Table 4.5.1. Excise tax on fuels (as on 1 May 2005)

Fuel	Unit	EUR/unit
Unleaded petrol	**1000 l**	**288**
Leaded petrol	**1000 l**	**422**
Kerosene	**1000 l**	**302**
Aviation spirit	**1000 l**	**72**
Gas oil (diesel fuel)	**1000 l**	**245**
Gas oil fuel for specific purposes	**1000 l**	**44**
LPG as motor fuel	**t**	**100**
Gas oil (light fuel oil)	**1000 l**	**44**
Heavy fuel oil	**t**	**15**
Shale oil	**t**	**15**
Coal, coke	**GJ**	**0.3**

It is planned to increase the rate of excise duty on gas oil used as a fuel (LFO) – to 61 EUR/1000 l since 01.01.2006.

As a Member State, Estonia has to meet the EU requirements (Directive 2003/96/EC) for taxation of fuels and energy. Nevertheless, Estonia was granted some transitional periods for introduction of taxation. Regarding the major source of the CO_2 in Estonia – the oil shale, the Directive 2004/74/EC stipulates that Estonia may apply a total exemption from taxation of oil shale until 1 January 2009. Until 1 January 2013, it may furthermore apply a reduced rate in the level of taxation of oil shale, provided that it does not result in taxation at below 50% of the relevant Community minimum rate as from 1 January 2011. Regarding to shale oil, Estonia is eligible to apply a transitional period until 1 January 2010 to adjust its national level of taxation on shale oil used for district heating purposes to the EU minimum level of taxation. The tax exemption for natural gas (methane) is permitted by the Directive 2003/96/EC, which allows an exemption on natural gas in those Member States in which the share of natural gas in final energy consumption was less than 15% in 2000. Exemption is for a maximum period of ten years after the entry into force of the Directive or until the national share of natural gas in final energy consumption reaches 25%, whichever will be reached sooner. There are no specific taxes imposed on electricity in Estonia. The Directive 2004/74/EC allows Estonia to apply a transitional period until 1 January 2010 to introduce the output taxation system on electricity.

The amendment (in force since 1 January 2005) to the Act stipulates that if biofuel has been added to motor fuel or heating fuel, the portion of biofuel contained in the motor fuel or heating fuel is exempted from excise duty. This provision needed approval from the European Commission (EC). In July 2005 the EC granted Estonia the relevant right: Estonia was authorised to exempt from excise duty non-synthetic biodiesel, vegetable oils made from biomass and bioethanol made of agriculture products or plant products.

Regarding the **pollution taxation**, in Estonia emission into air only from stationary pollution sources is taxed. *The Pollution Charge Act* (RT I 1999, 24, 361) provides the rates for the charge to be paid for release of pollutants or waste into the environment, as well as the procedure for calculation and payment of the charge. Up to the year 2005 (incl.) the rates of pollution charges are fixed in the Act. The charge rates for emission of major pollutants into ambient air are given in the Table 4.5.2. The pollution charge for release of carbon dioxide into ambient air was introduced on 1 January 2000. At present, the CO_2 charge has to be paid by all enterprises with total capacities of boilers over 50 MW, excluding the ones firing biomass, peat or waste. In addition to pollutants presented in Table 4.5.2 there are charges also for emitting mercaptans, heavy metals and compounds of heavy metals.

Table 4.5.2. Rates of pollution charge for release of pollutants into ambient air; EUR/t

Pollutant	2004	2005
Sulphur dioxide (SO_2)	7.29	8.76
Carbon monoxide (CO)	1.02	1.28
Nitrogen oxides (as NO_2)	16.74	20.13
Particulates	7.29	8.76
Volatile organic compounds	16.74	20.13
Carbon dioxide (CO_2) *	0.48	0.72

** - paid if the total rated thermal input of the combustion plants of a source of pollution of an energy undertaking is greater than 50 MW; not paid if these combustion plants utilise biomass, peat or waste.*

The Act provides higher rates (coefficients for fees: 1.2; 1.5; 2.0 and 2.5) for some areas in Estonia – densely populated, resort and recreation areas, and as well for areas with heavy industrial load. The Act also provides penalties for emissions without permits and emissions exceeding the volumes fixed in permits: the charges would be multiplied by 5.0 (in case of CO, solid particles), 10 (for SO_2, NO_x, VOC and mercaptans) or 100 (in case of heavy metals).

The MoE has proposed to continue the increase of charge rates with the average pace of at least 20% per year. According to the plans of the Ministry the *Pollution Charges Act* will be replaced with the *Environmental Charges Act*, which would incorporate all provisions related to charges and fees on utilization of natural resources, as well as charges on pollution. The draft of the new Act has not yet been delivered to the Parliament.

It is essential, that the income from environmental taxes (pollution charges) from the energy sector would be directed mainly back to the energy sector, for instance, as a support to special-purposed environmental investments. In June 1999 *the Act on the Use of Proceeds from the Exploitation of Environment* (RT I 1999, 54, 583) was amended by Parliament. It enabled the state, in accordance with the laws, to establish a foundation for organizing the use of proceeds from the exploitation of the environment. In November 2000 the Minister of Finance signed a regulation establishing the Centre of Environmental Investments, which started as the legal successor of the Estonian Environmental Fund to support environmental investments.

All fuels and energy types in Estonia, as a rule, are subject to taxation with the **value added tax** (VAT). According to the *Value Added Tax Act* (RT I 2001, 64, 368) in Estonia the standard VAT rate is 18% of the pre-tax value (i.e. 15.3 % of end-user price). The VAT is recoverable for most of enterprises. Regarding fuels, the only exception has been made for peat, peat briquettes, coal and fuel wood, sold to households, housing associations and churches, also to enterprises financed from state or municipal budgets. For these fuels the exemption provides a reduced VAT rate of 5% up to the 30 June 2007. The same provision is applied also to the district heat sold to these institutions. This tax allowance can be considered as distorting the market and slowing down investments into energy conservation measures. Since 1 July 2007 the standard VAT rate (18%) will be applied.

Since January 1997 the use of renewable resources in electricity production had been given preferential treatment by Value Added Tax Act: electricity generated by wind, and hydro-electricity was subject to the value added tax rate of 0% until Estonia’s accession to the EU. Thereafter, i.e. since 1 May 2004, the regular 18% rate is applied.

4.6. Environmental monitoring and supervision

The Environmental Supervision Act defines the features of environmental supervision and establishes the rights and obligations of persons and agencies that exercise environmental supervision. The Environmental Inspectorate, Land Board, local government bodies and agencies carry out environmental supervision. By law, other government agencies may also be assigned environmental supervision functions.

The Environmental Inspectorate as an environmental supervision body operates in all areas of environmental protection. It has to implement measures provided by law for the prevention of illegal activities and implementation of mandatory environmental protection measures. It has to suspend unlawful activities damaging or dangerous to the environment. The Land Board implements measures provided by law for the inspection of the legality of land use, land readjustment and compliance with land recording requirements, and for the suspension or termination of illegal activities. Local governments or persons and bodies authorised by local government councils have to perform environmental supervision inspecting adherence to the decisions related to environmental protection and use of environment established by the local government councils. All environmental supervision agencies and government agencies performing environmental supervision functions are required to submit information concerning supervision activities to the Environmental Inspectorate by the term and according to the form established by the MoE.

The Energy Market Inspectorate exercises supervision over the energy market. Supervision over the liquid fuel market is exercised by the Tax and Customs Board. The Technical Inspectorate checks the technical condition of the energy equipment.

As provided in Environmental Monitoring Act, state environmental monitoring is organised by the MoE and carried out pursuant to a relevant programme. Data from state environmental monitoring are to be stored in a general national register established. If the results of environmental monitoring indicate that the situation at an environmental monitoring station or site is becoming environmentally hazardous, the institution responsible for the environmental monitoring sub-programme is required to notify the Environmental Inspectorate and local health protection office immediately. Requirements for monitoring emission limit values at large (with rated thermal input equal to or greater than 100 MW_{th}) combustion plants are directly stipulated in the Ambient Air Protection Act – the concentrations of sulphur dioxide, particulate matter and nitrogen oxides must be measured at a continuous basis.

The Environmental Register is a general national register with the function to retain and process data regarding natural resources, natural heritage, the state of the environment and environmental factors, and to provide information. The data from the Environmental Register are used for issuing environmental permits for the right to use natural resources, for waste management or for release of pollutants into the environment. The Register is also used for the preparation of development plans, for organisation of the international exchange of data, etc.

4.7. Overview by sector

4.7.1. Energy sector

Regarding pollution, the most important part of the energy sector is the combustion of oil shale, as approximately 70% of atmospheric pollution, 80% of effluents and 80% of solid waste are connected with the oil shale power industry. Introduction of new combustion technology allows reducing emissions from oil shale firing power plants. Heat supply, particularly district heating, is the next important sector where there is a large potential for increasing energy efficiency, which in turn results in lower emissions. Deployment of renewable energy sources, especially biomass and wind, will have an increasing role of mitigating impact of energy sector on environment in Estonia.

Renovation of oil shale power plants

The development of oil shale based power production using environmentally sound technologies is an issue of high priority in Estonia. For complying with the requirements of the Directive 2001/80/EC the owner of the largest power plants, Eesti Energia AS, has to reconstruct several units in the power plants of Narva Elektrijaamad AS (Narva Power Plants, including Eesti and Balti plants). Up to 2004, only the pulverized combustion technology of oil shale had been used in these power plants. The conventional pulverized combustion technique for burning oil shale is characterized by a low net average efficiency: 27 – 29%. This, together with the peculiarities of oil shale as a fuel, results in an extremely high specific emission of carbon dioxide per generated electricity: 1.3 – 1.4 t CO_2/MWh_e. The use of pulverized combustion method causes also high emission of SO_2 and solid particles. All these factors have made it not acceptable to continue using this technology in mid- and long-term future.
The options for more efficient combustion measures for firing oil shale in large power plants have been under investigation for tens of years. The fluidized bed combustion technology (FBC) has been the most attractive option, also in the environmental aspect. As a result of relevant research, it was decided to start the gradual replacing of oil shale boilers of pulverized combustion with the ones utilizing the circulating fluidized bed combustion (CFBC) method. The CFBC is a variant of atmospheric circulating fluidized bed combustion, which has been in use for particularly low-grade fuels. In CFBC boilers the sulphur dioxide is better bound with the ash and therefore the SO_2 emission can be reduced significantly. The higher combustion efficiency reduces fuel consumption up to 25%, which in turn means substantially lower CO_2 emission as well (to 1.05-1.10 CO_2/MWh_e).
The first two new blocks (both 215 MW), in Narva Elektrijaamad AS, one at the Eesti and the other at the Balti Plant, adopting new CFBC boilers, were commissioned in 2004. This is Estonia's largest environment-related investment (245 MEUR) in the protection of the atmosphere. The scope of further reconstruction of other blocks will be determined on the basis of the experience gained with the operation of the first two blocks.

Deployment of renewable energy sources

In Estonia, the orientation to market based development has been the leading principle of the energy policy. Therefore, there have been almost no direct promotion schemes devised or subsidies granted in the field of energy technologies. The only field, where some concrete support measures have been introduced, is the use of renewable energy sources for electricity generation. A direct scheme for supporting the use of renewable energy for electricity generation is stipulated in the *Electricity Market Act*. The scheme includes the purchase obligation for network operators and the relevant feed-in tariff.

In 2003 the total electricity production from hydro and wind energy comprised 18.9 GWh, which is approximately 0.3% of the gross electricity consumption in Estonia. By 2010 the share of renewable electricity is planned to reach the level of at least 5.1% of the gross consumption.

The potential of Estonian renewable energy is primarily in the wind power and combined heat and power production based on biofuel; at the same time also small-scale hydropower industry can be developed. The competitiveness and proportion of other renewables (e.g. biogas, thermal solar energy) may also increase to some extent.

Regarding the use of renewable energy sources, Estonia's national goal is to achieve the share of renewable electricity 5.1% of total inland consumption by 2010, which is also the indicative target recommended for Estonia by the EU (Directive 2001/77/EC). To reach this goal the use of wind and biomass are the main options for Estonia, the share of small-scale hydro plants will remain almost marginal.

Regarding **biomass**, a large amount of the primary energy arising from the fuel wood (logs, chips, pellets and wood-waste) is used in the energy conversion processes, primarily in heat production. Logging waste may deemed to be a considerable additional source. But the development is hindered by a large-scale export of biomass, due to which local energy producers do not have enough resources. The export causes the high prices of some biomass products, especially of the wood pellets. The deployment of smaller scale cogeneration of heat and electricity (CHP) as an element of decentralized energy production strategy would increase the energy supply security in Estonia. Therefore, the potential use of biomass in new CHP plants can be a development option. Small heat load and the fact that new equipment producing only heat has already been installed in many areas with a favourable heat load can be indicated as barriers to the development of combined heat and power production based on biomass. The other option for reducing CO_2 emission in energy production is using the biomass in district heating and other heat-only boiler (HOB) plants. In Estonia, the heat production in HOB plants is relatively environment benign already: share of wood is 26% and of natural gas 40%.

In the islands of West Estonia, at the coastal areas of North-West Estonia and in South-West Estonia, but also the coastal areas of North Estonia and Lake Peipus there are several perspective areas for application of **wind power**. The technical limit for the installation of wind generators in the Estonian power system is 400-500 MW. But this requires investments to power networks and power stations to ensure the transmission, regulation and the necessary electrical reserves for wind power. Taking into account the current situation of the power system, it is possible to install wind generators in Estonia to the extent of 90-100 MW, but this would bring about deterioration of the operations quality of the power system. According to some preliminary estimations, it would be possible to erect only 30-50 MW of wind genearators without any negative effect for the power system. In addition to the problems relating to power networks, the more widespread use of wind resources is restricted by great generation unit capacity and poor maneuvering ability of oil shale based power stations.

In 2001 Eesti Energia AS, the Estonian Fund for Nature and hundreds of supporters launched the Green Energy project for supporting and promoting the production of electricity from renewable sources. Buyers of Green Energy use electricity produced from renewable sources of energy (up to now wind and water only) and thereby support the deployment of renewable energy sources in

Estonia. Green Energy trademark may be used by the companies, government institutions and residential customers of Eesti Energia who have purchased a Green Energy Certificate.

Increasing energy efficiency, demand side measures

In Estonia the only legal act directly targeted to improvement of energy efficiency is the *Energy Efficiency of Equipment Act,* which establishes requirements for the consumption and labelling of household electrical appliances. The wider awareness about specific energy consumption of electrical appliances would promote the gradual replacing of old out-of-date equipment resulting in reduced energy consumption and emission.

In 2000, *Energy Efficiency Target Programme* was approved by the Government. *Implementation Plan for Energy Efficiency Target Programme* was adopted in March 2001. The current Energy Efficiency Target Programme aims for energy consumption growth to be no more than half GDP growth and CO_2 emissions to be reduced by 8% against 1990 levels, mainly through energy efficiency and fuel switching. Energy Department within the MoEAC is responsible for promotion of energy efficiency. It has to be noted that in the new *Long-term National Development Plan for the Fuel and Energy Sector until 2015* there is provided a goal to maintain the volume of primary energy consumption at the level of the year 2003 until 2010.

The heat supply in buildings in residential and public sectors can be a significant source of energy savings (Table 4.7.1). In the beginning of 1990ies the potential was estimated up to 30%. In 2002 the MoEAC carried out a study for determining the required energy conservation investments in buildings of 58 smaller local municipalities (with the number of residents under 5500). The results of the investigation indicate that the practical energy conservation potential in those buildings is about 15–20% as an average. Obtaining such reduction needs large investments and is therefore a long-term task. In all sectors, including the public one, similar measures are needed in almost all buildings built according to requirements of old Building Codes. Due to the low loan taking capability the needed investments can be made and relevant measures taken with the very low pace.

At present, the preparations for implementing the EU Directive on the Energy Performance of Buildings (2002/91/EC) are in progress. Introduction of regular energy auditing in buildings with the floor area larger than 1000 m^2, formulation of energy conservation plans together with several other measures prescribed in the Directive would certainly promote the efficient energy use in buildings, which in turn will result in reduction of emission.

At the same time, the introduction by the *District Heating Act* of the zoning principle in the heat supply supports the use of district heating (DH) in larger cities. The Act stipulates the introduction of district heating regions, which are defined as areas determined by a comprehensive plan of the local municipality within which consumer installations are supplied with heat by the way of DH, instead of local heating. The principle of zoning enables the local governments to select the most environment bening solutions for the heat supply in densely populated areas.

The energy planning is being more closely integrated in spatial local planning in Estonia. During the second half of 1990ies the first efforts were made on the basis of the EU PHARE Programme "Investment Preparation Facility, Regional Development and Energy Planning". In frames of this programme 37 different energy planning projects as pilot ones were carried out in Estonia. It was found that in Estonia there were many feasible renovation projects in the heat supply energy sector. Later various bilateral aid programmes with several countries were used for implementing local energy development programmes. For example, up to 2004, the bilateral aid from Denmark was used to carry out the assistance programme supporting small municipalities in Estonia through the project "From Energy Plan to Implementation". The main goal of the project was the increasing of energy production efficiency together with the promotion of biomass use in the energy sector.

Table 4.7.1. Policies and measures in the energy sector

Name of policy / measure	GHG affected	Type of instruments	Status	Implementing entity	Period of imple-mentation	Annual emission reduction 2003-12
						Gg (=10^3 t)
Renovation of Narva Power Plants (2 units)	CO_2	Regulatory	Implemented	Eesti Energia AS	2002-05	53.4
Renovation of large combustion plants (excl. Narva PP)	CO_2	Regulatory	Planned, on-going	Owners	2003-12	11.8
Introduction of cogeneration of heat and electricity	CO_2	Voluntary	Planned	Owners	2005-12	3.4
Renovation of DH boilers and boiler plants	CO_2	Voluntary	Planned, on-going	Owners	2003-12	10.0
Renovation of DH systems	CO_2	Voluntary	Planned, on-going	Owners	2003-12	5.3
Fuel switch	CO_2	Voluntary	Planned, on-going	Owners	2003-10	2.7
Enhancing of oil shale enrichment	CO_2	Voluntary	Planned, on-going	Eesti Põlevkivi AS	2006-12	10.3
New methods for landfilling of oil shale ash	CO_2	Regulatory	Planned	Owners	2003-12	15-30
Installation of new wind generators (up to 75 MW)	CO_2	Voluntary	Planned, on-going	Owners	2004-12	53.0
Renovation of residential buildings (total of 4 Mm^2)	CO_2	Voluntary	Planned, on-going	Owners	2003-12	10.3
Replacement of electrical appliances in households	CO_2	Voluntary	Planned, on-going	Owners	2003-12	n.a.

4.7.2. Transport

Regarding impact on environment, the *National Development Plan of the Transport Sector 1999-2006* (adopted by the Government in March 1999) has set the stabilization of absolute amounts of GHG emissions from transport by 2005 as a general environment related objective for the transport sector. The goal for next periods is to decrease the GHG emissions from transport. Increasing the share of public transport has been foreseen as a main measure for reaching these targets. Changes in car stock towards new and more environment benign cars and trucks will also give positive impact on emission reduction. The new *Development Plan for Public Transport 2006-2013* is in the preparation phase since 2003.

In May 2005 the Minister of Environment established new requirements on environment related properties of liquid fuels (RT L 2005, 57, 803). The regulation foresees the gradual harmonisation of these requirements with the ones provided in EU directives. The regulation also established requirements on biofuels.

Regarding the use of biofuels in transport, quite ambitious targets have been set in the new draft *Environment Strategy* (as of 17 May 2004). The draft strategy foresees the introduction of biofuels to replace increasing amounts of fossil motor fuels. At present, no pure or blended biofuel has been sold or consumed for transport purposes in Estonia. The target share has been set at 2% by 2005 and at 5.75% by 2010.

As to road transport, already in 1996 stricter requirements were set on imported vehicles, but still the major problem is the age of the vehicle stock: approximately 80% of cars and trucks are older than 12 years. The average age of buses is over 16 years, while 23% of bus stock is older than 21 years. According to the Motor Vehicle Registration Centre approximately 70% of bus stock does not comply with the Euro-0 requirements. Nevertheless, exhaust gas norms have been harmonised with those of EU, and the technical inspection system of vehicles have been improved.

At the same time, the reduction of the share of public transport has been the non-established policy for the road and rail transport for several years. The major share of investments has been made in roads and parking places not as much in development of public transport. In the new draft of the *Public Transport Development Programme* (as of 8 April 2005), it is planned to stop this tendency and to increase the number of passengers by 12% by the year 2010 if compared to 2002. For raising the competitiveness of public transport and increasing its share the financial support of central government and local self-governments to public transport has to be increased. For example, in June 2002 the project *The strategy and investments programme of Tallinn public transport for the years 2002–2010*, initiated by the Department of Sustainable Development and Planning of Tallinn City, was completed. The objective of the project was to develop a strategy for accessible, environmentally friendly and energy efficient public transport and to draw up a necessary investments programme and relevant implementation schedule. The strategy includes concrete measures for raising the attractiveness of public transport and for keeping private cars away from the city centre.

At present, the drafting of the new development plan for the transport sector 2006-2013 is in progress. Also, according to the *Public Transport Act* (RT I 2000, 10, 58) the MoEAC has to elaborate and implement a long-term national public transport development plan.

According to the *Roads Act* (RT I 1999, 26, 377) the Government has to approve the road management plan, which is the financing basis for the annual road management. The current *Road Management Plan for 2004-2006* was adopted by the Government in February 2004 (RT L 2004, 24, 369). During last years, the financing of road management has been increased gradually – improving the quality of roads contributes to more environment benign operation of road transport as well.

As to air transport, the *Aviation Act* (RT I 1999, 26, 376) provides also items for the environmental eligibility of aircrafts. In the Act it is stipulated that the Government has to establish the environmental eligibility requirements for powered aircraft. The environmental eligibility of a powered aircraft has to be proven by a certificate, which contains data concerning the aircraft, the standards that constitute the basis for certification and the numerical values indicating engine emissions of the aircraft. The certificates of environmental eligibility for powered aircrafts are issued by the Civil Aviation Administration.

The measures aimed at reducing CO_2 emissions from the transport sector, presented in Table 4.7.2, are advisory and are not fixed in any governmental document. Drawing up concrete activity plans requires additional financing and research activities. According to expert opinions for the period up to 2012 it would be possible to reduce CO_2 emissions from transport by about 115 thousand tonnes, which makes up 11% of the total CO_2 emissions of the transport sector in the year 2000.

Among the measures listed, the increasing the share of public transport is the most promising. This includes state subsidies to public transport, directing a large part of the transport of goods from roads to the railway, improving the state of roads, building two-level crossings, rearrangement of parking in towns, expansion of motor-vehicle free areas in town centres, etc. All this would help make traffic more fluent, increase the speed on highways, save fuel and, as a result, reduce emissions into the atmosphere.

It is planned to start **technical inspection of vehicles on roads**. The Estonian Motor Vehicle Registration Centre plans to start with it in 2007 (in accordance with the EU Directive 98/14/EC). Mobile measuring equipment allows checking motor vehicles right on the road to remove vehicles that are technically not in order and dangerous to the environment.

Increasing the percentage of new vehicles concerns primarily the private sector. Considering recent statistics on purchases of new cars and assuming that under the conditions of economic growth the proportion of new cars acquired will increase, it can be expected that by the year 2012 new cars (up to 8 years old) can make up 44% of the total number of cars.

Table 4.7.2. Policies and measures in the transport sector

Name of policy / measure	GHG affected	Type of instruments	Status	Implementing entity	Period of imple-mentation	Annual emission reduction 2003-12
						Gg (=10^3 t)
Subsidies for public transport	CO_2, N_2O	Regulatory	Planned	Government, MoEAC	2002-12	32.0
Promotion of railway transport	CO_2, N_2O	Regulatory	Planned	Government, MoEAC	2003-12	34.0
Improvement of road quality	CO_2, N_2O	Regulatory	Planned, on-going	Government, MoEAC	2007-12	21.0
Technical inspection of vehicles	CO_2, N_2O	Regulatory	Planned	MoEAC, Vehicle Registration Centre	2003-12	10.0
Increasing the share of new vehicles	CO_2, N_2O	Voluntary	Planned	Government, MoEAC, owners	2003-13	23.0

4.7.3. Industry

In Estonia, after regaining of independence, large changes took place in the national economy. The whole industry was restructured and at present there are very few energy intensive manufacturing branches in Estonia. On the basis of the *Energy Efficiency Target Programme* and *Implementation Plan for Energy Efficiency Target Programme* some measures in plants, which have larger impact on environment, could be identified. Measures in cement and lime production plants can be taken in account. The introduction of new technology increases energy efficiency and results in lower specific emissions as well. The calculations are based on opinions of relevant industry experts (Table 4.7.3).

In Estonia's industrial sector carbon dioxide is formed mainly in the course of cement and lime manufacturing. Limestone decomposes at heating and carbon dioxide is emitted. By today, both of these manufacturing branches have almost reached their maximum output levels and further growth of output is possible only in case of plant renovation. Some reduction of greenhouse gas emissions can be achieved only through introduction of more modern production technologies.

In addition to direct technological measures some horizontal actions can be identified as measures supporting reduction of the GHG emission.

Increasing number of enterprises in Estonia are implementing **environmental management systems** (EMS). EMS is a voluntary instrument for improving the overall management of the organisation with the aim to identify and manage the significant environmental aspects. The main drivers for implementing EMS are usually market reasons, but at the same time the enterprises improve their environmental performance by more efficient use of resources, minimization of waste and emissions to air and water. Estonian enterprises have a choice to choose between two environmental management systems: international standard ISO 14001 or European Management and Audit Scheme (EMAS).

