconstruction of power stations. Out of transport projects, it is planned to reconstruct the cover of main motor roads of Latvia, railway and port infrastructure [9].

Environmental Protection Fund

The Environmental Protection Fund was established in Latvia in 1996 under the guidance of MEPRD to make use from environment-related charges and taxes. The money can be spent to finance or credit environmental projects, to eliminate consequences of ecological accidents and to mitigate ecological risks.

Effect of CO_2 taxation

There is no C or CO_2 tax imposed on fuels in Latvia presently. The tax can have a great effect on GHG abatement. It was calculated in the Study [5] that after implementation of a tax the combined effect of the mitigation measures, described in sect. 4.2.1.1. could be about 30% CO_2 reduction in 2020 in comparison with the Energy sector Reference Scenario (see sect. 5.2., Table 5.3.).

Effect of the CO_2 tax on economy will depend on how the tax revenues are recycled. The possible consequences after CO_2 tax implementation in Latvia were evaluated through experts opinion. It was based on the assumption that economic impact of implementation of the CO_2 tax should be the same as that of the growth of excise tax for fuel in 1996 in Latvia. The latter spiraled price rise in the whole national economy [9]. The modeling of results allowed experts from the Ministry of Economy to conclude that implementation of 25 USD/t CO_2 tax could rise inflation during a year to 1.5—2%, and 150 USD/tCO_2 — to about 2.3%.

Energy and road vehicle taxation in Latvia.

Though taxes are considered the most cost-effective measure to limit CO_2 emissions from the transport sector, the demand for transport fuels is relatively insensitive to price changes. In addition, some transport fuels are already heavily taxed. Fuels and road vehicles are subjected to the following taxes: excise tax, value added tax (VAT), custom tax, vehicle registration fee, annual road tax.

<u>Excise tax</u> is levied on fuels and energy products. The tax is differentiated to encourage the use of cleaner and environmentally less harmful fuels and it has been increased during last years. At the end of 1995 it was as follows (LVL per litre):

gasoline	—	0.06 (20—30% of fuel price)
diesel oil	—	0.04 (about 25% of fuel price)
natural gas	—	0.0.

The European Council Directive 92/82/EEC has set minimum rates for excise taxes for fuels. These are (USD per litre) [32]:

leaded gasoline	—	0.421
unleaded gasoline	—	0.359
diesel oil	—	0.306

Accordingly the Latvian government plans to increase the excise tax till 2001 (LVL per litre):

leaded gasoline	—	0.23,
unleaded gasoline	—	0.20,
diesel oil	—	0.17

<u>VAT</u> is paid upon purchasing vehicle. In Latvia its rate on products and services is 18%.

Programs

Latvia: Wood Harvesting, Distribution and Conversion Study.

In the study carried out by Jaako Poyry working group in 1994—1995 and financed by European Bank of Reconstruction and Development the comprehensive analysis of wood including wood waste utilization aspects, cost analysis and technical analysis for conversion boilers located in district heating enterprises and industries are given.

National Energy Development Program [22]

The Program was worked out in 1996—1997 and approved on the concept level by Cabinet of Ministers in September 1997. The Program defines a set of activities till 2020 for reliable supply of energy resources in the Republic of Latvia in the quality and quantity complying with the requirements of the consumers, at the lowest possible costs and least possible influence on the environment.

Draft National Program "Production and Use of Biofuels in Latvia" [23]

The Draft Program (1997—2010) was worked out by a team of Latvia's scientists in 1996, mainly transport fuels being discussed in it. It was concluded in the Program, that the most acceptable kinds of biofuels for Latvia's economic resources and possibilities are

— bioethanol produced from agricultural raw materials, from which Latol-005 (gasoline 95% and absolute bioethanol 5%), could be prepared,

— biodiesel produced from rape oil,

— biogas from organic waste (animal manure, households and agricultural waste, wastewater sludge) as local energy carrier.

After realization of the Program in 2010 all vehicles in Latvia could be provided for Latol-005, its quality and forecasted price being comparable with those of gasoline A-95E. 40% of the transport in agriculture could be provided for biodiesel. In the public transport a mixture of diesel oil together with 5—50% biodiesel could be used to reduce the toxicity of exhaust fumes, yet the forecasted price for biodiesel is much higher in comparison with that of imported diesel oil. Taking into consideration the present situation in Latvia — low yields in agriculture, inefficient technologies and rather low prices for oil products, as well as investments and subsidies needed to implement the Program, the likely time for biofuels entering the market in Latvia could not be earlier than 2002.

National Transport Development Program [14]

The National Transport Development Program is a complex long-term document (1996—2010). The Program determines the goal and the aims of transport development and the principal strategical and tactical means. As a result of successful implementation of the Transport program an increase in efficiency of transport operations is guaranteed that could be a precondition for expanding of society welfare and for development of the national economy.

Research, development and demonstration (RD&D)

NUTEK projects

The aim of the Swedish National Board for Industrial and Technical Development (NUTEK) in the Baltic region and Eastern Europe is to improve the energy systems through the increased use of renewable energy resources. The main activities are directed towards reduction of emissions, hazardous to the climate and environment, from oil or coal-heated energy production plants and up-grading of the heat distribution systems. The Program is formulated in line with the UN FCCC and its commitment in Article 4 on Joint Implementation and is thus the Swedish contribution to the Pilot phase for Activities Implemented Jointly under the Convention. Since 1994 the cooperation between Latvia and Sweden has been going on to convert the boilers constructed for liquid fuels or gas or to build new ones where biomass such as wood chips, saw dust, waste from wood processing industries could be burnt. The technical information has been given and personnel trained. Till now 18 such projects have been finished in Latvia. The projects were partially credited by Swedish government.

SCORE projects

In 1996 the SCORE program orientated towards the demand side was launched in three pilot countries in the CEE region: Poland, Hungary and Latvia. It will try to enhance efficient and rational use of energy in CEE countries and thus support their economic restructuring, environmental improvement and democratic development. The aim of program is to develop the markets for energy-efficient technologies and thus recapture the large energy saving potentials that exists on the demand side in Latvia. The SCORE program is provided by the Netherlands Agency for Energy and the Environment (NOVEM). The experts from MEPRD, Ministry of Economy, Energy Department of the Latvian Development Agency, Institute of Physical Energetics and local governments also take part in the activities of the SCORE program. The main activities in 1997 were:

— implementation of some pilot projects, aimed to demonstrate the possibilities for the heat conservation in existing buildings
— an energy saving campaign,
— institutional measures (exhibitions, data base building).

An overview of policy instruments to encourage adoption of the CO_2 reduction policies/measures is presented in Annex 1, Table A1-1.

4.2.2. Measures to increase CO_2 removals

CO_2 is the dominant and best explored GHG, the atmospheric concentration of which is influenced by anthropogenic activities in the Forest sector. Vegetation, mainly forests, are the most significant factor for C fluxes in nature. Living vegetation withdraws CO_2 from the atmosphere through the process of photosynthesis (CO_2 removals). After some time CO_2 is returned to the atmosphere by the respiration of the vegetation and the decay of organic matter in soils and litter (CO_2 release). On global scale and in the absence of significant human disturbance, this large flux of CO_2 from the atmosphere to the terrestrial biosphere is thought to be balanced by the return respiration fluxes. Measures that could activate the process of photosynthesis enhance the CO_2 removal from atmosphere. Forest clearing increases the return flux of CO_2 due to lower degree of photosynthesis [4].

In the first National Communication the annual CO_2 removals in forests were calculated to be about 10960 Gg. In 1995 CO_2 sequestration decreased a bit due to some increase in the forest harvesting [5] and was 10600 Gg (see Table 3.1.).

4.2.2.1. Land use change and Forestry (5A)

The data on Forestry sector measures which result in CO_2 removals were taken from the Study [5], the Forestry Sector Masterplan [25], the Forest Policy [19] and NEPP [20]. The following measures have been proposed in these documents.

*** FOREST AND FOREST LAND AREA CONSERVATION**

The goal of the forest policy is to ensure the conservation of existing forests by legislative restrictions to their transforming into other land-use systems.

*** AFFORESTATION OF ABANDONED AGRICULTURAL LAND**

In connection with land reform process which started in 1990 extensive areas of abandoned agricultural land can be seen in Latvia and till 2020 there could be about 0.58 mill. ha of abandoned agricultural land. The forestry experts have worked out the program for afforestation of abandoned farmlands, which envisages to afforest 10 thous. ha annually.

*** SILVICULTURE PRACTICES**

During the last 50 years extensive areas of agricultural lands in Latvia have been afforested naturally. They are overgrown by bushes and mainly deciduous tree species. To rise their value, the silviculture practices should be carried out, the main of them being purposeful cleaning and thinning. The expansion of total forest area and increase of forest productivity would favor the increment of the whole tree biomass and CO_2 sequestration in forest ecosystem as well.

*** SUSTAINABLE FOREST MANAGEMENT**

Forestry as a branch of Latvia's economy is obliged to produce forestry products, mainly wood. The target of a sustainable forest management is to balance all the components of forestry output as well as to ensure the even consumption of forestry resources. As a result the increment of growing stock in the forests would go on, and continue to remove CO_2 sustainably.

*** FORESTRY CERTIFICATION**

There could be a tendency created by market economy towards the commercial value of the forests to dominate over the other ones (ecological and social). To avoid such a tendency, the certification of forestry is necessary that could provide for the sustainable forest management in Latvia by the aid of market instruments. The certification of forestry will provide for the conservation of the present and future forest ecosystems, accomplishing in such a way CO_2 removal.

4.2.2.2. Policy instruments

Process of forest policy and legislation formation is going along with other processes in Latvia's society and is far from completion. At the same time these processes are tried to be harmonized with development of forest policy process in Europe and towards sustainable forest management.

Forestry Development Program for Latvia [24]

The Program was worked out in 1992, and it has provided comprehensive information about forest management, planting, protection, drainage as well as forecasts regarding forest resources till 2030. Unfortunately due to changes in Latvian political and economical situation and changes in forest ownership many aspects of this valuable study have become outdated now.

Latvia Forestry Sector Masterplan [25]

The Project was worked out by State Forest Service together with Swedforest International AB during 1993—1995, and it was funded by Swedish Government. The Masterplan addressed several broad areas: forest management; environmental management and protection; forest industry development; domestic and export market development.

Forest Policy in Latvia [19]

The principle of the sustainable development of forestry was defined by the Resolution of the Conference of European Forestry Ministers (Helsinki Resolution No.1) and is being now a part of the newly created Forest Policy for Latvia [19]. In accordance with this definition forests have to contribute to ecological, economical and social sphere. The following targets are defined by the Forest Policy in these spheres regarding climate change mitigation.

In the ecology:

— the principles of the forest management should be improved, taking into consideration the role of the forest ecosystem in local and global processes — C sequestration and stabilization of C fluxes, as well as preservation of watercourses, soils and landscapes;

— the environmental impact of forest management should be assessed;

— establishment of the ecologically sound system of protected areas, ensuring the conservation of ecosystems, species and genetic resources in the forests;

— forest health monitoring.

In the economy:

— the goal of forest policy is to provide sustainable development of forestry based on self-funding principles, taking into consideration ecological and social conditions. The following preconditions having impact on climate change should be developed:

— regulation of the utilization of forest resources by state; it could provide for continuous wood resources availability, creating good environment for the wood processing development;

— increased use of wood resources, including wood waste use for the boards, pulp, energy etc.; implementation of some economic instruments should be planned as well.

In the social sphere:

— the goal of forest policy is to balance the interests of community to those of the forest owners regarding the usage of social values and employment in forestry.

An overview of policy instruments to encourage adoption of the CO_2 removal policies/measures is presented in Annex 1, Table A1-1.

4.2.3. Measures to reduce CH_4 emissions

In 1995 CH_4 emissions in Latvia originated from Energy sector (28.7%), Agriculture (44%) and Waste (25.3%) (calculated from Table 3.9.).

4.2.3.1. Energy (1A, 1B2)

The policies/measures and related instruments to reduce CH_4 emissions from the fuel combustion (1A) are the same as with CO_2 (see sect. 4.2.1.).

The fugitive CH_4 emissions from leakage of natural gas distribution network (1B2b) could be decreased due to the regular replacement of old pipelines and as a result of improved maintenance. The underground natural gas storage facility "Inčukalns" has been reconstructed in 1995.

4.2.3.2. Agriculture (4A, 4B)

CH_4 is emitted from herbivores as a by-product of enteric fermentation gas emissions depending on amount and structure of feed; and CH_4 is produced from the decomposition of manure under anaerobic conditions by methanbacteria; these conditions occur where manure is stored in large piles or in lagoons [4].

CH_4 emissions from live-stock breeding during 1990—1996 has decreased considerably, due to reduction of the number of live-stock.

The data on Agriculture sector measures which result in GHG emission reduction were taken from the Conception for Making Use of Subsidies in the Agriculture [16] and National Environmental Action Program [21]. The following measures have been proposed in these documents.

*** IMPROVED MANAGEMENT OF RUMINANT LIVE-STOCK,**

including optimization of the number of live-stock and forage efficiency improvement.

*** IMPROVED MANAGEMENT OF LIVESTOCK MANURE,**

including biogas production from the live-stock manure.

4.2.3.3. Waste (6A)

Disposal and treatment of solid and liquid municipal and industrial waste can produce CH_4 emissions by anaerobic decomposition of organic matter by methanogenic bacteria. CH_4 generation depends on the amount of waste, quantities of organic (degradable) matter in waste and the activity of bacteria, the latter being affected by temperature, moisture, pH and nutrient availability.

In the first National Communication [3] it was reported that in 1990 the only important source of GHG emissions in Waste sector were SWDS. There were about 500 of them in Latvia, amount of solid waste disposed — about 292 thous. t (50% from the total amount), CH_4 emitted — 19.5 Gg (10.5% from the total amount of CH_4 emissions in 1990 in Latvia). Wastewater in Latvia was treated aerobically.

The forecasts are that the overall improvement of economic situation could cause some increase of per capita amount of waste, mainly due to better packaging. Nevertheless the total amount of waste is not going to increase till 2000 because the number of population will continue to diminish. It is for after that year, that the amount of waste is expected to increase, and at the end of time frame (2010) it could reach 616—733 thous. t annually [26]. The improvement of waste collection system could provide for better environmental quality and ecosystems stability in Latvia, yet the CH_4 emissions from landfills could increase considerably in 2010, if nothing is done to reduce the amount of waste and to recover landfill gas.

The data on Waste sector measures which result in CH_4 emission reduction were taken from the Strategy for the Municipal Waste Management in Latvia [26], Draft Municipal Solid Waste Management Project [27], NEPP [20] and NEAP [21]. Following measures have been proposed in these documents.

*** ESTABLISHMENT OF SEPARATE WASTE COLLECTION SYSTEMS WILL BE IMPLEMENTED TILL 2010**

There are pilot projects in some communities (in Riga, Jelgava, Ogre) to separate municipal waste, such as paper, glass and metal. Separation of all the municipal waste could be implemented in Latvia only after 2010, when there are better possibilities for management of to be recycled separated materials. A sorting line for separation of recyclable materials will be established in Getliņi SWDS according its reconstruction project. For the hazardous municipal waste, including waste from hospitals, separate collection system in Latvia will be implemented till 2010, and these wastes will be moved to special waste disposal site.

*** WASTE REUSE**

usually is related to glass and hard plastic containers, polyethylene products, paper, car tires, scrap metal, etc. [20]. Paper recycling is an important technical option for CH_4 emission reduction, because there is about 72% of degradable matter in paper [27].

*** WASTE MINIMIZATION IN LANDFILLS**

Strategy [26] envisages municipal waste minimization to about 20% till 2005, which will reduce CH_4 emissions.

*** BIOLOGICAL TREATMENT:**

1) in the Bolderāja sewage treatment plant the biogas generation in vertical tanks was started in 1991 from sludge and wet sediments, arising from aerobic wastewater treatment; biogas capacity — 6 thous. m^3/day , and it was used to produce heat for heating the plant buildings;

2) recovery of biogas in Riga SWDS "Getliņi" is planned to be started in 2000, which will reduce CH_4 emissions considerably.

4.2.3.4. Policy instruments

Market-based incentives

Public Investment Program (PIP)

is the aggregate of infrastructure-related investment projects which annually receive or are planned to receive government financing. Presently priority sectors for PIP are the power sector, transport, environment protection. The environmental projects are mainly related to the construction of waste water treatment plants and waste disposal projects. Projects receive also large foreign grants [9].

Environment Protection Fund (EPF)

was established in Latvia in 1996 to make use from environment-related charges and taxes to finance projects in environment-related activities. EPF provides subsidies from state's special budget to firms, which are occupied in waste recycling. Though the recycling of old tires and plastics have been introduced into Latvia already some years ago, it was only in 1997 when the firms received some subsidies from EPF and gained the economical profit.

Programs

The Conception for Making Use of Subsidies in Agriculture and Motivation for Programs 1998—2002 [16]

envisages to implement the program on cattle breeding and seed growing. One of the goals of this program is an increase of the output in cattle breeding without increasing the live-stock number.

HELCOM recommendation 7/2

concerning measures aimed at the reduction of discharges from agriculture (having regard to Article 13, Paragraph b) of the Helsinki Convention) recommends that the storage facilities for manure should be improved, including effluent control, and in animal husbandry, a certain area of farmland should be designed per animal. Implementation of the recommendation not only could minimize land-based pollution of the marine environment of the Baltic Sea area, but it would reduce CH_4 emissions to the atmosphere as well.

Strategy for the Municipal Waste Management in Latvia [26]

was worked out in the MEPRD in 1997. It was stated that the amount of solid municipal waste in 1996 totalled about 600—700 thous. t, from which disposed only 50—60%. The municipal and industrial waste collection system are going to be improved in the future. The collection of 85—90% from the total amount of solid waste should be ensured till 2005. Number of SWDS should be reduced by 50% till 2000. Till 2007 there will be about 50 SWDS in Latvia and they should not have negative environmental impact.

Draft Municipal Solid Waste Management Project (Document of the World Bank)

has been worked out in 1997 [27]. It is stated in the Project that about 205 thous. t solid waste from the city and about 45 thous. t industrial waste are disposed in Getliņi annually. The use being made of some computer programs, current as well as future biogas generation has been estimated with different waste treatment schemes being applied and the most acceptable biogas production system has been proposed. An advanced energy-cell technology will ensure enhanced degradation of biodegradable waste and recovery of landfill gas, which will be used for power generation.

The elaboration of the projects "800+" and "500-" has been started.

As a result of both projects, new infrastructures for water supply and sewage treatment as well as for waste management will be developed. They will be closely linked with municipalities and will ensure cooperation in construction and management of new waste management objects.

An overview of policy instruments to encourage adoption of the policies/measures to reduce CH_4 emissions is presented in Annex 1, Table A1-2.

4.2.4. Measures to reduce N_2O emissions

N_2O emissions in Latvia in 1995 came mainly from agricultural soils (98%), the remaining 2% originating from fuel combustion and wastewater handling (human sewage) (calculated from Table 3.10.).

A Transport sector policy measure that could lead to an increase of N_2O emissions should be mentioned. It is the penetration of catalytic converters in road transport with the aim of reducing emissions of NO_x, CO and NMVOC. It is known that N_2O emissions from private cars with catalytic converters are 3—4 times higher than emissions from cars without such converters.