The most common EMS implemented in Estonia is ISO 14001. There are more than hundred enterprises in Estonia, which have ISO 14001 certificate. As to EMAS, at present, there are no enterprises in Estonia certified to it. The preparations for introducing the EMAS have been made – the Estonian Accreditation Centre has been appointed as an Accreditation Body and the Estonian Environment Information Centre has been designated by the MoE as the competent body for implementing the EMAS regulation in Estonia. The competent body registers the participating companies and issues the registration numbers and the right to use the EMAS logos.

In 2003 the Estonian Association of Environmental Management has been established with 34 members. Organisations who participate are recognised as making strong commitments to the environment and to improving their economic competitiveness.

Regarding **eco-labelling**, there is no national eco-label scheme in Estonia. Several food products are labelled with Estonian Organic Farming Label; in service sector the Green Key is used, as well as Blue Flag for ports. Amongst the eco-labels there is a possibility to implement EU Eco-label. The European Eco-label is given to products and services with the aim to promote sustainable consumption and production. At present, the only company in Estonia having the EU Eco-lable is Kreenholmi Valduse AS (Kreenholm Holding Group), the largest in country textile manufacturer.

In 2003 Estonian Green Movement initiated a campaign "Environmental Friendly Product" in supermarkets to draw more attention to products, which are labelled with accepted national and/or international labels (e.g. Nordic Swan, Blue Angel, Estonian Organic Farming label, etc).

Voluntary agreements are voluntary or negotiated agreements between governments and enterprises, which can be defined as guidelines adopted or measures taken in the absence of mandatory regulation in order to improve environmental performance of the enterprise and to enhance corporate responsibility. No financial liability is involved. In Estonia seven enterprises have made a voluntary agreement with the MoE. The Ministry is obliged to inform enterprises on changes in legislation and involve them in amendment processes. To improve their environmental performance, enterprises are supposed to implement voluntary environment related measures, which introduce stronger than mandatory requirements.

Voluntary environmental reporting differs from mandatory reporting by its wide range of forms and content of the report. This may range from environmental brochures and policy statements to a periodic account given either separately in a specific environmental report or as a part of an annual financial report. Up to now, a separate annual environmental report has been published by few Estonian enterprises – e.g. by Eesti Energia AS, State Forest Management Centre, Kunda Nordic Cement.

It can be assumed that the introduction of the **EU emission trading scheme** creates incentives for involved seven energy intensive enterprises to seek the most efficient ways for reducing emissions.

Table 4.7.3. Policies and measures in the industry

Name of policy / measure	GHG affected	Type of instruments	Status	Implementing entity	Period of imple-mentation	Annual emission reduction 2003-12
						Gg (=10^3 t)
Efficiency improvements in cement production	CO_2	Voluntary	Planned	Owners	2003-10	12.9
Efficiency improvements in lime production	CO_2	Voluntary	Planned	Owners	2005-12	1.0

4.7.4. Agriculture

The emissions of greenhouse gases from agriculture make up about 6–7% of the aggregate emissions (as CO_2 equivalent) in Estonia. Although agriculture has traditionally been one of the most important sectors of economy in Estonia, its importance has been continuously decreasing after Estonia regained its independence. The emissions of CH_4 and N_2O from agriculture have fallen during the last ten years by about 60–70%.

For preparing the agricultural sectors and rural areas of candidate countries for accession to the European Union, the programme SAPARD was used. It was approved according to the *Rural Development Plan 2004-2006* drawn up under the EU Resolution 1268/1999/EC. This development plan is very important from the aspect of the abatement of greenhouse gas emissions because investments made in the framework of the SAPARD programme were envisaged basically for increasing production efficiency and solving problems of sustainable development in the agricultural sector.

In can be concluded that total emissions from the agricultural sector would not be decreasing in the medium to long-term perspective, as the development of Estonia's agriculture starts to be supported by various programmes and measures. Estonian agriculture is mainly following the EU Common Agricultural Policy (CAP). One of the goals of the Common Agricultural Policy is to increase the productivity of the agricultural sector. In the future the grant of direct payments should be dependent on the fulfilment of environmental, food safety and quality requirements, thus promoting high-quality and environmentally friendly production. The objective of all political and other measures is to raise the production efficiency by means of introducing new technologies. Investments into technologies and equipment will reduce emissions per output unit but not the total amount of emissions.

For estimating changes in greenhouse gas emission different scenarios were drawn up on the basis of long-term forecasts obtained from the MoA and MoE and according to the *National Programme of Greenhouse Gas Emission Reduction for 2003-2012* (RT L 2004, 59, 990), it can be assumed, that Estonian agriculture will reach the level of other EU member states with regard of all indicators. The aggregate greenhouse gas emissions from the agricultural sector would increase by the year 2020 to up to 60% of the 1990 level. More optimistic scenario assumes rising production efficiency as a result of increasing investments. In 2000 the average production of milk per cow was 4660 kg, but by 2020 the forecast is 7800 kg per cow. The total annual milk production cannot increase much because of the quotas allocated after accession to the EU, the same amount of milk will be obtained from a smaller number of cows as the production efficiency will rise. It is also necessary make investments to improve the state of cowsheds and manure pits, which will further reduce greenhouse gas emissions. According to expert estimates, the use of mineral fertilisers will not increase so much as allowed by agronomic optimum (110 kg N/ha, organic and mineral fertilisers combined); this is due to high prices of fertilisers and the direction towards organic agriculture. According those assumptions the greenhouse gas emissions should not increase more than to 45% of the 1990 level by 2020 (about 2400 Gg CO_2 equivalent in 1990).

4.7.5. Forestry

Approximately 47.3% of the Estonia's territory is covered with forest stands. The forestry, together with the land use, is the main greenhouse gas sink in Estonia. Nevertheless, the sector has several problems, especially with implementing the legislation and supervision. The reasons are manifold – the forestry policy in Estonia has undergone major changes in recent times. Until 1995 most of forestland belonged to the State. By the time the land reform is completed 40 – 50% of the forests ought to be in private hands. This has made forest cutting a very lucrative business in a situation where state control over cutting and reforestation has been insufficient. Unofficial forestry has been one of the problems in the sector as the state has been unable to put a stop to illegal cutting. As a result, the statistics about actual cutting volumes is of poor quality.

As regards to climate change, it is important to develop and implement a reconstruction programme for land under cultivation which is overgrown and is temporarily not used for agricultural purposes. In the *Development Plan of Estonian Forestry up to the Year 2010* (RT I 2002, 95, 552) afforestation of at least 300 thousand hectares of abandoned agricultural lands is foreseen (Table 4.7.4). It will help to bind additionally approximately 1290 Gg of carbon dioxide by the year 2020. Also natural forest growth on abandoned fields is possible. In that case the CO_2 emissions accompanying forest planting can be avoided.

Forest harvesting volumes have to be planned considering forest biomass increment. Based on the *Act on Sustainable Development* (RT I 1995, 31, 384) the Government has to set the limit to forest use so that natural balance and forest reproduction, following protective harvesting regimes and preservation of species and landscape diversity would be secured. To secure continuous carbon dioxide sink by forests, the annual harvesting volume should be at least 1–2 million cubic metres smaller than the current increment. In that case annual sink by forests would be approximately 2000 Gg CO_2. It is recommended that the intensity of logging should be reduced. The following measures are considered necessary for making a better use of forests:

- gaining control over forest harvesting and securing correct forestry statistics;

- intensification of forest renewal after harvesting;
- use of forest maintenance methods that increase CO_2 sink (e.g. selection of tree species suitable for the area, maintenance work favouring stock increment). This would enable to increase average forest biomass increment and thus net CO_2 sink;
- research on the role of forest soils in CO_2 balance. Soils may act both as emitters and sinks of CO_2. An inventory of Estonian greenhouse gases revealed that the methodology used does not adequately take into account the sink of carbon dioxide by soils. Research has to provide scientific explanation to considering the role of soils in CO_2 balance;
- allocation of additional funds to research aimed at finding solutions enabling to increase net CO_2 sink by forest (including cultivation of tree species with a short harvesting cycle or brushwood for energy).

Efficient implementation of these measures will ensure that Estonian forests will be continuously able to act as CO_2 sinks. Several of these measures are included also in the development plan of forestry, which is the basis for developing forestry policy and legal acts concerning forestry in Estonia.

Table 4.7.4. Policies and measures in the forestry sector

Name of policy / measure	GHG affected	Type of instruments	Status	Implementing entity	Period of imple-mentation	Annual emission reduction 2003-12
						Gg (=10^3 t)
Re-forestation of out-of-use agricultural lands (approx. 100 thousand ha)	CO_2	Regulatory /voluntary	Planned	MoE, MoE, owners	2003-10	330
Re-forestation of used mining areas	CO_2	Regulatory /voluntary	Planned	MoE, MoE	2005-13	20

4.7.6. Waste management

In waste management methane is produced in disposal sites from biologically degradable municipal and industrial waste and as well as in the treatment of municipal and industrial wastewaters. In Estonia, over the period 1997–2001 the emissions of methane from water management fell by about 52% (71.15 Gg in 1997 and 34.35 Gg in 2001).

Waste disposal sites have so far been the major source of methane emissions in the waste management sector in Estonia. To improve the situation, a number of significant measures have been and will be taken. A resolution of the Estonian Minister of the Environment from 26 June 2001 (RT L 2001, 87, 1219) was the first legal act introducing most of the EU requirements concerning waste disposal under Directive 1999/31/EC. After the new *Waste Act* (RT I 2004, 9, 52) came into force in May 2004, several new secondary level acts have been issued, e.g. the Regulation of the Minister of Environment *Requirements for the Construction, Use and Closure of Landfills* (RT L 2004, 56, 938). In connection with the new requirements for landfills the number of waste disposal sites was significantly reduced. The *National Waste Management Plan* (RT I 2002, 104, 609) envisages 8–9 regional waste disposal sites for municipal wastes. After some large waste disposal sites are shut down measures will be taken to further reduce methane emissions. According to the Waste Disposal Resolution, from 16 July 2009 wastes can be dumped only at sites meeting the relevant requirements.

To reduce the methane emissions from waste disposal sites it is necessary to decrease the proportion of biologically degradable wastes among municipal wastes. Waste disposal sites where biologically degradable wastes are dumped have to be equipped with gas trapping and collecting units. The operators of the landfills have to arrange recovery of methane. The methane collected can be used for heat production and/or power generation. The collected methane that cannot be used has to be burnt. Presently methane is recovered only at the Tallinn landfill in Pääsküla where it is used for combined generation of electricity and heat.

Considering that over the period 2003–2012 the volume of wastes dumped in Estonian landfills will decrease by at about 25% due to recycling part of the wastes and reduction of the proportion of biologically degradable wastes, it can be estimated that the amount of methane emissions from the waste management sector will decrease by about 7.5 Gg by 2012 (Table 4.7.5).

Table 4.7.5. Policies and measures in waste management

Name of policy / measure	GHG affected	Type of instruments	Status	Implementing entity	Period of imple-mentation	Annual emission reduction 2003-12
						Gg (=10^3 t)
New requirements for landfills	CH_4	Regulatory	Planned	MoE	2003-07	3.3
Reduction of landfilled waste by 25% (re-cycling, etc.)	CH_4	Regulatory, voluntary	Planned	MoE, households, local governments	2003-12	4.2

The Waste Management Plan is a dynamic strategic document, which is regularly revised, the activities undertaken are subjected to assessment, and new activities are added to take account of the changing trends and needs. An important external objective of the Waste Management Plan is approximation of the EU and Estonian waste management trends, transposition and implementation of the EU waste handling principles.

5. PROJECTIONS AND EFFECTS OF POLICIES AND MEASURES

5.1. Methodology

An effective assessment of energy-related policy instruments requires the use of models capable of simulating the technological change necessary to induce long-term, economical shifts towards a sustainable global energy system(s), while simultaneously representing in adequate detail key energy-economy-environment interactions.

The analysis has been carried out using the Estonian MARKAL model.

MARKAL is a dynamic linear programming “bottom-up” model, which finds the optimal development of the energy system in time under given technology characteristics and boundary conditions. Since its initial development in the late 1970s, the MARKAL model has become a widely applied tool for evaluating the impacts of policies imposed on the energy system. As for any other MARKAL (Market Allocation)-type modelling exercises, the analyses and results reported herein should also be considered prospective, with emphasis placed on the trends and insights resulting from driving forces determined by implementing the respective policy options.

5.1.1. MARKAL model features

MARKAL is an energy-system optimization model that represents current and potential future technology alternatives through the so-called Reference Energy System (RES). The MARKAL model is a generic technology-oriented model tailored by the input data to obtain the least-cost energy system configuration for a given time horizon under a set of assumptions about end-use demands, technologies and resource potentials. It represents the time evolution of a specific RES at the local, national, regional, or global level. The MARKAL models allow a wide flexibility in representation of energy supply and demand technologies and are typically used to examine the role of energy technologies under specific policy constraints, e.g. CO_2 mitigation, local air pollution reduction, etc.

5.2. Basic considerations

5.2.1. Forecast of main energy indicators

The development of the main energy indicators until 2010 as forecast in the Draft National Long-Term Development Plan for the Fuel and Energy Sector until 2015 (with a vision until 2030) can be found in the following table.

Table 5.2.1. Estonian main energy indicators until 2010

	2000	2010
Primary energy supply (PJ)	189	220–250
Consumption of oil shale (Mt)	13,2	11–13
Share of renewables in primary energy supply (%)	10,5	13–15
Share of renewables in electricity generation (%)	0,1	5,1
Final consumption of electricity (TWh)	5,4	6,5–8,0
Necessary net capacity of power plants (MW)	1980	2200–2500
Share of CHP in electricity generation (%)	12–14	15-20
Maximum net load of Estonian power system (MW)	1400	1600–1900
Openness of electricity market (%)	10	35–40
Heat consumption (TWh)	8,5	8–9
Share of CHP in heat production (%)	33	35–40
SO_2 emissions (% of limit in 2008)	181	90–100
CO_2 emissions (% of limit in 2008)	48	50–55

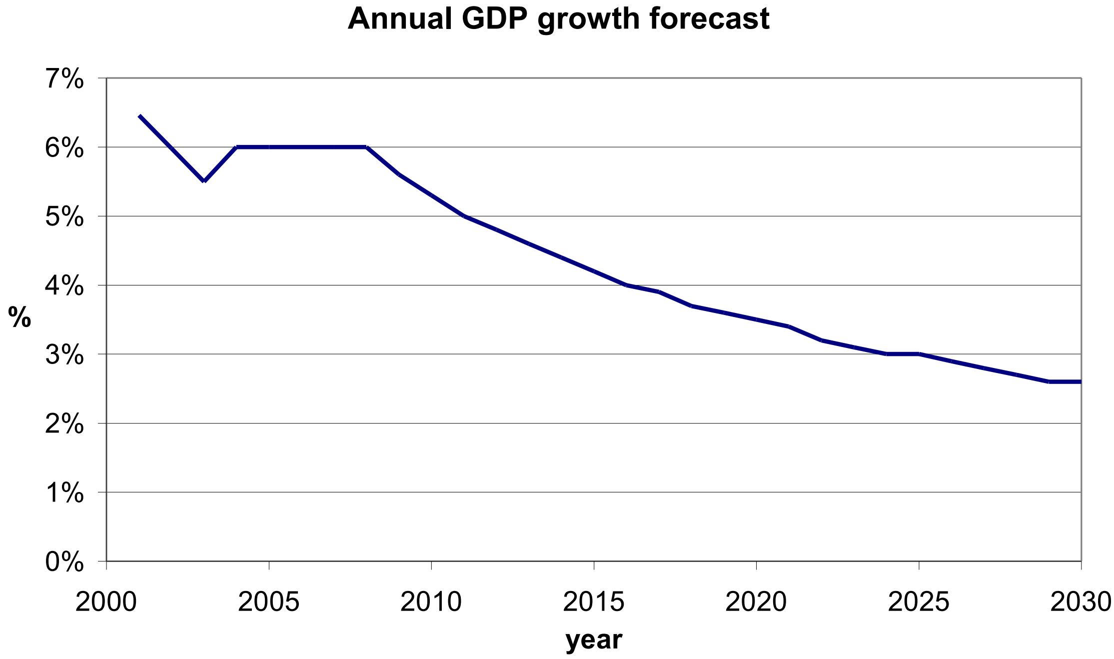
5.2.2. Basic modelling assumptions

The following basic assumptions were made in all scenarios:

8. Electricity and biomass imports and nuclear plants are restricted.
9. Electricity net export is allowed until 2015.
10. Price of natural gas will increase rapidly to the European level.
11. GDP forecast is based on the actual value of 2000 GDP at market prices, actual growth in 2001 and 2002, and the annual growth forecast from, that in turn bases on the forecast of the Ministry of Finance of Estonia until 2030. The base year GDP and energy data are taken from publications of the Statistical Office of Estonia.
12. All scenarios use low energy consumption forecast. Introduction of large-scale energy intensive industry is not envisaged. A possible future new pulp & paper plant is modelled as a separate unit and it can be closed and easily excluded from the results, if this investment is not actually made. It is assumed that high energy prices will stimulate the implementation of conservation measures in all sectors of economy. Heat consumption is assumed to be stable over the planning period, but electricity consumption is forecast to increase.
13. The planning period is 2000-2030 and the discount factor is 0.05.
14. The number of population remains stable around 1.4 million over the planning period. The number population is presently actually decreasing, but this decrease is assumed to be compensated for by immigration here.

The value of Estonian GDP was 5.584 billion EUR (4076 EUR per capita) in 2000. The annual growth forecast for the current project was taken from (average forecast) and it is depicted in Figure 5.2.1.

Figure 5.2.1. Estonia's annual GDP growth 2001-2030



The forecasts of population and GDP used in the modelling are presented in Table 5.2.2.

Table 5.2.2. Forecast of population and GDP

	Unit	2000	2005	2010	2015	2020	2025	2030
Population	million	1.37	1.35	1.35	1.4	1.4	1.4	1.4
GDP	billion EUR_{2000}	5.584	7.469	9.892	12.39	14.88	17.37	19.86
GDP/capita	EUR/cap	4076	5533	7327	8847	10630	12407	14188

The primary energy resources of Estonia are estimated as follows:

Oil shale – active resources of the deposit are ca 1.2 Gt and passive resources 4 Gt. Latest research results of the Mining Department of TUT estimate that the resources can last 60 years under current level of exploitation.

Peat – total deposits 775 Mt (annual limit for extraction is 2.78 Mt/a = 31 PJ/a, annual growth is 0.5 Mt/a = 5.6 PJ/a).

Biomass and waste – theoretical total annual resources are 102 PJ, economically feasible annual resources for CHPs are 21 PJ.

Hydro – potential is 30 MW (corresponds to the annual production of 0.5 PJ/a).

Wind – theoretically a very large resource, but its use is involves several restrictions. Considering the possibilities of the Estonian power system and its neighbours to integrate the windmills, the capacity limit is ca 400 MW, which corresponds to the annual production of 0.84 TWh/a = 3 PJ/a. Maximum long-term annual utilization of wind energy is estimated at 10 PJ/a (requires 1400 MW of installed capacity of windmills).

Solar – the estimates of annual utilization vary in a wide range: from 0.5 to 8 PJ/a.

Geothermal – in principle 0, only ground heat pumps can be used.

All other fuels have to be imported. The existing **natural gas** pipelines can supply up to 70 PJ/a.

Coal and oil products can be imported via rail and harbours.

Average consumer prices of fuels, electricity and heat in 2003 are presented in Table 5.2.3.

Table 5.2.3. Average fuel and energy prices for consumers in 2003

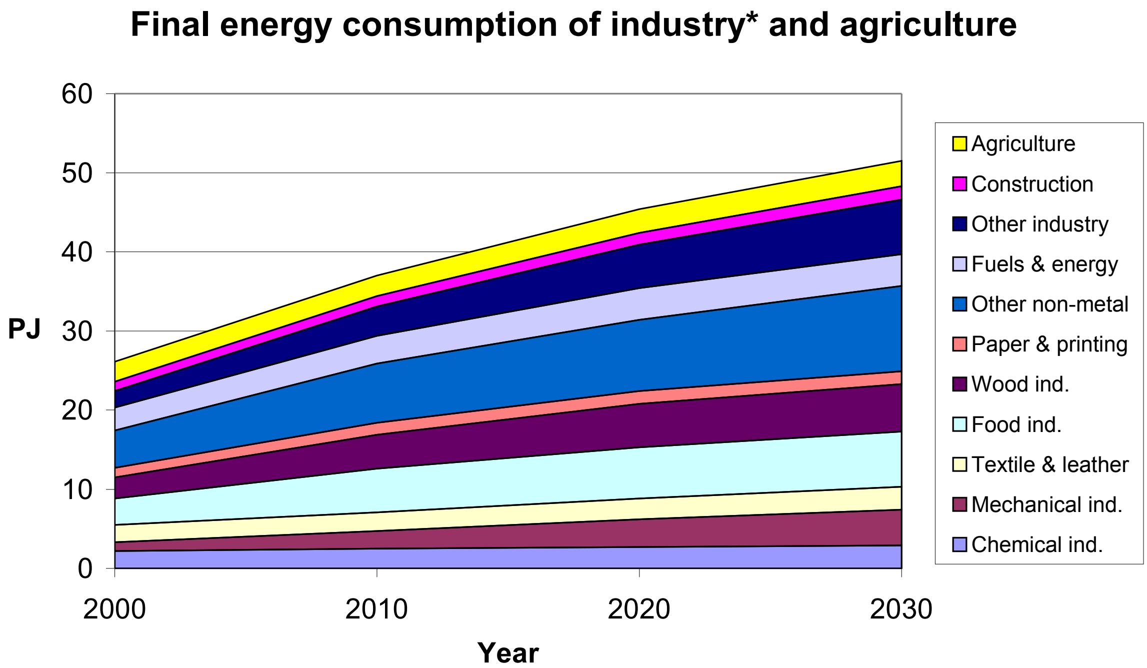
	Unit	Value	Value EUR/GJ
Coal	EEK/t	857	2.43
Oil shale	EEK/t	117	0.77
Sod peat	EEK/t	305	1.95
Peat briquette	EEK/t	865	3.35
Firewood	EEK/m^3 sol.vol.	167	1.42
Wood chips and waste	EEK/m^3 sol.vol.	124	1.22
Natural gas	EEK/1000 m^3	1375	2.62
Heavy fuel oil	EEK/t	2477	3.91
Shale oil	EEK/t	1898	3.22
Light fuel oil	EEK/t	4329	6.51
Diesel oil	EEK/t	6601	9.93
Gasoline	EEK/t	9663	14.20
Electricity	EEK/MWh	749	13.30
Heat	EEK/MWh	343	6.09

The forecasts of tax-free production and import prices (without inflation) of the main fuels for MARKAL modelling were the following:

- The oil shale price 14.2 EEK/GJ=0.91 EUR/GJ will remain constant until 2020 and then it will rise to the level of 18 EEK/GJ. This forecast is based on the information from the oil shale mining company "Eesti Põlevkivi".
- The import price of coal will be stable on the level of 25 EEK/GJ=1.6 EUR/GJ.
- It is assumed that stable prices of oil shale and coal will slow down the growth of the prices of wood and peat. The production price of peat is assumed to grow from 20 EEK/GJ to 30 EEK/GJ and the price of wood fuel from 13 EEK/GJ to 30 EEK/GJ during 2000-2030.
- It is assumed that Estonia's joining the EU brings rapidly about the same price levels and its growth predictions for natural gas and oil products. It means the growth of the heavy fuel oil price from 50 EEK/GJ=3.2 EUR/GJ in 2000 to 170 EEK/GJ = 10.9 EUR/GJ in 2030 and the growth of the natural gas price from 35 EEK/GJ = 2.24 EUR/GJ to 125 EEK/GJ = 8 EUR/GJ during the same period.

Forecasts of final energy consumption of industry* (without a new large pulp and paper factory) and agriculture are presented in Figure 5.2.2. As it was mentioned before, the possible new pulp & paper factory was modelled separately.

Figure 5.2.2. Final energy consumption forecasts of industry* (without a new pulp & paper factory) and agriculture



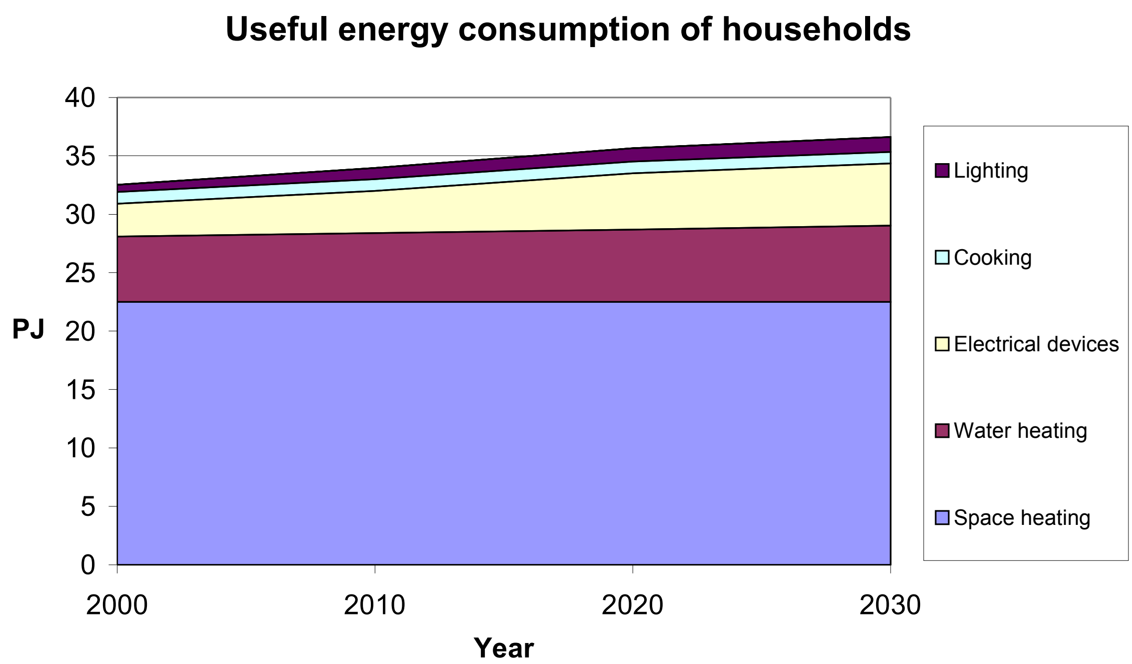
The transport sector of Estonia as a transit country between East and West is assumed to grow rather fast. The main growth will come from the road transport (trucks, buses, trams, trolleys and company cars) and private cars. The corresponding forecasts are presented in Table 5.2.4.

Table 5.2.4. Forecast of transport energy consumption, PJ/year

	2000	**2010**	**2020**	**2030**
Railways	2.0	2.5	2.8	2.9
Road transport	11.0	18.9	22.6	26.6
Private cars	10.0	15.0	20.0	24.0
Inland waterway	0.3	0.4	0.5	0.6
Air transport	1.0	1.8	2.6	3.9

The household sector was modelled as much as possible on the basis of useful energy consumption. The corresponding forecast is depicted in Figure 5.2.3. In addition to the specific electrical appliances, electricity is used also for lighting, cooking, space heating and water heating.

Figure 5.2.3. Useful energy consumption projections of households



The energy consumption of commercial and public services was modelled via final demand of electricity and heat. The corresponding forecast figures are presented in Table 5.2.5.

Table 5.2.5. Forecast of final energy consumption in the service sector, PJ/year

	2000	2010	2020	2030
Electricity consumption	4.9	7.0	9.7	12.4
Heat consumption	4.6	5.0	5.5	6.0

The reference level of 1990 total CO_2 emissions from fossil fuel combustion is 37.5 Mt. Considering the Kyoto obligation to reduce the emissions by 8% by the years 2008-2012, the limit of emissions of Estonia for the year 2010 can be set at 34.5 Mt. Estonia's net GHG emissions (including all gases, sources and sinks) in 1990 were 37.2 Mt.

The actual total CO_2 emissions were 16.43 Mt in the year 2000. It means 56% reduction compared with the reference year 1990.

5.3. Energy related CO_2 emission scenarios

5.3.1. With measures (WM) scenario

In this scenario approved or already decided policy measures are as described in "Policy and Measures). The following basic assumptions were considered in the scenario:

- Starting from 2008 our power plants have to comply with the EU directive on the limitation of emissions into the air from large combustion plants. During the accession negotiations with the EU Estonia got some transition periods but the existing oil shale pulverized combustion units cannot work after 2015. So Estonia will close these power plants before the end of 2015 in accordance with the schedule agreed with the EU. As a result, only 6% of the capacity of power plants that existed in the 1990s (over 3000 MW) can continue operating after 2015.

- Estonia will fulfil requirements on emission reductions and introduction of renewables. The national target for the introduction of RES in electricity production is 5.1% of the total domestic electricity consumption in 2010. Estonian Environmental Strategy and agreements with Finland state that sulphur dioxide (SO_2) emissions in 2005 should not exceed 20% of the 1990 level, emission of solid particles must be reduced by 25% as compared to 1995 and NO_X emissions should not exceed the 1987 level.
- Environmental taxes continue to increase 20% annually and they will reach the European forecast values at the end of the planning period.

According to the Estonian Pollution Charge Act the level of fees for emissions that do not exceed the volume limits were the following (1 EUR=15.64664 EEK):

Pollutant	SO_2	CO	CO_2	Nontoxic dust	Oil shale ash, fly ash	Soot and coal dust	NO_X
Charge EEK/t	55.2	7.9	5.0	39.6	55.2	79.2	126.4

There are different multiplication coefficients of fees (from 1.2 to 2.5) depending on the location of the pollution source. The fees will rise 5–100 times if the permitted volumes are exceeded.

- To fulfil the environmental requirements of the year 2005, reconstruction of two production units of the oil shale power plants with the total net capacity of 390 MW and renewal of ash filters of all units had to be completed in 2004. The new units use circulating fluidized bed combustion technology that raises conversion efficiency from 29% to 34% and minimizes sulphur emissions. Next steps in the new capacity building will be decided after gaining experience from the operation of the first units. Considerable options are also coal, peat and co-combustion of different fuels. It is important to continue research of pressurized fluidized bed combustion of oil shale. Only this technology could provide oil shale plants the necessary conversion efficiency (ca 44%) and emissions reduction in the longer perspective.
- Ash removal systems of oil shale power plants have to be renewed before July 2009.

WM scenario is conservative concerning technological development of oil shale combustion. It trusts only the circulating fluidized bed combustion (CFBC) technology and does not consider the more advanced and efficient but premature pressurized fluidized bed combustion (PFBC) option.

New power plant and electric grid investments of this scenario base mainly on. This plan envisages partial reconstruction of oil shale power plants on the basis of CFBC technology, but also investments into gas turbines, biomass CHP and wind turbines.

The investment plan states that the power production capacity of Eesti Energia Ltd will decrease from present 100% of peak load + reserve capacity down to 85% of peak load in 2010. As a result of this statement, new independent producers or imports (import is restricted under this modelling exercise) have to cover the rest of the necessary capacity.

There were no specific “forced solutions” in the heating sector.

Estonian CO_2 emissions will never climb up to the Kyoto limit under any scenario. Therefore the additional reduction targets were set in relation to the MARKAL model estimate for the year 2010 under WM scenario. This estimate was 16.52 Mt.

5.3.2. With additional measures (WAM) scenario

In this scenario approved or already decided policy measures are as described in “National Programme for the Reduction of GHG Emissions”. The following basic assumptions were made in scenario:

- The long-term objective of the National Programme is reduction of greenhouse gas emissions by 21% by 2010 as compared with the 1999 emission level. This includes reduction of carbon dioxide emissions by 20%, reduction of methane emissions by 28%, and increase of nitrogen dioxide emissions by 9%.

Development in accordance with the information given above yields an infeasible solution with assumptions described before.

Instead the following scenarios are used:

a. WAM-LEVEL1 – gradual reduction of CO_2 emissions by 1% during 2010-2030 compared to the 2010 level in WM scenario.

b. WAM-LEVEL2 – gradual reduction of CO_2 emissions by 15% during 2010-2030 compared to the 2010 level in WM scenario.

5.3.3. Without measures (WOM) scenario

All measures described in 5.3.1. With measures (WM) scenario were excluded.

5.3.4. Comments on results

<u>General remarks:</u>

Estonia has mainly two renewable energy sources – biomass and wind. Hydro potential is only ca 30 MW. Wind power is limited by the balancing capability of the existing power system. The model uses these resources up to their limits.

Future solutions in the Estonian energy system are very sensitive to the price of natural gas. The security of the Russian gas supply is an extremely important factor as well. Here the high gas price scenario was used. The share of natural gas determines largely the CO_2 reduction. If the gas price forecast was lower, condensing power plants and CHP plants mainly on natural gas would be built instead of using oil shale. Considering the carbon emission factors (tonnes of carbon per 1 TJ of fuel) of oil shale (29.1 tC/TJ for pulverized or CFB combustion under atmospheric conditions and 22 tC/TJ for PFBC) and natural gas (15.6 tC/TJ) and the efficiency coefficients of condensing oil shale power plants (29% for pulverized combustion, 34% for CFBC, 44% for PFBC) and combined cycle natural gas plants (56%) as well as the lower specific investments and O&M costs and other advantages of natural gas plants, the preference of natural gas is not surprising.

A nuclear plant was prohibited under the considered scenarios. The Baltic States are still discussing very seriously the construction of a new joint nuclear plant after Ignalina 3 GW plant is closed down. A nuclear plant appears in the optimal solution of energy modelling when it is allowed, emission taxes are high and CO_2 targets are strict. It appeared also in the scenario LEVEL1 in the model special test run. A nuclear plant changes the scenario results significantly.

Research on co-combustion of different fuels with oil shale in the fluidized bed boilers of large power plants is conducted in Estonia, but has not been not tested and implemented. The options are coal, peat and woodchips. It is evaluated that the co-combustion of wood in oil shale power plants would require wood import.

This study did not use the electricity and biomass import options as possible ways for reducing GHG emissions.

MARKAL model bases on the concept of Reference Energy System and therefore the representation of energy flows differs slightly from the official energy balance statistics.

Without measures scenario:

Power plants continue to use oil shale as the main fuel. The existing capacity of power plants will be utilized until the end of planned lifetime. During 2004–2010, 200 MW of new condensing and 190 MW of new CHP net capacity will be built using CFBC technology to replace the capacity of the old pulverized combustion plants. Coal will dominate after 2015.

With measures scenario:

Power plants continue to use oil shale as the main fuel. During 2004-2015, 1230 MW of new condensing and 190 MW of new CHP net capacity will be built using CFBC technology. The new capacity will replace less than half of the initial installed capacity of the old pulverized combustion plants. This will raise the average conversion efficiency from 28% to 34%, eliminate sulphur emissions and solve fly ash problems.

The more advanced pressurized fluidized bed combustion (PFBC) technology will not be used for oil shale power plants under WM scenario. This technology could give conversion efficiency of 44% and lower the specific CO_2 emissions, but its large-scale implementation is technically questionable today.

At the end of the planning period, a coal power plant will be built.

The total capacity of the CHP plants will increase quite rapidly providing the main future solution for heat production as well. This tendency is common in all scenarios. The CHP potential will be used fully at the end of the planning period in all scenarios, only market shares of different fuels differ by scenarios.

Renewables will be used extensively under this scenario. Wood fuels will reach their resource limit quite fast and the capacity of windmills will reach the limit at the end of the planning period. More extensive use of renewable energy would require import of cheap biomass (wood).

Condensing natural gas power plants will be built starting from 2010. Their capacity will be substantial, but their utilization factor will be very low. They will be used for covering sharp peak loads, balancing wind power and for reserve capacity. One reason for the low utilization factor is the limited possibility of MARKAL model to describe the load curve in detail.

The main driving factors for CO_2 reduction are the improvement of the conversion efficiency of fossil technologies, and increase in the share of CHP and renewables. In spite of decreasing specific emissions, the total CO_2 emissions will increase after 2005 due to growing energy consumption. The increase is not fast and the emissions will not reach 1995 level, not to speak about the 1990 level.

Scenarios with additional measures.

CO_2 emission limits will be met mainly by wider use of natural gas in high efficiency condensing power plants. Use of oil shale in electricity generation will decrease and PFBC technology will be a considerable option starting from 2015.

The higher the target for CO_2 reduction, the higher will be the share of imported energy carriers (mainly natural gas in addition to motor fuels, coal and fuel oils).

The main modelling results for all scenarios are presented in the following figures.

Figure 5.3.1. CO_2 emissions from the energy system.

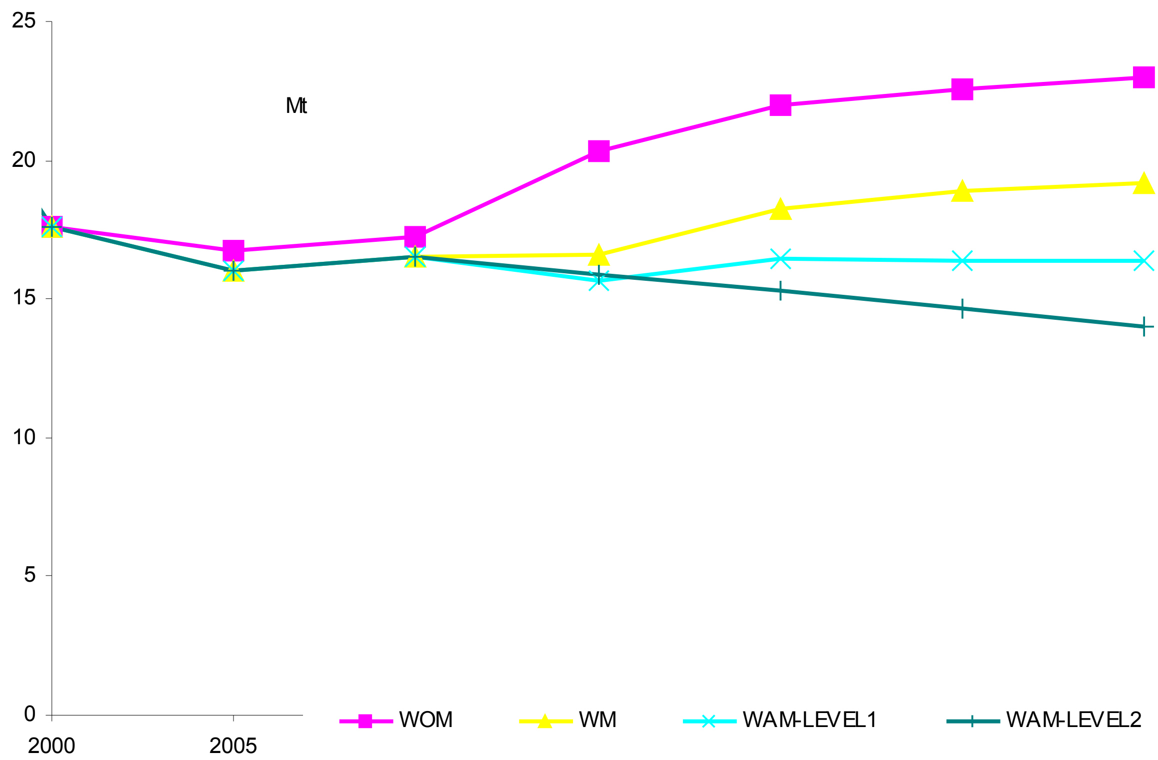


Figure 5.3.2. Primary fuel supply for the scenario without measures.

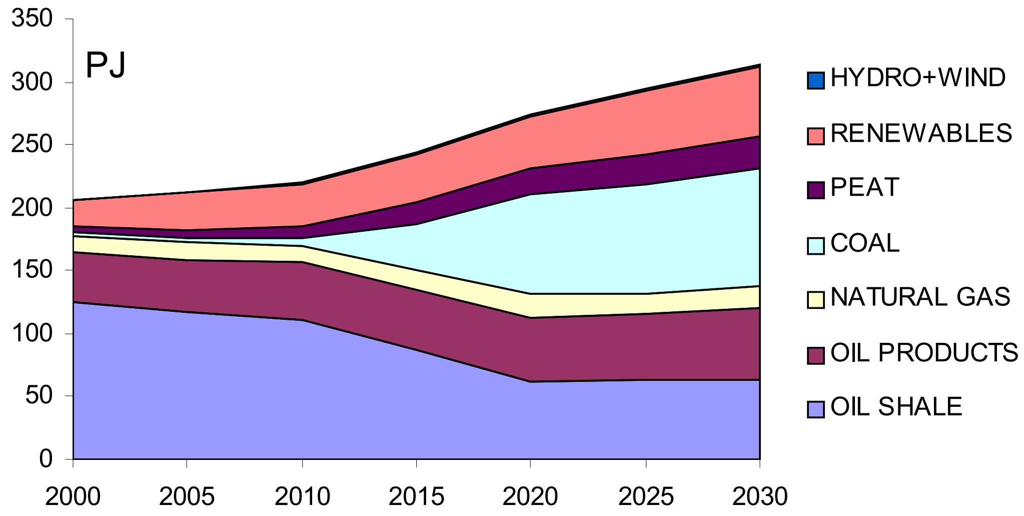


Figure 5.3.3. Primary fuel supply for the scenario with measures.

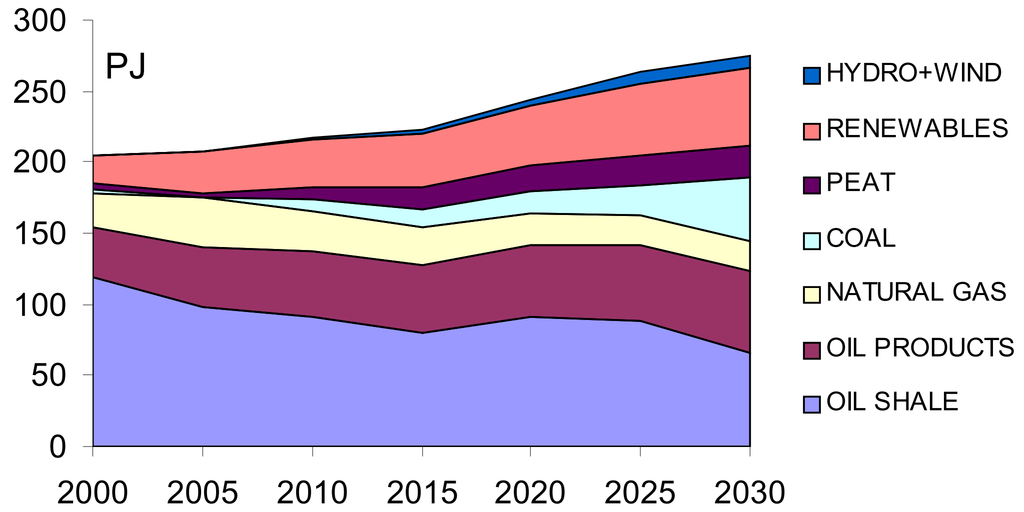


Figure 5.3.4. Primary fuel supply for the scenario with additional measures – LEVEL1.

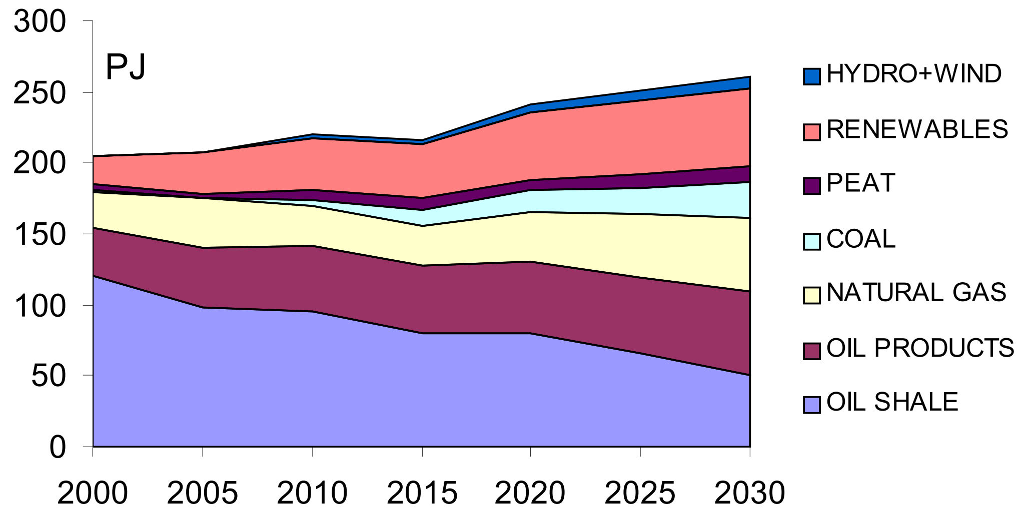
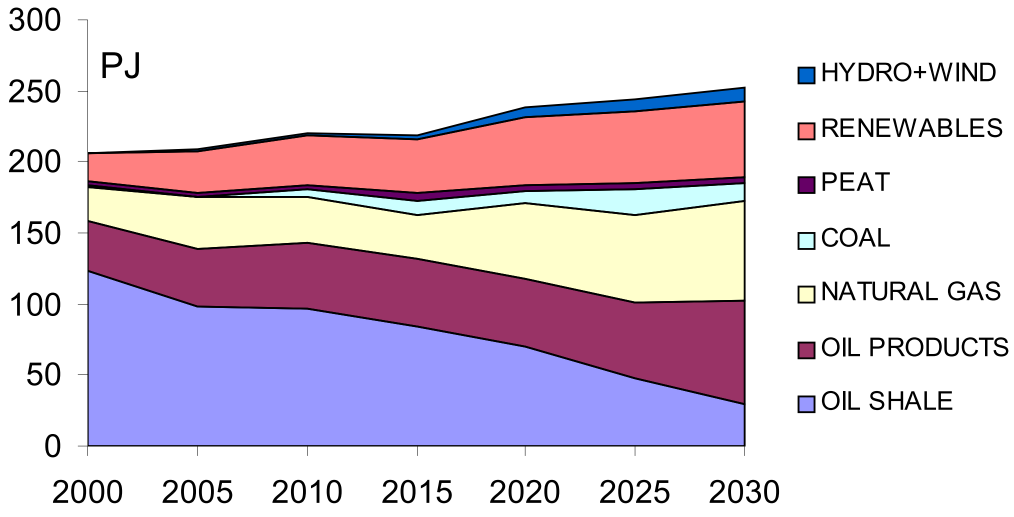


Figure 5.3.5. Primary fuel supply for the scenario with additional measures – LEVEL2.



5.3.5. Conclusions

During 1990–1993, the energy demand fell due to the economic decline and a sharp rise in the fuel and energy prices as well as a decrease in electricity exports, this resulted in ca 45% reduction of CO_2 emissions. The trend of CO_2 decrease continued until 2000 and now the emissions are stabilized on more than 50% lower level than in 1990. For the same reasons, Estonia has been able to meet the requirements set in the agreements on SO_2 and NO_X emissions. To meet the more rigid SO_2 restrictions and growing energy consumption in the future, Estonia must invest in abatement and in new clean and efficient oil-shale combustion technology. Along with the closing of the old oil-shale plants and growing electricity consumption, other fuels will be used. The increase in energy demand then should not be fast due to constantly rising prices and efficient energy use. Measures to reduce SO_2 and NO_X emissions will also reduce CO_2. In MARKAL runs the Kyoto Agreement level of CO_2 emissions will never be exceeded. Restricted availability of imported fuels, acceptability of nuclear power or enabling large-scale electricity import can change the results significantly. The results presented here can also change because the database is being improved.

Real actions will be also affected by their social costs and political considerations not taken into account in the modelling. Substitution of oil shale is not easy. It will bring about increasing imports. Being an indigenous fuel, oil shale creates a sophisticated complex of economic, political, national security, social and environmental problems.

The reference level of 1990 total CO_2 emissions from fossil fuel combustion is 37.5 Mt. Considering the Kyoto obligation to reduce the emissions by 8% by the years 2008–2012, the emissions limit of Estonia for the year 2010 can be set at 34.5 Mt. Estonia's net GHG emissions (including all gases, sources and sinks) in 1990 were 37.2 Mt. The actual total CO_2 emissions were 16.43 Mt in the year 2000. It means 56% reduction compared with the reference year 1990.

The main findings are as follows:

- Estonian CO_2 emissions will never climb up to the Kyoto limit under any scenario. There is no need to buy emission permits in the future.
- Main driving factors for CO_2 reduction are the improvement of conversion efficiency of fossil technologies, and increase in the share of CHP and renewables, but also the reduction of grid losses of heat and electricity and energy conservation and efficiency measures.
- This study did not use electricity and biomass import options as possible ways to reduce GHG emissions. Analysis of markets of neighbouring countries and the EU shows that the import possibilities of those commodities can be very limited after 2010.
- Total capacity of CHP plants will increase quite rapidly giving the main future solution for heat production as well. This tendency is common in all scenarios. The CHP potential will be used fully at the end of the planning period in all scenarios, only market shares of different fuels will differ by scenarios.
- Future solutions in the Estonian energy system are very sensitive to the price of natural gas. The security of Russian gas supply is an extremely important factor as well.
- In the scenarios With Additional Measures (WAM), the more rigid CO_2 emission limits compared with the With Measures (WM) scenario will be met to a great extent by larger use of natural gas in high efficiency condensing power plants. Use of oil shale in electricity generation will decrease, but the PFBC technology is a considerable option starting from 2015. This shows that it is important to continue the research of pressurized fluidized bed combustion of oil shale. Only this technology could provide oil shale plants with the necessary conversion efficiency and emissions reduction in the longer perspective.
- The higher the target for CO_2 reduction, the higher will be the share of imported energy carriers (mainly natural gas in addition to motor fuels, coal and fuel oils).

From the viewpoint of supply and also national security, high dependence of the power and heating sector on natural gas (economically optimal under strict environmental restrictions and taxes) is not desirable until Estonia has only one gas supplier – Russia. Increase of the share of imported energy carriers in the energy balance can probably be restricted by the national foreign trade balance.

GHG mitigation options for Estonia are:

Supply side:

- Change of fuels, especially reducing the share of oil shale in electricity production;
- New clean and efficient fossil conversion technologies;
- Wider use of CHP;
- Wider use of renewables (mainly wood and wind);
- Reduction of grid losses of heat and electricity;
- Possible introduction of nuclear power;
- Import of electricity.

Demand side:

- Energy conservation;
- Reduction of energy intensity of production.
- Change of transport policy towards public transport and railways.

5.4. Forestry

Estonian forestry policy is based on the Forest Act (RT I 1998, 113/114, 1872) and on the Development Plan of Estonian Forestry up to the Year 2010 (RT I 2002, 95, 552). These legal acts, however, do not acknowledge the role of forests as GHG sinks and do not provide direct measures to increase the removal of GHG by forests.

The development plan of forestry states three basic principles that may affect the emissions of GHG in the forestry sector:

Forest land area cannot decline below the current level (i.e., approximately 50% of Estonian terrestrial area);
The annual harvesting volume should not exceed the annual increment (it is suggested that optimal volume of annual harvesting should be 12.6 million m^3);
Afforestation of abandoned agricultural lands and mining areas.

WAM scenario grounds mainly on these principles and on the predictions of the Ministry of the Environment (Table 5.4.1).

Table 5.4.1. Forestry activities projected from current data by MoE according to the development plan of forestry

	2005	2010	2015	2020	2025
Forest land area, ha	2 287 500	2 325 000	2 362 500	2 400 000	2 437 500
Growing stock increment, m^3 ha^{-1}	5.80	5.76	5.74	5.72	5.70
Total harvest, m^3	7 640 000	7 630 000	7 620 000	7 610 000	7 600 000
Area of afforestation, ha	11 500	15 000	15 000	15 000	15 000

In the case of WM scenario, it is presumed that the annual harvest will continue to increase and this is the main reason for the decline in the removal of CO_2 by forests. The WM projections for 2010–2025 are made from the actual inventory data.