4.2.4.1. Agriculture (4D)

N_2O is produced in agricultural soils as a result of microbiological processes of nitrification and denitrification; N_2O emissions depend on nitrogen (N) input and on the sum of various factors, such as meteorological conditions, type of soil and its pH, amount of N metabolized by plants etc.; N input to the soils occurs by use of both organic and N-based inorganic fertilizers, biological N fixation, and return of crop residues to the field [4].

The data on Agriculture sector measures which result in GHG emission reduction were taken from the Conception for Making Use of Subsidies in Agriculture [16] and NEAP [21]. The following measure has been proposed in these documents.

*** ELABORATION OF SCIENTIFICALLY SOUND RECOMMENDATIONS ON N-FERTILIZER USE EFFICIENCY**

There have never been practices in Latvia's agriculture of using fertilizers in such large quantities as in West European countries. Upon commencement of agrarian reform after 1990 even these meager quantities of fertilizers have dropped considerably, and till 2000 they would not reach the base year level. Problems of this type in Latvia are addressed by State Scientific Production Enterprise "Ražība". It should be noted, that the amount of N input by fertilizers fails to cover the amount turned out by crops [3].

4.2.4.2. Policy instruments

The Conception for Making Use of Subsidies in Agriculture and Motivation for Programs 1998—2002 [16]

was worked out in 1997. The program on improvement of agricultural soils envisages to optimize main factors of soils, such as watering, pH, extent of utilization of nutrients by plants etc. Implementation of the program would improve the utilization of N turned in the soils, and reduce N_2O emissions. The program on development of non-traditional branches in agriculture envisages to develop good agriculture practice in accordance with EU Directives and HELCOM recommendations.

EU Directive No. 91/676EEC

concerning measures aimed at the water protection from nitrogen pollution created by use of fertilizers in agriculture ("Nitrate Directive") determines the use and storage of synthetic fertilizers and animal manure in a way not causing damage to environment. The "Nitrate Directive" will be entered into Latvia's legislation till 2000 when the rules of the Cabinet of Ministers "On the use of fertilizers in agriculture not causing damage to environment" will be worked out. Implementation of the rules will help to reduce N_2O emissions from soils.

HELCOM recommendations 7/2 and 9/3

concerning measures aimed at the reduction of discharges from agriculture (having regard to Article 13, Paragraph b) of the Helsinki Convention) recommends to inform and educate farmers and advisors on environmental effects of the use of fertilizers and agricultural practices; to carry out research work on environmental effects of farming management, cultivation practices, choice of crops; to monitor the losses of nutrients.

HELCOM recommendation 13/9

concerning reduction of nitrogen, mainly nitrate, leaching from agricultural land (having regard to Article 13, Paragraph b) of the Helsinki Convention) recommends to apply artificial fertilizers and animal manure according to crop need. Implementation of the recommendations not only could minimize land-based pollution of the marine environment of the Baltic Sea area, but it would reduce N_2O emissions to the atmosphere as well.

An overview of policy instruments to encourage adoption of the policies/measures to reduce N_2O emissions is presented in Annex 1, Table A1-3.

4.2.5. Reduction strategies for indirect GHG and SO_2

Fuel combustion activities (1A), mainly transport and residential sector small combustion equipment were the main source of NO_x, CO and NMVOC emissions in Latvia in 1995 (see sect. 3.5., Table 3.12.). The policies/measures and related instruments to reduce emissions of these GHG are the same as with CO_2 (see sect. 4.2.1.).

Fugitive fuel emissions from oil products (1B2a) include only those from gasoline use in transport and handling in filling stations. New regulations concerning oil product filling stations are under way in MEPRD, in which installation of the technologies required to prevent NMVOC emissions into atmosphere is envisaged in 2005.

SO_2 emissions in 1995 in Latvia arose from fuel combustion mainly in small and medium boiler houses. Certification of imported fuels and establishment of fuel quality control mechanisms in accordance with EU environment standards will solve the problem. The policies/measures and related instruments to reduce SO_2 emissions are the same as with CO_2 (see sect. 4.2.1.). Till now there are no flue-gas desulphurisation technologies in use in Latvia. If Liepāja coal-fuelled plant is built in 2010, than such technology should be implemented.

Reduction of NO_x, NMVOC and SO_2 emissions is subject to EMEP. Targets according to the Protocols are:

— from December 31, 1994 onwards, the level of NO_x emissions produced in the country and the level of transmitted pollution entering the country should correspond to the level of 1987; by 1999, the annual emissions of NMVOC should be at the level of 1988;

— from the year 2000 onwards, the total amount of SO_2 emissions should be below the level of 1980.

The SO_2 reduction target in Latvia can be reached if switching to natural gas and biomass in energy supply takes place [22].

5. PROJECTIONS AND EFFECTS OF POLICIES AND MEASURES

5.1. Introduction

5.1.1. Economy Development Scenarios

Macroeconomic Reference Scenario (MRS)

MRS in this document is a hypothetical economy development scenario of the country for the selected time frame, which includes all the transformations that are expected to take place over time as a result of normal economic development. It does not include any additional effort resulting from specific measures intended to mitigate climate change. MRS is a basis for creating sectoral scenarios and forecasting GHG emissions. MRS was elaborated by experts from the Ministry of Economy and University of Latvia.

Two cases for economy development for 1995—2020 with different growth rates of the gross domestic product (GDP) have been discussed — a lower one and a higher one (see Fig. 5.1.). The latter is modeling a more favorable development case with large investments and, based on these, faster growth of production and export [9]. The forecast was based on the data of the State Committee of Statistics published till the end of 1996. Only the higher growth rate case was assumed for MRS, because a higher economic growth usually leads to a higher level of GHG emissions.

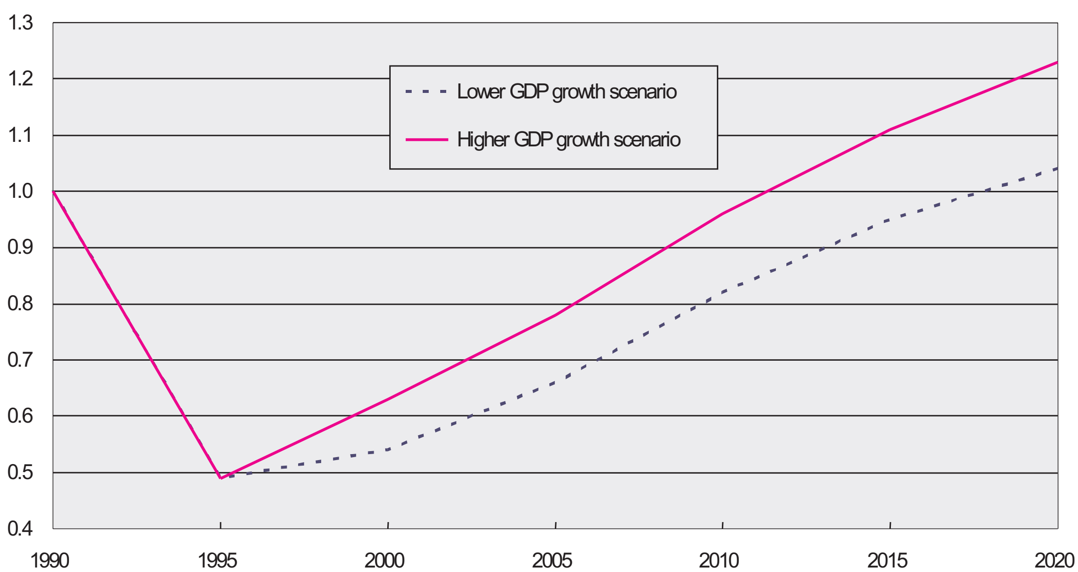

Fig. 5.1. GDP dynamics for the period of 1990—2020

The following annual average growth rate of the GDP was assumed:
1996—2000..................5%
2001—2005..................4%
2006—2010..................4%
2011—2015..................3%
2016—2020..................2%

Other assumptions for creating MRS:

— number of population in Latvia is not increasing, and it will be about 2.33 mill. in 2020 compared to 2.56 mill. in 1994 [8];

— integration of the state in the EU is one of the most important objectives of the Government; it proceeds in accordance with the National Program for Integration into the EU which covers legislation approximation methods and sequence for participation of Latvia in the European internal market [9];

— the Government plans until the middle of 1998 to finalize privatization (including also big companies) [9];

— liberation of prices and tariffs and reduction of inflation is going on.

The forecasted changes in the structure of the GDP till 2020 see in Fig. 5.2.

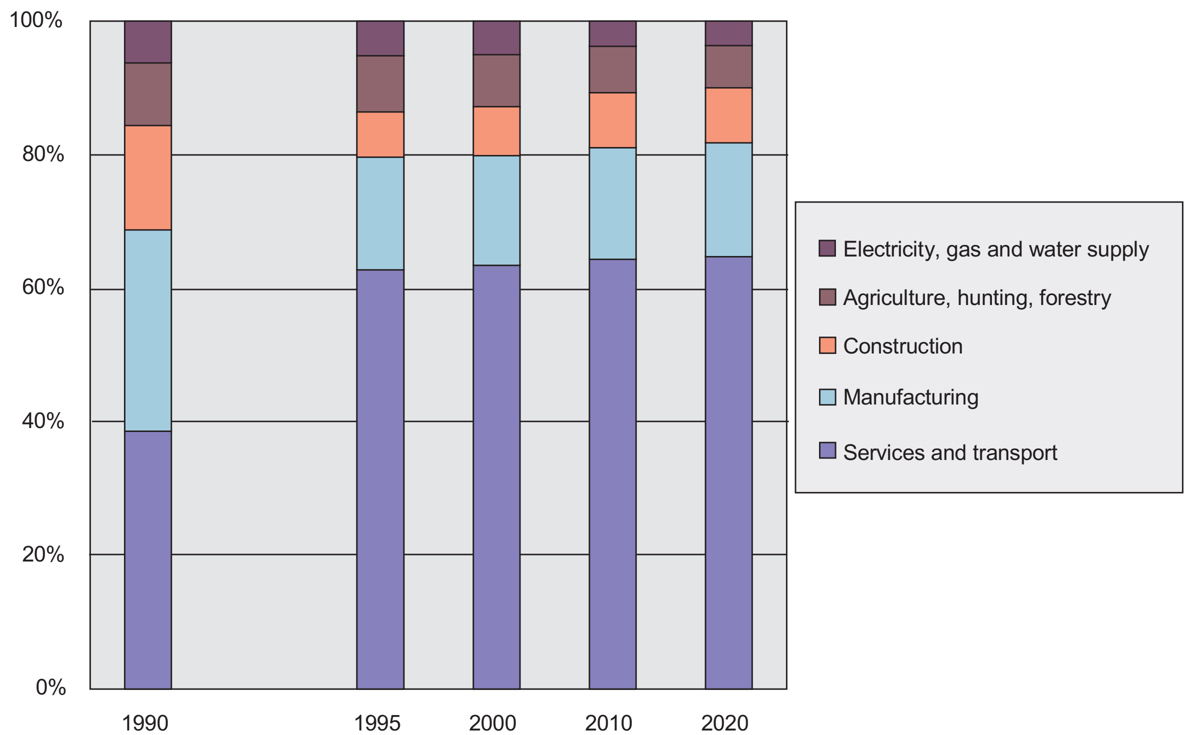

Fig. 5.2. Structure of the GDP for the period of 1990—2020, %

Sectoral development scenarios

The results presented for the Energy and Forestry sectors come from the Study [5]. To create the Energy sector development scenarios and calculate related GHG emissions, the growth rate of the useful energy demand till 2020 as forecasted by MRS were used as exogenous input data for MARKAL model — bottom-up dynamic optimization model for Energy sector. Modeling was carried out by specialists from the Energy department of Latvian Development Agency. For creating the Forestry sector projections the methodology developed by experts from State Forest Service were used.

The data on economic activities in the Industry, Agriculture and Waste sectors necessary to calculate GHG emissions were obtained from the Long-term Economic Development Forecast till 2020 elaborated by experts of the

Ministry of Economy of the Republic of Latvia. The Forecast was based on MRS and on the latest strategic plans, programs, conceptions or reports worked out by the ministries or other institutions in Latvia:

* Riga Development Plan 1995—2005 [28].

* Economic Development of Latvia. Report. Ministry of Economy of the Republic of Latvia. Riga, 1997 [9].

* Draft Conception for the Strategy in the Industry. Ministry of Economy of the Republic of Latvia, June 1995 [15].

* Draft National Program for Construction. MEPRD. 1997 [33].

* Conception for Making Use of Subsidies in Agriculture and Motivation for Programs 1998—2002. Ministry of Agriculture of the Republic of Latvia, November 1997 [16].

* Conception for Agricultural Development. Ministry of Agriculture of the Republic of Latvia. Riga, 1998 [29].

* Draft National Program "Production and Use of Biofuels in Latvia". Ministry of Agriculture of the Republic of Latvia. Riga, 1996 [23].

* Strategy for the Municipal Waste Management in Latvia. MEPRD, May 1997 [26].

* Republic of Latvia. Draft Municipal Solid Waste Management Project. Document of the World Bank. November 1997 [27].

5.1.2. GHG emission reduction targets in Latvia

In accordance with Kyoto Protocol to the UN FCCC on 10 December 1997, Latvia individually or jointly should ensure, that its aggregate anthropogenic CO_2 equivalent emissions of CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 in 2008—2012 should be 8% below the 1990 level.

As follows from the Energy sector Reference Scenario (see sect. 5.2.1.), GHG emissions from energy in 2010 and even in 2020 may remain below the level of 1990. It means that if economic growth is not higher than assumed in MRS and Energy sector Reference Scenario is realistic, which means — if there is rather high level of investments available in Latvia's economy (especially in energy and transport) to introduce modern, resource-saving technologies and to implement appropriate economic and fiscal instruments, then the GHG reduction target according to the Kyoto Protocol can be fulfilled without any additional effort in Latvia.

5.2. Projections of CO_2 emissions and removals

5.2.1. Energy

The future emissions of CO_2 in the Energy sector (except the activities in transport) were calculated from the primary energy supply data of the MARKAL model. Since we use the Energy sector scenarios developed earlier for the Study [5], some GHG emission values for 1990—1995 in Chapter 3, which were recalculated in accordance with Revised Guidelines [4] for the purpose of the Second National Communication Inventories, may differ from those presented in Chapter 5.

The Energy sector Reference Scenario (scenario without specific measures to reduce GHG emissions) in the Study [5] cannot be defined a "business-as-usual" scenario. "Business-as-usual" scenario concept is used in energy development planning for industrialized countries. In this approach trends for the future development are projected, assuming the use of existing policy instruments, including legislation already passed, but not yet implemented. The existing energy system is normally perceived as a relatively efficient and stable system. It means that "business-as-usual" approach is inappropriate for economy in transition countries, because of the existence of inefficiencies in the energy and in the economy in general and because economy in transition in any country means considerable and fast changes [34].

The "efficient" Reference Scenario for Energy sector was created. The increased development of Energy sector is based on the forecasts of MRS, in which macroeconomic stabilization, an increase of the investments, liberalization of the markets and privatization is assumed, as well as it is based on various future outlooks developed in national programs and plans. Therefore a lot of economically profitable, cost-effective GHG mitigation options resulting in considerable energy efficiency improvements were included in the Scenario. At the same time these measures also reduce GHG emissions.

Key assumptions for Energy sector Reference Scenario
(more detailed information is provided in sect. 4.2.1.1.):
— increase of fuel prices,
— switching to environmentally less hazardous fossil fuels and technologies,
— increase of the share of cogeneration in heat production,
— improving the average efficiencies of CHP plants,
— improving the efficiency of regional (small and medium) DH plants,
— reduction of heat energy losses in DH network,
— reduction of power transmission losses,
— optimization of the energy supply system in Latvia,
— heat energy conservation in buildings,
— electricity conservation,
— implementation of the system for analysis and checking of energy consumption.

The Energy sector Reference Scenario was constructed by optimization model MARKAL as the least-cost representation of energy system, consisting of the primary energy supply, energy conversion, final energy demand and CO_2 emissions. Results of the model calculations for primary energy supply, energy conversion, final energy demand are presented in Fig. 5.3.—5.6.

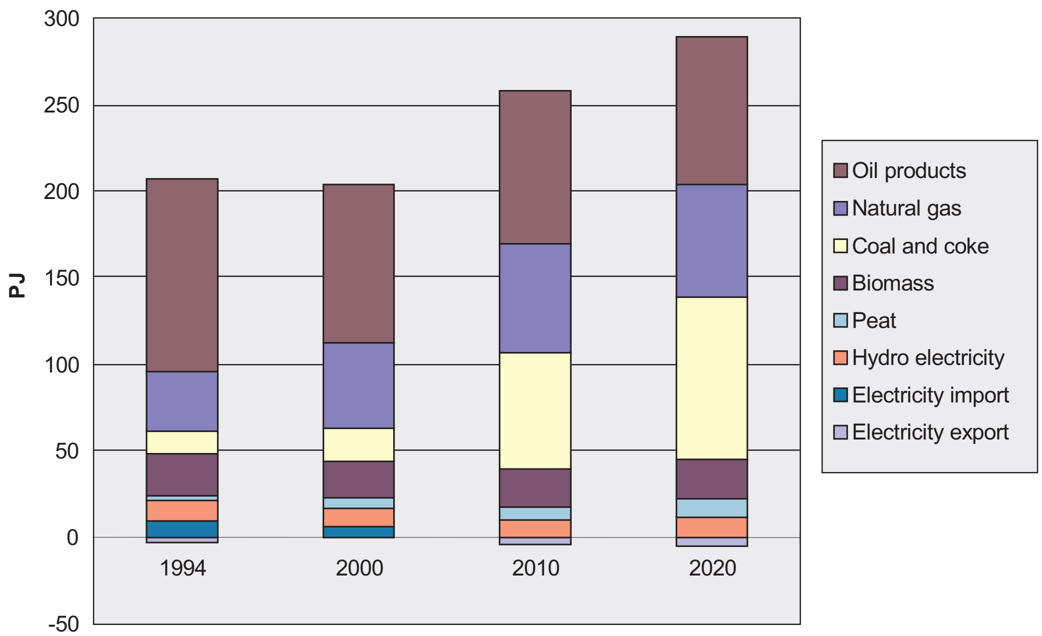

Fig. 5.3. Primary energy supply for the period of 1994—2020, PJ

Fig. 5.7. presents the Energy sector Reference Scenario primary energy supply and CO_2 emissions from fuel combustion activities.

Results of model calculation for Energy sector Reference Scenario show that CO_2 emissions (biomass burning excluded) will increase in 2020 compared to 1994 by about 68%, being at the same time about 18% below the level of 1990, and Latvia can meet its internationally adopted commitments in 2008—2012 without any additional efforts.