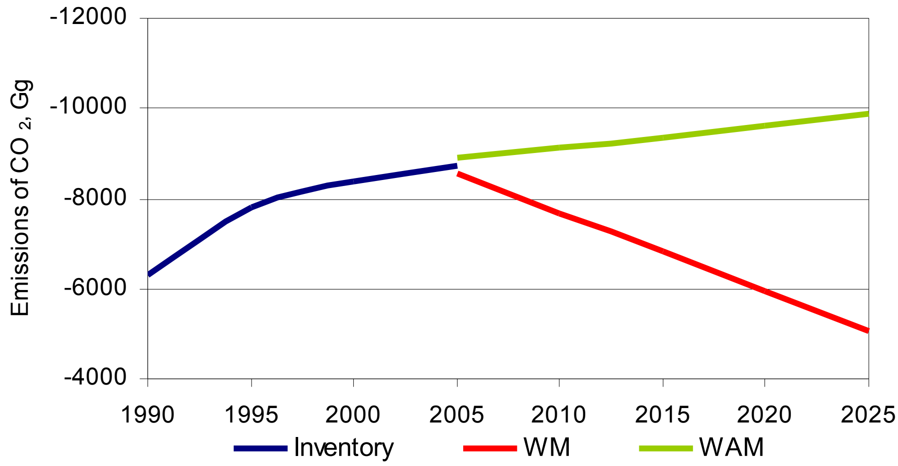
Table 5.4.2. CO_2 emission projections for the WM scenario (Gg)

	1990	1995	2000	2005	2010	2015	2020	2025
5 Land -use Change and Forestry	-6319	-7782	-8364	-8554	-7684	-6815	-5946	-5076

Table 5.4.3. CO_2 emissions projections for the WAM scenario (Gg)

	1990	1995	2000	2005	2010	2015	2020	2025
5 Land -use Change and Forestry	-6319	-7782	-8364	-8907	-9118	-9367	-9615	-9860

Figure 5.4.1. Projections of CO_2 emissions from the forestry sector.



5.5. Agriculture

The most important source of CH_4 emission in agriculture is domestically raised animals, who produce methane through enteric fermentation. Manure management is also an important source of CH_4, but methane emission from enteric fermentation forms 75% of the total CH_4 emission in Estonian agriculture. The main source of N_2O in agriculture is the use of fertilisers. As compared with developed agricultural countries, the application of fertilisers in Estonia was in the mid-1990s very low, but during the previous few years it has risen. According to the data from the Ministry of Agriculture, fertilised area will increase up to 500 000 ha by 2020. A very small amount of N_2O is emitted by manure management (about 1-3% of the total N_2O emission in agriculture).

Figure 5.5.1. Number of livestock.

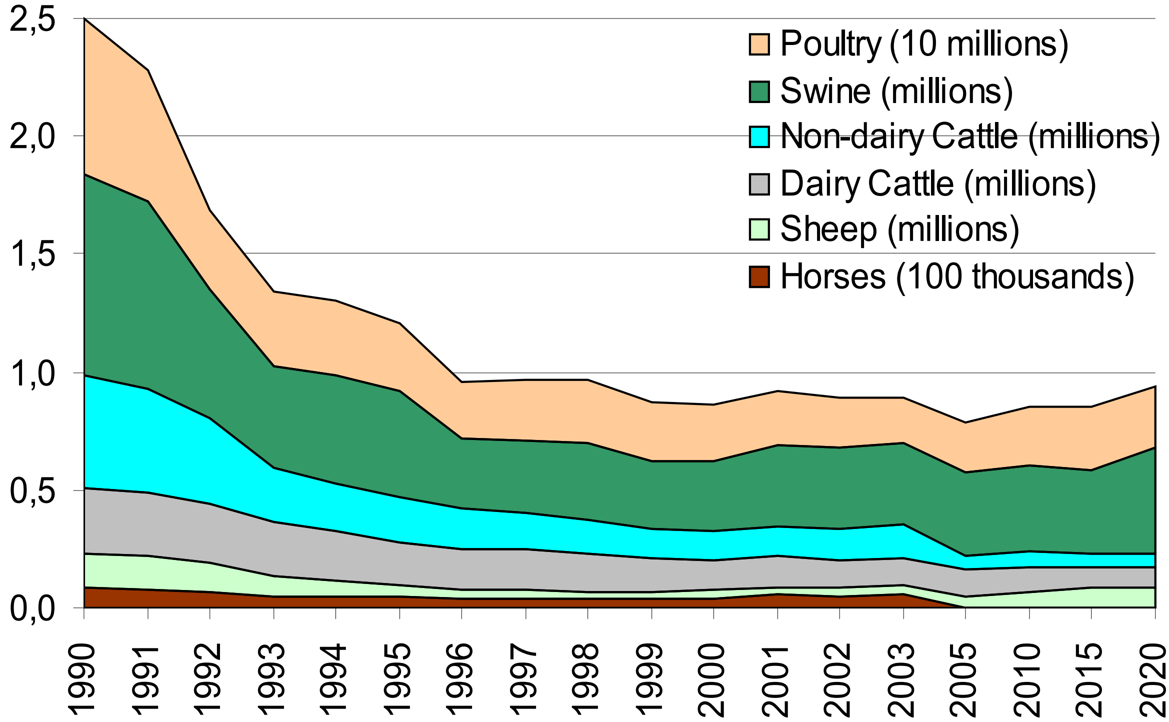
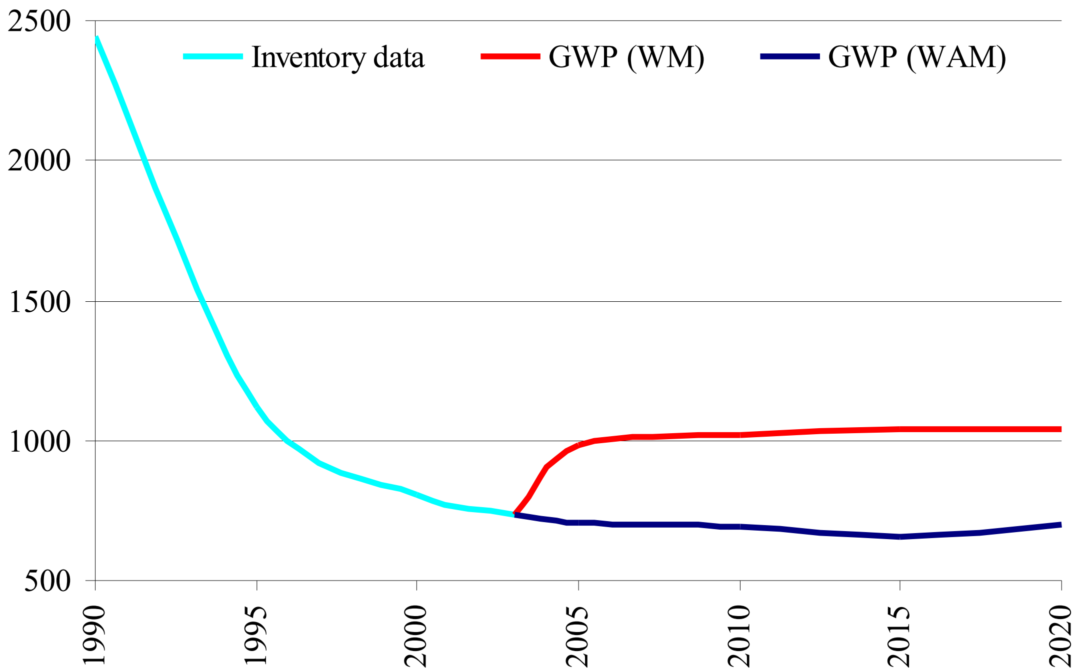


Figure 5.5.2. Emission from agriculture (Gg, CO_2-eq).



Different scenario calculations are based on different assumptions and basic data. The WM scenario is based on the National Programme of Greenhouse Gas Emission Reduction for 2003-2012 (RT L 2004, 59, 990), where projections (scenario B) proceed from the situation before EU full membership. WAM scenario is based on latest expert projections from MoA. In the WAM scenario calculations include changes in number of animals (Figure 5.5.1) and in the use of fertilisers. Emission was calculated using the IPPC methodology. The dynamics of aggregated emission (actual and projected) from the agricultural sector is presented in Figure 5.5.2.

6. EXPECTED IMPACTS OF CLIMATE CHANGE AND VULNERABILITY ASSESSEMENT

6.1. Climate change

Due to the geographical location in a transitional zone between Atlantic Ocean and the huge Eurasian continent, Estonia is characterised by very high climate variability. The air from the Atlantic Ocean brings mild and moist weather in winter and rather cool and rainy weather in summer. The polar continental air coming from the East European Plain induces cold and dry weather in winter and warm in summer. Advections of extremely cold and dry arctic air are the most frequent in winter and spring. Hot and moist tropic air comes up to Estonia only in some extreme cases in summer.

At the same time the territory of Estonia belongs to the regions where the most remarkable increase in air temperature has been observed during the last decades (IPCC, 2001). For example, the annual mean air temperature in Estonia has increased by 1.0-1.7°C during the second half of the 20th century (Jaagus, 2003a) (Figure 6.1.1).
It is important to emphasise the seasonality in the climate warming. The increase in air temperature is not observed during all months. Statistically significant increase in monthly mean temperature is present only during the period from January to May with the maximum in March (Figure 6.1.2).

Figure 6.1.1. Time series of annual mean air temperature in Võru (solid line) and Ristna (dashed line), and their linear trends during 1951-2000 (Jaagus, 2003a).

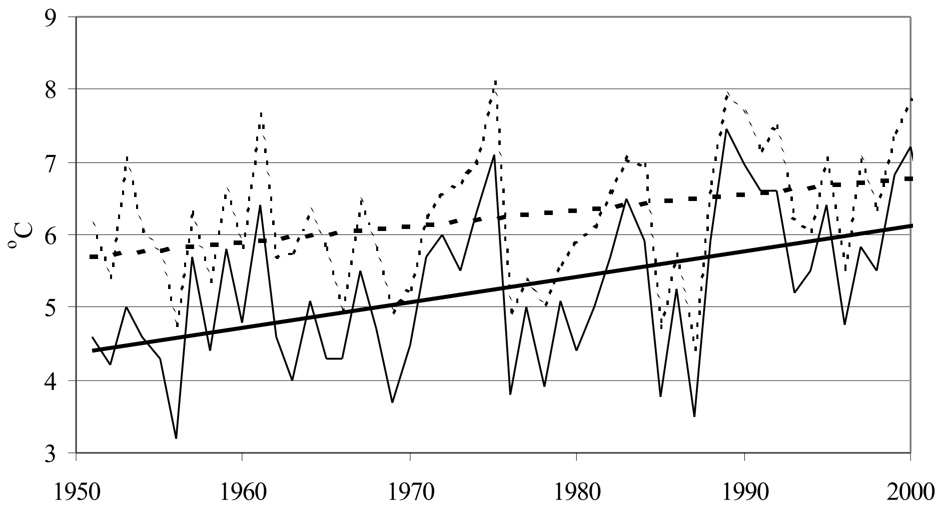
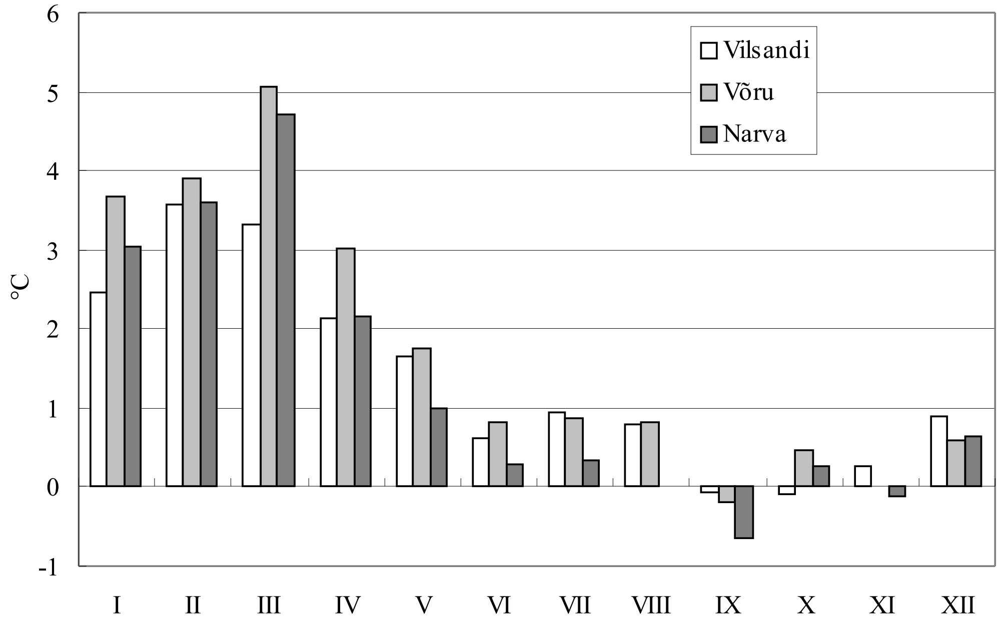
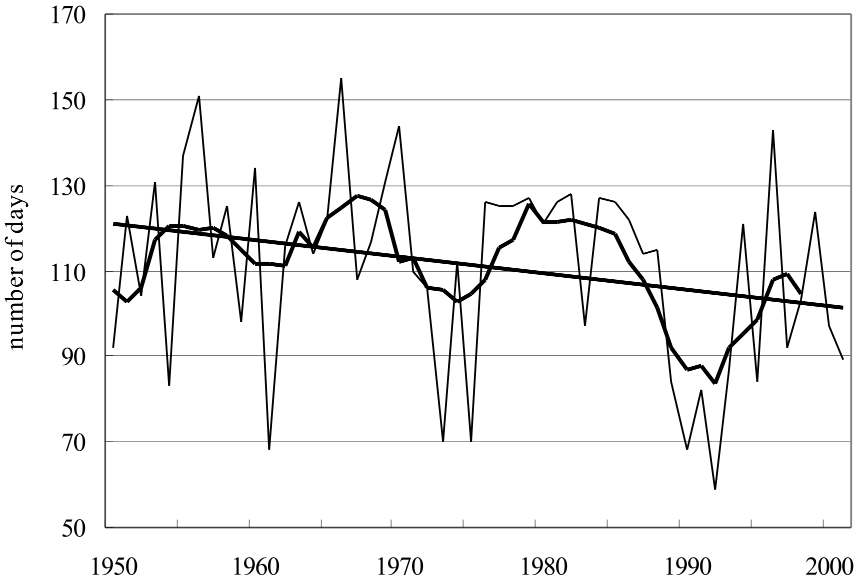


Figure 6.1.2. Change by trend of monthly mean air temperature during 1951–2000 (Jaagus, 2003a).



Winter warming has caused changes in snow cover and ice regime in Estonia. Duration of snow cover (Jaagus, 2003a; Tooming, Kadaja, 1999) and sea ice cover in the Baltic Sea (Haapala, Leppäranta, 1997; Jaagus, 2003b) has decreased remarkably. The beginning date of ice cover formation including sea ice has been quite stable but the date of their disappearance has shifted much earlier at the end of winter (Figure 6.1.3). The maximum extent of sea ice in the whole Baltic Sea has decreased by 50 000 km^2 or 12% according to linear trend during the second half of the 20^{th} century. In general, the end of winter and start of spring occurs much earlier than before. This is the most important change in Estonia that has direct influence on snow cover and sea ice regime, and on ecological conditions as a whole. Winters are warmer with a number of melting periods within.

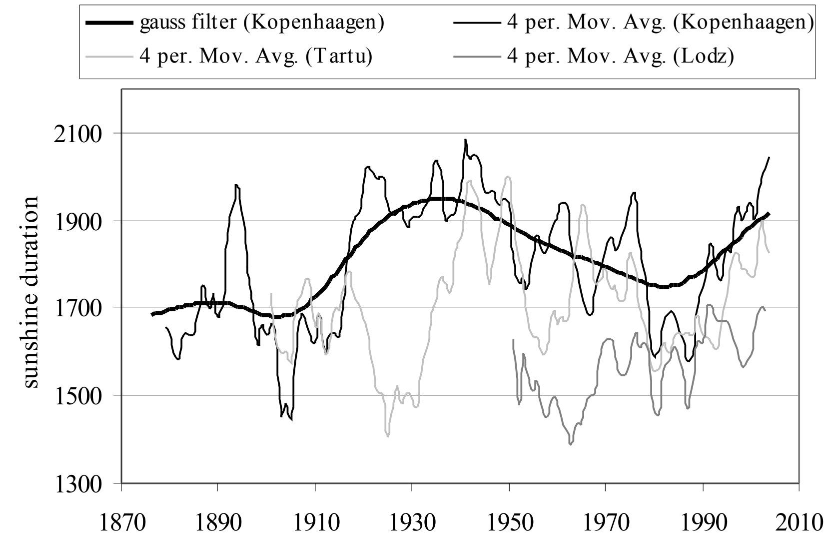
Figure 6.1.3. Time series of spatial mean snow cover duration in Estonia during 1949/50-2000/01, its 7-year moving mean and linear trend (Jaagus, 2003a).



As for cloudiness and sunshine duration, an increasing trend is detected in lower, but not in total cloudiness in Estonia. The amount of low clouds has increased in March, June and September while decreased in some observation stations in May and October (Keevallik, Russak, 2001). S. Keevallik (2003) demonstrated that March has been the key month when the climate change has been the most significant in Estonia.

It can be assumed that an increase in cloudiness is densely related to a decrease in sunshine duration. A very long series of sunshine duration from Copenhagen are available since 1876 (Laursen, Cappelen, 1998; Cappelen, 2005). The lowest level was found at the end of the 19th century, rising to the highest level in the middle of the last century, followed by a slight decrease in the 60s and 70s and an overall increase from the the 80s to present (Figure 6.1.4). The mean level of annual sunshine duration now is nearly of the same magnitude as in the middle of the last century. All seasons show more or less the same tendencies.

Figure 6.1.4. Annual sums of sunshine duration in Copenhagen, 1876-2004 (the heavy line represents filtered values using a 9-year gauss filter), Tartu and Łódź (Russak & Jaagus, 2005). The Łódź series obtained from Podstawczyńska (2003).



The longest time series of sunshine duration in Estonia is available from Tartu since 1901. Substantial fluctuations have been observed during the 20th century, although, no general trend exists (Jaagus, 1998). The sunniest period was in the 1940s. After that, sunshine duration decreased significantly up to the 1980s. The latest increase in sunshine duration started in the 1990s. Corresponding time series for Helsinki, Finland (Heino, 1994) as well as for Riga, Latvia (Lizuma, 2000) show much of the similar features.

Changes in atmospheric circulation over Estonia have taken place during the last decades (Rajasalu, Keevallik, 2001; Tomingas, 2002; Jaagus, 2003a). The most important trend detected is a significant increase in intensity of zonal circulation i.e. westerlies in winter, especially in February and March. Parameters of meridional circulation show an increase in southerly airflow and decrease in northerly airflow in March and in October. Both these changes are related to increase in temperature and precipitation during the cold period.

Earlier melting of snow cover causes changes in hydrological regime. Modelling results demonstrate earlier maximum in river runoff and, mostly, decrease in its magnitude. Water sources in soil will be comparatively small and the drought conditions will appear earlier. A good example of such kind of warm conditions in Estonia was the year 2002 when drought started even at the end of April. Drier climatic conditions in spring and in the first half of summer are projected for the future climate in Estonia (Kont et al., 2002).

Changes in precipitation are the most uncertain. Due to many changes on measuring technique, the higher amount of precipitation is possible to register (Jaagus, 1992). But it is very likely that precipitation in Estonia has increased, especially in winter.
Climatic changes in Estonia can be also explained by increased frequency of cyclonic weather conditions and decrease in anti-cyclonic ones. It is illustrated by the decreasing trend in winter mean air pressure (Figure 6.1.5). Cyclonic weather is favourable for storms generation. The number of storm days in Vilsandi, the westernmost station on the coast of the Baltic Proper, has increased dramatically in winter (Orviku et al., 2003) (Figure 6.1.6).

Figure 6.1.5. Time series of winter mean air pressure (Dec-Feb) in Tartu and its linear trend (Jaagus, 2003a).

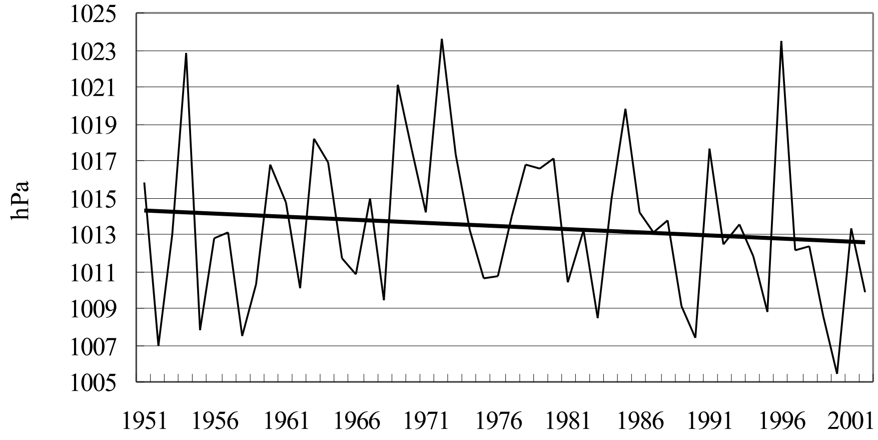
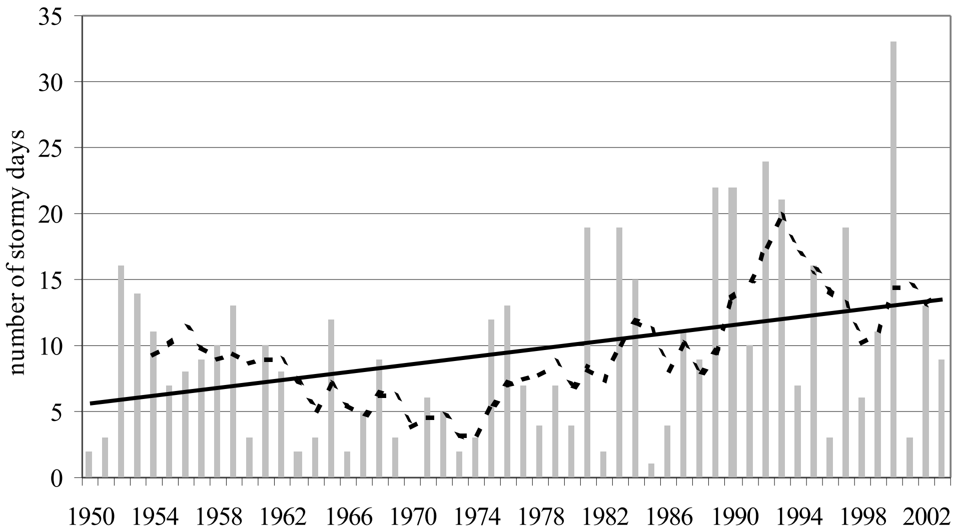


Figure 6.1.6. Number of storm days in Vilsandi and its linear trend (solid line) and 5year moving mean (dashed line) during the period December-March (Orviku et al., 2003).



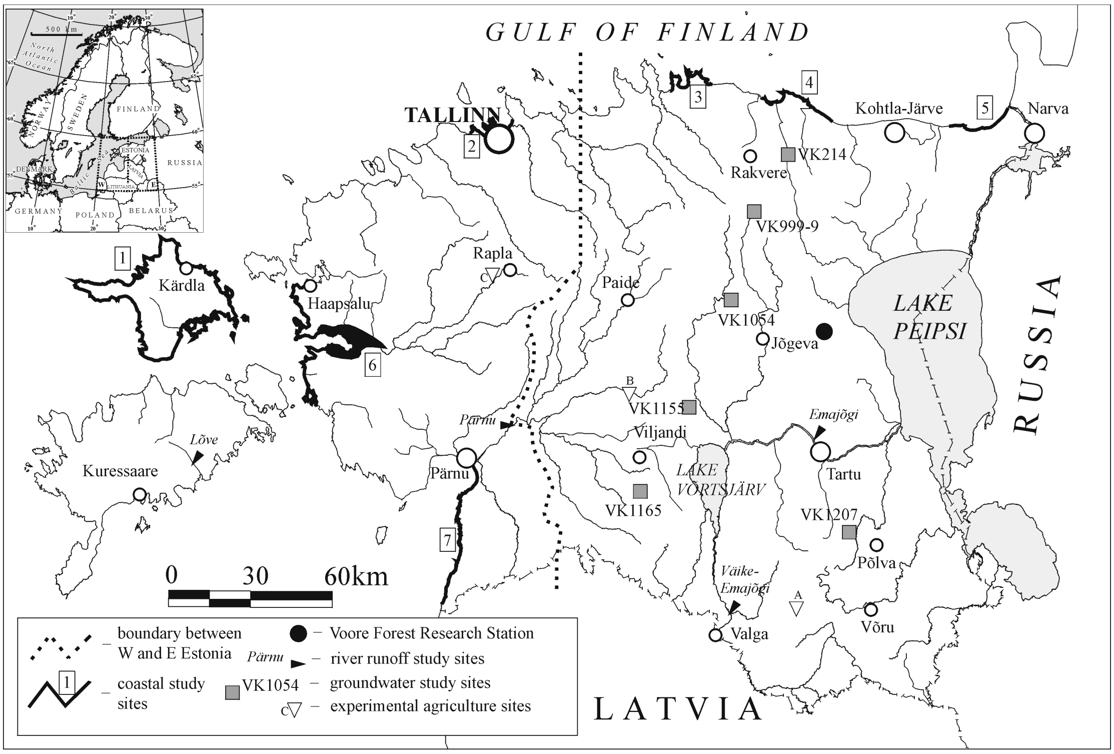
6.2. Climate scenarios

Climate change scenarios for the 21st century were constructed following the methodology recommended for regional climate change impact studies. Air temperature and precipitation projections were compiled using a climate model – Model for the Assessment of Greenhouse-Gas Induced Climate Change (MAGICC) and a regional climate change database – (SCEN)ario (GEN)erator (SCENGEN). The baseline climate was defined as that prevailing between 1961 and 1990. Climate change scenarios were created for the years 2050 and 2100.