If efficiency improvements for the Energy sector Reference Scenario are not fully implemented, it would cause additional 3000—4000 Gg CO_2 emission, as calculated in National Energy Development Program [22]. In this case

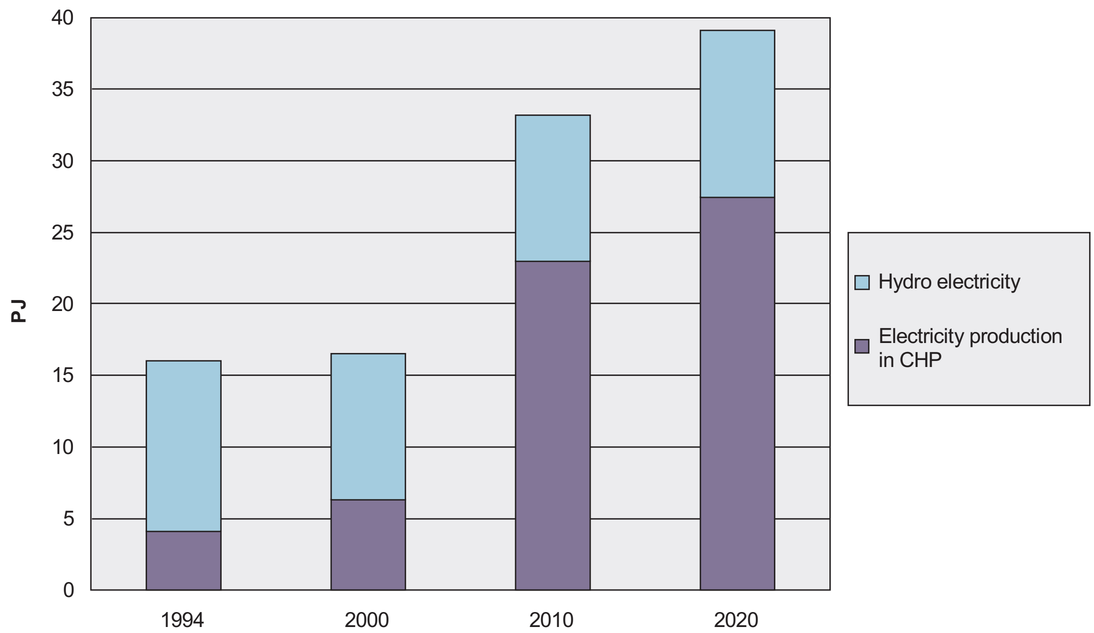

Fig. 5.4. Electricity generation for the period of 1994—2020, PJ

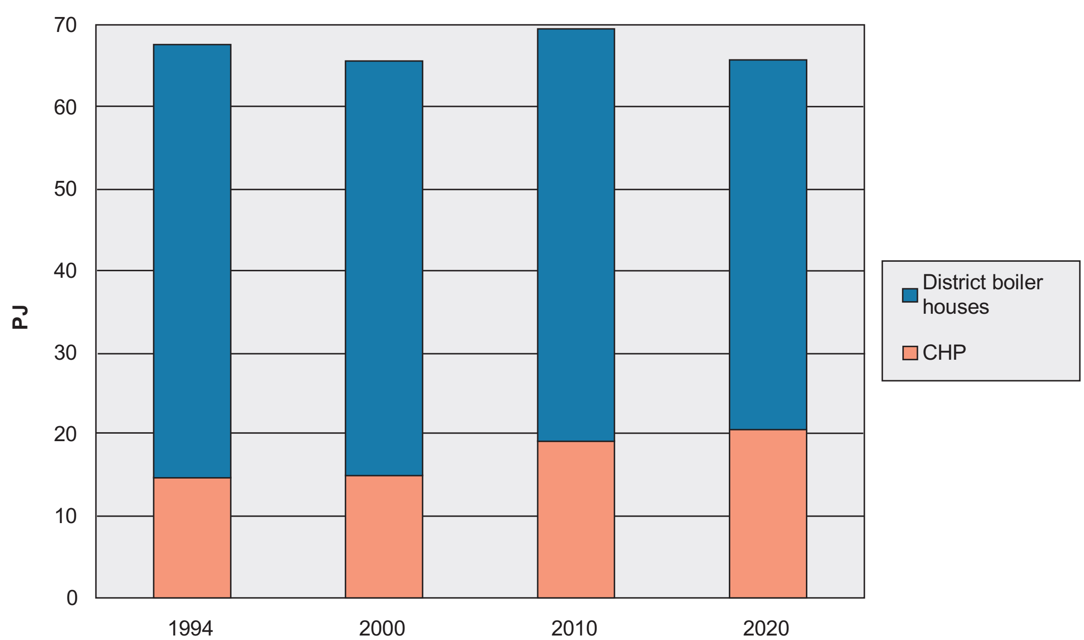

Fig. 5.5. District heat production for the period of 1994—2020, PJ

aggregated GHG emissions may be only some 10% below the 1990 level and it does not seem easy to fulfill the commitments under the UN FCCC in coming years. At the same time Transport sector emissions according experts opinion may be much higher than assumed in the Reference Scenario. Therefore the Energy sector Scenario "with measures" envisages additional specific measures to reduce CO_2 emissions.

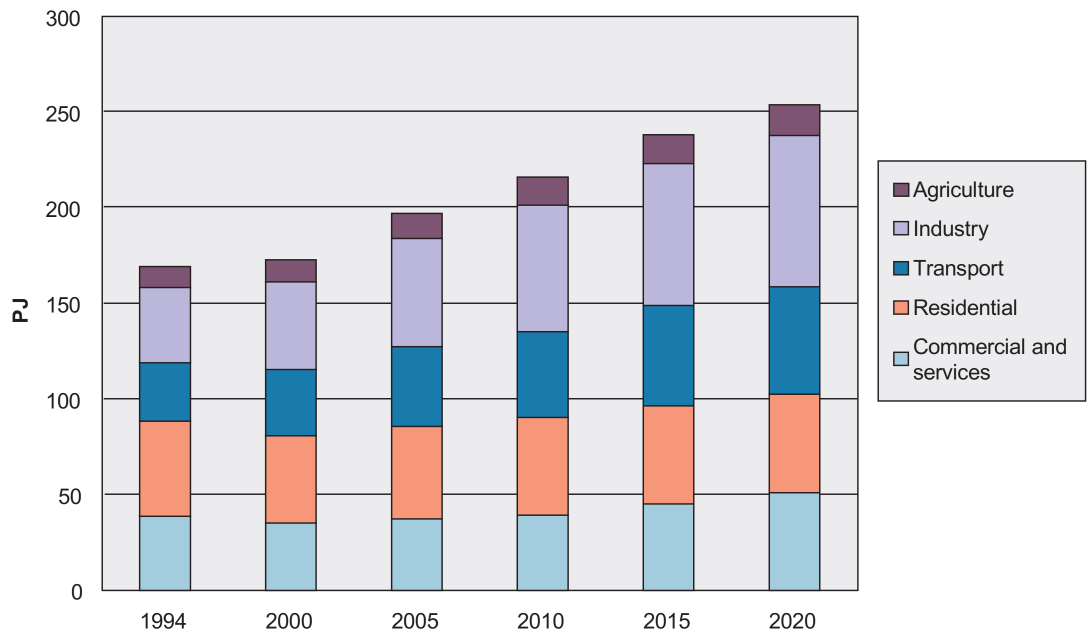

Fig 5.6. Final energy demand for the period of 1994—2020, PJ

Fig. 5.7. Energy sector Reference Scenario primary energy supply (PJ)
and CO_2 emissions from fuel combustion activities (Gg) for the period of 1990—2020

Key assumptions for Energy sector Scenario "with measures"

(the technological and policy measures for the Energy sector Scenario "with measures" were taken from the Study [5] and the Energy Development Program [22]; more detailed information is provided in sect. 4.2.1.1.):

— energy efficiency improvement actions already implemented in Energy sector Reference scenario,

— fuel switching,

— increased use of CHP production in comparison with Energy sector Reference Scenario,
— increased use of biomass for DH production,
— reconstruction of small HPPs,
— increased use of wind energy.

MARKAL model has calculated that the combined effect of implementation of all these measures in an integrated approach could be about 30% CO_2 emission reduction till 2020 compared to the Reference Scenario. As described in Chapter 4, a lot of policy instruments is necessary to reach the emission reduction. Fig 5.8. shows the CO_2 emissions impact if a policy measure, such as CO_2 tax is implemented [5].

CO_2 emissions for the Energy sector Reference Scenario and Scenario "with measures" for 1990—2020 are presented in Table 5.3.

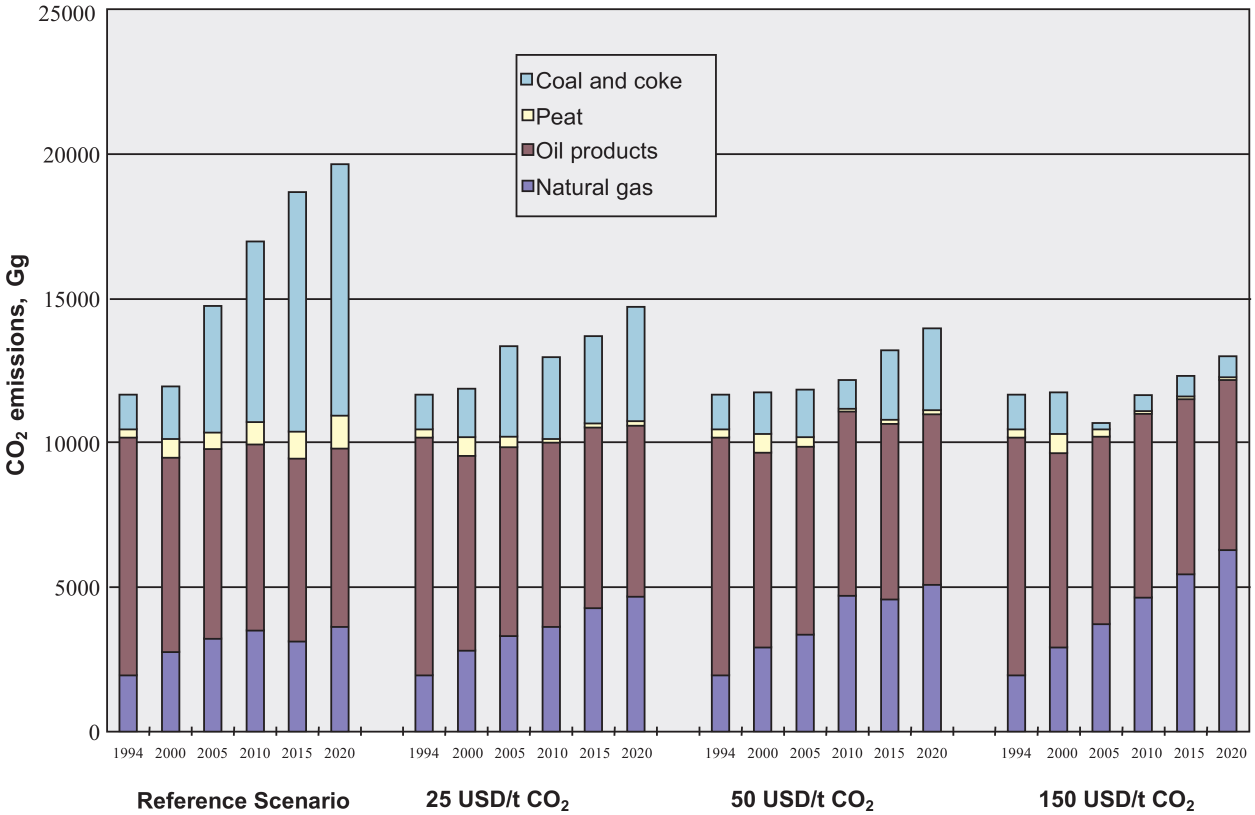

Fig. 5.8. CO_2 emissions by fuels in Energy sector Reference Scenario and different CO_2 tax levels for the period of 1994—2020, Gg

Transport

The results for Transport sector analysis were obtained from the Study [5], where they were calculated making use of the National Transport Development Program [14] and expert judgement.

The same as in other CEE countries very rapid increase in car ownership is taking place in Latvia. The increase in 1995 was about 24% in comparison with 1990. Forecast for following years were made on an assumption of steady growth of number of cars before reaching the current level of developed European countries (see Table 5.1.).

Table 5.1.

Number of cars for the period of 1995—2020

Year	Number of cars per 1000 inhabitants
1995	132
2000	220—240
2010	280—320
2020	380—400

Source: [5,14].

As a result of the sharp increase in the number of vehicles and development of transit traffic the annual CO_2 emissions from transport in 2020 in the Energy sector Reference Scenario case (about 4070 Gg) will exceed the level of 1995 considerably, but will not reach the level of 1990. Other experts yet are of the opinion that just after 2010 CO_2 emissions from transport will start to exceed the level of 1990, and in 2020 it will be about 6000 Gg. Some additional researches should be performed to clear up the problem. CO_2 projections for 1990—2020 are presented in Table 5.3.

The following Transport sector CO_2 emission reduction possibilities were discussed in the Study [5]:

— improved public transport system,
— maintenance of existing vehicles,
— engine power reduction for cars,
— road vehicles with alternative fuels,
— speed limits,
— improved drivers' behavior.

Effect of implementation of these measures was not included in the Energy sector Scenario “with measures”.

5.2.2. Other CO_2 emission sources

The CO_2 emission projections for other sectors were elaborated making use of the Long-term Economic Forecast till 2020 elaborated by the experts of the Ministry of Economy of the Republic of Latvia (see sect. 5.1.1.).

Besides fuel combustion, there are two other CO_2 emission sources in Latvia. They are cement and lime production and soil management and liming. Their contribution was only 2% in total CO_2 emissions in 1995. The 1995 cement and lime production levels are not expected to change remarkably until 2010. If targets of the Draft National Program for Construction [33] are reached regarding an increase in the production of cement and other materials for building in 2010, than the related emissions could grow after 2010 considerably.

CO_2 projections for 1990—2020 are presented in Table 5.3. (emissions from increased cement and lime production included).

5.2.3. CO_2 removals by forests

The information presented in this section comes from the Study [5].

The forest area and growing stock are increasing in Latvia. The Forestry Sector Reference Scenario envisages that the area of actual forest land will increase from 2.88 mill. ha in 1995 up to 3.4 mill ha in 2020 and will cover about 52% of total area. The area of strict reserves (undisturbed forest) may increase from 52.4 thous. ha in 1995 to about 80 thous. ha in 2020 (opinion of other experts is that this area will be smaller). The area of agricultural land will decrease from 2.54 mill. ha in 1995 to 1.96 mill. ha in 2020, and part of the agricultural land (about 0.58 mill. ha) will transform naturally into a low economical value forest land where bushes and deciduous tree species, such as white alders, birches and aspens will be growing. Mainly this area includes land with poor soils, wet clay soils, light sandy soils, as well as hilly, stony or very small plots.

The changes in land-use in Latvia in 1990—2020 due to geographical and economical reasons as assumed for the Forestry sector Reference Scenario are shown in Table 5.2.

Table 5.2.

Land-use in Latvia for the period of 1990—2020, thous. ha

	1990		1995		2000		2010		2020	
	thous. ha	%	thous. ha	%	thous. ha	%	thous. ha	%	thous. ha	%
Total area	6459	100	6459	100	6459	100	6459	100	6459	100
1.Total actual forest land	2803	43	2881	44.6	2980	46.1	3310	51	3400	52.6
Undisturbed forests (strict reserves)	52		52		60		70		80	
Managed forests	2751		2829		2920		3240		3320	
2.Other wooded land	143	2.2	112	1.7	255	3.9	185	2.9	175	2.7
3.Agricultural land	2567	40	2542	39.4	2300	35.6	2040	32	1960	30.3
Abandoned agricultural land			300		260		50		20	
4.Inland waters	254	3.9	254	3.9	254	3.9	254	3.9	254	3.9
5.Other	692	11	670	10.4	670	10.4	670	10	670	10.4

Because of the increase in the forest area, and because of the forests in Latvia will be on average composed of relatively young classes as they recover from the past harvesting and abandonment of agricultural land, forests will remain net C sink during 1995—2020. The net CO_2 sequestration will increase from 10960 Gg in 1990 up to 12630 Gg in 2020. Carbon enrichment in the soil of afforested abandoned agricultural land is included in figures. Detailed calculations for the Forestry sector CO_2 emissions and removals till 2020 for the Reference Scenario are presented in Annex 2.

The following measures aiming to increase C storage in forest ecosystem were analyzed in the Study [5]:

— controlled natural afforestation of abandoned agricultural land;

— purposeful afforestation of abandoned agricultural land and forest tending (2 cases);

— silviculture practices in young stands (4 cases).

As there was no model for Forestry sector assessment, no integrated approach was possible to analyze mitigation options. Only one of the above mentioned measures to increase CO_2 removals was chosen for the Forestry sector Scenario with measures — purposeful afforestation of abandoned agricultural land and forest tending.

In this Scenario it was assumed that up to 1997 the same increase of forest area and of growing stock would take place as in the Reference Scenario case, and the abandoned agricultural land (580 thous. ha) is gradually afforested naturally. But starting the year 1997 and till 2020 annually about 10 thous. ha of abandoned agricultural land are purposefully planted with conifers and birches, the remaining area of naturally afforested abandoned agricultural land being specially tended. As a result the annual biomass increment will be higher in comparison with Forestry sector Reference Scenario. CO_2 removals will begin to increase after 2000, and will reach about 2.5% annual incremental CO_2 removal starting from 2020. Full benefits (economical and social) could be observed only over a period of some 50—60 years. There is no evidence to suggest that biomass production will conflict with food production in Latvia.

CO_2 removals for the Forestry sector Reference Scenario and Scenario "with measures" for 1990—2020 are presented in Table 5.3.

5.3. Projections of CH_4 emissions

The future emissions of CH_4 in the Energy sector were calculated from the primary energy supply data of the MARKAL model described in the sect. 5.2.1. The CH_4 emission projections for other sectors were elaborated making use of the Long-term Economic Forecast till 2020 elaborated by experts of the Ministry of Economy of the Republic of Latvia.(see sect. 5.1.1.).

Table 5.3.

CO_2 emissions and removals for the period of 1990—2020, Gg

Sector	1990	1995	Sectoral Reference Scenarios		Sectoral Scenarios "with measures"	
			2010	2020	2010	2020
Total emissions	24905.89	12143.79	17884.08	20573.42	12565..55	13935.60
1. Energy	24208.93	11899.91	17083.29	19772.63	11764.76	13134.81
1A. Fuel combustion activities	24208.93	11899.91	17083.29	19772.63	11764.76	13134.81
1A1. Energy industries	9529.56	4922.94	8140.19	8500.02	3996.75	3838.57
1A3. Transport	5829.05	1748.79	3488.09	4070.60	3460.46	4034.87
2. Industrial processes	562.54	127.42	682.50	682.50	682.50 (ne)	682.50 (ne)
2A. Mineral products	562.54	127.42	682.50	682.50	682.50 (ne)	682.50 (ne)
5. Land use change and forestry	134.42	116.45	118.29	118.29	118.29	118.29
5D. CO_2 emissions and removals from soil	134.42	116.45	118.29	118.29	118.29	118.29
Total removals						
5. Land use change and forestry	10960	10600	13600	12320	13870	12630
5A. Changes in forest and other woody biomass stocks	10960	10600	13600	12320	13870	12630

Notes:
1) Recalculation of the CO_2 emissions and removals for 1990 according Revised Guidelines [4] gave values which differed from those presented in [3].
2) ne - effect of implementation of measure not estimated.

Energy

Implementation of CO_2 emission reduction measures till 2020 will reduce CH_4 emissions from fuel combustion activities as well. Increased use of natural gas may cause some growth of CH_4 emissions from gas distribution network in future years especially in case of Energy sector scenario "with measures" (key assumption for the Scenario see in sect. 5.2.1.). Emission factor for the former SU [4] was chosen to calculate the emissions. If measures to replace old pipelines and improve maintenance of network are implemented, then the CH_4 emissions may be reduced. Possible CH_4 emission reduction effect was not calculated.

CH_4 emissions from Energy sector for the Reference Scenario and Scenario "with measures" for 1990—2020 are presented in Table 5.4.

Agriculture

It is assumed that share of large-scale farming will grow in coming years. It will enable farmers to form modern enterprises, to increase productivity and develop efficient technologies. Forecasts for 2020 do not envisage a growth of the live-stock number (see sect. 2.2.4., Table 2.7.), and CH_4 emissions from enteric fermentation and manure management will remain far below the level of 1990. The possible CH_4 emission reduction effect after implementation of measures described in sect. 4.2.3.2. was not calculated.

CH_4 emissions from Agriculture sector for the Reference Scenario and Scenario "with measures" for 1990—2020 are presented in Table 5.4.

Waste

As stated before, the amount of waste in SWDS and related CH_4 emissions is going to grow after 2000 though the number of population in Latvia will continue to decrease (see sect. 4.2.3.). If nothing is done (Waste sector Reference Scenario), amount of CH_4 produced in landfills in 2020 could exceed the level of 1990 by about 70%.

The Strategy for the Municipal Waste Management was worked out in MEPRD in 1997 [26], one of the main tasks of it being to reduce the negative environmental impact of SWDS in Latvia. "Getliņi" SWDS reconstruction has been started [27]. Combined effect of measures proposed in these documents (Waste sector Scenario "with measures"), such as decrease in landfilling by about 20% from 2005 due to waste reuse, and recovery of biogas after 2000 will result in the CH_4 emission reduction till 2020 by about 46% compared to Reference Scenario; in this case CH_4 emissions will remain about 6% below the level of 1990 (see Fig. 5.9.).

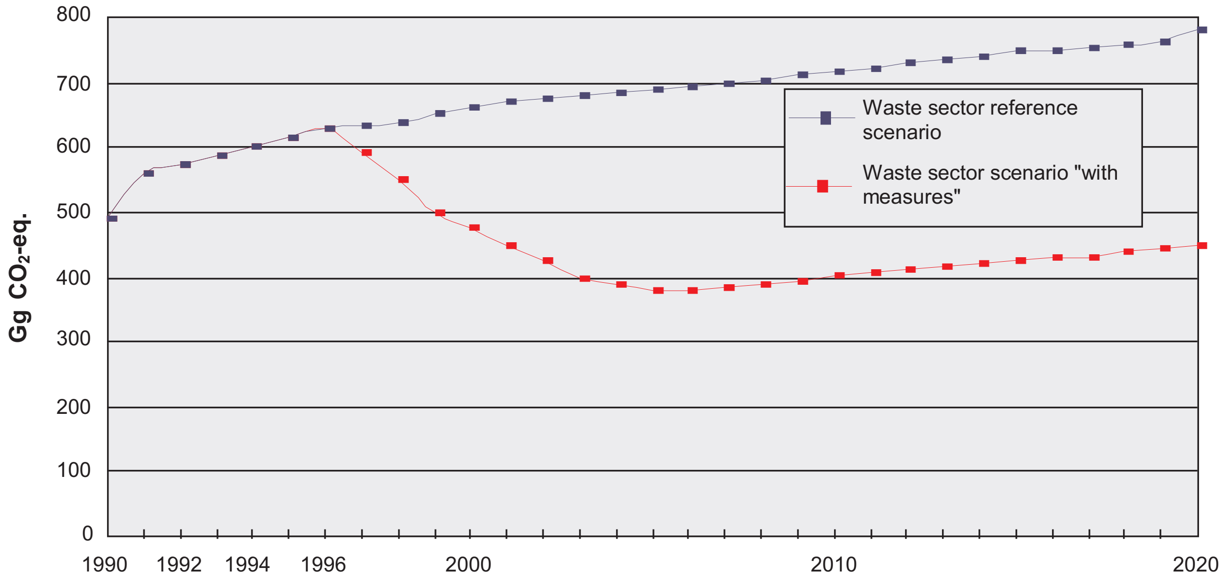

Fig. 5.9. CH_4 emissions from Waste sector for the period of 1990—2020, Gg CO_2-eq.

Waste incineration is on a research scale in Latvia presently. No waste incineration is planned to be implemented in Latvia till 2010. After that year Riga city waste incineration might be possible [26].

CH_4 emissions from Waste sector for the Reference Scenario and Scenario “with measures” for years 1990—2020 are presented in Table 5.4.

Table 5.4.

CH_4 emissions for the period of 1990—2020, Gg

Sector	1990	1995	Sectoral Reference Scenarios		Sectoral Scenarios “with measures”	
			2010	2020	2010	2020
Total emissions	186.33	101.33	118.51	135.41	114.14	142.75
1A. Energy	55.67	29.10	36.94	39.74	47.68 *)	62.79 *)
1A. Fuel combustion	2.43	7.50	5.58	7.25	6.12	6.60
1B. Fugitive fuel emissions	53.24	21.60	31.36	32.49	41.56 *)	56.19 *)
4. Agriculture	111.27	44.63	50.66	61.76	50.66 (ne)	61.76 (ne)
4A. Enteric fermentation	97.96	39.31	44.81	54.01		
4B. Manure management	13.31	5.32	5.85	7.75		
5. Land use change and forestry	nd	2.00	0.00	0.00	0.00	0.00
5A. Changes in forest and other woody biomass stocks	nd	2.00	0.00	0.00	0.00	0.00
6. Waste	19.39	25.60	30.91	33.91	15.80	18.20
6A. Solid waste disposal on land	19.39	25.60	30.91	33.91	15.80	18.20

Notes:
1) Recalculation of the CH_4 emissions for 1990 according to Revised Guidelines [4] gave values which differ from those presented in [3];
2) *) an increase in CH_4 emissions is due to increased use of natural gas in the Energy sector scenario “with measures” (see sect. 5.2.1.); effect of CH_4 mitigation measures not estimated;
3) ne — effect of implementation of measure not estimated;
4) nd — no data.

5.4. Projections of N_2O emissions

The future emissions of N_2O in the Energy sector were calculated from the primary energy supply data of the MARKAL model described in the sect. 5.2.1. of this document. Data on economic activities in other sectors were obtained from the Long-term Economic Forecast till 2020 elaborated by the experts of the Ministry of Economy of the Republic of Latvia.

N_2O emissions in Latvia are not going to exceed the level of 1990 till 2020. As mentioned in sect. 4.2.4., an environmental policy measure in the Transport sector which could lead to an increase of N_2O emissions in Latvia in future should be mentioned. It is the penetration of catalytic converters in road transport with the aim of reducing emissions of NO_x, CO and NMVOC.

N_2O emissions for the Sectoral Reference Scenarios and Scenarios "with measures" for 1990—2020 are presented in Table 5.5. (penetration of catalytic converters in transport and reduction effect from measures in the Agriculture sector described in sect. 4.2.4.1. was not calculated).

Table 5.5.

N_2O emissions for the period of 1990—2020, Gg

Sectors	1990	1995	Sectoral Reference Scenarios		Sectoral Scenarios "with measures"	
			2010	2020	2010	2020
Total emissions	22.53	16.25	16.79	18.46	16.7	18.3
1. Energy	0.26	0.26	0.49	0.59	0.5	0.5
1A. Fuel combustion	0.26	0.26	0.49	0.59	0.5	0.5
4. Agriculture	22.00	15.73	16.07	17.65	16.07 (ne)	17.65 (ne)
4D. Agricultural soils	22.00	15.73	16.07	17.65		
6. Waste	0.27	0.25	0.23	0.22	0.23	0.22
6B. Wastewater handling	0.27	0.25	0.23	0.22	0.23	0.22

Notes:
1) Recalculation of the N_2O emissions for 1990 according to Revised Guidelines [4] gave values which differed from those presented in the [3];
2) ne — effect of implementation of measure not estimated;

5.5. Projections of indirect GHG and SO_2 emissions

The future emissions of the indirect GHG, such as NO_x, CO, NMVOC and the sulfate aerosol precursor SO_2 in the Energy sector were calculated from the energy supply data of the MARKAL model described in the sect. 5.2.1. of this document. Data on economic activities in other sectors were obtained from the Long-term Economic Forecast till 2020 elaborated by the experts of the Ministry of Economy of the Republic of Latvia (see sect. 5.1.1.).

Projected emissions for 1990—2020 are presented in Table 5.6.

5.6. Projections of aggregated GHG emissions

Table 5.7. and Fig. 5.10. present the aggregated emission projection of CO_2, CH_4 and N_2O for the Sectoral Reference Scenarios and Scenarios "with measures" for the period of 1990—2020 in Gg CO_2-equivalents, using GWP values for a 100-year time horizon [4].

Table 5.6.

NO_x, CO, NMVOC and SO_2 emissions for the period of 1990—2020, Gg

Emissions	1990	1995	Sectoral Reference Scenarios		Sectoral Scenarios "with measures"	
			2010	2020	2010	2020
NO_x						
1.Energy	92.56	41.80	80.59	92.54	67.07	75.84
2.Industrial processes	nd	nd	nd	nd	nd	nd
3.Solvent use	nd	nd	nd	nd	nd	nd
4.Agriculture	nd	nd	nd	nd	nd	nd
5.Land-use change and Forestry	nd	0.50	0.00	0.00	0.00	0.00
6.Waste	nd	nd	nd	nd	nd	nd
Total	92.56	42.30	80.59	92.54	nd	nd
CO						
1.Energy	387.59	436.17	329.57	382.05	359.01	408.27
2.Industrial processes	nd	0.00	0.02	0.08	0.02 (ne)	0.08 (ne)
3.Solvent use	nd	nd	nd	nd	nd	nd
4.Agriculture	nd	nd	nd	nd	nd	nd
5.Land-use change and Forestry	nd	17.50	0.02	0.02	0.02	0.02
6.Waste	nd	nd	nd	nd	nd	nd
Total	387.59	453.67	329.61	382.15	nd	nd
NMVOC						
1.Energy	56.35	48.70	56.66	64.99	59.99	68.48
2.Industrial processes	60.55	8.37	128.21	540.63	128.21	540.63
3.Solvent use	30.90	12.54	19.26	21.16	19.26	21.16
4.Agriculture	nd	nd	nd	nd	nd	nd
5.Land-use change and Forestry	nd	nd	nd	nd	nd	nd
6.Waste	nd	nd	nd	nd	nd	nd
Total	147.80	69.61	204.13	626.77	nd	nd
SO_2						
1.Energy	118.01	59.07	139.15	172.18	42.09	33.91
2.Industrial processes	1.32	0.11	18.30	18.30	18.30(ne)	18.30(ne)
3.Solvent use	nd	nd	nd	nd	nd	nd
4.Agriculture	nd	nd	nd	nd	nd	nd
5.Land-use change and Forestry	nd	nd	nd	nd	nd	nd
6.Waste	nd	nd	nd	nd	nd	nd
Total	119.33	59.18	157.45	190.48	nd	nd

Notes:
1) Recalculation of GHG emissions for 1990 according to Revised Guidelines [4] gave values which differed from those presented in [3];
2) ne — effect of implementation of measure not estimated;
3) nd — no data.

Table 5.7.

Aggregated GHG emissions for the period of 1990—2020, Gg CO_2-eq.

GHG	GWP factor [1]	1990	1995	Sectoral Reference Scenarios		Sectoral Scenarios "with measures"	
				2010	2020	2010	2020
Total emissions		35803.12	19309.22	25577.69	29139.63	20145.69	22622.05
CO_2	1	24905.89	12143.79	17884.08	20573.42	12565.55	13935.80
CH_4	21	3912.93	2127.93	2488.71	2843.61	2396.94	2997.75
N_2O	310	6984.30	5037.50	5204.90	5722.60	5183.20	5688.50

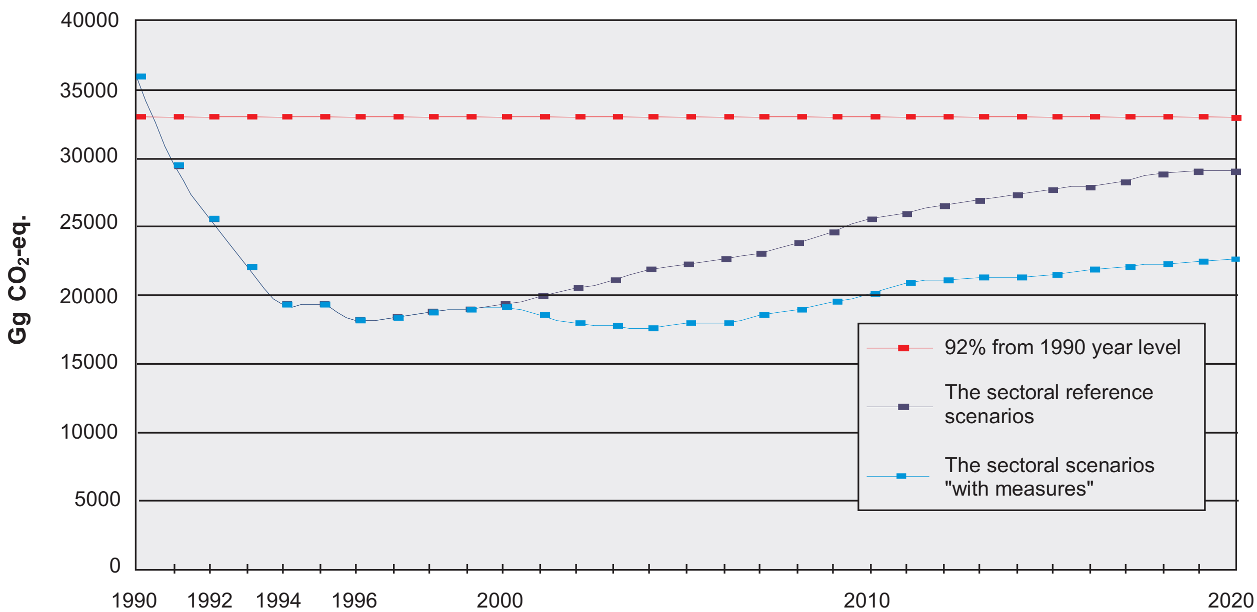

Fig. 5.10. Aggregated GHG emissions for the period of 1990—2020, Gg CO_2-eq.

The figures indicate that aggregated total GHG emissions after 2010 may be some 15—25% below the 1990 level if the key assumptions for the Energy sector efficient Reference Scenario are fulfilled. If not, aggregated GHG emissions after 2010 may be only 10% below the 1990 level (not shown in table and in figure), and it seems difficult to fulfill the commitments under Kyoto Protocol to the UN FCCC on 10 December 1997 in the future.

If all GHG reduction options in Energy, Forestry and Waste sectors are implemented (scenarios "with measures" in Table 5.7. and Fig. 5.10.), then the aggregated GHG emissions will be 35—40% below the 1990 level in 2008—2012.

6. VULNERABILITY ASSESSMENT OF THE ECOLOGICAL SYSTEMS AND ADAPTATION TO THE IMPACTS OF CLIMATE CHANGE

6.1. Introduction

Climate change is expected to be only one factor among many others that affect ecological systems and economic development. Other factors that interact with climate change could include air pollution, water availability and population growth. Adaptation can be spontaneous or planned, and can be carried out in response to or in anticipation of changes in conditions. In the context of climate change, adaptation refers to actions required to achieve sustainable adjustments to future changes in the global climate. Adaptation actions may be expected to provide net economic benefits in the short term, in addition to reducing vulnerability to climate change in the longer term. There are several approaches to adaptation, in both natural and socio-economic systems. These include economic, legal, institutional and technological approaches [35].

6.2. Vulnerability assessment of the ecological systems and adaptation measures

No vulnerability assessment of the ecological systems (coastal zone, water resources, agriculture) has been carried out, and no national programs or plans created regarding adaptation measures in these systems as demanded by Article 4.1 (b,e) of the UN FCCC till now in Latvia because of lack of financial resources. However, there are some earlier started researches on the genetic variability of regionally important tree species in response to climate change and on the degree and rate of evolutionary processes and adaptation, by means of genetic changes. The study now could be considered as part of the efforts of European countries for the Helsinki Resolution 4 "Strategies for a Process of Long-term Adaptation of Forests in Europe to Climate Change". One of the conclusions from the researches under Resolution is that the objective of forest management should be to maintain and improve the properties, which render a forest ecosystem capable of protecting itself against destruction when environmental changes occur. The following basical methods in the field of forest management for increasing the adaptability of forests to climate change could be mentioned:

— anticipating future developments, for example, by afforesting with tree species, which are better equipped to cope with the expected warm-up;

— utilizing and promoting the existing adaptability.

Latvia together with other Baltic region countries will have to contribute financial resources and to perform scientific researches to work out a long-term strategy for adaptation of forest and other ecosystems, as well as socio-economic systems to climate change.

7. RESEARCH AND SYSTEMATIC OBSERVATIONS

7.1. National research targeted on climate science

The regaining of independence and increase of prestige of Latvia as a country of Europe and the Baltic region provide Latvian scientists with an opportunity to participate in the international labor division in the field of science, including the research on climate science. Comparing to the years before regaining of independence, now there are no formal obstacles to participation in the global scale programs, that have been initiated or are financially supported by the Council of Scientific Union, the United Nations Environment Program, World Meteorological Organization. As it will be shown further on, the Latvian scientists with themes of their research and scientific level of work can contribute to the World Climate Research Program, International Geosphere and Biosphere Program, and the Global Change Human Dimension Program. In addition to that, Latvia has a scientific research corresponding in its contents to other programs and projects, which are aimed at particular problems related to the green-house effect, such as transformation of agricultural land into forest land and sea coast-line as a result of human activities. Some projects have been started dealing with sustainable use of resources; environment-friendly energy system development models for Latvia; use of waste for energy production. It has to be mentioned that scientific activities orientated towards research of climate changes in Latvia are rather uncoordinated. It can be explained by both the limited possibilities of the Latvian Council of Science to finance such research, and by insufficient integration of Latvian scientists into international climate research programs.

In addition to universities and research institutes, the State Hydrometeorological Agency shall be mentioned, which through a public procurement in the field of meteorology, hydrometeorology and pollution control, has undertaken certain research assignments related to Latvia's international obligation in the WMO. Thanks to this factor, State Hydrometeorological Agency has co-operation projects, it receives certain support and the results of its everyday (routine) measurements are used in the following WMO programs:

— Sub-program of the World Climate Research Program — World Climate Data and Monitoring Program;
— Hydrology and Water Resources Program;
— GAW;
— Education program;
— IPCC.

7.2. International cooperation

Latvia as a country in transition, where almost all sectors of the national economy face restructuring and problems of market change and therefore are forced to radically change the assortment of production, encounters essential problem of the choice of technology. An elaborated planning and use of best available technologies would ensure good future development possibilities for Latvian economy, based on the energy and resource saving technologies. It is clear that such technologies have to be used thinking about problems of the climate change as well as in broader context of the sustainable development. The Latvian Environmental Protection Fund has in some way contributed to this through carrying out a project “Physics and technologies for sustainable development” at the Faculty of Physics and Mathematics of the University of Latvia. It is provided for orientation of scientific and studying work of teaching staff and students towards nature and human-friendly future technologies.