Three GHG emission scenarios elaborated by IPCC – IS92a (central), IS92c (low) and IS92e (high) – were used in the MAGICC model.

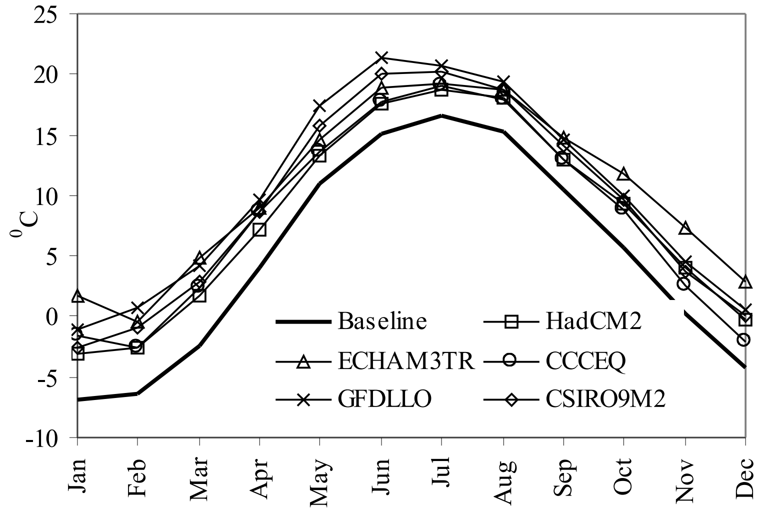
Data from two 5x5 degree grid boxes with medium co-ordinates 57.5°N/22.5°E and 57.5°N/27.5°E cover the territory of Estonia (Figure 6.2.1).

Figure 6.2.1. Location of Estonia in Northern Europe and in relation to the SCENGEN data grid boxes. Location of study areas. Agricultural Experimental Stations: A – Antsla; B – Olustvere; C – Kuusiku. Voore Forest Research Station. River runoff study sites. Groundwater study sites. Lake Võrtsjärv. Coastal study sites: 1 = Hiiumaa; 2 = Tallinn; 3 = Käsmu - Vergi; 4 = Toolse - Aseri; 5 = Sillamäe - Narva-Jõesuu; 6 = Matsalu Bay; 7 = Pärnu – Ikla; 8 = Küdema; 9 = Harilaid; 10 = Järve.



The results of the 14 GCM experiments provided a wide variety of possible climate change scenarios in Estonia. Middle emission scenarios projected an increase in annual mean temperature by 1.3-2.6°C for the year 2050 with greater increases occurring in central and eastern Estonia. In addition, warming in winter and spring was expected to exceed that in summer and autumn, indicating a continuation, if not intensification, of the trend observed in Estonia during the 20th century. Climate change scenarios yielding the greatest changes were compiled for the year 2100 using the high emission scenario. All GCMs expressed an exceptional warming throughout the year (Figure 6.2.2), yet the highest temperature increases seem unrealistic for a country at such a high latitude.

Figure 6.2.2. Annual curve of modelled air temperature in grid box 57.5ºN/27.5ºE for the year 2100 using the high emission scenario (IS92e) and different GCMs. HadCM2 – Hadley Centre Unified Model 2 Transient (UK); ECHAM3TR – European Centre/Hamburg Model 3 Transient (Germany); CCCEQ – Canadian Climate Centre Equilibrium Model (Canada); GFDLLO – Geophysical Fluid Dynamics Laboratory Transient Model (USA); CSIRO9M2 – Commonwealth Scientific and Industrial Research Organisation, Mark 2 (Australia).



The modelled increase in annual precipitation for the year 2050 was generally < 10%, an insignificant change compared to the large inter-annual variability of precipitation. Only two GCMs predicted higher increases of approximately 15%. The greatest seasonal change in precipitation was modelled for winter. Some GCMs demonstrated a decrease in summer (July) rainfall. Increases in precipitation during the cold half-year were modelled by every GCM, but results for the summer season were contradictory.

6.3. Vulnerability analysis

6.3.1. Agriculture

Estonian agriculture is specialized in animal husbandry, which depends on the yields of crops. Since meteorological conditions during the growth period of plants vary substantially from year to year, the yields of crops and grasslands are unstable. Despite a small territory, the soil and climate conditions for growth of plants are extremely variable. For example, in central Estonia the pedoclimatic conditions for the cultivation of cereals are 20-30% more favourable than in northern and south-eastern parts of the country.

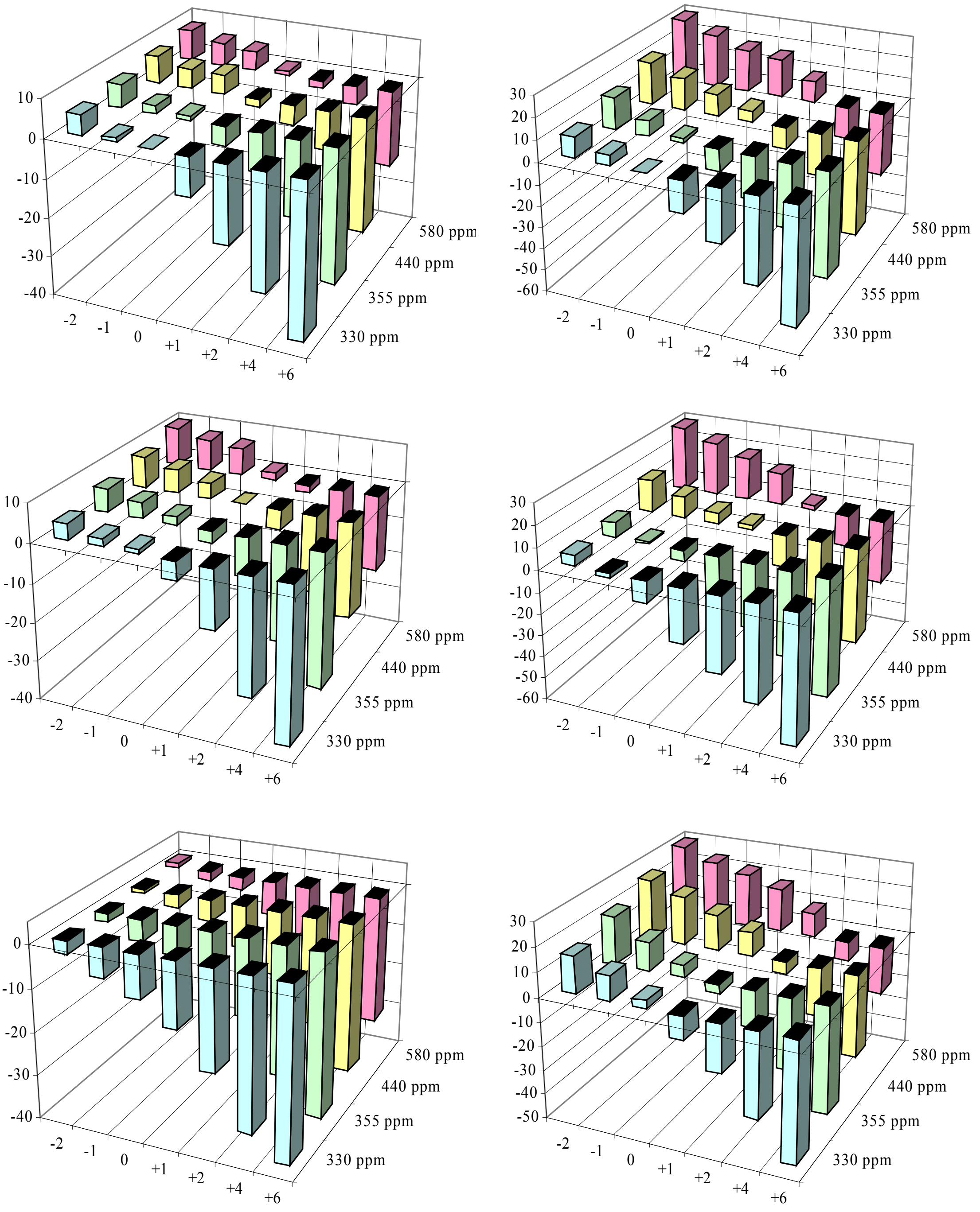
The vulnerability and adaptation assessment for Estonia in the sector of agriculture supported by the U.S. Country Studies Program was carried out in 1995. At that time 38% of the total arable land of Estonia was covered by grain fields, and the main cereal was barley (60% of the sown area). The impact of climate change on potato and clover-timothy mixture yields was also considered.

The CERES-Barley model was used for crop productivity assessment. For analysis of the sensitivity of barley yields to temperature, precipitation and carbon dioxide level, incremental scenarios were created, combining certain changes in the climatic variables (-2°, -1°, 0°, +1°, +2°, +4°, and +6°C in temperature; 0%, ±10%, and ±20% in precipitation; and 330 ppm, 355 ppm, 440 ppm, and 580 ppm in CO_2 level). Using the model, it was possible to simulate the plant development and the yield capacity, integrating the climatic, soil, genotype, and management factors. Unfortunately, the CERES-Barley model is more appropriate to dry and rubbly soils. On Gleysols and on soils with heavy texture, great variation of groundwater level at the beginning of the vegetation period is strongly disturbing the modelling results. In addition to barley, possible changes in potato (main food crop in Estonia) yields were also examined using the results of earlier experiments.

Three case study areas (Antsla, Olustvere and Kuusiku) were selected in different parts of Estonia (Figure 6.2.1). All three areas have experimental stations where special trials (1966-1987) were carried out on four different soil types characteristic of Estonia. These are the following: (1) Haplic Podzol at Antsla, (2) Podzoluvisol at Olustvere, (3) Cambi-Rendzic Leptosol and (4) Base-saturated Gleysol at Kuusiku. The trials consisted of 6-field crop rotation: potato → barley → barley → timothy-clover mixture → timothy-clover mixture → rye.

The data on barley are based on 16 variants of fertilizing experiments. The simulations done with a barley cultivar Julia indicate a considerable decrease in productivity in the case of climate warming (Figure 6.3.1). At the present CO_2 concentration level, the increase in temperature without changes in precipitation would decrease the barley yield by 45-48% on unfertilized soils. On arid fertilized sandy soils, a temperature rise of 6°C would cause a drop of barley productivity by even 56-61%. On gleyic and gleyed soils with heavy texture and much better water supply, the effect of higher temperatures is less notable. On dry sandy soils, the barley yields depend mainly on the rate of nitrogen fertilization and the plant water supply. On the other soils, the relative effect of fertilization is less important.

Figure 6.3.1. Sensitivity of barley yield to climate change on Cambi-Rendzic Leptosols.



The productivity of pastures in Estonia depends on solar radiation, temperature and water supply. The soil and climate conditions for herbage are the most favourable in central and western parts of the country. A temperature rise would increase the timothy-clover mixture yield by 10% in average.

It is necessary to irrigate the sown pastures (100-120 mm on average, in some droughty years even up to 200 mm) to get a maximum yield (7-12 t/ha of dry matter). Such irrigation rates may increase the pasture yield by 1.3-1.9 t/ha. In general, the productivity of sown pastures depends on the type of grass sward and the rates of fertilization and irrigation (Table 6.3.1).

Table 6.3.1. The influence of nitrogen fertilization and irrigation on the yield of sown pastures (Viiralt, 1986)

Grass Sward	N (kg/ha)	Dry Matter Yield (t/ha)	
		Unirrigated	Irrigated
Grasses	0	1.83	2.56
	100	4.96	6.52
	200	7.63	9.27
	300	8.38	10.58
White Clowergrasses	0	3.03	6.48
	100	5.44	7.09
	200	6.25	9.03

Potato is very sensitive to climatic conditions. In general, high temperatures during the planting and sprouting period give a positive effect on potato yield. The temperatures after sprouting and during harvesting are less significant. On moist gleyed soils, heavy rainfalls in spring cause a very strong decrease in potato yield. For instance, every millimetre of precipitation in spring reduces the potato yield by 0.3-0.6 t/ha. However, precipitation during and after flowering gives a positive result.

For the analysis of the effect of various climate change scenarios on the national grain yield, changes in barley productivity were estimated by aggregating the results on the tested soils and presenting as weighted mean values over the whole cultivated area of Estonia. As the tested soils of various properties are typical cultivated soils in the country, the aggregation makes it possible to evaluate reliably the potential effect of climate change on the national grain yield (Table 6.3.2).

Table 6.3.2. Aggregation of the CCCM results for barley

Soils	Main occurance	Sowing area of barley (thous. ha)	N (kg/ha)	% of total production	Percent of change in yield	Weighted average
Cambi-Rendzic Leptosols, Calcareous Cambisols and Luvisols	North- and Central-Estonia	84	0	48.9	-18.4	-0.44
			70	49.6	-18.7	-1.25
Haplic Podzols, Podzoluvisols, Stagnic Luvisols and Planosols	South-Estonia	68	0	39.2	-18.9	-0.45
			70	39.1	-19.2	-1.26
Gleysols	West Estonia	36	0	11.9	+4.4	+0.04
			70	11.3	-9.0	-0.34
National		188	0	100	-18.8	-0.41
			70		-17.8	-1.07

It may be concluded that despite the small territory of Estonia, the soil and climate conditions are extremely variable, affecting strongly plant growth. As the modelling results show, temperature rise would decrease the crop yields everywhere in Estonia. Most vulnerable would be the cultivated areas on dry sandy soils. The fields on gleyic and gleyed soils would

be less affected. However, the yields on these soils are so low (1.42-3.20 t/ha) and unstable that cultivation of barley is not profitable at all.
Earlier experiments using biophysical models for the productivity of various crops have shown that the effect of climate warming is more favourable on herbage cultivation than on cereals. Climate warming would make the potato yield very unstable. It may fall on unfertile and overmoist soils. It is worth mentioning that various potato cultivars have different disease-resistance, which, in our conditions, is of great importance to the formation of potato yield. Unlike herbage, the soil and climatic preconditions are relatively unfavourable for potato cultivation in western Estonia.

6.3.2. Forestry

The RipFor forest-soil-atmosphere model was used to analyse the potential influence of climate change on forest biomass production and nutrient cycling in Estonian forests. The objective of this exercise was to estimate the changes in nutrient availability and nutrient fluxes in the soil-vegetation system. Changes in forest productivity were estimated according to the HadCM2 and ECHAM3TR climate change scenarios.

The main processes addressed by the RipFor model are net primary production (proportional to foliage biomass affected by nutrient availability), biomass respiration, litterfall (including throughfall), litter decay (including translocation of nutrients and of photosynthate before foliage fall), nutrient uptake from available nutrient pools within the soil, ion exchange, and replenishment of soil base cations (Ca, Mg, K, Na) via soil weathering, and atmospheric deposition. The model includes balanced cycles (mass, ion charge) for Ca, Mg, K, N, P and S, and addresses biomass growth for forest stands and forest gaps. The climatic factors included in the model are radiation, CO_2 concentrations in the atmosphere and soil, atmospheric deposition of nutrients, air temperature and precipitation. In the model, air temperature, precipitation and leaf area affect the rate of evapotranspiration. In turn, rates of evapotranspiration and nutrient availabilities affect productivity and water use efficiency. Rates of evapotranspiration and soil moisture availability were calculated separately with the ForHyM model.

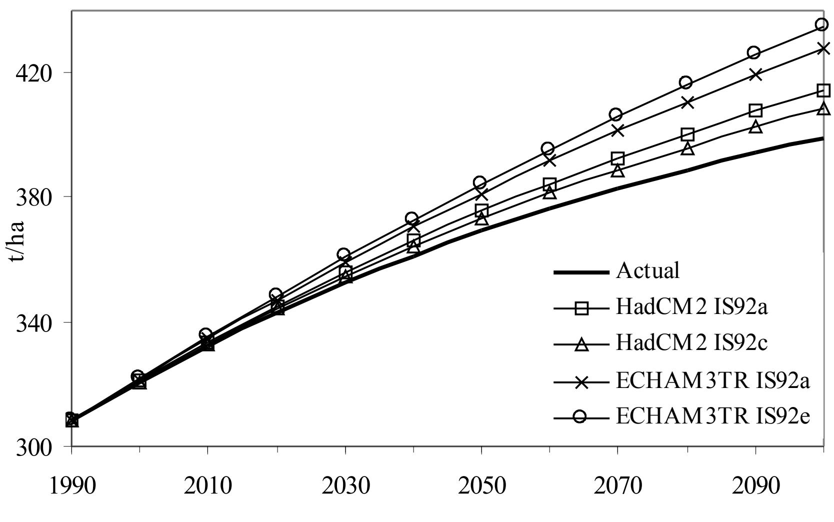
The climate change scenarios with respect to forest resources reflected obvious trends: a decrease in the snow pack duration and earlier snowmelt with increasing climate warming. The reduced influence of snowmelt on stream discharge would increase the synchronization between precipitation and stream discharge. Soils would become slightly drier during the growing season and, coupled with decreased spring and summer precipitation, increase drought stress. This could increase the forest fire potential, which could, in turn, accelerate species migration. A major species shift, anticipated or not, would make the RipFor calculations unreliable and require increased quantification. However, calculations made with different species compositions demonstrated stability of the model, indicating that minor changes in species composition yield insignificant changes in model output.
This study assumed linear climatic changes over 100 years. Calculations presented in the figures below were carried out for the period 1990 - 2100 for a spruce stand at Vooremaa (Figure 6.2.1). Results from other sites showed similar behaviour and the general trends presented here are characteristic of all spruce stands in Estonia.
The simulations based on the climate change scenarios imply increased productivity due to (1) increased atmospheric CO_2, (2) increased evapotranspiration, (3) increased allocation of photosynthate to foliage, and (4) increased rates of nutrient cycling (increased net primary

production implies increased nutrient uptake, litterfall, litter decomposition and mineralization).

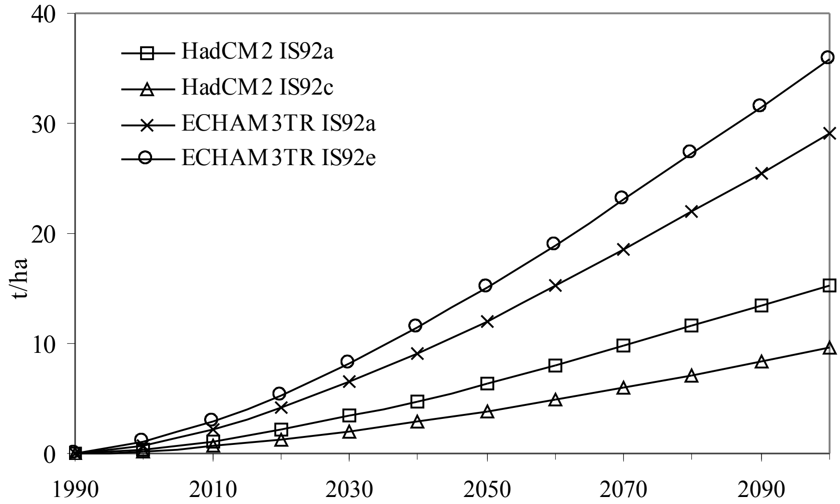
These calculations were based on reasonable assumptions of net primary production, allocation pattern of nutrients and photosynthates within the vegetation, nutrient cycling rates, but ignored the effects of soil temperature and moisture on organic matter decomposition, soil weathering, and nutrient mineralization and nutrient transformations within the soil (e.g., nitrification). The calculations also neglected the possibility of changing atmospheric ion loads, changing rates of N fixation and denitrification, as well as P-dependent vegetation-soil dynamics. Most of these omissions reflected a lack of site-specific data that could quantify the related effects.
Increased nutrient availability, in particular that of nitrogen, clearly favours increased forest biomass. Growth rates of wood biomass under four different scenarios and current conditions for a Norway spruce stand at Vooremaa (eastern Estonia) are presented in Figure 6.3.2. Stable growth without harvesting and natural disasters (e.g. diseases or storm events) was assumed for all calculations. Wood biomass in these calculations included branches, stump and larger roots. The additional wood biomass growth during the 100 year period was predicted to range from 2.5 to almost 9%. We assume a proportional increase in harvestable timber.

Figure 6.3.2. (a) Wood biomass growth in Norway spruce forest at Vooremaa (eastern Estonia) under four different climate change scenarios. (b) Additional woody biomass growth (tons per hectare) in a Norway spruce stand in Vooremaa under four climate change scenarios compared to growth under current climatic conditions during the next century.

a)



b)



6.3.3. Water resources

To investigate the influence of climate change on river runoff after a hundred years, a point model (Wat)er (Bal)ance – WatBal – was chosen. The WatBal model requires a large amount of meteorological and hydrological data, which were obtained from the Estonian Institute of Meteorology and Hydrology. Runoff data from 36 river basins were used to model climate change impact. A number of model parameters were determined for each river basin, including the monthly mean precipitation, air temperature and runoff. The data on precipitation were obtained from four meteorological observation stations located near the study areas (Figure 6.2.1). An algorithm was written to calculate the spatial mean values. The monthly mean temperature, as well as the long-term mean values of sunshine duration, relative humidity, and wind speed were collected from the central meteorological observation stations of the studied catchment areas. The runoff data of the lowest discharge stations of the observed rivers were used to calibrate and validate the model. The baseline period for vulnerability assessment of water resources was the same (1961-1990) as for the climate scenarios.

The Estonian Geological Survey has been collecting the data for groundwater regime analysis. The modelling results of river runoff were used to determine possible changes in groundwater levels due to changes in climatic conditions. The time series of groundwater levels reflect the changes in aquifer storage as well as aquifer recharge or discharge. The seasonal patterns of precipitation and runoff in the analysed regions are similar, but the correlation between runoff and groundwater level is higher than between precipitation and groundwater level.

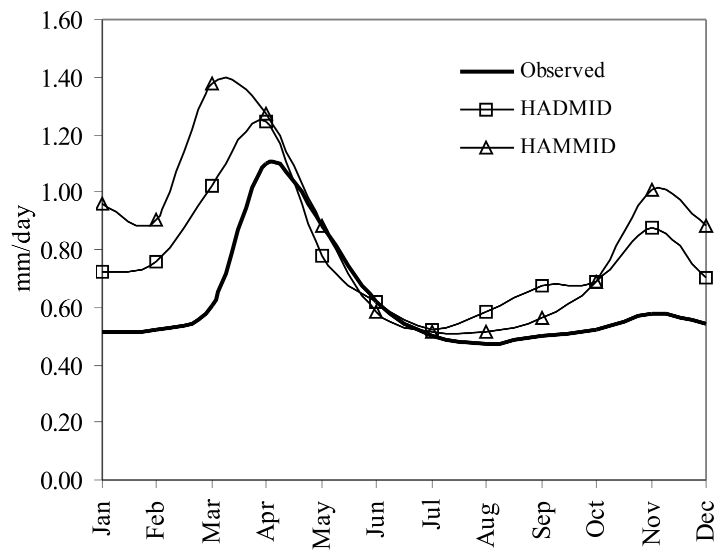
The modelled changes in annual mean runoff for the four climate change scenarios in the 36 studied river basins ranged from -1% to +74%. Modelling results demonstrate the possibility of significant changes in the annual course of monthly runoff caused by climate warming. A significant re-distribution of the seasonal runoff was projected. The most important changes would take place during the cold half-year. Frequent melting periods would decrease snow and ice accumulation during winter. Consequently, the start of snowmelt in spring would be earlier with a reduced runoff maximum.

All climate scenarios predicted a significant increase in river runoff during autumn caused by increased precipitation. In the western part of Estonia, the runoff maximum in autumn (November) was expected to exceed the spring maximum. In eastern Estonia, typical snow cover conditions would remain but the duration of winter and its stability would decrease.

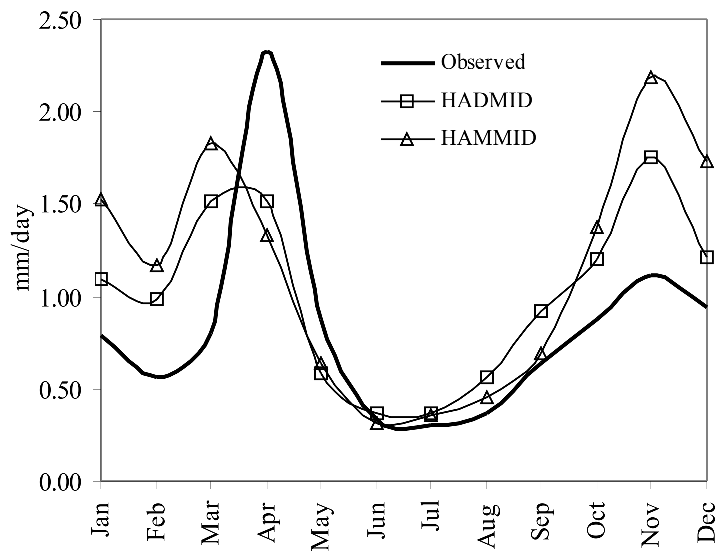
These predicted changes were not equal throughout Estonia. Figure 6.3.3 illustrates the modelling results for three river basins located in different parts of the country. Runoff changes in the Emajõgi River basin represent the region with the most continental climate in Estonia. The modelling results show that runoff changes in western Estonia are greatly different than in the rest of continental Estonia.