However, national resources that could be assigned for these objectives are limited. There is a need for more active practical international co-operation in order to implement the requirements of the Article 4 (c) of the UN FCCC on transfer of technology and knowledge. The mutual exchange of experience and information, and initiating further common activities to mitigate climate change is assured through international conferences, special meetings, workshops and seminars, where Latvia as a Party to the Convention participates in. The Government of the Netherlands has allocated funds to assist Latvia in preparing the country study on sources of GHG emissions and emission mitigation [5]. The climate change mitigation related international cooperation projects in Latvia mainly are orientated towards energy efficiency improvements and waste management.

The PHARE Program is the European Union's initiative to support, by means of grants, the process of economic transformation and to strengthen the democracy in the countries of Central and Eastern Europe. As part of the PHARE Program in 1992/1993 the “Energy Economy Restructuring Program” and “Energy Saving Strategy for Latvia” were worked out by foreign experts together with high level team of Latvian specialists. An excellent analysis of the Latvian energy situation was carried out and is to a large extent still valid. The short and medium term strategy for energy saving was proposed consisting of the following main parts:

— pricing reform,
— introduction of consumption quotas,
— cutting down losses,
— restriction of supply where possible,
— and 10 high priority energy saving projects.

The study proposed energy efficiency action plans for each end-use sector but these plans did not got off the ground. One of the reasons was that financial mechanism for energy efficiency activities had not been worked out.

Estonia, Latvia, Lithuania and Denmark have made an agreement on Danish assistance to an Environmental Related Energy Sector Program. The support from the Danish Ministry of Environment and Energy to the present countries is motivated by a wish to transfer knowledge and implementation of planning systems. The objective of the program is to promote a sustainable development of the states' energy sectors. The agreements for the respective countries were settled in 1994, and they include cooperation within the areas:

— rational use of energy, especially energy efficiency and energy savings,
— cleaner energy technology and fuels,
— institutional strengthening.

Within these areas a number of projects is identified by the consulting company the Carl Bro Group in Denmark and tenders will be invited for bidding and elaboration of the projects. For the 1996 programs in Latvia the following projects have been identified and will start soon:

— the Hydro carbon sector support project,
— rehabilitation of Inčukalns Gas Storage,
— heating plan for Daugavpils,
— energy efficiency in industries,
— strategy for the use of CHP,
— implementation of a straw-fired district heating system in the State Agricultural School of Saulaine.

The projects are expected to be finalized by the end of 1999 at the latest.

The Swedish NUTEK together with experts from Latvia has started the Program for an Environmentally Adapted Energy System in the Baltic Region and Eastern Europe. Its aims are to promote:

— reduction of emissions hazardous to climate and environment;

— ecologically sustainable development in the energy sector through energy efficiency and increased use of renewable fuels;

— economic development and business cooperation;

— environmental awareness.

In 1996 the SCORE program orientated to demand side was supposed to be launched by NOVEM in three pilot countries in the CEE region: Poland, Hungary and Latvia.

The more detailed information about NUTEK and SCORE activities in Latvia is provided in sect. 4.2.1.3.

WEC is an independent international non-profit association for the world-wide development of environment protection in industry with a respect for the care of public health and labor protection. Since 1993 WEC has carried out 51 projects for the waste minimizing in 25 industrial enterprises in the Baltic states. The projects were financially supported by the US Agency for International Development.

In Latvia the WEC projects were implemented in 14 industrial enterprises. In 3 of them — (Kvadrāts, Grindex and Olainfarm) the projects for the assessment of the environment protection measures were carried out, in 4 — the demonstration projects, and in 7 — the so-called impact projects, which were based on the results and experience gained from the demonstration projects. WEC has established the Pollution Prevention Center for Latvia to support the enterprises in their efforts to reduce waste. Its main activities are:

— to provide experts' advices on the waste minimization programs, and to disseminate information about concrete achievements in this area in industrial enterprises in Latvia and USA;

— to organize the participation in the seminars on waste minimizing methods;

— to help to get in contact with enterprises in USA.

The UNDP — GEF, which Latvia has joined in 1994, serves as the interim financial mechanism for the projects in such spheres as preservation of biological diversity of ecological systems, climate change mitigation, international water protection and ozone depleting substance activities. Currently there are 3 projects related to these spheres financed under GEF' in Latvia, including Getliņi SWDS reconstruction project. The Project is one of the priorities of national government in Latvia. The full cost of the Project is 25.21 mill. USD, out of which about 8 mill. USD is loan from the World Bank, grant from the Global Environment Facility — 5.12 mill. USD, grant from Swedish government — 1.5 mill. USD, Riga city council will invest 6 mill. USD, and the new company to manage the landfill *Getliņi-EKO* Ltd. — 4.64 mill. USD. These funds should be invested during 1998—2002, when the Project is supposed to be finished.

The Agenda 21 (Action Program for Sustainable Development in the 21st century) is termed Baltic 21 for the Baltic Sea region. Baltic 21 comprises 7 sectors: energy, agriculture, forestry, industry, fishing, tourism and transport.

The main purpose for the Baltic 21-Energy sector is to create a vision for development of a sustainable energy sector for the Baltic Sea Region. The main overall goals for the region until 2030 are:

— to reduce the economic differences between the countries;

— the basic energy services must be affordable to the whole population;

— energy supply must not increase pollution and exceed critical loads or levels of acidification, eutrophication, tropospheric ozone and global climate change;

— elimination of hazards related to nuclear waste and nuclear energy production;

— maintain long-term security of supply by resource management.

The main goal for Baltic 21-Agriculture sector is a sustainable production of high quality food and other agricultural products/services in the long run with consideration taken to economy and social structure, in such a way that the resource base of non-renewable and renewable resources is maintained. Important sub-goals till 2030 are:

— the farmers' income should be sufficient to provide a fair standard of living in the agricultural community;

— the farmers should practice production methods which do not threaten human or animal health or degrade the environment including biodiversity and at the same time minimize our environmental problems that future generations must assume responsibility for;

— non-renewable sources have to gradually be replaced by renewable resources and re-circulation of non-renewable resource has to be maximized;

— sustainable agriculture will meet society needs of food and recreation and preserve the landscape, cultural values and the historical heritage of rural areas and contribute to create stable well developed and secure rural communities;

— the ethical aspects of agricultural production have to be secured.

To coordinate information and experience exchange in the environmental field between the three Baltic states Estonia, Latvia and Lithuania, the Baltic Environmental Forum (BEF) project started operating in 1995. The main BEF themes during the first two years were such as national environmental strategies in the Baltic states, biodiversity and biological farming issues, problem of the hazardous waste etc. The most important issue for 1998 is supporting the process of integration of the three Baltic states into the EU in the field of environment, including legislation approximation.

Danish Environmental Protection Agency is financing the elaboration of the project "National strategy for management of municipal solid waste, 500- ". Danish consultant Carl Bro Group together with experts from Latvia is carrying out implementation of this project. The project regards solid waste management, where solid waste shall be understood as municipal waste (i.e., including hospital waste and non-toxic industrial waste). The overall objective of the project is to reduce contamination and environmental hazards from collection and disposal of municipal solid waste. In 1998 a pilot project on solid waste management in north-eastern part of Latvia was started. Application for funding of this study is submitted to EU PHARE and other international financial institutions.

In 1995—1998 a Danish consulting firm, Chemcontrol a/s, was assigned to undertake the study on National Hazardous Waste Management Strategy launched by EU PHARE. The assessment of produced and disposed of hazardous waste was carried out using questionnaires and site selection for interim storage of not-utilized hazardous agricultural waste. The storage site was decided to be built in a former tankodrome at Gardene. The possibility of incinerating of collected organic waste was also reviewed at the Brocēni Cement Plant, which has already investigated the possibilities of partly replacing heavy fuel oil with waste oil and old tires. A Project implementation unit was established in 1997. Its first task is to carry out detailed analysis of data on generated and stored hazardous waste.

7.3. Activities Implemented Jointly

Joint implementation (JI), provided by Article 4.2 (a) of the UN FCCC, involves cooperation between countries to meet the goals of the Convention. One country (or firm in that country) funds emission reduction actions in a second country. For the investor (developed country or firm) it is a good opportunity for stimulating its exports — it implements the cost-effective GHG mitigation technology achieving a low-cost GHG reduction. Developing country has access to the modern technology, but at the same time it is obliged to return to the investor after the year 2000 part of the emission reduction resulted from JI project.

Following the Berlin meeting (COP 1, 1995), pilot projects now are being undertaken on AIJ by a number of countries, and it should be finished by the year 2000. It is essential for Latvia to show the political initiative on the Government or ministries level to get into contact with Annex II countries governments and to clear up possibilities on funding such projects.

The MEPRD has started cooperation in the field of increasing of energy efficiency and use of alternative and renewable energy resources with Sweden, Germany and Netherlands.

If the working groups for performing AIJ can be established in 1998 and guidelines as well as estimated costs for the projects developed, than negotiations with other partner countries, such as Canada and Japan, will be started and AIJ carried out during pilot stage. An opinion of Latvia's forestry and agriculture experts is, that one of the AIJ projects could be the afforestation of abandoned agricultural land.

7.4. Observation of environmental quality and pollution load

Pursuant to the requirements of the UN FCCC, the Hydrometeorological Agency of Latvia has provided for systematic pollution observations and climate monitoring, in this manner creating a data base for the evaluation of climate-related factors and the study of tendencies.

Within the global climate system GAW system has responsibility for providing the necessary information on global climate change studies. GAW has integrated a number of WMO activities in the field of the atmospheric environment with the purpose of providing information on the changing chemical composition and related physical characteristics of the atmosphere to understand the relationship, direct and potential, between the changing atmospheric composition and climate, the ozone layer, ultraviolet radiation, terrestrial and marine ecosystems.

Latvia has been involved in the GAW activities through regional stations in Rucava (1993) and Zosēni (1994). In addition, these stations are occupied in the EMEP protocol activities as well.

The GAW activities include:

— assessment of contents of pollutants (gases and aerosols) in the air on background level;

— assessment of quality of precipitation;

— measurements of ozone in the atmosphere;

— measurements of physical parameters of atmosphere.

Both stations provide representative information for seaside areas (Rucava) and the inland part of the country (Zosēni) that allows to detect changes in the atmosphere and responses of biological systems to these changes and predict further evolution of the systems.

The annual total sulphur and nitrogen atmospheric deposition includes dry deposition from air as well as that in precipitation. The example from Rucava station, in which a long term observation range is available, shows that sulphur deposition has decreased about 1.3 times in last 4 years; total nitrogen deposition remains on the level of previous 5 years (see Fig. 7.1.).

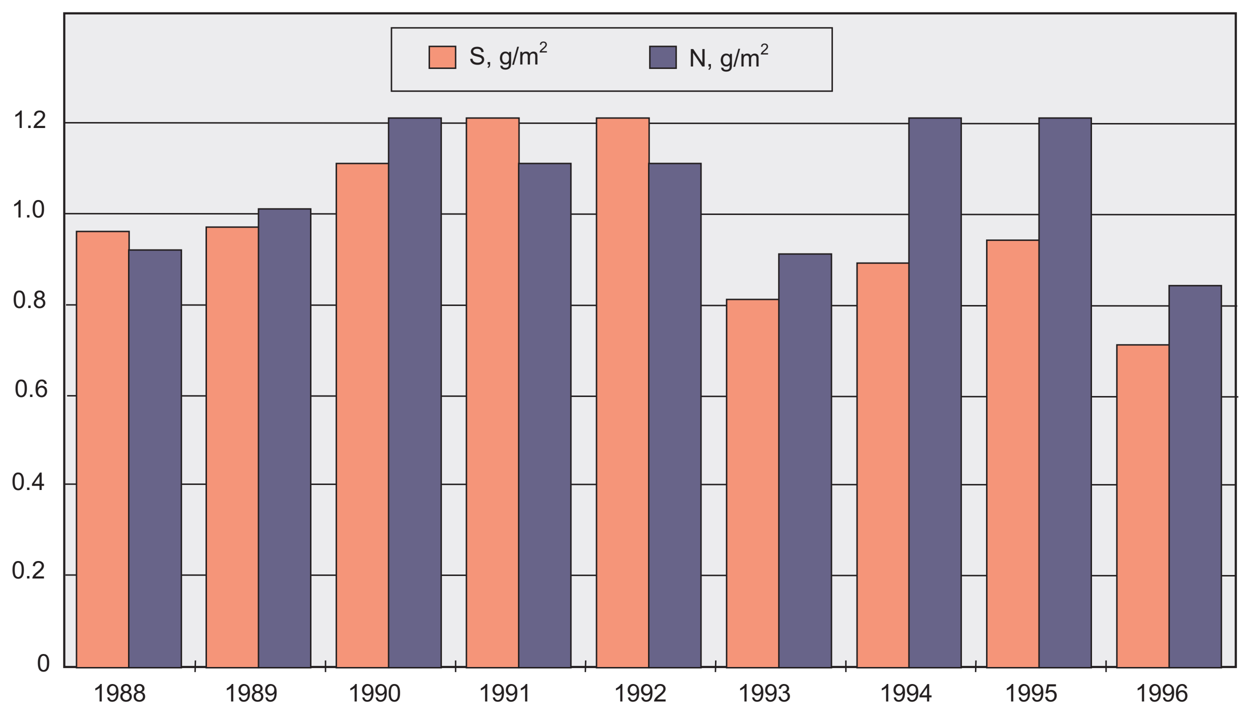

Figure 7.1. Total nitrogen and sulphur deposition in Rucava station for the period of 1988—1996, g/m^2

The observation results meet the international standards and are available to specialists worldwide at the WMO World Data Center for GHG (Tokyo, Japan).

An important GHG presented in both the stratosphere and the troposphere is ozone. Besides shielding the life on the Earth from the harmful solar ultraviolet radiation (below about 320 nm) ozone also largely determines the thermal structure of the atmosphere. The decreases in stratospheric ozone lead to decreasing of stratospheric temperatures, thus affecting the troposphere and its meteorological parameters. The ozone increase near the ground can pose some threats to human health, it can damage the living tissue of plants and animals. In 1994 the tropospheric ozone measurements were incorporated in the work of Rucava station. Measurement results showed that in 1994—1996 accordingly in 36%, 18% and 0.4% cases the concentration of tropospheric ozone exceeded the EU precaution level for vegetation (65 mkg/m^3).

Information about anthropogenic pollution load is necessary to assess reasons of changes in the environmental quality. At the Environmental Data Center of the MEPRD the following statistical reports are filed in the database:

"2-air" - emissions from enterprises (including CHP and DH plants);

"2-water" - information about water pollution from point sources and about sewage treatment plants;

"4-KP" - data about imported and locally produced chemical products and substances;

"3-BA" - data about toxic waste which are kept in enterprises.

In accordance with HELCOM PLC-3 program data are being accumulated and pollution load estimated for the Baltic Sea.

Pollution sources are divided into 3 groups:

* pollution from silts (data from the Hydrometeorological Agency);
* direct effluent into Baltic sea and Riga Gulf from point sources;
* diffuse load from coastal zone.

8. EDUCATION, TRAINING AND PUBLIC AWARENESS

In the biggest Latvian universities — University of Latvia, Riga Technical University and Latvian University of Agriculture lecture courses or even separate bachelor's or master's programs majoring in environmental protection and environmental science are available. However, 5—7 years of practice in such courses and programs until now has proved to be insufficient for introduction of conceptual integrated approach and development of interdisciplinary studies. The main contra-argument in these discussions are limited financial resources for preparation of teachers, equipment of laboratories and practical studies process. There is a need for practical positive steps otherwise maintainance of present level can be problematic.

Feasibility of Latvia to support education on environmental issues from the state budget is limited; the present level in environmental education is achieved by virtue of activities of the informed part of general public, as well as owing to support of governmental and non-governmental organizations of Nordic countries and EU. The support continues to grow, which can be regarded as a certain guarantee that knowledge, connected with issues of environment and global climate change, is going to be integrated into Latvian system of education.

NGO can play an important role in putting environmental issues on the political agenda, raising awareness, and setting priorities. About 30 organizations dealing with environmental protection are registered in the NGO Center of Latvia, such as Environment 2000, Environmental Protection Club, Green Library, Ecological Center of the University of Latvia, Nature Fund of Latvia etc. The Green Library has prepared a booklet on climate change process, as well as possible measures to mitigate it. The booklet is supposed to be distributed in schools. Actions in the streets have been carried out in the framework of the project “To think globally, to act locally”, during which informative sheets were distributed. Seminars and mass media are used to disseminate information as well.

Public awareness is a necessary pre-requisite for the implementation and development of climate policy, since its efficiency is directly dependent on the level of knowledge, understanding of situation and sense of responsibility of all the persons involved. Efforts should be made to expand the ideas of the climate change mitigation policy and other information, based on the latest scientific findings on global warming, to promote environmental education and public awareness, so as to enhance concrete actions of business people and to change the consumers behavior. This change is increasingly important for the success of overall environmental policy.