Figure 6.3.3. Changes in the monthly runoff in the river basins of different regions: a – Emajõgi River basin; b – Pärnu River basin (Oreküla station); c – Lõve River basin (locations of stations in Figure 6.2.1).

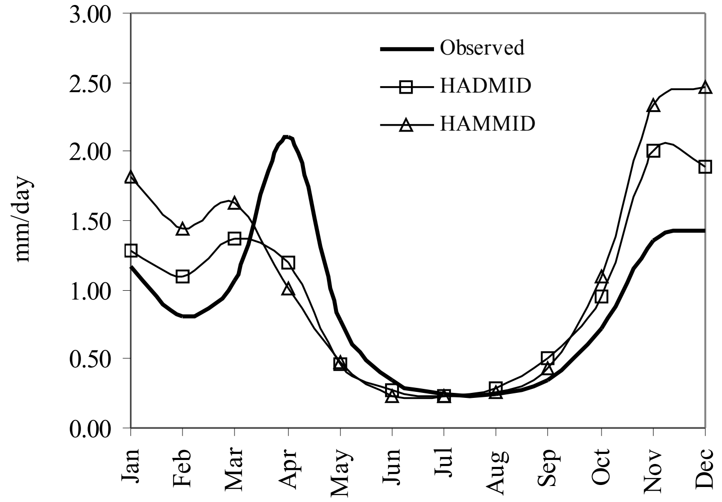
a)



b)



c)



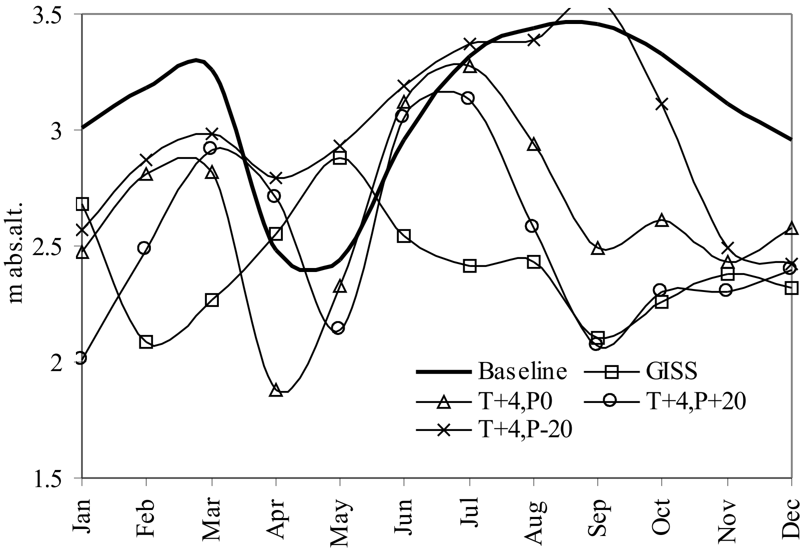
On Saaremaa Island, West-Estonian archipelago, the region with the most maritime climate in Estonia, the hydrological cycle would change completely. With no runoff maximum in spring, the annual cycle would consist of a single maximum (cold half-year) and one minimum (warm half-year).

As a consequence of the earlier spring runoff maximum, the minimum runoff in summer would also start earlier, in May rather than June. Therefore, its duration would increase by an average of one month. A certain pattern is influenced by local conditions, first of all by the character of the spring runoff peak of the rivers. The results of the water resources vulnerability assessment showed a strong dependence on regional changes in runoff and local topography and landscape features.

Examples of modelled groundwater level changes in different geohydrological conditions are presented in Figure 6.3.4. A rising groundwater table would enhance the water supply. The head of the uppermost confined aquifers would rise by 0.5-1.5 m due to the climate change in areas >50 m a.s.l. Wells in these areas with a depth from 60 to 100 m tap the upper confined aquifers and are commonly used for urban water supply. The discharge of these wells usually ranges from 200 to 800 m^3/d per a drawdown of 3-8 m. As a result of general increment of groundwater recharge, the safe yield of bored wells would augment by at least 20%. Thus, the required groundwater can be obtained with fewer wells or reduced pumping. Consequently, climate change would reduce the cost of groundwater extraction from upper confined aquifers.

Figure 6.3.4. Modelled groundwater level changes in different geohydrological conditions: a – Sämi observation area (VK214); b – Väike-Maarja observation area (VK999-9).

a)



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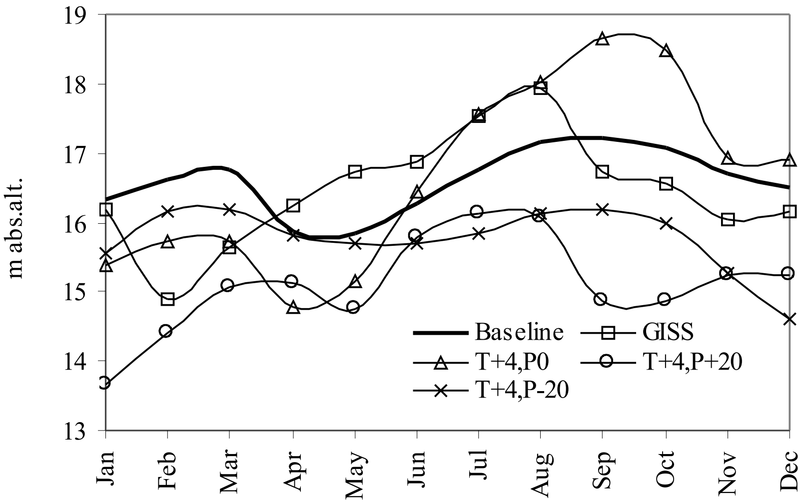
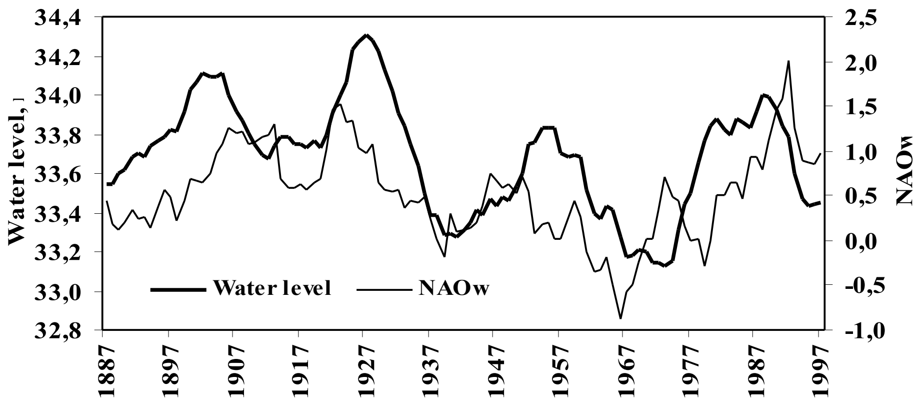


The results of analysis of water supply and demand indicated no effect of climate change on water use in Estonia. The groundwater resources can guarantee a sufficient supply of good quality domestic water in all regions of the country. Water consumption in towns and other settlements would be independent of the quantity and quality fluctuations of rivers. Climate warming would also have a positive influence on the ecological state of water-bodies in Estonia.

In recent years, some scientific projects have been developed to study the influence of climate change and hydrological factors on the ecological state of Lake Võrtsjärv, the second biggest lake in Estonia (Nõges *et al*., 2002; Järvet, 2004). Due to its small depth (mean 2.8, maximum 6 m) and relatively large surface area (270 km^2) and drainage basin (3104 km^2), Lake Võrtsjärv reflects sensitively the changes occurring in its watershed as well as in the climate and hydrology. The lake, in turn, has very strong ecological impact on the surrounding ecosystems. It has also been economically valuable water body for inland fisheries.

In general, the most important problems of Lake Võrtsjärv are fluctuations of its water level and thickness and duration of ice cover during the cold half-year. The worst ecological conditions in the lake can be formed in a combination of low water level (monthly mean below 33.00 m), thick (>50 cm) ice cover and long (>130 days) ice cover duration. Low water level in summer accelerates nutrient cycling, and leads to massive growth of planktonic algae and submerged macrophytes. In winter, it causes oxygen depletion due to a significantly smaller oxygen storage capacity and a higher amount of easily degradable organic matter produced during the vegetation period.
The ecosystem of Lake Võrtsjärv is highly sensitive to water level fluctuations, which follow the pattern of the North Atlantic Oscillation (NAO) index, reflecting changes in climate in the northern hemisphere (Figure 6.3.5). Phytoplankton biomass has been significantly lower in years of high water level and the changes have not been related to nutrient loads. In low-water years, better water column illumination and increased release of phosphorus from resuspended bottom sediments has resulted in substantially higher phytoplankton biomass than in high-water years (Nõges *et al.*, 2002).

Figure 6.3.5. Relationships between NAO index for winter and annual mean water level in Lake Võrtsjärv presented as 7-year moving average values (Nõges et al., 2002).



According to the future climate change scenarios the warmer and wetter weather conditions could bring about higher water levels in winter in Lake Võrtsjärv. The deeper the mixed water column, the lower the average light intensity, causing reduced phytoplankton biomass (Nõges, Nõges, 1999). In the deeper water both resuspension and denitrification rates are lower, the first reducing the phosphorus release from the bottom sediments and causing lower P concentration while the second causes increased nitrogen concentration. Consequently, in warmer weather conditions the N/P ratio in Lake Võrtsjärv would be higher and N_2-fixing cyanobacteria would have less chance to develop. Due to climate warming, the highest mean monthly nutrient losses in spring will be shifted to an earlier period (from early April to mid March) and despite the lower intensity of land use, the winter nutrient losses may remain almost as high as in the past.

In northern Europe, winter is the most critical period, as the greatest changes in air temperature and precipitation are expected to occur during this period. The shift towards earlier spring events in lake ice cover is a global phenomenon that can be observed in lakes of the Northern hemisphere (Magnusson *et al.*, 2000). The positive phases of the NAO are associated with warmer and rainy late-onset winters and earlier springs in Estonia (Järvet, 2004). At the same time, local meteorological conditions such as type of snow cover and melting-refreezing sub-periods influence the length of the ice cover period more strongly than the large-scale NAO. In the same conditions, air temperature and warm rainfall significantly affect the timing of snow cover, but do not have too much impact on ice break-up in the lake. In general, the ice break-up dates of Lake Võrtsjärv cannot be statistically connected with large-scale atmospheric circulation. Maximum lake ice thickness is not a good direct measure of the severity of a winter, but rather a complicated function of snowfall and temperature patterns.

6.3.4. Coastal resources

Estonia is rich in different geomorphic types of shores: cliff shore, scarp shore, rocky shore, till shore, gravel shore, sandy shore, silty shore, and artificial shore have been distinguished. Ten study areas containing all these shore types were selected for detailed analysis and assessment (Figure 6.2.1). Risk analysis of potential sea-level rise was carried out in seven study areas. Detailed measurements and observations have been done in three study sites on Saaremaa Island with the aim of recording the changes resulted from increased storminess over recent decades. The study sites serve different human functions and represent a variety of coastal settlements. Thus, detailed analysis of the study areas provides the means of extrapolating the results for the whole country.

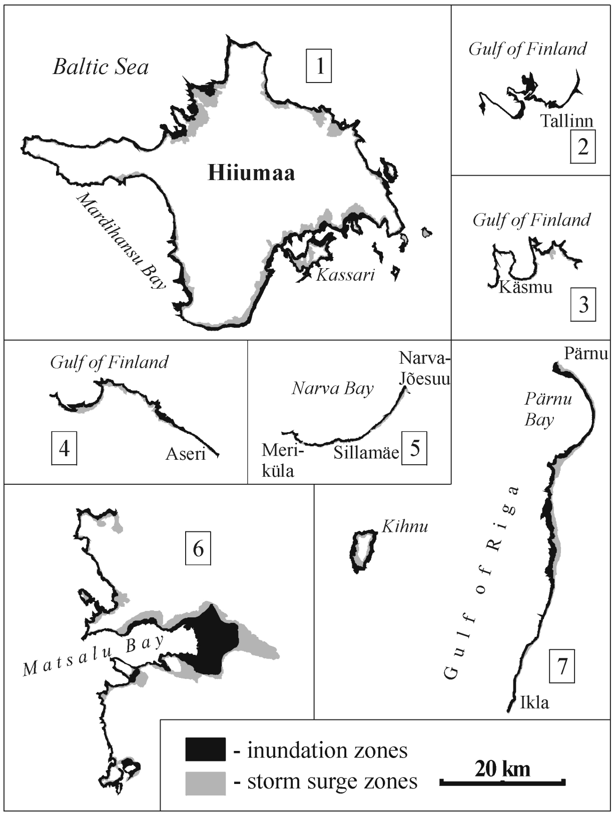
Detailed measurements were made along the coastline at 200 m intervals using 1:25000 topographic and geomorphic maps and calculations according to the Bruun Rule. There were some problems in using the Bruun Rule: (1) shoals off the Estonian coasts reduce wave energy and thus defend the shore against erosion; (2) the Bruun Rule was created to calculate erosion only on sandy beaches. Because the US Country Studies Program provides no alternative methods for non-sandy shores, the Bruun Rule was also used to calculate erosion on other depositional shore types (gravel, pebble and till). Therefore, the overfill ratio of 1.0 for sandy shores was modified for the other shore types: gravel and pebble – 0.7; till (shingle-rich loam) – 0.4; and limestone – 0.1.
The results of the Estonian vulnerability assessment were obtained from a hypothetical 1.0 m sea-level rise with respect to the Kronstadt benchmark from 1990 to 2100. The data from isostatic uplift measurements were taken into account in land loss estimates at each site. Calculations of relative sea-level rise by the year 2100 took into account the rate of land uplift.

All potential loss from inundation and storm surge zones was calculated at current average prices in Estonia in 1995. The monetary values of three different types of losses was calculated: cost of submerged and temporarily damaged land; cost of actually existing features in these two zones today; and profit theoretically missed from the damaged meadows and forests. The overall potential loss for the whole coastal zone of Estonia was calculated by multiplying the losses of the study areas by four (the coastline length of the study areas provides 25% of the total coastline length of Estonia), and adding the losses in the coastal settlements. The results were presented in the previous communication as an example of monetary losses according to the prices that existed ten years ago. These figures do not have any significance today.

A 1.0 m sea rise would change substantially the coastline contour and the number of small islands. The most significant changes would occur on the western coast, including the

Matsalu Bay test area (Figure 6.3.6). Coastal meadows and reed beds, characteristic ecosystems of the western coast of mainland Estonia, would migrate inland, but would not perish. Nevertheless, sea-level rise would reduce species richness, because the new sites for developing seashore grasslands are currently arable lands or young species-poor forests, and many of the rare species may not survive the migration into initially unfavourable conditions.

Figure 6.3.6. Inundation and storm surge zones of study areas. Numbers of study areas see Figure 6.2.1.



The main hazard of the rising sea would manifest with modern land use. Today, natural and semi-natural communities are located more often near the shoreline, while cultivated communities and overgrown lands tend to penetrate inland. A sea-level rise would restore the coastline close to its position in the 1700s. Consequently, all plant communities would migrate inland. Unlike in the 1700s, current arable lands, secondary species-poor forests, and cultivated grasslands impede migration of natural and semi-natural communities. The lack of suitable species pools at new sites and unfavourable conditions for migrating grassland species would probably result in a considerable decrease in species richness.

Although dikes protect 1/3 of Tallinn's coastline, the damage potential is greater than in the other study areas. The most vulnerable area is the Paljassaare Peninsula, which contains over half the potentially submerged area of Tallinn.

The territories most vulnerable to sea level rise in the Pärnu-Ikla study area lie in the north, where silt shores are predominant, and on the densely populated Kihnu Island. Waves during the recent strong storms approached dwellings 300 m inland. Almost 2.5 km^2 of the territory of Pärnu, the largest town in this region, is located in the zone of inundation. The low-lying coastal districts of Pärnu were flooded during the last very strong storm in January 2005 when sea level rose over 2.7 m above the mean value. Although no rare or valuable natural

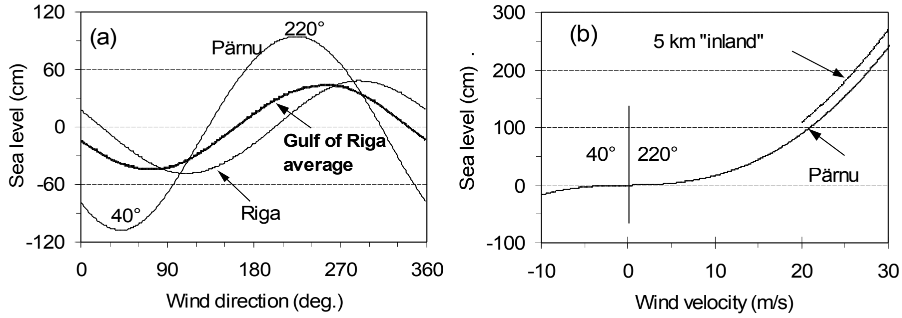
ecosystems in this area require special protection, the socio-economic impact, particularly, concerning recreational areas, would be critical.
A site at risk in north-eastern Estonia was Sillamäe, an important industrial centre. The dumping site of the former uranium enrichment plant was the greatest threat to the environment of the coastal plain and the Gulf of Finland. Separated from the sea by a narrow dam, thousands of tons of radioactive substances containing ^{238}U, ^{232}Th, and ^{226}Ra leaked into the soil and sea every year. Sea level rise and stronger storms would have increased the risk of dam rupture, causing catastrophic pollution of the sea. The dumping site is put into sarcophagi, and is firmly isolated from the surrounding environment today.

Estimates of losses on Hiiumaa Island indicate that 100% of reed beds and 80% of coastal meadows (salt marshes), including rare saline plant communities (*Salicornia europaea*, *Carex glareosa*, and *Glaux maritima-Juncus gerardi* site types, that occur in all successional transitions, are in direct danger. The rare ecosystems of numerous lagoons and calcareous orchid-rich meadows on the north-western coast of Hiiumaa would completely disappear, along with the spawning grounds for trout and lavarets.
Warmer winters in moderate latitudes during the last decades have lead to critical changes in the dynamics and development of coastal areas. Despite a slow uplift of the earth's crust, extensive erosion and retreat of depositional coasts, e.g., sandy beaches, has been observed in Estonia in recent years. In autumn and winter, westerly and south-westerly storm winds raise the sea level up to 2.0 m above its summer level. Because there is little evidence of a rising sea over this period, beach erosion appears to be largely due to the recent increased storminess in the eastern Baltic Sea (Orviku *et al.*, 2003).

The actual sea level reflects the existing equilibrium in the wind regime in reaction with the configuration of the shoreline. In strongly indented and semi-enclosed coastal areas the conditions vary considerably between straight coasts and long tapering bays, leeward and windward sides of the sub-basins, *etc*. The local sea level differences may be up to 1 m or even more at a distance of only about 100 km. The hydrodynamic reason for that feature can be explained by the dependence of the sea levels on the direction of wind in the semi-enclosed basins.

SW winds prevail above the Baltic Sea with the increase in westerlies due to the climate change over the last half-century. An increase in wind speed from specific directions, for instance 220° for the Pärnu Bay, elevates the sea level in that bay (Figure 6.3.7). The effect is very small in case of low wind speed values but very strong during storm events. The 2 m/s wind speed increment between 28 and 30 m/s yields a 50 cm higher surge (240 cm vs. 290 cm plus background Baltic sea level value which should be added to obtain the final sea level height at Pärnu). Consequently, only a slightly higher wind speed during a storm can produce a significantly higher storm surge (Suursaar *et al.*, 2004).

Figure 6.3.7. Modelled dependence of the sea levels on the stationary and uniform wind (with 20 m/s modulus) from different directions (a). Sea levels at Pärnu and at a hypothetical "inland" point (after flooding the coastal plains near Pärnu for 5 km) depending on wind velocity (b) (Suursaar et al., 2004).



The greatest destruction of the coastal zone in Estonia today is associated with stormy periods. Research carried out in Estonia over the last decade shows that the absence of sea ice cover in winter fosters coastal damage. The most exceptional changes in shoreline position and contour in many coastal areas of Estonia are attributable to a combination of strong storms, high sea level and mild (ice-free) weather. Depositional coasts, particularly beaches, are most vulnerable to this combination. As a result, the balance between erosion and deposition is fragile and an initial coastal shape cannot be restored during the intermediate period between storms.

7. EDUCATION, TRAINING AND PUBLIC AWARENESS

7.1. Introduction

Climate change education and outreach is key to engage all stakeholders and major groups in the development and implementation of related policies. At COP 8 (New Delhi, October/November 2002), recognizing the need to establish a country-driven work programme on Article 6 of the Convention that enhances cooperation, coordination and exchange of information among governments, intergovernmental organizations, non-governmental organizations and community-based organizations, as well as the private and public sectors, Parties adopted the "New Delhi work programme" (Decision 11/CP.8).

The five-year work programme engages all stakeholders and recommends a list of activities that could be undertaken at the national level to enhance climate focused education and training programmes and increase the availability and dissemination of information on climate change. Climate change education should be linked to environmental education and education for sustainable development. Appropriate training programmes should be organized for different target groups. Access to information/public participation should be ensured.

Estonia has followed these recommendations and in recent years provisions promoting the involvement of the general public have started to appear in the national legislation (e.g. Environmental Impact Assessment and Environmental Auditing Act (RT I 2002, 99, 579)). Through synergies between the UNFCCC and other conventions the cooperation is promoted both at the national and the international level. In the Final document of the National Capacity Needs Self-Assessment for Global Environmental Management in Estonia (NCSA-Estonia, 2004) among the major actions for further capacity building it is also stated that the role of the environmental conventions should be increased in study programmes of all school levels and in continuing education programmes aimed at companies.

7.2. Education

7.2.1. Educational system

The Estonian educational system consists of basic, secondary, vocational, higher and adult education. After satisfactory completion of the compulsory nine-year basic education, pupils may continue their studies either in gymnasiums or vocational educational institutions. Gymnasiums offer three-year secondary general education and vocational education institutions offer secondary vocational education from one to three years on the basis of both basic and secondary education. After completion of both types of secondary education, young people may choose between entering the labour market and continuing studies at the higher education level. Adult education providers support the principle of life-long learning in a variety of different institutions, methods and forms – in that sense the learning opportunities leading to success both in one's personal and professional life are even wider.

The Estonian higher education system consists of academic and professional higher education. Higher education is provided mainly by universities and professional higher education institutions. Since 1999 some post-secondary vocational schools offer professional higher education programmes. Recent trends in higher education, carried out in accordance with the objective to create a European higher education area, have led to the adoption of a higher education system based on two main cycles – undergraduate and graduate studies.

Since the academic year 2002/2003 students are admitted only to reformed professional higher education study programmes, bachelor, master and doctoral study programmes. Students admitted to higher education study programmes before June 2002 can continue their studies according to the requirements set at the beginning of their studies until September 2007. Institutions offering higher education may be state, public or private institutions.

In the academic year 2004/2005 there are 532 pre-primary schools, 620 basic schools, 67 vocational schools and 36 professional and academic higher schools.

Providing environmental education is considered to be a priority throughout Europe. There are different terms in use in Estonia like *Loodusharidus* (Nature Education, Out-door Education), *Keskkonnaharidus* (Environmental Education) *Säästvat arengut toetav haridus* (Education for Sustainable Development, Education for Sustainability).

7.2.2. Environmental education in pre-primary schools

Estonia has enhanced efforts to develop and use curricula and teacher training focused on climate change as methods to integrate climate change issues at all educational levels and across the disciplines. As the number of children in pre-primary schools is slightly increasing, it is important to start with environmental projects already there. The children today will be adults in ten years and if they are used to behave in a sustainable way, the ideas will be carried over in the activities of the new generation also in their adulthood. Additionally, informing children about sustainability has positive influence on adults or parents. Our experience shows that it is possible to influence adults via children to be more environmentally friendly because the feedback from parents has shown it. The project "Green Spider" involves children of age 3–8 years. The main aim of this project is to prepare a teaching material about the environment where a fish called Lope is teaching children the sustainable way of living. The project partners are 13 European countries and in Estonia 260 pre-primary and primary schools are participating.

7.2.3. Environmental education in basic school and gymnasium

Having the environment and sustainable development as the underlying themes in the curricula is quite a new phenomenon in our educational system and therefore teachers and heads of schools need advice and training in these matters. To meet this demand, a successful environmental education project for schools, Tuulik, was organized by the Dutch Foundation of Permanent Education. EMI-ECO was the Estonian project coordinator. Partners included also the Ministry of the Education and Research, University of Tartu, Tallinn University, Estonian Youth Work Centre and the Sagadi Nature School of the State Forest Management Centre. The project aims to make students aware of changes in the environment over time and take responsibility for the environment in which they live. The project materials are in Estonian and Russian and can also be obtained through the Internet.

In addition to Tuulik a number of other environmental projects are ongoing for schoolchildren. Internationally, GLOBE is being implemented through bilateral agreements between the US government and governments of partner nations. Among the 109 countries that have signed GLOBE agreements is also Estonia. Since Estonia joined the GLOBE Program in 1995, the impact countrywide has been impressive. The success is also the result of extraordinary cooperative efforts among the Estonian Ministry of Education, National Centre of Environmental Investments; the US Embassy in Tallinn; and the Nordic/Baltic Regional Environmental Office at the US Embassy in Copenhagen. The GLOBE Program is a valuable learning experience and promotes science as a communication. The academic year 2004/2005 was the 9th year of the GLOBE program in Estonia. Schools continued the environmental measurements and observations. The number of GLOBE schools in the country has increased to 46; the majority of the schools (27) have reported data during this year. The traditional annual events are the GLOBE student research project competition/conference, and the GLOBE Learning Expedition.