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Annex 1

Overview of policies and measures

Table A1-1. **CO_2 emissions and removals. Policies and measures**

Measure/Objective	Type of instrument	GHG mitigation impact
1	2	3
Energy industries (1A1)		
Fuel switching to environmentally more friendly Improvement of energy efficiency Increased use of CHP production compared to Energy sector Reference Scenario Increased use of biomass for DH production Reconstruction of small HPPs Increased use of wind energy	Common instruments for the measures: Regulations 1) harmonization of legislation in Latvia with that of EU (UI) 2) “Law on Energy Elaboration and Implementation” (P) 3) “Law on Regulation Entrepreneurship Activities in Energy Industries” (I) 4) “Law on Natural Resources tax” (I) 5) Rules on the control of the imported fuels (P) 6) “Law on Regulation of Monopolies” (UI) Market-based incentives 1) Public Investment program 2) Activities of Environmental Protection Fund 3) Revision of the rates of the “Law on Natural Resource Tax” and elaboration of related documents (P) 4) “Law on Regulation Entrepreneurship Activities in Energy Industries” (I) 5) Harmonization of taxes. prices and tariffs with those in EU (UI) 6) Introduction of new taxes (energy tax, C or CO_2 tax) to promote utilization of environment friendly fuels and technologies (P) Voluntary agreements and programs 1) Fulfillment of the EMEP (I) 2) Fulfillment of targets of national and international programs RD&D 1) Cooperation with Sweden, NUTEK; with Denmark; SCORE; Baltic 21 (UI) Information and education 1) Public awareness building to save energy (I, UI) 2) Transfer of technologies and “know-how” (UI) 3) Modernization of the Energy sector infrastructure (UI)	Combined CO_2 reduction by all measures till 2020 - about 30% compared to Energy sector Reference Scenario [5]. Possible CO_2 reduction by implementation of small HPP — about 13 Gg till 2020 [22]. Possible CO_2 reduction by implementation of wind plants — 22—25 Gg till 2020 [22]
End-use sectors (1A2, 1A4)		
Fuel switching in energy demand side to environmentally more friendly	Market-based incentives 1) Regulations were adopted in 1996 according to which the price reduction for the additionally consumed natural gas in industry was provided after the limit had been used	ne

Continuation of Table A1-1

1	2	3
Heat energy conservation in buildings	Common instruments for the measures: Regulations 1) Standards for new buildings (P) 2) Efficiency standards for electric equipment (P) Market-based incentives 1) Establishment of a system for credit construction, renovation, modernization of buildings (P) 2) Developing the ecological certification and marking of the equipment, a special attention being paid to its efficiency (P) 3) New and progressive tariff system for electricity (P) 4) Price reductions when energy-efficient equipment is purchased (P) 5) Introduction of new taxes (energy tax, C or CO_2 tax) to promote utilization of environment-friendly fuels and technologies (P) Voluntary agreements and programs 1) Fulfillment of targets of national and international programs (UI) RD&D 1) Cooperation with Sweden — NUTEK; with Denmark; SCORE; Baltic 21 (UI) 2) Project proposal "Efficient Lighting Initiative" (P) Information and education 1) Centers for the demonstration of and practices for the energy-efficient equipment. 2) Programs for education. information. practices (UI)	ne
Efficiency improvement in electricity demand-side		ne
Implementation of the system for analysis and checking of energy consumption. including — installation of heat meters. multi-tariff electric power meters and natural gas meters; — audit of energy consumption and analysis of production processes in the production processes		ne
Transport (1A4)		
Maintenance of existing vehicles	Common instruments for the measures: Regulations 1) Vehicles engine exhaust gas standards (UI) 2) Harmonization of legislation in Latvia with that in EU (P) 3) Elaboration and implementation of fuel quality standards (UI) Market-based incentives 1) Supporting consumer choice of more efficient use and choice of vehicles (P) 2) Different custom duties for products which are transported by pipelines and other modes of transport (P) 3) Increase of excise tax (UI) 4) Policy of differentiated taxes to promote use of environment-friendly transport. fuels and catalysts (P) 5) Control and penalties over sale of low quality fuels and other chemicals for use in transport (P) 6) privatization of public transport companies (P) Information and education (UI) Transfer of technologies and "know-how"	CO_2 annual reduction 1—3% in Latvia *) or 5 % according to [31]
Engine power reduction for cars		CO_2 annual reduction 5 % according [31]
Road vehicle with alternative fuels		LPG and CNG can offer 10—30 % CO_2 reduction [31].
Speed limits		CO_2 annual reduction 1—2 % in Latvia *) or 5—10% at average vehicle speed [31]
Improved public transport system		CO_2 annual reduction about 5 % [31]
Improved drivers' behavior		CO_2 annual reduction 1—2 % in Latvia *)

Continuation of Table A1-1

1	2	3
Complex processing of local material resources with low-waste technologies: — lower material content, — use of recycled materials, — environment protection with local waste utilization systems	Regulations 1) Restriction of transit traffic in places with high density of population (UI) 2) Restriction of individual transport in cities (UI) 3) Elaboration of standards for transport infrastructure (UI) 4) Elaboration of municipalities standards for vehicles parking (UI) Market-based incentives 1) Investment programs (State Motor Road Fund etc.) (UI) 2) Road tax (I) 3) Implementation of payment for road use (P)	ne
Industrial processes (2)		
Implementation of up-to-date technologies, the replacement of old equipment and hazardous substances	Regulations 1) Elaboration of the rules to promote implementation of up-to-date technologies (P) 2) Use and implementation of certification to promote usage of up-to-date technologies (P) Market-based incentives 1) Subsidies to create technologies for the switching from non-renewable resources to other materials (P)	ne
Complex processing of material resources with low-waste technologies: — lower material content, — use of recycled materials, — environment protection with local waste utilization systems	Market-based incentives 1) Revision of the rates of the "Law on Natural Resource Tax" and elaboration of related documents (P) 2) Activities of the Environmental Protection Fund (UI) 3) Tax relief for enterprises engaged in waste recycling (P) Voluntary agreements and programs 1) Project on water supply and sanitation "800+" (UI) 2) Waste management project "500-"(UI) RD&D 1) Research on the potential availability of resources for reuse (P) Information and education 1) Popularization and implementation of the use of environment friendly materials (UI)	
Forestry (5A)		
Afforestation of abandoned agricultural land	Common instruments for the measures: Regulations 1) "Law on Management and Utilization of Forests" (I) 2) Harmonization of forestry legislation in Latvia with international conventions and EU documents regarding preservation of biodiversity (UI) 3) Elaboration of rules about specially protected nature's areas and objects (P)	Annual increase of CO_2 removals after 2010 compared to Energy sector Reference Scenario 2—2.5% [5]

Conclusion of Table A1-1

1	2	3
Silviculture practices in young stands	Market-based incentives (UI. P) Voluntary agreements and programs (UI) 1) Research in natural forest in Latvia aimed to elaborate ecologically sound forest management methods (P) Information and education (UI) Public awareness building	Annual increase of CO_2 removals after 2010 compared to Energy sector Reference scenario 2.5—3% [5]
Forest and forest land conservation		ne
Sustainable forest management		ne
Forestry certification		ne

Notes:
1) I — implemented; UI - under implementation; P - planned;
2) ne — not estimated;
3) *) — estimated for the year 1994 total number of road vehicles

Table A1-2. **CH_4 emissions. Policies and measures**

Measure/Objective	Type of instrument	GHG mitigation impact
1	2	3
Fugitive emissions from fuels (1B2b)		
Reduction of natural gas leakages from network	Regulations 1) New “Law on Air Protection” (P) 2) “Law on Regulation Entrepreneurship Activities in Energy Industries” Market-based incentives 1) Investments for gas distribution network to replace old pipelines and improve maintenance(P) Voluntary agreements and programs 1) Proper maintenance of underground natural gas storage facility “Inčukalns” (UI)	ne
Agriculture (4A. 4B)		
Improved management of ruminant live-stock	Common instruments for the measures: Market-based incentives 1) subsidies for manure storage building (UI) 2) tax reliefs (UI) Voluntary agreements and programs 1) Program on cattle breeding and seed growing (P) 2) HELCOM recommendation 7/2 concerning measures aimed at the reduction of discharges from agriculture (UI) RD&D (UI) 1) Biogas production	ne
Improved management of live-stock manure		ne

Continuation of Table A1-2

1	2	3
Elaboration of scientifically sound recommendations on N-fertilizer use efficiency	Regulations 1) Rules on "Use of fertilizers" elaboration (P) 2) Rules on "Certification of output of the biological farming" (P) Market-based incentives 1) EPF and other subsidies (UI) Voluntary agreements and programs 1) Program on improvement of agricultural soils (P) 2) HELCOM recommendations 7/2 and 9/3 concerning measures aimed at the reduction of discharges from agriculture and HELCOM recommendation 13/9 concerning reduction of nitrogen, mainly nitrate, leaching from agricultural land (UI) Information and education 1) Elaboration of the Conception on the implementation of methods of biological farming in peasants farms (P) 2) Environmental education programs for peasants in the framework of the Agricultural consultations service system (UI)	ne
Waste (6A)		
Establishment of separate waste collection systems	Regulations 1) Elaboration and implementation of "Law on Household Waste" (P) 2) Rules on sorting of the industrial waste (P) 3) Standards and norms for industrial waste (P) RD&D 1) Danish firm's "Carl Bro" pilot project on collection of separated wastes (UI) Information and education 1) Public awareness building on separating municipal waste (UI)	Combined CH_4 reduction from 20% decrease of landfilling [26] and biogas recovery in Getliņi waste disposal site [27] - about 46% till 2020 compared to Waste sector Reference Scenario.
Waste reuse	Regulations 1)Elaboration and implementation of "Law on Packing" (P) 2) Elaboration of rules for the scrap car sites organization and maintenance (P) Market-based incentives 1) Tax relief for recycled goods (P) 2) Tax relief for enterprises engaged in waste recycling (P) 3) Major principles included into "Law on Natural Resource Tax" (I) 4) Activities of the Environmental Protection Fund (UI) Voluntary agreements and programs (UI) 1) Fulfillment of targets of national and international programs RD&D 1) Research on the potential availability of resources for reuse (P) Information and education 1) Public awareness building - why and how to reuse household items (UI)	
Clean-up old landfills	Common instruments for the measures Regulations 1) "Law on Household Waste" (I) Market-based incentives 1) Public investment program (UI)	
Development of waste management infrastructure		

Conclusion of Table A1-2

1	2	3
	Voluntary agreements and programs 1) Elaboration of waste management project "500-" (UI) 2) Water supply and sanitation project "800+" (UI) 3) Riga waste management project (UI) 4) Projects for waste management in Liepāja (P), Talsi (I), Ziemeļvidzeme (UI)	
Waste minimization	Regulations 1) "Law on Packing" (P) Market-based incentives 1) Major principles included into "Law on Natural Resource Tax" (I) 2) Activities of Environment Protection Fund (UI) 3) Taxes on packing (P) 4) Increased payment for the final disposal of wastes (UI) 5) Providing low-cost financing for local governments to implement municipal waste incineration systems (P) Voluntary agreements and programs 1) Voluntary agreements with producers on more rational resource use, including packing volume reduction (P) 2) Fulfillment of targets of national and international programs (UI) RD&D 1) Waste incineration projects (UI) Information and education 1) Public awareness building (UI)	
Biological treatment of waste	Voluntary agreements and programs 1) Technical project for the rehabilitation and continued operations of the Riga city SWDS "Getliņi" (UI)	

Notes:
1) I — implemented; UI — under implementation; P — planned;
2) ne — not estimated

Table A1-3. **N_2O emissions. Policies and measures**

Measure/Objective	Type of instrument	GHG mitigation impact
1	2	3
Agriculture (4D)		
Elaboration of scientifically sound recommendations on N-fertilizer use efficiency	Regulations 1) Rules on "Use of fertilizers" elaboration (P) 2) Rules on "Certification of output of the biological farming" (P) Market-based incentives 1) EPF and other subsidies (UI) Voluntary agreements and programs 1) Program on improvement of agricultural soils (P) 2) HELCOM recommendations 7/2 and 9/3 concerning measures aimed at the reduction of discharges from agriculture and HELCOM recommendation 13/9 concerning reduction of nitrogen, mainly nitrate, leaching from agricultural land (UI) 3) Implementation of good agricultural practice (P)	ne

Conclusion of Table A1-3

1	2	3
	4) Elaboration of the Conception on the implementation of methods of biological farming in peasants farms (P) Information and education 1) Environmental education programs for peasants in the framework of the Agricultural consultations service system (UI)	

Notes:
1) I — implemented; UI — under implementation; P — planned;
2) ne — not estimated

Annex 2

Calculation of Reference Scenario GHG emissions in Forestry sector

Table A2-1. **Calculation of Forestry sector Reference Scenario CO_2 emissions and removals*)** **(Category: Changes in forest and other woody biomass stocks)**

	1990	1995	2000	2010	2020
1	2	3	4	5	6
Land area, thous. ha					
Forest land area for calculation of CO_2 sequestration**)	2894	2941	3175	3425	3495
— managed forest.	2751	2829	2920	3240	3320
— newly afforestated land (other wooded land)***)	143	112	255	185	175
Increase of forest land area compared to 1990. in which					
— naturally afforested abandoned	-	47	281	531	601
agricultural land	-	26	260	510	580

*) Data on CO_2 fluxes are based on State Forest Service experts' opinion and not on a model
**) The area of strict reserves excluded from calculation [4]
***) Wooded land or shrubs in Latvia mainly arises from the abandoned agricultural land. and assumptions regarding its area are highly uncertain. Forests regrowing on the abandoned agricultural land are managed forests in Latvia, and are classified into "Changes in forest and other woody biomass stocks" category (5A).

	1990	1995	2000	2010	2020
C increment calculation					
Annual increment of growing stock (stemwood volume) 1)					
— m^3/ha	5.58	5.65	5.44	5.57	5.60
— total in forestland, mill. m^3	16.14	16.61	17.26	19.09	19.57
from which					
in managed forest					
— m^3/ha	5.83	5.83	5.83	5.83	5.83
— total, mill. m^3	16.0	16.5	17.0	18.9	19.4
in other wooded land					
— m^3/ha	1	1	1	1	1
— total, mill. m^3	0.143	0.112	0.255	0.185	0.175

Continuation of Table A2-1

1	2	3	4	5	6
Annual increment of whole tree biomass [2]					
expansion factor	1.62	1.62	1.62	1.62	1.62
— m^3/ha	9.04	9.15	8.82	9.02	9.07
— total in forestland, mill. m^3	26.15	26.91	28.0	30.90	31.70
from which					
in managed forest:					
— m^3 /ha	9.44	9.44	9.44	9.44	9.44
— total, mill. m^3	25.92	26.73	27.54	30.62	31.43
in other wooded land					
— m^3/ha	1.60	1.60	1.60	1.60	1.60
— total, mill. m^3	0.23	0.18	0.42	0.30	0.28
Annual increment of C storage in whole tree biomass. [3], [4]					
— t/ha	2.26	2.26	2.26	2.26	2.26
— total in forestland, mill. t	6.54	6.73	7.0	7.73	7.93
Annual soil C increment in newly afforestated land[5]					
— t /ha		1.8	1.8	1.8	1.8
— total, mill. t		0.08	0.51	0.96	1.1
Total C increment. mill. t	6.54	6.81	7.51	8.69	9.03
C release calculation					
Annual natural forest die-off in forest ecosystems (stemwood vol.), mill. m^3	3.0	2.8	2.5	2.3	2.0
Whole tree biomass die-off, mill. m^3	4.86	4.54	4.05	3.73	3.24
from which					
— used as fuelwood, mill. m^3 [6]	1.46	1.37	1.22	1.13	0.97
Annual harvesting (stemwood vol.), mill. m^3	5.76	6.89	8.5	10.0	12.0
Harvested biomass, mill. m^3	9.33	11.16	13.77	16.20	19.44
from which					
— tops and branches used as fuelwood, mill. m^3 [7]	0.23	0.27	1.03	1.21	1.45
— tops and branches burnt on-site, mill. m^3 [7]	0.47	0.56	-	-	-
— timber used as fuelwood, mill. m^3 [8]	1.55	1.85	2.28	2.69	3.22
Total biomass loss, mill. m^3	14.19	15.7	17.82	19.93	22.68
Total C release, mill. t	3.55	3.92	4.45	4.98	5.67
Net annual C sequestration, mill. t	**2.99**	**2.89**	**3.06**	**3.71**	**3.36**
Net annual CO_2 sequestration, mill. t	10.96	10.60	11.22	13.60	12.32

Note: explanations see after Table A2-3.

Table A2-2. **Forestry sector Reference Scenario non-CO_2 GHG emissions (calculated according to [4]).**

	1990—1994	1995—1999
Annual amount of biomass (tops and branches) burnt on-site, mill. m^3 7)	0.47	0.56
Fraction of biomass oxidized on-site [4]	0.9	0.9
Annual amount of biomass oxidized on-site, mill. m^3	0.42	0.50
Annual amount of C released, mill. t	0.10	0.125
CH_4 emissions, mill. t	0.0016	0.0020
CO emissions, mill. t	0.014	0.0175
N_2O emissions, mill. t	0.000011	0.000014
NO_x emissions, mill. t	0.00039	0.00050

Table A2-3. **Emission ratios for open burning of cleared forests [4].**

Compound	Ratios
CH_4	0.012
CO	0.06
N_2O	0.007
NO_x	0.121

Assumptions:

1) Annual current increment of growing stock in managed forest 16.5 mill. m^3 was taken from [18]; annual increment of growing stock in other wooded land is assumed to be 1 m^3/ha.

2) Expansion factor for conversion of stemwood volume to whole tree biomass volume was assumed to be 1.62 in managed forest (specified by experts from State Forest Service)). If special steps are taken for forest tending (Forestry sector Scenario "with measures"), then expansion factor is assumed to be 1.75.

3) The average dry wood density was assumed to be 0.5 t dry matter/m^3.

4) C content is assumed to be 0.5 t/t dry matter [4].

5) C accumulation in soil of newly afforestated abandoned agricultural land is assumed to be 1.8 t C/ha/year [4].

6) Experts' opinion is that annually about 30% of the natural forest die-off rural people are collecting informally for the burning (see Annex 1 for calculations). Non-CO_2 GHG emissions are calculated as emissions from biomass burning in Energy sector. 70% of the natural forest die-off are left to decay in the forest.

7) It was assumed. that about 15 % of the whole tree biomass volume are branches and tops and that after harvesting 50 % of it should be left to decay in the forest because of biological and economical constraints. The remaining 50 % could be burnt on site or used as wood for energy. Experts' opinion is that in 1995—1999 about 1/3 of these 50% was removed from the forests for domestic fuel use (burnt off-site). the remaining 2/3 being burnt on-site. Non-CO_2 GHG emissions are calculated as emissions from biomass burning in Energy sector and Forestry sector respectively. Beginning from the year 2000 all amount of tops and branches is assumed to be burnt off-site and GHG emissions are calculated in Energy sector only.

8) It was assumed that about 27% of the total harvested amount is used as fuelwood (see Annex 1 for calculations). The non-CO_2 GHG emissions are calculated as emissions from biomass burning in Energy sector. The remaining timber is used for wood processing industry, pulp and export, and it is assumed that C release takes place immediately.

ANNEX 3

Fuel combustion. PJ

Table A3-1. **Fuel combustion by types. 1990—1996. PJ***

Type of fuel	1990	199	1992	1993	1994	1995	1996
Diesel oil	55.3	46.0	34.0	31.1	25.9	21.3	25.3
RFO	63.4	49.9	45.6	44.9	62.5	40.1	40.9
LPG	3.8	3.6	2.9	2.9	2.3	0.5	1.2
Other liquid	26.6	5.3	4.4	0.3		4.1	3.3
Coal	26.0	21.4	17.6	15.9	12.6	9.4	8.6
Coke	0.4	0.1	0.1	0.1	0.2		0.0
Peat	4.2	3.1	4.1	3.6	2.7	4.4	3.6
Wood	15.4	11.1	17.2	18.2	24.2	20.3	16.3
Natural gas	102.9	98.9	70.8	47.4	34.6	41.1	35.5
Gasoline	42.3	31.3	29.7	31.4	20.2	19.6	11.3
Jet fuel	2.4	0.1	0.0	1.2	0.7	0.2	1.4
Total	342.7	270.8	226.4	197.0	185.9	161.0	147.4

Table A3-2. **Fuel combustion by types. 2000—2020. PJ (forecast)**)**

Type of fuel	2000	2005	2010	2015	2020
Diesel oil	28.7 28.7	30.0 25.5	31.7 25.3	32.9 24.4	33.2 25.1
RFO	43.2 43.2	36.9 36.6	30.7 30.4	26.1 24.3	22.4 19.7
LPG	1.6 1.6	1.0 5.7	1.0 7.5	0.9 8.4	0.9 9.1
Coal	18.9 18.9	46.7 1.8	66.9 5.3	88.9 6.9	93.2 7.1
Coke	0.4 0.4	0.4 0.4	0.5 0.5	0.5 0.5	0.5 0.5
Peat	6.3 6.3	5.6 2.3	7.5 0.9	9.1 1.0	10.9 1.0
Wood	20.9 20.9	21.8 45.1	21.9 49.0	24.6 51.9	22.8 54.0
Natural gas	49.2 49.2	57.6 66.6	62.7 83.1	56.0 97.6	65.0 112.4
Gasoline	17.7 17.7	21.5 21.5	24.9 24.9	27.0 27.0	28.9 28.9
Total	186.9 186.9	221.5 205.5	247.8 226.9	266.0 242.0	277.8 257.8

Notes:

1)

Type of fuel	Fuel combustion in Energy Sector Reference Scenario Fuel combustion in Energy Sector Scenario “with measures” **)

2) *) data according to adopted energy balances;

3) **) data according to the MARKAL model calculations in the Study [5].