Nineteen schools from Estonia take part in the Baltic Sea Project (BSP) – the first regional Project within UNESCO *Associated Schools Project*. Teachers have got the materials like Learners' Guide 1–6. Over 600 pupils from 25 schools participated in the international project Naturewatch Baltic (NW). The Estonian Youth Work Centre organizes every year a contest of environmental research projects for schoolchildren. The best ones represent Estonia on the International Contest.

The idea of the project ÖKOKRATT (www.okokratt.ee) is to increase the environmental consciousness and sustainable lifestyle of Estonian population, especially children. The main goal is to explain the principles of sustainable lifestyle and to show what the human activities cause to environment (causes and effects) and to expand the activities to local governments. The environmental project Ökokratt was started in Kuusalu municipality and has successfully been going on since 1999. Kuusalu municipality has arranged several events in order to raise the awareness and change the attitudes of its residents and especially children, and in order to introduce the environmental situation and improve the situation of the environment. The events have been supported by enterprises, local governments and the Environmental Investment Centre. Enterprises have supported the events by introducing a company's product or service. Lectures and seminars for children and adults have been carried out. Considering the age and previous knowledge level, different approaches to topics have been used. Future plans are connected with the developing of an environmental consciousness supplementary education system for the staff of educational institutions (schools-kindergartens) and for municipalities in cooperation with Estonian and foreign partners. This project gives an opportunity for young people to develop themselves during their free time (environmental education centre, environmental education portal, eco-camp, cooperation projects with young people from Estonia and other countries and with other similar organizations). The benefit from the project is investment in education and erudition. The more conscious the citizens, the cleaner will become the environment. In the framework of the environmental week events take place in the educational institutions every day and require active involvement of children and teachers (to carry out studies, to make things, to draw, to write poetry, to sing, to move in nature, to discuss, to organize exhibitions and quizzes, to organize a waste disco, a day of clowns, to visit places with problems). The aim is to provide knowledge considering the concrete age group and interests and to include all staff of kindergartens and schools and possibly parents. The project ends with festive delivery of the supplementary education certificates to teachers by the municipality and the trainers

Beside the running projects there is a system of various types of centres whose activities include environmental training. For example the State Forest Management Centre (RMK) has 7 nature centres: Aegviidu nature centre in the northern part of Estonia in Harju County, Pähni and Kiidjärve nature centres in southern Estonia, Kauksi nature centre in eastern Estonia, Mustjala nature centre on the island of Saaremaa, Kabli nature centre in Pärnu

County and Nõva nature centre in Lääne County. Our best-known educational temple is the Sagadi Nature School in Lääne-Viru County. This system of the environmental education offers more than 360 one-day courses per year and about 14 000 persons (not only pupils but also teachers, parents, school administrators) took part in this education in 2004.

The Foundation Tartu Environmental Education Centre (TEEC) was established in 2002 on the basis of the former Tartu Loodusmaja (Nature House). The purpose of TEEC is to develop environmental awareness and to promote sustainable values of life through training programmes, projects and public information. The target group of TEEC includes children and adults living in Tartu and elsewhere in the southern part of Estonia, also different organizations, companies, the public sector etc. The aim is to influence public opinion towards sustainable development. Different environmental courses are being run by TEEC: nature trail organizing course, ecosystems and fieldwork. It is planned to build Tartu Ecohouse to create a proper home for TEEC in the future. The ecohouse project is being developed in cooperation with Tartu City Government. TEEC's priority is running projects that promote sustainable lifestyle. The following projects were organized in 2003: training courses for adults (sustainable office and home), Garbage Separation in Tartu City Government, Eco-team Project in Tartu Nature House and Eco-team Coach Training for Teachers in Estonia, Sustainable School, Coordination of Environmental Awareness projects in Tartu County financed by the Centred of Environmental Investments Centre, Children's Nature Summer Camp, Tartu Youth Bicycle Project, The Green File of Nature in Tartu – a study material project, Tartu Environmental Study materials, activity programmes in nature education.

In March 2003 a contract was signed between Tartu Environmental Education Centre (TEEC) and the US Embassy in Estonia. The US Embassy gives financial support to TEEC for an Environmental Education Development project in Tartu and South Estonia. The main goal of the project is to develop an environmental education system for adults and to run pilot courses. The financial support is also very important for TEEC in order to develop the whole organization.

7.2.4. Environmental education in higher schools

All Estonian public law universities have curricula in environmental education, devoted to sound environmental management, sustainable development, environmentally efficient power engineering, protection of the atmosphere etc. There are similar courses in the private universities. This topic is part of the curricula of the future teacher training but not in all specialities. The positive change is in Tallinn University where future journalists have an opportunity take the environmental education course.

7.2.5. Adult training

There are several adult training facilities in Estonia where one can study environmental subjects. EMI-ECO is one of them. EMI-ECO is a non-profit independent training and consultation organization following the principles of life-long training. The activities of the organization are aimed at increasing administrative capacity and competitiveness of enterprises and raising the educational levels of society.

7.3. NGOs

The environmental education is incorporated also to the activities of the 58 NGOs. Besides Friends of Earth – Estonia also the European Youth Forest Action Estonia, Estonian Geographical Society, Forest Youth, Estonian Union of Scout Supporter's Societies, Viljandi Youth Society for Nature Conservation, Estonian Ecotourism Association, Centre for Applied Ecology, Estonian Biology and Geography Teachers' Union, Estonian Environmental Women's Union, Tartu Students' Nature Protection Circle, Society for Nature Conservation of Tallinn; Sorex etc are dealing with environmental education and climate change issues. Peipsi Centre for Transboundary Cooperation is an international non-profit institution, which works to promote sustainable development and cross-border cooperation in the international catchment area of Lake Peipsi. In 2003–2005 this organization launched several small projects aimed at increasing public participation to solve environmental problems in the region.

REC Estonia was founded as a local office of REC in 1995. The task of REC Estonia is to assist in solving environmental problems by encouraging cooperation among governments, nongovernmental organizations, environmental businesses and other stakeholders. The Regional Environmental Center for Central and Eastern Europe (REC) was established by the United States, the European Commission and Hungary in 1990. Today there are local offices in 15 countries of Central and Eastern Europe while the headquarters is situated in Szentendre in Hungary.

Stockholm Environment Institute Tallinn Center (SEI-Tallinn) is a non-governmental, non-profit foundation, founded by SEI and registered under the Estonian law in 1992.

The mission of SEI-Tallinn is to direct the decision-making on the community development and environment towards balance and sustainability. One of the programme areas is Climate, Energy and Atmosphere. SEI-Tallinn conducts applied research and consults international organizations, governments and private organizations in the areas of the community development and environment.

Estonian Green Movement-FoE is a non-governmental, non-profit environmental organization. It was founded in 1988 as one of the first environmental NGOs in Estonia that started to deal with a wide range of environment and development issues. In its activities the Estonian Green Movement-FoE is backed by a nationwide active network of some 600 individual members.

Currently the Estonian Green Movement-FoE is one of the most influential environmental groups in Estonia, advocating for the environmental needs of Estonia's inhabitants. Estonian Green Movement-FoE has adopted the mission of responding to the regional environmental problems brought about by the political and social changes, and protecting Estonian natural resources at grass root, national and international levels. Its activities are carried out in the framework of seven permanent working groups, which are dealing with following issues: Consumption, Energy and Atmosphere, Forestry, Transport, Water and Youth.

7.4. Green Energy and Estonian Fund for Nature

Each Green Energy customer supports the Estonian Fund for Nature (ELF). The customer donations to ELF uses these funds to finance the projects of ELF related to nature conservation, environmental education and sustainable development. The Estonian Fund for Nature was founded in Tartu on 1 February 1991 as a non-profit NGO for the implementation of and fund-raising for environmental projects.

Since its foundation, ELF has participated in establishing nature protection territories with the total area of almost 100 000 ha, among them Karula and Soomaa National Parks, and Puhatu and Lower Pedja Nature Reserves. Today, ELF’s main lines of activity are sustainable forest management, environmental education and sustainable development. In environmental protection, ELF collaborates with several international organizations, the most important of which are the World Wide Fund for Nature (WWF) in Sweden, Denmark and Finland, Danish Environmental Assistance to Eastern Europe (DANCEE), forest protection organizations Smartwood (US) and Nepenthes (Denmark).

ELF's cooperation partners in Estonia are the Ministry of the Environment, Estonian Institute for Sustainable Development, Friends of the Earth – Estonia, Estonian Ornithological Society, Estonian Youth Nature Protection Association, the City Governments of Tartu and Tallinn and several other local authorities, universities etc.

Alkranel LCC. The main tasks of this organization are promotion of environmental awareness and involvement of the public in environmental issues. The environmental specialists of Alkranel have an educational background of environmental engineering from the University of Tartu. Alkranel offers environmental consultation services in water and waste treatment technologies, water and waste management, environmental management, environmental impact assessment, environmental research and raising environmental awareness.

7.5. Research

During the reporting period the Estonian Science Foundation and Ministry of Education and Research have financed more than 54 research projects that are connected with climate studies. The spectrum of these studies is very wide the studies being connected with the atmospheric circulation processes, ionization, analyses of satellite images and climate modelling. Investigations of this kind are the main goal of the research groups from the National Institute of Hydrology and Meteorology, Tartu Observatory and the Institute of Geography of the University of Tartu.

The interaction of water and terrestrial ecosystems and their response to climate change are the basic interest of researchers from the Estonian Agricultural University. Climate and the environment of the Earth are under increasing pressure of anthropogenic activity, which is likely to provoke climate warming, frequent droughts and other stresses that decrease the stability of forest ecosystems. The case studies reported consistent increasing trends in general height growth, as well as diameter growth of different tree species in Central and Western Europe. The same trends are traced also in Estonia. According to the forest inventory data the site index of Estonian forests was found to have increased during the last decades. The increasing trends in air temperature and precipitation, detected in meteorological time series in Estonia, may be partly responsible for the annual increase of tree growth. Results of the study should show trends in site conditions and in the growth of economically important coniferous stands. A better understanding of altered growth conditions may be useful for planning forest regeneration, for adjusting thinning regimes and final cutting strategies, and for forest policy makers to ensure continuous sustainable management.

Climate warming may cause also changes in the matter cycling of the lake ecosystems. A research group from the Institute of Ecology at Tallinn University is studying the processes in the past to better predict the future trends. Scientists from the Limnological Centre of the Estonian Agricultural University are following the present situation in small and large lakes of Estonia.

During the reporting period the studies concerning the effect of climate change on the Baltic Sea and the Estonian coast continued at the Marine Institute at the University of Tartu, Marine Systems Laboratory of Tallinn University of Technology and the Institute of Ecology at Tallinn University.

Owing to a relatively long coastline (3800 km) and flat and low-lying bays, frequent and strong storms resulting from climate change and combined with sea-level rise could destroy many valuable ecosystems in the coastal areas of Estonia. Extensive erosion and destruction of depositional coasts, e.g. sandy beaches, has been observed in Estonia in recent years. The basic research theme of the Department of Landscape Ecology of the Institute of Ecology "Climate change impact on the structure and functioning of wetlands" is focusing the impact of increased storminess on different shore types. The project originates from Agenda 21 and several other international agreements that clearly call for more integrated management of coastal and ocean resources.

As an example of applied research projects connected with the climate change impact is the breeding of new potato and fruit varieties that are resistant to changing climate conditions. Studies on the phenological trends connected with climate change are an interesting topic that is studied by researchers from the Institute of Geography of the University of Tartu. This project is part of the larger R&D project of the 5th Framework. There are also other international cooperational research projects on climate change topics.

7.6. Cooperation at international level

The Århus Convention is an agreement made in Denmark in 1998, which was signed by Estonia in June of the same year and ratified by the Estonian Parliament in 2001. The idea of the convention is to give the general public an opportunity to receive information and contribute to making environmental decisions and, if necessary, have recourse to the court in these matters. The aim of the organization is to prepare for the implementation of the Access to Information Directive and the *Aarhus Convention*: The activities inside the organization are connected with producing a leaflet for the public on the right to information & public participation and to train Regional Environmental Services in public participation activities. The legal framework to ensure access to environmental information and public participation in the decision-making process has been prepared and guidelines for public officials on procedures for responding to information requests and how the authorities can organize public participation activities have been produced.

7.6.1. Joint projects with EU

As a member state of the European Union, Estonia will have the opportunity to take part in the regional policy of the Community and to receive financial assistance from the EU budget. The EU regional policy aims to ensure rapid, socially and regionally balanced and sustainable economic development. Another aim is to reduce social and economic disparities between various regions of the Community.

There are several Structural Funds that support the EU structural policy and that can be connected with climate change education as well:
* European Social Fund (ESF), supporting promotion of skills of employees and jobseekers and promotion of employment;
* European Regional Development Fund (ERDF), supporting economic development through promotion of business environment, modernization of infrastructure and creation of new jobs;
* European Agricultural Guidance and Guarantee Fund (EAGGF), supporting reorganization of agriculture and rural life.

These funds are implemented in Estonia on the basis of the Estonian National Development Plan (NDP). In this document, structural assistance and development aims are broken down by four priorities: Human Resource Development; Competitiveness of Enterprises; Agriculture, Fisheries and Rural Development and Infrastructure and Local Development

The Archimedes Foundation is an independent body established by the Estonian government in 1997 with the objective to coordinate and implement different EU programmes and projects in the field of training, education, research, technological development and innovation. Estonian schools have used the opportunities to participate in EU programmes and have got financial support there. In 2003, 20 schools participated in the subprogramme Comenius of the Socrates programme. For example, Kuressaare Gymnasium has the project "Open the School to Your Environment", whose main aim is to analyse and improve the environmental education considering local and regional peculiarities.

The Baltic Environmental Forum (BEF) was founded by the Baltic Ministries of the Environment, Germany and the European Commission as a technical assistance project aiming at strengthening the cooperation among the Baltic environmental authorities. To keep the networks active and to implement more projects in the Baltic Sea Region, in 2003 the BEF team founded NGOs in Latvia, Estonia, Lithuania and Germany. BEF organizes workshops and meetings for the stakeholders to raise their awareness and knowledge about the emissions trading scheme and practical implementation of the requirements.

7.7. Cooperation at national levels

The Sustainable Development Committee approved the Estonian sustainable development strategy "Sustainable Estonia 21" on 14 September 2005. This enables the Ministry of the Environment to submit the strategy to the Government of the Republic for approval.

"Sustainable Estonia 21" (SE21) is a strategy for the development of the Estonian state and society until 2030. The strategy creates the general framework for interconnecting the social, economic and environmental spheres in terms of long-term development of the society and defines the general objective of the development for Estonia as movement towards the so-called knowledge-based society. The long-term objectives of development determined in the strategy are: vitality of the Estonian cultural sphere (maintaining national traditions), greater well-being, coherent society (without sharp social conflicts) and ecological balance. Knowledge-based society is a type of comprehensive social order marked by a new operating and decision-making culture in which the achievement of commonly set and accepted objectives is based mainly on knowledge and analysis.

By approving the SE21 and achieving its aims Estonia takes part in shaping the development policy of the European Union as well as the whole world. The preparation of the strategy was coordinated by a consortium led by Tallinn University (TLU) and consisting of TLU, TLU Institute of International and Social Studies, TLU Institute of Ecology, and AS Lõhmus, Haavel and Viisemann. It was an extensive and open process during which all materials were available for commenting to all interested parties at the Ministry Internet address under the heading Sustainable Development/Estonia.

The preparation of the Estonian strategy of sustainable development called "Sustainable Estonia 21" was based on the initial tasks approved by the Government of the Republic in 2002 and the project was led by the Sustainable Development Committee. Estonia 21 website houses an organized collection of publications, references, events, projects and links related to sustainable development in Estonia and around the world. The site is in Estonian and English and the target audience is mainly local governments, community planners, NGOs and anyone interested in sustainable development.

7.7.1. Cooperation between the ministries

The Ministry of the Environment and the Ministry of Education and Research aim at promoting education supporting sustainable development, including nature and environmental education. On the basis of this preliminary task the priorities of environmental education, related activities and spheres of responsibility of ministries will be specified for the years ahead. The development of a national concept of education supporting sustainable development, including nature and environmental education, will be launched in order to integrate the aforesaid education into the curricula of schools of general education. The concept will be developed by a working group of environmental education and education supporting sustainable development established under the Ministry of Education and Research. Representatives of the both ministries, citizens' associations and scientific research establishments will participate in the work of this working group promoting activities related to nature education, environmental education and education supporting sustainable development in cooperation with NGOs. Regular communication of environmental information through the media, including the promotion of economical and environmentally friendly consumption habits and behaviour will be conducted.

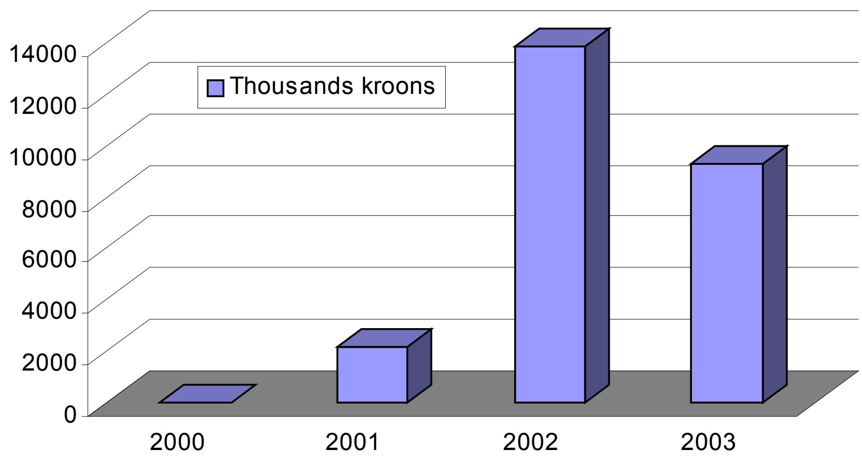
The objective is to include means provided specially for environmental activities in the capitation fee of every pupil, to ensure that in schools of general education pupils get to know the nature in practice and are engaged in practical environmental activities, and thereby implement the course Environment and Sustainable Development, which is inherent in the curricula. In addition, one of the objectives is to restore a network of environmental education support centres for both children and adults.

Some existing national resources for priority activities

The Environmental Investment Centre (EIC) was established based on the law about using the money gained from the usage of the environment (RT I 1999, 54, 583) and the law about its amendment (RT I 1999, 101, 905). EIC is under the governance area of the Ministry of Finance. The decision to establish EIC was signed by the Minister of Finance on 11 May 2000. EIC was added to the registry of non-profit making organizations and other foundations on 2 June 2000. The main activities of EIC are as follows:

- Using the money gained from the usage of the environment to the development of national environmental projects;
- Filling the assignment of the Implementing Agency for European Regional Development Fund project;
- Filling the assignment of the Implementing Agency for the European Union Cohesion Fund projects,
- Offering long-term loans to environmental projects.

Figure 7.7.1. Grant financed projects expenses in Environmental awareness program (1 EUR=15.64664 EEK).



The programme of the environmental awareness financed by EIC includes hundreds of projects with the main aim to promote environmental education in schools (Figure 7.7.1). Great attention is paid to the issuing of various publications and other study materials. To raise and maintain interest among the public, support was provided to the organization of the regular Nature Conservation Months and Forest weeks. The project of environmental pages in county newspapers is continued. This project has three main tasks: to introduce the staff and duties of local environmental departments, to explain laws and regulations and to answer frequent questions concerning regional environmental protection. It is also intended to educate people and to make them think about environmental issues. One project was to establish a network of cooperation partners in counties. County cooperation partners of EIC are non-profit associations and NGOs; the network will also increase the involvement of the third sector in promoting environmental awareness.

One of the most reliable ways to bring environmental information to people is television. Therefore EIC supported environmental broadcasts produced by three different TV programmes. From the total budget of the environmental awareness subordinate programmes the media got 35%, various publications 26%, youth projects 24% and national campaigns 15%. EIC financed also the publication of the Estonian nature magazines that unites naturalists of several generations and also of different levels.

The Ministry of the Environment is going to determine the most environmentally friendly organizations. The objective of the competition is to acknowledge the efforts and investments of Estonian enterprises and organizations in reducing pollution. The competition also aims at promoting clean production and sustainable development. In 2004 the winners were Eesti Energia AS (energy company), AS Rakvere Lihakombinaat (meat processing plant) and AS Harku Karjäär (quarry).

The cooperation agreement between the Ministry of the Environment and Tallinn University covers a wide scope of issues such as the training of environmental specialists and experts. It is important to spread the attitude of environmental sustainability and awareness among young teachers so that they would pass it on to the next generations.

7.8. Outlook for implementation in the field of education, training and public awareness

There are many barriers to strengthening climate change education and outreach activities as well as issues that need attention, including:

– Shortage of funding and technical skills;
– Weak political support;
– Linguistic differences;
– More products are needed in local languages;
– More tools should be developed for exchanging information;
– Local funding needs to be found;
– Involvement of high-level policy-makers needs to be enhanced;
– Important role of the media should be made better use of;
– Priority could be given to strengthening regional cooperation;
– Synergy with other environmental conventions could be promoted;
– Countries could consider developing and sharing replicable templates.

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ANNEXES

SUMMARY 1.B SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7B)
(Sheet 1 of 1)

Estonia
1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs[1] P	HFCs[1] A	PFCs[1] P	PFCs[1] A	SF_6 P	SF_6 A	NO_x	CO	NMVOC	SO_2
	(Gg)				CO_2 equivalent (Gg)				(Gg)					
Total National Emissions and Removals	**38 107,41**	**-6 319,96**	**207,76**	**3,30**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**90,62**	**176,19**	**34,05**	**274,91**
1. Energy	**37 493,66**		**61,31**	**0,15**							**90,47**	**174,40**	**28,17**	**270,11**
A. Fuel Combustion — Reference Approach[2]	37 493,66													
Sectoral Approach[2]	37 493,66		4,13	0,15							90,47	174,39	27,47	270,01
B. Fugitive Emissions from Fuels	NO		57,18	0,00							0,01	0,01	0,69	0,10
2. Industrial Processes	**613,74**		**NO**	**NO**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**0,10**	**0,38**	**5,89**	**4,80**
3. Solvent and Other Product Use	**NO**			**NO**							**NO**	**NO**	**NO**	**NO**
4. Agriculture [3]	**NO**	NC **0,00**	**69,73**	**3,15**							**NO/NE**	**NO/NE**	**NO/NE**	**NO**
5. Land-Use Change and Forestry	(4)	(4) **-6 319,96**	**0,16**	**NE**							**NO**	**NO**	**NO**	**NO**
6. Waste	**NO**		**76,57**	**NE**							**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**
7. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:														
International Bunkers	**NE**		**NE**	**NE**							NE	NE	NE	NE
Aviation	NE		NE	NE							NE	NE	NE	NE
Marine	NE		NE	NE							NE	NE	NE	NE
Multilateral Operations	**NE**		**NE**	**NE**							**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**846,74**													

P = Potential emissions based on Tier 1 approach of the IPCC Guidelines.
A = Actual emissions based on Tier 2 approach of the IPCC Guidelines.

[1] The emissions of HFCs and PFCs are to be expressed as CO_2 equivalent emissions. Data on disaggregated emissions of HFCs and PFCs are to be provided in Table 2(II) of this common reporting format.

[2] For verification purposes, countries are asked to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in document box of Table1.A(c). Where possible, the calculations using the Sectoral approach should be used for estimating national totals. Do not include the results of both the Reference approach and the Sectoral approach in national totals.

[3] See footnote 4 to Summary 1.A.

[4] Please do not provide an estimate of both CO_2 emissions and CO_2 removals. "Net" emissions (emissions - removals) of CO_2 should be estimated and a single number placed in either the CO_2 emissions or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS (Sheet 1 of 1)

Estonia
1990

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**31 787,45**	**4 363,04**	**1 023,88**	**NO/NE**	**NO/NE**	**NO/NE**	**37 174,37**
1. Energy	**37 493,66**	**1 287,52**	**47,34**				**38 828,52**
A. Fuel Combustion (Sectoral Approach)	37 493,66	86,66	47,34				37 627,66
1. Energy Industries	29 753,46	7,87	19,99				29 781,31
2. Manufacturing Industries and Construction	2 654,88	1,49	2,91				2 659,27
3. Transport	2 693,06	6,91	7,54				2 707,51
4. Other Sectors	2 392,27	70,39	16,91				2 479,57
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	NO	1 200,86	NO				1 200,86
1. Solid Fuels	NO	407,69	NO				407,69
2. Oil and Natural Gas	NO	793,17	NO				793,17
2. Industrial Processes	**613,74**	**NO**	**NO**	**NE**	**NE**	**NE**	**613,74**
A. Mineral Products	613,74	NO	NO				613,74
B. Chemical Industry	NO	NO	NO	NE	NE	NE	NO
C. Metal Production	NO	NO	NO		NE	NE	NO
D. Other Production	NE						NO
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NO**		**NO**				**NO**
4. Agriculture	**NO**	**1 464,25**	**976,20**				**2 440,45**
A. Enteric Fermentation		1 092,36					1 092,36
B. Manure Management		371,89	24,42				396,31
C. Rice Cultivation		NO					NO
D. Agricultural Soils[(2)]		NO	951,78				951,78
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[(1)]	**-6 319,96**	**NE**	**NE**				**-6 316,23**
6. Waste	**NO/NE**	**1 607,88**	**NO/NE**				1 607,88
A. Solid Waste Disposal on Land	NO	1 416,04					1 416,04
B. Wastewater Handling		191,84	NE				191,84
C. Waste Incineration	NE	NE	NE				NO
D. Other	NO	NO	NO				NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	**NE**	**NE**	**NE**				**NE**
Aviation	NE	NE	NE				NE
Marine	NE	NE	NE				NE
Multilateral Operations	**NE**	**NE**	**NE**				**NE**
CO_2 Emissions from Biomass	**846,74**						**846,74**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	2 745,60	-10 208,40	-7 462,80			-7 462,80
B. Forest and Grassland Conversion	75,38		75,38	3,39	0,34	79,11
C. Abandonment of Managed Lands	NE	-1 985,20	-1 985,20			-1 985,20
D. CO_2 Emissions and Removals from Soil	3 052,67	0,00	3 052,67			3 052,67
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	5 873,65	-12 193,61	-6 319,96	3,39	0,34	-6 316,23

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	43 490,60
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	37 174,37

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

ANNEX

SUMMARY 1.B SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7B)
(Sheet 1 of 1)

Estonia
2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**16 848,88**	**-8 365,14**	**114,43**	**1,32**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**37,28**	**129,86**	**21,74**	**124,21**
1. Energy	**16 494,54**		**36,85**	**0,13**							**37,20**	**129,55**	**19,07**	**123,15**
A. Fuel Combustion — Reference Approach[2]	16 494,54													
Sectoral Approach[2]	16 494,54		5,23	0,13							37,18	129,53	17,54	122,93
B. Fugitive Emissions from Fuels	NO		31,62	0,00							0,01	0,02	1,53	0,22
2. Industrial Processes	**354,33**		**NO**	**NO**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**0,08**	**0,31**	**2,68**	**1,06**
3. Solvent and Other Product Use	**NO**			**NO**							**NO**	**NO**	**NO**	**NO**
4. Agriculture [3]	**NO**	**NO**	**20,64**	**1,20**							**NO/NE**	**NO/NE**	**NO/NE**	**NO**
5. Land-Use Change and Forestry	[4]	[4] **-8 365,14**	**0,00**	**NE**							**NO**	**NO**	**NO**	**NO**
6. Waste	**NO**		**56,93**	**NE**							**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**
7. Other	**MO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:														
International Bunkers	**328,62**		**NE**	**NE**							**6,59**	**4,39**	**0,88**	**2,16**
Aviation	NE		NE	NE							6,59	4,39	0,88	0,00
Marine	328,62		NE	NE							NE	NE	NE	2,16
Multilateral Operations	**NE**		**NE**	**NE**							**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**2 269,04**													

P = Potential emissions based on Tier 1 approach of the IPCC Guidelines. A = Actual emissions based on Tier 2 approach of the IPCC Guidelines.