ANNEX 4

Summary report for national GHG inventory 1995 (according to [4] Table 7A)

Table A4-1. **Summary report for national GHG inventory. 1995**

GHG source and sink categories	CO_2 Emissions	CO_2 Removals	CH_4	N_2O	NO_x	CO	NMVOC	SO_2
Total	12143.79	-10600	101.33	16.25	42.30	453.67	69.61	59.18
1. Energy	11899.91		29.10	0.26	41.80	436.17	48.70	59.07
1A. Fuel Combustion	11899.91		7.50	0.26	41.80	436.17	46.56	59.07
1A1. Energy Industries	4922.94		0.35	0.06	12.01	8.52	0.67	40.18
1A1a. Losses	129.52							
1A2. Manufacturing Industry and construction	1205.21		0.17	0.01	3.01	25.88	0.98	3.11
1A3. Transport	1748.79		0.38	0.11	22.36	113.11	18.66	4.77
1A4. Other Sectors	3893.45		6.60	0.08	4.42	288.66	26.25	11.01
1B. Fugitive Emissions from Fuels			21.60				2.14	
1B2. Oil and Natural Gas			21.60				2.14	
2. Industrial Processes	127.42					0.00	8.37	0.11
2A. Mineral Products	127.42					0.00	6.47	0.06
2A1. Cement production	101.59							
2A2. Lime production	25.83							
2A6. Road paving with asphalt							6.47	
2D. Other Production							1.90	0.05
2D1. Pulp and Paper								0.05
2D2. Food and Drink							1.90	
3. Solvent and Other Product Use							12.54	
4. Agriculture			44.63	15.73				
4A. Enteric Fermentation			39.31					
4B. Manure Management			5.32					
4D. Agricultural Soils				15.73				
5. Land-Use Change & Forestry	116.45	-10600	2.00	0.01	0.50	17.50		
5A. Changes in Forest and Other Woody Biomass Stocks		-10600	2.00	0.01	0.50	17.50		
5D. CO_2 Emissions, Removals from Soil	116.45							
6. Waste			25.60	0.25				
6A. Solid Waste Disposal on Land			25.60					
6A1. Managed Waste Disposal			21.74					
6A2. Unmanaged Waste Disposal			3.86					
6B. Wastewater handling				0.25				
CO_2 Emissions from Biomass	1882							

ANNEX 5

Sectoral reports for national GHG inventory 1990. 1994. 1995 (according to [4] Standard Tables 1-7)

T a b l e A 5 - 1 a. **Sectoral report for Energy. Fuel combustion activities in 1990**

GHG source and sink categories	Activity	Emission (Gg)							Emission factors						
									CO_2	SO_2	CH_4	N_2O	NO_X	CO	NMVOC
	PJ	SO_2	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	Gg/PJ	Gg/PJ	Mg/PJ	Mg/PJ	Mg/PJ	Mg/PJ	Mg/PJ
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.A Fuel combustion activities	343	118.0	24209	2.425	0.264	92.56	387.6	56.34							
1.A.1 Energy industries	140	60.1	9530	0.512	0.069	15.25	22.91	0.652							
RFO	55.14	57.6	4223	0.160	0.033	8.878	0.827	0.160	76.6	1.045	2.9	0.6	161	15	2.9
Coal	1.51	2.33	140	0.001	0.001	0.169	0.080	0.007	92.7	1.54	0.6	0.8	112	53	4.8
Peat	0.75	0.13	78	0.014	0.002	0.084	1.105	0.019	103.9	0.178	18	2	112	1473	25
Wood	13.39		1241	0.241	0.027	1.500	19.723	0.335	92.7		18	2	112	1473	25
Natural gas	68.92		3847	0.096	0.007	4.618	1.172	0.131	55.8		1.4	0.1	67	17	1.9
1.A.1a Losses	0.29		25.2												
Gasoline	0.04		3.1						68.6						
Diesel oil	0.04		2.9						73.3						
RFO	0.04		3.1						76.6						
Coal	0.13		12.1						92.7						
Peat	0.04		4.1						103.9						
1.A.2 Manufacturing industry and construction	40.0	14.3	2683	0.103	0.015	3.55	24.70	0.979							
Gasoline	0.88		62	0.044	0.002	0.185	23.760	0.880	71		50	2	210	27000	1000
Diesel oil	3.48		255	0.000	0.002	0.237	0.052	0.010	73.3		0.003	0.6	68	15	2.9
RFO	6.91	7.22	529	0.020	0.004	1.113	0.104	0.020	76.6	1.045	2.9	0.6	161	15	2.9
Other liquid	3.52	0.81	256	0.000	0.002	0.239	0.053	0.010	72.6	0.23	0.003	0.6	68	15	2.9
Coal	4.06	6.25	376	0.010	0.003	0.382	0.378	0.019	92.7	1.54	2.4	0.8	94	93	4.8
Coke	0.42		45						106.0						
Natural gas	20.77		1159	0.029	0.002	1.392	0.353	0.039	55.8		1.4	0.1	67	17	1.9
1.A.3 Transport	82.5	5.45	5829	1.558	0.113	67.43	329.9	54.33			Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ

Continuation of Table A5-1A

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Jet fuel	2.37		167.8	0.0012	0.0047	0.711	0.237	0.1185	70.8		0.0005	0.002	0.3	0.1	0.05
Coal	0.21	0.32	19	0.002	0.0003	0.063	0.032	0.004	92.7	1.54	0.01	0.0014	0.3	0.15	0.02
Natural gas	1.38		77	0.069	0.0001	0.828	0.552	0.007	55.8		0.05	0.0001	0.6	0.4	0.005
Gasoline	41.38		2839	1.275	0.035	15.79	310.8	49.43	68.6						
Passenger	27.24		1869	0.855	0.025	10.62	199.7	31.05	68.6		0.0314	0.0009	0.39	7.33	1.14
Light-duty	7.33		503	0.197	0.007	3.005	50.50	9.676	68.6		0.0269	0.0009	0.41	6.89	1.32
Heavy-duty	6.03		414	0.121	0.003	2.111	53.43	6.754	68.6		0.02	0.0005	0.35	8.86	1.12
Motorcycles	0.78		54	0.101	0.001	0.055	7.176	1.950	68.6		0.13	0.0009	0.07	9.2	2.5
Diesel oil	37.17	5.13	2726	0.212	0.073	50.04	18.30	4.765	73.3						
Light-duty	5.33	0.74	391	0.005	0.010	0.906	1.013	0.533	73.3	0.138	0.001	0.0019	0.17	0.19	0.10
Heavy-duty	7.06	0.97	518	0.071	0.013	7.131	3.601	1.271	73.3	0.138	0.01	0.0019	1.01	0.51	0.18
Railways	11.76	1.62	862	0.071	0.024	21.17	7.174	1.529	73.3	0.138	0.006	0.002	1.8	0.61	0.13
Boats	13.02	1.80	955	0.065	0.026	20.83	6.510	1.432	73.3	0.138	0.005	0.002	1.6	0.5	0.11
1.A.4a Commercial/Services and other institutions	38.7	25.5	3041	0.094	0.033	2.75	1.05	0.135							
Diesel oil	0.46		34	0.001	0.000	0.023	0.007	0.001	73.3		2.9	0.6	51	15	2.9
RFO	1.26	1.32	97	0.004	0.001	0.064	0.019	0.004	76.6	1.045	2.9	0.6	51	15	2.9
LPG	0.71		44	0.002	0.000	0.036	0.011	0.002	62.4		2.9	0.6	51	15	2.9
Other liquid	23.08	5.31	1676	0.067	0.014	1.177	0.346	0.067	72.6	0.23	2.9	0.6	51	15	2.9
Coal	12.27	18.9	1138	0.018	0.017	1.387	0.650	0.059	92.7	1.54	1.5	1.4	113	53	4.8
Natural gas	0.96		54	0.001	0.000	0.064	0.016	0.002	55.8		1.4	0.1	67	17	1.9
1.A.4b Residential	22.9	8.87	1714	0.091	0.019	2.18	6.00	0.150							
Diesel oil	3.06		224	0.009	0.002	0.156	0.046	0.009	73.3		2.9	0.6	51	15	2.9
LPG	2.85		178	0.008	0.002	0.145	0.043	0.008	62.4		2.9	0.6	51	15	2.9
Coal	5.49	8.45	509	0.008	0.008	0.620	0.291	0.026	92.7	1.54	1.5	1.4	113	53	4.8
Peat	2.32	0.41	241	0.035	0.005	0.464	3.480	0.058	103.9	0.178	15	2	200	1500	25
Wood	1.34		124	0.020	0.003	0.268	2.010	0.034	92.7		15	2	200	1500	25
Natural gas	7.83		437	0.011	0.001	0.525	0.133	0.015	55.8		1.4	0.1	67	17	1.9
1.A.4c Agriculture/Forestry	18.4	3.80	1387	0.067	0.014	1.40	3.03	0.094							
Diesel oil	11.05		810	0.032	0.007	0.564	0.166	0.032	73.3		2.9	0.6	51	15	2.9
LPG	0.21		13	0.001	0.000	0.011	0.003	0.001	62.4		2.9	0.6	51	15	2.9

Conclusion of Table A5-1A

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Coal	2.34	3.60	217	0.004	0.003	0.264	0.124	0.011	92.7	1.54	1.5	1.4	113	53	4.8
Peat	1.13	0.20	117	0.017	0.002	0.226	1.695	0.028	103.9	0.178	15	2	200	1500	25
Wood	0.66		61	0.010	0.001	0.132	0.990	0.017	92.7		15	2	200	1500	25
Natural gas	3.02		169	0.004	0.000	0.202	0.051	0.006	55.8		1.4	0.1	67	17	1.9

Table A5-1b. **Sectoral report for Energy. Fuel combustion activities in 1994**

GHG source and sink categories	Activity	Emission (Gg)							Emission factors						
									CO_2	SO_2	CH_4	N_2O	NO_X	CO	NMVOC
	PJ	SO_2	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	Gg/PJ	Gg/PJ	Mg/PJ	Mg/PJ	Mg/PJ	Mg/PJ	Mg/PJ
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.A Fuel combustion activities	186	86.4	11757	8.775	0.296	47.87	306.5	48.52							
1.A.1 Energy industries	71	48.1	4726	0.404	0.066	12.84	9.69	0.746							
Diesel oil	0.36		26	0.001	0.000	0.072	0.005	0.002	73.3		3	0.6	200	15	5
RFO	40.69	42.5	3116	0.122	0.024	8.138	0.610	0.203	76.6	1.045	3	0.6	200	15	5
LPG	0.01		1	0.000	0.000	0.002	0.000	0.000	62.4		3	0.6	200	15	5
Coal	3.37	5.19	312	0.003	0.005	1.011	0.067	0.017	92.7	1.54	1	1.4	300	20	5
Peat	2.37	0.42	246	0.071	0.009	0.237	2.370	0.119	103.9	0.178	30	4	100	1000	50
Wood	6.27		581	0.188	0.025	0.627	6.270	0.314	92.7		30	4	100	1000	50
Natural gas	18.35		1024	0.018	0.002	2.753	0.367	0.092	55.8		1	0.1	150	20	5
1.A.1a Losses															
1.A.2 Manufacturing industry and construction	27.4	15.0	1772	0.148	0.019	4.87	4.56	0.242							
Diesel oil	1.60		117	0.003	0.001	0.320	0.016	0.008	73.3		2	0.6	200	10	5
RFO	12.72	13.3	974	0.025	0.008	2.543	0.127	0.064	76.6	1.045	2	0.6	200	10	5
LPG	0.05		3	0.000	0.000	0.010	0.001	0.000	62.4		2	0.6	200	10	5
Coal	1.11	1.71	103	0.011	0.002	0.333	0.167	0.022	92.7	1.54	10	1.4	300	150	20
Coke	0.23		24						106.0						
Peat	0.05	0.01	5	0.002	0.000	0.005	0.100	0.003	103.9	0.178	30	4	100	2000	50
Wood	1.93		179	0.058	0.008	0.193	3.860	0.097	92.7		30	4	100	2000	50
Natural gas	9.76		545	0.049	0.001	1.464	0.293	0.049	55.8		5	0.1	150	30	5
1.A.3 Transport	30.4	2.83	2229	0.583	0.118	24.81	183.8	30.87			Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ
Jet fuel	0.67		47	0.0003	0.001	0.20	0.067	0.034	70.8		0.0005	0.002	0.3	0.1	0.05
LPG	0.05		3.25	0.001		0.05	0.13	0.03	65.0		0.02		0.9	2.6	0.6
RFO	1.64	1.71	125.6	0.01	0.001	2.46	1.64	0.33	76.6	1.045	0.005	0.0006	1.5	1	0.2

Conclusion of Table A5-1b

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Natural gas	0.05		2.81	0.003	0.00001	0.030	0.020	0.0003	56.1		0.05	0.0001	0.6	0.4	0.005
Gasoline	19.88		1451	0.532	0.033	14.81	176.6	29.17	73.0						
Passenger	13.44		981	0.403	0.027	9.41	125.0	22.85	73.0		0.030	0.002	0.70	9.30	1.70
Light-duty	1.95		142	0.039	0.002	1.365	16.19	2.730	73.0		0.020	0.001	0.70	8.30	1.40
Heavy-duty	4.49		328	0.090	0.004	4.041	35.47	3.592	73.0		0.020	0.001	0.90	7.90	0.80
Diesel oil	8.12	1.12	599	0.039	0.082	7.26	5.33	1.309	74.0						
Light-duty	0.73	0.10	54	0.001	0.003	0.292	0.292	0.073	74.0	0.138	0.001	0.004	0.40	0.40	0.10
Heavy-duty	4.88	0.67	361	0.029	0.015	4.880	4.392	0.976	74.0	0.138	0.006	0.003	1.00	0.90	0.20
Passenger	0.40	0.06	30	0.001	0.002	0.120	0.120	0.028	74.0	0.138	0.002	0.004	0.30	0.30	0.07
Railways	1.46	0.20	107	0.006	0.044	1.31	0.365	0.161	73.0	0.138	0.004	0.030	0.9	0.25	0.11
Boats	0.65	0.09	47	0.003	0.020	0.65	0.163	0.072	73.0	0.138	0.004	0.030	1.0	0.3	0.11
1.A.4a Commercial/Services	22.7	10.49	1435	2.154	0.028	2.20	25.40	2.974							
Diesel oil	8.67		636	0.087	0.005	0.867	0.173	0.043	73.3		10	0.6	100	20	5
RFO	5.94	6.21	455	0.059	0.004	0.594	0.119	0.030	76.6	1.045	10	0.6	100	20	5
Coal	2.77	4.27	257	0.831	0.004	0.277	5.540	0.554	92.7	1.54	300	1.4	100	2000	200
Peat	0.11	0.02	11	0.033	0.000	0.011	0.550	0.066	103.9	0.178	300	4	100	5000	600
Wood	3.79		351	1.137	0.015	0.379	18.950	2.274	92.7		300	4	100	5000	600
Natural gas	1.37		76	0.007	0.000	0.069	0.069	0.007	55.8		5	0.1	50	50	5
1.A.4b Residential	24.4	7.65	983	4.839	0.054	2.23	65.44	7.667							
Diesel oil	1.81		133	0.018	0.001	0.181	0.036	0.009	73.3		10	0.6	100	20	5
RFO	0.20	0.21	15	0.002	0.000	0.020	0.004	0.001	76.6	1.045	10	0.6	100	20	5
LPG	2.14		134	0.021	0.001	0.214	0.043	0.011	62.4		10	0.6	100	20	5
Coal	4.82	7.42	447	1.446	0.007	0.482	9.640	0.964	92.7	1.54	300	1.4	100	2000	200
Peat	0.10	0.02	10	0.030	0.000	0.010	0.500	0.060	103.9	0.178	300	4	100	5000	600
Wood	11.0		1020	3.300	0.044	1.100	55.000	6.600	92.7		300	4	100	5000	600
Natural gas	4.36		243	0.022	0.000	0.218	0.218	0.022	55.8		5	0.1	50	50	5
1.A.4c Agriculture/Forestry	9.5	2.26	612	0.646	0.011	0.94	17.59	6.017							
Gasoline	0.30		21	0.024	0.001	0.051	9.900	5.100	71		80	2	170	33000	17000
Diesel oil	5.33		391	0.053	0.003	0.533	0.107	0.027	73.3		10	0.6	100	20	5
RFO	1.33	1.39	102	0.013	0.001	0.133	0.027	0.007	76.6	1.045	10	0.6	100	20	5
LPG	0.01		1	0.000	0.000	0.001	0.000	0.000	62.4		10	0.6	100	20	5
Coal	0.56	0.86	52	0.168	0.001	0.056	1.120	0.112	92.7	1.54	300	1.4	100	2000	200
Peat	0.05	0.01	5	0.015	0.000	0.005	0.250	0.030	103.9	0.178	300	4	100	5000	600
Wood	1.23		114	0.369	0.005	0.123	6.150	0.738	92.7		300	4	100	5000	600
Natural gas	0.73		41	0.004	0.000	0.037	0.037	0.004	55.8		5	0.1	50	50	5

Table A5-1c. **Sectoral report for Energy. Fuel combustion activities in 1995**

GHG source and sink categories	Activity	Emission (Gg)							Emission factors						
									CO_2	SO_2	CH_4	N_2O	NO_X	CO	NMVOC
	PJ	SO_2	CO_2	CH_4	N_2O	NO_X	CO	NMVOC	Gg/PJ	Gg/PJ	Mg/PJ	Mg/PJ	Mg/PJ	Mg/PJ	Mg/PJ
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.A Fuel combustion activities	161	59.1	11900	7.499	0.262	41.80	436.2	46.56							
1.A.1 Energy industries	67	40.2	4923	0.355	0.058	12.01	8.52	0.675							
Diesel oil	1.80		132	0.005	0.001	0.360	0.027	0.009	73.3		3	0.6	200	15	5
RFO	32.60	34.1	2497	0.098	0.020	6.520	0.489	0.163	76.6	1.045	3	0.6	200	15	5
Other liquid	0.50	0.12	36	0.002	0.000	0.100	0.008	0.003	72.6	0.23	3	0.6	200	15	5
Coal	3.50	5.39	324	0.004	0.005	1.050	0.070	0.018	92.7	1.54	1	1.4	300	20	5
Peat	3.40	0.61	353	0.102	0.014	0.340	3.400	0.170	103.9	0.178	30	4	100	1000	50
Wood	4.10		380	0.123	0.016	0.410	4.100	0.205	92.7		30	4	100	1000	50
Natural gas	21.50		1200	0.022	0.002	3.225	0.430	0.108	55.8		1	0.1	150	20	5
1.A.2 Losses	2.20		129.5												
Gasoline	0.10		6.9						68.6						
Diesel oil	0.10		7.3						73.3						
Coal	0.10		9.3						92.7						
Natural gas	1.90		106.1						55.8						
1.A.2 Manufacturing industry and construction	18.2	3.11	1205	0.166	0.014	3.01	25.88	0.985							
Gasoline	0.80		57	0.040	0.002	0.168	21.600	0.800	71		50	2	210	27000	1000
Diesel oil	1.70		125	0.003	0.001	0.340	0.017	0.009	73.3		2	0.6	200	10	5
RFO	1.60	1.67	123	0.003	0.001	0.320	0.016	0.008	76.6	1.045	2	0.6	200	10	5
Other liquid	0.80	0.18	58	0.002	0.000	0.160	0.008	0.004	72.6	0.23	2	0.6	200	10	5
Coal	0.80	1.23	74	0.008	0.001	0.240	0.120	0.016	92.7	1.54	10	1.4	300	150	20
Peat	0.10	0	10	0.003	0.000	0.010	0.200	0.005	103.9	0.178	30	4	100	2000	50
Wood	1.80		167	0.054	0.007	0.180	3.600	0.090	92.7		30	4	100	2000	50
Natural gas	10.60		592	0.053	0.001	1.590	0.318	0.053	55.8		5	0.1	150	30	5
1.A.3 Transport	23.7	4.78	1749	0.375	0.107	22.36	113.1	18.66			Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ	Gg/PJ
Jet fuel	0.20		14	0.000	0.000	0.060	0.020	0.010	70.8		0.0005	0.002	0.3	0.1	0.05
RFO	3.50	3.66	268	0.02	0.002	5.25	3.50	0.70	76.6	1.045	0.005	0.0006	1.5	1	0.2
Gasoline	11.90		869	0.314	0.018	9.21	103.9	16.55	73.0						
Passenger	6.43		469	0.193	0.013	4.50	59.8	10.92	73.0		0.030	0.002	0.70	9.30	1.70
Light-duty	0.60		43	0.012	0.001	0.417	4.94	0.833	73.0		0.020	0.001	0.70	8.30	1.40