[1] The emissions of HFCs and PFCs are to be expressed as CO_2 equivalent emissions. Data on disaggregated emissions of HFCs and PFCs are to be provided in Table 2(II) of this common reporting format.

[2] For verification purposes, countries are asked to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in document box of Table1.A(c). Where possible, the calculations using the Sectoral approach should be used for estimating national totals. Do not include the results of both the Reference approach and the Sectoral approach in national totals.

[3] See footnote 4 to Summary 1.A.

[4] Please do not provide an estimate of both CO_2 emissions and CO_2 removals. “Net” emissions (emissions - removals) of CO_2 should be estimated and a single number placed in either the CO_2 emissions or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Estonia
2000

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [1]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [1]	**8 483,73**	**2 402,93**	**410,48**	**NO/NE**	**NO/NE**	**NO/NE**	**11 297,14**
1. Energy	**16 494,54**	**773,92**	**39,89**				**17 308,36**
A. Fuel Combustion (Sectoral Approach)	16 494,54	109,80	39,89				16 644,24
1. Energy Industries	13 945,36	7,35	15,29				13 968,00
2. Manufacturing Industries and Construction	482,94	0,49	0,91				484,34
3. Transport	1 030,29	2,65	3,03				1 035,97
4. Other Sectors	1 035,96	99,32	20,66				1 155,93
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	NO	664,11	NO				664,11
1. Solid Fuels	NO	236,21	NO				236,21
2. Oil and Natural Gas	NO	427,91	NO				427,91
2. Industrial Processes	**354,33**	**NO**	**NO**	**NE**	**NE**	**NE**	**354,33**
A. Mineral Products	354,33	NO	NO				354,33
B. Chemical Industry	NO	NO	NO	NE	NE	NE	NO
C. Metal Production	NO	NO	NO		NE	NE	NO
D. Other Production	NE						NO
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NO**		**NO**				**NO**
4. Agriculture	**NO**	**433,42**	**370,59**				**804,01**
A. Enteric Fermentation		377,34					377,34
B. Manure Management		56,08	10,32				66,40
C. Rice Cultivation		NO					NO
D. Agricultural Soils [2]		NO	360,26				360,26
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NO	NO				NO
5. Land-Use Change and Forestry [1]	**-8 365,14**	**NE**	**NE**				**-8 365,14**
6. Waste	**NO/NE**	**1 195,60**	**NO/NE**				1 195,60
A. Solid Waste Disposal on Land	NO	976,91					976,91
B. Wastewater Handling		218,69	NE				218,69
C. Waste Incineration	NE	NE	NE				NO
D. Other	NO	NO	NO				NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0,00
Memo Items:							
International Bunkers	**328,62**	**NE**	**NE**				**328,62**
Aviation	NE	NE	NE				NE
Marine	328,62	NE	NE				328,62
Multilateral Operations	**NE**	**NE**	**NE**				**NE**
CO_2 Emissions from Biomass	**2 269,04**						**2 269,04**

[1] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[2] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	5 524,66	-11 923,69	-6 399,03			-6 399,03
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE
C. Abandonment of Managed Lands	NE	-2 456,12	-2 456,12			-2 456,12
D. CO_2 Emissions and Removals from Soil	462,99	NE	462,99			462,99
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	6 014,67	-14 379,81	-8 365,14	NE	NE	-8 365,14

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [a]	19 662,29
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [a]	11 297,14

[a] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 1.B SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7B)
(Sheet 1 of 1)

Estonia
2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs[1] P	HFCs[1] A	PFCs[1] P	PFCs[1] A	SF_6 P	SF_6 A	NO_x	CO	NMVOC	SO_2
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**17 083,44**	**-9 417,43**	**93,77**	**1,17**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**43,16**	**207,62**	**36,69**	**1,29**
1. Energy	**16 727,87**		**38,14**	**0,13**							**43,08**	**207,33**	**33,56**	**0,24**
A. Fuel Combustion — Reference Approach[2]	16 033,44													
Sectoral Approach[2]	16 727,87		5,22	0,13							43,06	207,31	31,92	0,00
B. Fugitive Emissions from Fuels	NO		32,92	0,00							0,02	0,02	1,64	0,24
2. Industrial Processes	**355,58**		**NO**	**NO**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**0,08**	**0,29**	**3,13**	**1,05**
3. Solvent and Other Product Use	**NO**			**NO**							**NO**	**NO**	**NO**	**NO**
4. Agriculture [3]	**NO**	**NO**	**21,28**	**1,04**							**NO/NE**	**NO/NE**	**NO/NE**	**NO**
5. Land-Use Change and Forestry	[4]	[4] **-9 417,43**	**0,00**	**NE**							**NO**	**NO**	**NO**	**NO**
6. Waste	**NO**		**34,35**	**NE**							**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**
7. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:														
International Bunkers	**312,86**		**NE**	**NE**							**6,28**	**4,19**	**0,84**	**2 157,81**
Aviation	NE		NE	NE							6,28	4,19	0,84	NE
Marine	312,86		NE	NE							NE	NE	NE	2 157,81
Multilateral Operations	**NE**		**NE**	**NE**							**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**2 341,99**													

P = Potential emissions based on Tier 1 approach of the IPCC Guidelines.

A = Actual emissions based on Tier 2 approach of the IPCC Guidelines.

[1] The emissions of HFCs and PFCs are to be expressed as CO_2 equivalent emissions. Data on disaggregated emissions of HFCs and PFCs are to be provided in Table 2(II) of this common reporting format.

[2] For verification purposes, countries are asked to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in document box of Table1.A(c). Where possible, the calculations using the Sectoral approach should be used for estimating national totals. Do not include the results of both the Reference approach and the Sectoral approach in national totals.

[3] See footnote 4 to Summary 1.A.

[4] Please do not provide an estimate of both CO_2 emissions and CO_2 removals. "Net" emissions (emissions - removals) of CO_2 should be estimated and a single number placed in either the CO_2 emissions or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Estonia
2001

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**7 666,01**	**1 969,26**	**363,62**	**NO/NE**	**NO/NE**	**NO/NE**	**9 998,89**
1. Energy	**16 727,87**	**801,00**	**41,58**				**17 570,45**
A. Fuel Combustion (Sectoral Approach)	16 727,87	109,72	41,58				16 879,16
1. Energy Industries	13 912,22	8,21	16,75				13 937,17
2. Manufacturing Industries and Construction	588,17	0,74	1,38				590,29
3. Transport	1 921,08	6,93	5,29				1 933,30
4. Other Sectors	306,40	93,85	18,16				418,41
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	NO	691,28	NO				691,28
1. Solid Fuels	NO	231,47	NO				231,47
2. Oil and Natural Gas	NO	459,81	NO				459,81
2. Industrial Processes	**355,58**	**NO**	**NO**	**NE**	**NE**	**NE**	**355,58**
A. Mineral Products	355,58	NO	NO				355,58
B. Chemical Industry	NO	NO	NO	NE	NE	NE	NO
C. Metal Production	NO	NO	NO		NE	NE	NO
D. Other Production	NE						NO
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NO**		**NO**				**NO**
4. Agriculture	**NO**	**446,90**	**322,04**				**768,94**
A. Enteric Fermentation		386,59					386,59
B. Manure Management		60,31	10,58				70,89
C. Rice Cultivation		NO					NO
D. Agricultural Soils[(2)]		NO	311,46				311,46
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[(1)]	**-9 417,43**	**NE**	**NE**				**-9 417,43**
6. Waste	**NO/NE**	**721,36**	**NO/NE**				721,36
A. Solid Waste Disposal on Land	NO	503,52					503,52
B. Wastewater Handling		217,84	NE				217,84
C. Waste Incineration	NE	NE	NE				NO
D. Other	NO	NO	NO				NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0,00
Memo Items:							
International Bunkers	**312,86**	**NE**	**NE**				**312,86**
Aviation	NE	NE	NE				NE
Marine	312,86	NE	NE				312,86
Multilateral Operations	**NE**	**NE**	**NE**				**NE**
CO_2 Emissions from Biomass	**2 341,99**						**2 341,99**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	10 121,98	-15 742,65	-5 620,67			-5 620,67
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE
C. Abandonment of Managed Lands	NE	-2 829,75	-2 829,75			-2 829,75
D. CO_2 Emissions and Removals from Soil	-967,01	NE	-967,01			-967,01
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	9 154,97	-18 572,40	-9 417,43	NE	NE	-9 417,43

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	19 416,32
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	9 998,89

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 1.B SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7B) (Sheet 1 of 1)

Estonia
2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**17 311,86**	**-8 563,79**	**90,38**	**1,01**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**46,61**	**211,07**	**37,87**	**97,85**
1. Energy	**16 971,38**		**34,28**	**0,14**							**46,51**	**210,71**	**34,29**	**96,59**
A. Fuel Combustion — Reference Approach[2]	15 577,27													
Sectoral Approach[2]	16 971,38		5,27	0,14							46,50	210,68	32,53	96,34
B. Fugitive Emissions from Fuels	MO		29,01	0,00							0,02	0,02	1,77	0,26
2. Industrial Processes	**340,48**		**NO**	**NO**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**0,10**	**0,37**	**3,58**	**1,26**
3. Solvent and Other Product Use	**NO**			**NO**							**NO**	**NO**	**NO**	**NO**
4. Agriculture [3]	**NO**	**NO**	**20,50**	**0,88**							**NO/NE**	**NO/NE**	**NO/NE**	**NO**
5. Land-Use Change and Forestry	[4]	[4] **-8 563,79**	**0,00**	**NE**							**NO**	**NO**	**NO**	**NO**
6. Waste	**NO**		**35,60**	**NE**							**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**
7. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:														
International Bunkers	**368,24**		**NE**	**NE**							**7,30**	**4,86**	**0,97**	**2 382,28**
Aviation	NE		NE	NE							7,30	4,86	0,97	NE
Marine	368,24		NE	NE							NE	NE	NE	2 382,28
Multilateral Operations	**NE**		**NE**	**NE**							**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**2 339,04**													

P = Potential emissions based on Tier 1 approach of the IPCC Guidelines. A = Actual emissions based on Tier 2 approach of the IPCC Guidelines.

[1] The emissions of HFCs and PFCs are to be expressed as CO_2 equivalent emissions. Data on disaggregated emissions of HFCs and PFCs are to be provided in Table 2(II) of this common reporting format.

[2] For verification purposes, countries are asked to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in document box of Table1.A(c). Where possible, the calculations using the Sectoral approach should be used for estimating national totals. Do not include the results of both the Reference approach and the Sectoral approach in national totals.

[3] See footnote 4 to Summary 1.A.

[4] Please do not provide an estimate of both CO_2 emissions and CO_2 removals. “Net” emissions (emissions - removals) of CO_2 should be estimated and a single number placed in either the CO_2 emissions or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

ANNEX

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Estonia
2002

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**8 748,07**	**1 897,92**	**313,97**	**NO/NE**	**NO/NE**	**NO/NE**	**10 959,96**
1. Energy	**16 971,38**	**719,84**	**42,49**				**17 733,70**
A. Fuel Combustion (Sectoral Approach)	16 971,38	110,70	42,49				17 124,57
1. Energy Industries	13 911,44	8,44	17,09				13 936,97
2. Manufacturing Industries and Construction	421,68	0,44	0,87				422,99
3. Transport	2 174,71	7,28	6,03				2 188,02
4. Other Sectors	463,54	94,55	18,50				576,59
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	NO	609,14	NO				609,14
1. Solid Fuels	NO	223,26	NO				223,26
2. Oil and Natural Gas	NO	385,87	NO				385,87
2. Industrial Processes	**340,48**	**NO**	**NO**	**NE**	**NE**	**NE**	**340,48**
A. Mineral Products	340,48	NO	NO				340,48
B. Chemical Industry	NO	NO	NO	NE	NE	NE	NO
C. Metal Production	NO	NO	NO		NE	NE	NO
D. Other Production	NE						NO
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NO**		**NO**				**NO**
4. Agriculture	**NO**	**430,51**	**271,48**				**701,99**
A. Enteric Fermentation		371,99					371,99
B. Manure Management		58,53	10,12				68,65
C. Rice Cultivation		NO					NO
D. Agricultural Soils[(2)]		NO	261,36				261,36
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[(1)]	**-8 563,79**	**NE**	**NE**				**-8 563,79**
6. Waste	**NO/NE**	**747,57**	**NO/NE**				747,57
A. Solid Waste Disposal on Land	NO	495,55					495,55
B. Wastewater Handling		252,03	NE				252,03
C. Waste Incineration	NE	NE	NE				NO
D. Other	NO	NO	NO				NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
							0,00
Memo Items:							
International Bunkers	**368,24**	**NE**	**NE**				**368,24**
Aviation	NE	NE	NE				NE
Marine	368,24	NE	NE				368,24
Multilateral Operations	**NE**	**NE**	**NE**				**NE**
CO_2 Emissions from Biomass	**2 339,04**						**2 339,04**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).
[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	10 601,08	-15 886,20	-5 285,12			-5 285,12
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE
C. Abandonment of Managed Lands	NE	-2 311,65	-2 311,65			-2 311,65
D. CO_2 Emissions and Removals from Soil	-967,01	NE	-967,01			-967,01
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	9 634,06	-18 197,85	-8 563,79	NE	NE	-8 563,79

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	19 523,75
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	10 959,96

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

SUMMARY 1.B SHORT SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7B)
(Sheet 1 of 1)

Estonia
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	CH_4	N_2O	HFCs[1]		PFCs[1]		SF_6		NO_x	CO	NMVOC	SO_2
					P	A	P	A	P	A				
	(Gg)				CO_2 equivalent (Gg)						(Gg)			
Total National Emissions and Removals	**19 106,44**	**-8 717,19**	**93,71**	**1,01**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**	**49,32**	**214,20**	**38,21**	**150,72**
1. Energy	**18 830,01**		**36,69**	**0,14**							**49,22**	**213,83**	**34,27**	**149,35**
A. Fuel Combustion — Reference Approach[2]	17 806,76													
Sectoral Approach[2]	18 830,01		5,50	0,14							49,20	213,80	32,31	149,07
B. Fugitive Emissions from Fuels	NO		31,19	NO							0,02	0,03	1,96	0,28
2. Industrial Processes	**276,43**		**NO**	**NO**	**NE**	**NE**	**NE**	**NE**	**NE**	**NE**	**0,10**	**0,38**	**3,95**	**1,37**
3. Solvent and Other Product Use	**NO**			**NO**							**NO**	**NO**	**NO**	**NO**
4. Agriculture [3]	**NO**	**NO**	**22,11**	**0,86**							**NO/NE**	**NO/NE**	**NO/NE**	**NO**
5. Land-Use Change and Forestry	[4]	[4] **-8 717,19**	**NE**	**NE**							**NO**	**NO**	**NO**	**NO**
6. Waste	**NO**		**34,90**	**NE**							**NO/NE**	**NO/NE**	**NO/NE**	**NO/NE**
7. Other	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:														
International Bunkers	**354,69**		**NE**	**NE**							**7,07**	**4,71**	**0,94**	**2 250,97**
Aviation	NE		NE	NE							7,07	4,71	0,94	NE
Marine	354,69		NE	NE							NE	NE	NE	2 250,97
Multilateral Operations	**NE**		**NE**	**NE**							**NE**	**NE**	**NE**	**NE**
CO_2 Emissions from Biomass	**2 587,51**													

P = Potential emissions based on Tier 1 approach of the IPCC Guidelines.

A = Actual emissions based on Tier 2 approach of the IPCC Guidelines.

[1] The emissions of HFCs and PFCs are to be expressed as CO_2 equivalent emissions. Data on disaggregated emissions of HFCs and PFCs are to be provided in Table 2(II) of this common reporting format.

[2] For verification purposes, countries are asked to report the results of their calculations using the Reference approach and to explain any differences with the Sectoral approach in document box of Table1.A(c). Where possible, the calculations using the Sectoral approach should be used for estimating national totals. Do not include the results of both the Reference approach and the Sectoral approach in national totals.

[3] See footnote 4 to Summary 1.A.

[4] Please do not provide an estimate of both CO_2 emissions and CO_2 removals. “Net” emissions (emissions - removals) of CO_2 should be estimated and a single number placed in either the CO_2 emissions or CO_2 removals column, as appropriate. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

SUMMARY 2 SUMMARY REPORT FOR CO_2 EQUIVALENT EMISSIONS
(Sheet 1 of 1)

Estonia
2003

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs	PFCs	SF_6	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**10 389,26**	**1 967,85**	**312,76**	**NO/NE**	**NO/NE**	**NO/NE**	**12 669,86**
1. Energy	**18 830,01**	**770,53**	**44,77**				**19 645,31**
A. Fuel Combustion (Sectoral Approach)	18 830,01	115,48	44,77				18 990,26
1. Energy Industries	15 854,75	8,18	16,53				15 879,46
2. Manufacturing Industries and Construction	419,92	1,50	2,86				424,29
3. Transport	2 146,56	7,05	5,93				2 159,55
4. Other Sectors	408,78	98,74	19,44				526,97
5. Other	NO	NO	NO				NO
B. Fugitive Emissions from Fuels	NO	655,05	NO				655,05
1. Solid Fuels	NO	229,37	NO				229,37
2. Oil and Natural Gas	NO	425,68	NO				425,68
2. Industrial Processes	**276,43**	**NO**	**NO**	**NE**	**NE**	**NE**	**276,43**
A. Mineral Products	276,43	NO	NO				276,43
B. Chemical Industry	NO	NO	NO	NE	NE	NE	NO
C. Metal Production	NO	NO	NO		NE	NE	NO
D. Other Production	NE						NO
E. Production of Halocarbons and SF_6				NE	NE	NE	NE
F. Consumption of Halocarbons and SF_6				NE	NE	NE	NE
G. Other	NO	NO	NO	NO	NO	NO	NO
3. Solvent and Other Product Use	**NO**		**NO**				**NO**
4. Agriculture	**NO**	**464,34**	**267,98**				**732,32**
A. Enteric Fermentation		405,39					405,39
B. Manure Management		58,95	10,22				69,17
C. Rice Cultivation		NO					NO
D. Agricultural Soils[(2)]		NO	257,76				257,76
E. Prescribed Burning of Savannas		NO	NO				NO
F. Field Burning of Agricultural Residues		NO	NO				NO
G. Other		NO	NO				NO
5. Land-Use Change and Forestry[(1)]	**-8 717,19**	**NE**	**NE**				**-8 717,19**
6. Waste	**NO/NE**	**732,98**	**NO/NE**				732,98
A. Solid Waste Disposal on Land	NO	464,99					464,99
B. Wastewater Handling		268,00	NE				268,00
C. Waste Incineration	NE	NE	NE				NO
D. Other	NO	NO	NO				NO
7. Other *(please specify)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Memo Items:							
International Bunkers	**354,69**	**NE**	**NE**				**354,69**
Aviation	NE	NE	NE				NE
Marine	354,69	NE	NE				354,69
Multilateral Operations	**NE**	**NE**	**NE**				**NE**
CO_2 Emissions from Biomass	**2 587,51**						**2 587,51**

[(1)] For CO_2 emissions from Land-Use Change and Forestry the net emissions are to be reported. Please note that for the purposes of reporting, the signs for uptake are always (-) and for emissions (+).

[(2)] See footnote 4 to Summary 1.A of this common reporting format.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 emissions	CO_2 removals	Net CO_2 emissions / removals	CH_4	N_2O	Total emissions
Land-Use Change and Forestry	CO_2 equivalent (Gg)					
A. Changes in Forest and Other Woody Biomass Stocks	10 954,23	-16 031,40	-5 077,17			-5 077,17
B. Forest and Grassland Conversion	NE		NE	NE	NE	NE
C. Abandonment of Managed Lands	NE	-2 673,00	-2 673,00			-2 673,00
D. CO_2 Emissions and Removals from Soil	-967,01	NE	-967,01			-967,01
E. Other	NO	NO	NO	NO	NO	NO
Total CO_2 Equivalent Emissions from Land-Use Change and Forestry	9 987,21	-18 704,40	-8 717,19	NE	NE	-8 717,19

Total CO_2 Equivalent Emissions without Land-Use Change and Forestry [(a)]	21 387,05
Total CO_2 Equivalent Emissions with Land-Use Change and Forestry [(a)]	12 669,86

[(a)] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report emissions and removals from Land-Use Change and Forestry.

TABLE 10 EMISSION TRENDS (SUMMARY)
(Sheet 5 of 5)

GREENHOUSE GAS EMISSIONS	Base year[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	CO_2 equivalent (Gg)														
Net CO_2 emissions/removals	31 787,45	31 787,45	28 752,03	18 325,28	10 857,88	13 773,17	11 533,02	10 656,55	11 117,78	9 795,40	8 663,72	8 483,73	7 685,49	8 748,07	10 389,26
CO_2 emissions (without LUCF) [6]	38 107,41	38 107,41	35 914,91	26 141,80	20 553,41	21 378,07	19 314,97	20 263,76	20 224,61	18 317,70	16 770,89	16 848,88	17 102,92	17 311,86	19 106,44
CH_4	4 363,04	4 363,04	3 667,70	2 975,61	2 409,11	2 631,30	2 561,26	2 694,48	2 866,12	2 663,54	2 450,77	2 402,93	1 969,26	1 897,92	1 967,85
N_2O	1 023,54	1 023,54	1 001,99	816,80	527,00	472,85	410,42	386,64	423,22	430,34	358,82	414,06	363,62	313,97	312,76
HFCs	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
PFCs	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
SF_6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total (with net CO_2 emissions/removals)	**37 174,03**	**37 174,03**	**33 421,71**	**22 117,70**	**13 793,98**	**16 877,32**	**14 504,70**	**13 737,67**	**14 407,12**	**12 889,28**	**11 473,31**	**11 300,72**	**10 018,37**	**10 959,96**	**12 669,86**
Total (without CO_2 from LUCF) [6]	**43 493,99**	**43 493,99**	**40 584,60**	**29 934,22**	**23 489,51**	**24 482,22**	**22 286,66**	**23 344,89**	**23 513,95**	**21 411,59**	**19 580,48**	**19 665,87**	**19 435,80**	**19 523,75**	**21 387,05**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year[1]	1 990,00	1 991,00	1 992,00	1 993,00	1 994,00	1 995,00	1 996,00	1 997,00	1 998,00	1 999,00	2 000,00	2 001,00	2 002,00	2 003,00
	CO_2 equivalent (Gg)														
1. Energy	38 828,52	38 828,52	36 605,91	26 734,52	20 957,69	21 873,98	19 891,46	20 947,80	20 873,12	18 716,62	17 154,85	17 308,36	17 589,92	17 733,70	19 645,31
2. Industrial Processes	613,74	613,74	614,67	313,46	193,06	214,87	221,45	207,01	226,02	367,63	346,79	354,33	355,58	340,48	276,43
3. Solvent and Other Product Use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
4. Agriculture	2 440,45	2 440,45	2 327,58	2 049,84	1 480,46	1 358,08	1 116,72	909,05	920,58	911,48	774,67	807,59	768,94	701,99	732,32
5. Land-Use Change and Forestry [7]	-6 316,57	-6 316,57	-7 159,90	-7 813,94	-9 693,35	-7 603,09	-7 781,79	-9 607,04	-9 106,71	-8 522,19	-8 107,17	-8 365,14	-9 417,43	-8 563,79	-8 717,19
6. Waste	1 607,88	1 607,88	1 033,45	833,81	856,12	1 033,48	1 056,87	1 280,86	1 494,12	1 415,74	1 304,18	1 195,60	721,36	747,57	732,98
7. Other	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

[6] The information in these rows is requested to facilitate comparison of data, since Parties differ in the way they report CO_2 emissions and removals from Land-Use Change and Forestry.

[7] Net emissions.