Conclusion of Table A5-1c

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Heavy-duty	4.76		347	0.095	0.005	4.284	37.60	3.808	73.0		0.020	0.001	0.90	7.90	0.80
Motorcycles	0.12		9	0.014	0.000	0.007	1.547	0.988	73.0		0.12	0.001	0.06	13.0	8.3
Diesel oil	8.11	1.12	598	0.043	0.086	7.84	5.73	1.399	74.0						
Light-duty	0.08	0.01	6	0.000	0.000	0.032	0.032	0.008	74.0	0.138	0.001	0.0040	0.40	0.40	0.10
Heavy-duty	5.68	0.78	420	0.034	0.017	5.677	5.109	1.135	74.0	0.138	0.01	0.0030	1.00	0.90	0.20
Passenger	0.08	0.01	6	0.000	0.000	0.024	0.024	0.006	74.0	0.138	0.002	0.0040	0.30	0.30	0.07
Railways	1.62	0.22	118	0.006	0.049	1.46	0.406	0.178	73.0	0.138	0.004	0.030	0.9	0.25	0.11
Boats	0.65	0.09	47	0.003	0.019	0.65	0.162	0.071	73.0	0.138	0.004	0.030	1.0	0.3	0.11
1.A.4a Commercial/Services	18.3	4.67	1388	1.352	0.018	1.34	17.06	2.011							
Gasoline	3.90		277						71						
Diesel oil	5.20		381	0.052	0.003	0.520	0.104	0.026	73.3		10	0.6	100	20	5
RFO	2.20	2.30	168	0.022	0.001	0.220	0.044	0.011	76.6	1.045	10	0.6	100	20	5
Other liquid	0.80	0.18	58	0.008	0.000	0.080	0.016	0.004	72.6	0.23	10	0.6	100	20	5
Coal	1.40	2.16	130	0.420	0.002	0.140	2.800	0.280	92.7	1.54	300	1.4	100	2000	200
Peat	0.20	0	21	0.060	0.001	0.020	1.000	0.120	103.9	0.178	300	4	100	5000	600
Wood	2.60		241	0.780	0.010	0.260	13.000	1.560	92.7		300	4	100	5000	600
Natural gas	2.00		112	0.010	0.000	0.100	0.100	0.010	55.8		5	0.1	50	50	5
1.A.4b Residential	24.9	6.12	1980	4.189	0.050	2.42	235.55	12.079							
Gasoline	2.30		163	0.276	0.005	0.414	181.7	5.750	71		120	2	180	79000	2500
Diesel oil	2.20		161	0.022	0.001	0.220	0.044	0.011	73.3		10	0.6	100	20	5
RFO	0.20	0.21	15	0.002	0.000	0.020	0.004	0.001	76.6	1.045	10	0.6	100	20	5
LPG	0.50		31	0.005	0.000	0.050	0.010	0.003	62.4		10	0.6	100	20	5
Other liquid	1.80	0.41	131	0.018	0.001	0.180	0.036	0.009	72.6	0.23	10	0.6	100	20	5
Coal	3.50	5.39	324	1.050	0.005	0.350	7.000	0.700	92.7	1.54	300	1.4	100	2000	200
Peat	0.60	0.11	62	0.180	0.002	0.060	3.000	0.360	103.9	0.178	300	4	100	5000	600
Wood	8.70		807	2.610	0.035	0.870	43.500	5.220	92.7		300	4	100	5000	600
Natural gas	5.10		285	0.026	0.001	0.255	0.255	0.026	55.8		5	0.1	50	50	5
1.A.4c Agriculture/Forestry	6.3	0.22	526	1.062	0.016	0.67	36.05	12.152							
Gasoline	0.60		43	0.048	0.001	0.102	19.800	10.200	71		80	2	170	33000	17000
Diesel oil	2.20		161	0.022	0.001	0.220	0.044	0.011	73.3		10	0.6	100	20	5
Other liquid	0.20	0.05	15	0.002	0.000	0.020	0.004	0.001	72.6	0.23	10	0.6	100	20	5
Coal	0.10	0.15	9	0.030	0.000	0.010	0.200	0.020	92.7	1.54	300	1.4	100	2000	200
Peat	0.10	0	10	0.030	0.000	0.010	0.500	0.060	103.9	0.178	300	4	100	5000	600
Wood	3.10		287	0.930	0.012	0.310	15.500	1.860	92.7		300	4	100	5000	600

Table A5-1d. **Sectoral report for Energy. Fugitive emissions from fuels in 1990, 1994, 1995**

Year 1990

GHG source and sink categories	Activity	Inčukalns*)	Emissions (Gg)		Emission factors (Gg/PJ)	
	PJ	CH_4 (Gg)	CH_4	NMVOC	CH_4	NMVOC
1.B. Fugitive emissions from fuels			53.24	4.62		
1B2b. Natural gas	102.88	1.80	53.24		0.50	
1B2a. Oil products (gasoline only)	42.30			4.62		0.11

Year 1994

GHG source and sink categories	Activity	Inčukalns*)	Emissions (Gg)		Emission factors (Gg/PJ)	
	PJ	CH_4 (Gg)	CH_4	NMVOC	CH_4	NMVOC
1.B Fugitive emissions from fuels			18.27	2.20		
1B2b. Natural gas	34.62	0.96	18.27		0.50	
1B2a. Oil products (gasoline only)	20.18			2.20		0.11

Year 1995

GHG source and sink categories	Activity	Inčukalns*)	Emissions (Gg)		Emission factors (Gg/PJ)	
	PJ	CH_4 (Gg)	CH_4	NMVOC	CH_4	NMVOC
1.B Fugitive emissions from fuels			21.60	2.14		
1B2b. Natural gas	41.1	1.05	21.60		0.50	
1B2a. Oil products (gasoline only)	19.60			2.14		0.11

*) Data from Inčukalns underground gas storage facility

Table A5-2. **Industrial processes in 1990, 1994, 1995**

Year: 1990

GHG source and sink categories	Activity data (kiloton)	Emission (Gg)			Emission factors (t/t;* kg/hl; ** kg/t)		
		CO_2	SO_2	NMVOC	CO_2	SO_2	NMVOC
2 Industrial processes		562.54	1.32	60.56			
2.A Mineral products		562.54	0.22				
2.A.1 Cement	744.3	370.66	0.22		0.498	0.0003	
2.A.2a. Lime (prod.)	156	123.24			0.79		
2.A.2b. Lime (use)	156	68.64			0.44		
2.A.6 Asphalt	174.96			55.99			0.32
2.D. Other production							
2.D.1 Pulp	36.589		1.10			30**	
2.D.2 Food & Beverage				4.56			
Wine (hl)	6.3			0.00			0.08*
Beer (hl)	873.8			0.03			0.035*
Spirits (hl)	85.7			1.29			15*
Meat. fish & poultry	569.3			0.17			0.3**
Sugar	31			0.31			10**
Cakes. biscuits &breakfast cereals	54.8			0.05			1**
Bread	314			2.51			8**
Animal feed	200			0.20			1**

Year: 1994

GHG source and sink categories	Activity data (kiloton)	Emission (Gg)			Emission factors (t/t;* kg/hl; ** kg/t)		
		CO_2	SO_2	NMVOC	CO_2	SO_2	NMVOC
2. Industrial processes		153.69	0.08	42.77			
2.A Mineral products		153.69	0.07				
2.A.1 Cement	244.4	121.71	0.07		0.498	0.0003	
2.A.2a Lime (prod.)	26	20.54			0.79		
2.A.2b Lime (use)	26	11.44			0.44		
2.A.6 Asphalt	125.60			40.19			0.32
2.D. Other production							
2.D.1. Pulp	0.173		0.01			30**	
2.D.2. Food & Beverage				2.58			
Wine (hl)	25.5			0.00			0.08*
Beer (hl)	637.9			0.02			0.035*
Spirits (hl)	58.8744			0.88			15*
Meat. fish & poultry	94.3			0.03			0.3**
Sugar	15.8			0.16			10**
Cakes. biscuits & breakfast cereals	22.7			0.02			1**
Bread	161.5			1.29			8**
Animal feed	174			0.17			1**

Year: 1995

GHG source and sink categories	Activity data (kiloton)	Emission (Gg)			Emission factors (t/t;* kg/hl; ** kg/t)		
		CO_2	SO_2	NMVOC	CO_2	SO_2	NMVOC
2. Industrial processes		127.42	0.11	8.37			
2.A Mineral products		127.42	0.06				
2.A.1. Cement	204	101.59	0.06		0.498	0.0003	
2.A.2a Lime (prod.)	21	16.59			0.79		
2.A.2b Lime (use)	21	9.24			0.44		
2.A.6 Asphalt				6.47			0.32
2.A.6a Road paving	20.16			6.4512			0.32
2.A.6b Asphalt (prod.)	117			0.01872			0.00016
2.D. Other production							
2.D.1 Pulp	1.539		0.05			30**	
2.D.2 Food & Beverage				1.90			
Wine (hl)	47			0.00			0.08*
Beer (hl)	652.8			0.02			0.035*
Spirits (hl)	9.5			0.14			15*
Meat. fish & poultry	82.8			0.02			0.3**
Sugar	30.5			0.31			10**
Cakes. biscuits &breakfast cereals	24.2			0.02			1**
Bread	145.4			1.16			8**
Animal feed	214.4			0.21			1**

T a b l e A 5 - 3 . Solvent and other product use in 1990, 1994, 1995

Year: 1990

GHG source and sink categories	Activity data (t.t)	From stationary sources (t.t)	Emission (Gg)	Em.fact. (t.t./t.t.) *)
			NMVOC	NMVOC
3. Solvent and other product use	47.0	7.40	30.90	0.50

Year: 1994

GHG source and sink categories	Activity data (t.t)	From stationary sources (t.t)	Emission (Gg)	Em.fact. (t.t./t.t.) *)
			NMVOC	NMVOC
3. Solvent and other product use	11.5	1.77	7.52	0.50

Year: 1995

GHG source and sink categories	Activity data (t.t)	From stationary sources (t.t)	Emission (Gg)	Em.fact. (t.t./t.t.) *)
			NMVOC	NMVOC
3. Solvent and other product use	21.7	1.69	12.54	0.50

*) Data from FEWE. Poland

T a b l e A 5 - 4 . **Agriculture. Enteric fermentation and manure management in 1990, 1994, 1995**

Year: 1990

GHG source and sink categories	Activity data (1000 heads)	Emission (Gg)		Emission factor (kg/head/year)	
		4B. CH_4 from manure management	4A. CH_4 from enteric fermentation	4A. CH_4 from enteric fermentation	4B. CH_4 factor from manure management
4. Agriculture					
4A. and 4B. Enteric fermentation and manure management		13.31	97.96		
Dairy cattle	535	3.21	43.34	81	6
Other cattle	904	3.62	50.62	56	4
Sheep	165	0.03	1.32	8	0.19
Goats	5	0.00	0.03	5	0.12
Horses	31	0.04	0.56	18	1.4
Swine	1401	5.60	2.10	1.5	4
Poultry	10321	0.81			0.078

Year: 1994

GHG source and sink categories	Activity data (1000 heads)	Emission (Gg)		Emission factor (kg/head/year)	
		4B. CH_4 from manure management	4A. CH_4 from enteric fermentation	4A. CH_4 from enteric fermentation	4B. CH_4 factor from manure management
4. Agriculture					
4A. and 4B. Enteric fermentation and manure management		5.17	40.60		
Dairy cattle	311.9	1.87	25.26	81	6
Other cattle	238.9	0.96	13.38	56	4
Sheep	86.3	0.02	0.69	8	0.19
Goats	7.4	0.00	0.04	5	0.12
Horses	26.8	0.04	0.48	18	1.4
Swine	500.7	2.00	0.75	1.5	4
Poultry	3700	0.29			0.078

Conclusion of Table A5-4

Year: 1995

GHG source and sink categories	Activity data (1000 heads)	Emission (Gg)		Emission factor (kg/head/year)	
		4B. CH_4 from manure management	4A. CH_4 from enteric fermentation	4A. CH_4 from enteric fermentation	4B. CH_4 factor from manure management
4. Agriculture					
4A. and 4B. Enteric fermentation and manure management		5.324	39.315		
Dairy cattle	291.9	1.7514	23.6439	81	6
Other cattle	245.2	0.9808	13.7312	56	4
Sheep	72.1	0.013699	0.5768	8	0.19
Goats	8.9	0.001068	0.0445	5	0.12
Horses	27.2	0.03808	0.4896	18	1.4
Swine	552.8	2.2112	0.8292	1.5	4
Poultry	4198	0.327444			0.078

Table A5-6a. **Waste. Solid waste disposal on land in 1990, 1994, 1995**

Year: 1994

GHG source and sink categories	Popululation of 1000 persons	Waste generation rate (kg/cap/day)	Waste generation rate (Gg/1000 pers./year)	Waste generated (Gg)	Fraction landfilled	Annual MSW landfilled (Gg)	CH_4 corr.	Fraction DOC (DOC/MSW)	Annual DOC landfilled (Gg)	Fraction which actually degrades	Annual carbon released as biogas (Gg)	Fraction CH_4	CH_4-C emissions (Gg)	Conv. factor	CH_4 emissions (Gg)
6. Waste															
6A. Solid waste disposal on land															19.39
6.A.1 Managed Waste Disposal Sites	2671	0.60	0.219	584.8	0.5	292.4	0.60	0.17	29.8	0.77	22.97	0.5	11.48	16/12	15.31
6.A.2 Unmanaged Waste Disposal Sites	2671	0.60	0.219	584.8	0.5	292.4	0.16	0.17	8.0	0.77	6.12	0.5	3.06	16/12	4.08

Year: 1994

GHG source and sink categories	Popululation of 1000 persons	Waste generation rate (kg/cap/day)	Waste generation rate (Gg/1000 pers./year)	Waste generated (Gg)	Fraction landfilled	Annual MSW landfilled (Gg)	CH_4 corr.	Fraction DOC (DOC/MSW)	Annual DOC landfilled (Gg)	Fraction which actually degrades	Annual carbon released as biogas (Gg)	Fraction CH_4	CH_4-C emissions (Gg)	Conv. factor	CH_4 emissions (Gg)
6. Waste															
6A. Solid waste disposal on land															24.93
6.A.1 Managed Waste Disposal Sites	2548	0.74	0.270	688.0	0.58	399.0	0.60	0.17	40.7	0.77	31.34	0.5	15.67	16/12	20.89
6.A.2. Unmanaged Waste Disposal Sites	2548	0.74	0.270	688.0	0.42	288.9	0.16	0.17	7.9	0.77	6.05	0.5	3.03	16/12	4.03

Year: 1995

GHG source and sink categories	Popululation of 1000 persons	Waste generation rate (kg/cap/day)	Waste generation rate (Gg/1000 pers./year)	Waste generated (Gg)	Fraction landfilled	Annual MSW landfilled (Gg)	CH_4 corr.	Fraction DOC (DOC/MSW)	Annual DOC landfilled (Gg)	Fraction which actually degrades	Annual carbon released as biogas (Gg)	Fraction CH_4	CH_4-C emissions (Gg)	Conv. factor	CH_4 emissions (Gg)
6. Waste															
6A. Solid waste disposal on land															25.60
6.A.1 Managed Waste Disposal Sites	2516	0.75	0.275	691.9	0.6	415.1	0.60	0.17	42.3	0.77	32.61	0.5	16.30	16/12	21.74
6.A.2 Unmanaged Waste Disposal Sites	2516	0.75	0.275	691.9	0.4	276.8	0.16	0.17	7.5	0.77	5.80	0.5	2.90	16/12	3.86

Table A5-6b. **Waste. Wastewater handling in 1990, 1994, 1995**

Year: 1990

GHG source and sink categories	Population of 1000 persons	Protein generation rate (kg/ cap/day)	Protein (Gg/ year)	Emission factor (kg N_2O-N/kg sewage-N produced)	Fraction of nitrogen in protein (N/kg prot.)	Fraction N_2O	N_2O emissions (Gg)
6. Waste							
6B Wastewater handling							0.27
6B2. Domestic and commercial wastewater	2671	0.11	40.150	0.01	0.16	44/28	0.27

Year: 1994

GHG source and sink categories	Population of 1000 persons	Protein generation rate (kg/ cap/day)	Protein (Gg/ year)	Emission factor (kg N_20-N/kg sewage-N produced)	Fraction of nitrogen in protein (N/kg prot.)	Fraction N_2O	N_2O emissions (Gg)
6. Waste							
6B. Wastewater handling							0.26
6B2 Domestic and commercial wastewater	2548	0.11	40.150	0.01	0.16	44/28	0.26

Year: 1995

GHG source and sink categories	Population of 1000 persons	Protein generation rate (kg/ cap/day)	Protein (Gg/ year)	Emission factor (kg N_2O-N/kg sewage-N produced)	Fraction of nitrogen in protein (N/kg prot.)	Fraction N_2O	N_2O emissions (Gg)
6. Waste							
6B. Wastewater handling							0.25
6B2. Domestic and commercial wastewater	2516	0.11	40.150	0.01	0.16	44/28	0.25

SECOND NATIONAL COMMUNICATION OF THE REPUBLIC OF LATVIA UNDER UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE

Redaktore V. Stabulniece
Mākslinieciskais redaktors G. Krutojs
Tehniskā redaktore G. Sļepkova

Formāts 60x84/8. Izdevniecība "Zinātne", Akadēmijas laukums 1, Rīga, LV-1050. Reģistrācijas apliecība Nr. 2-0250. Iespiesta tipogrāfijā "Svētdienas Rīts", Aizkraukles iela 21, Rīga, LV-1006.