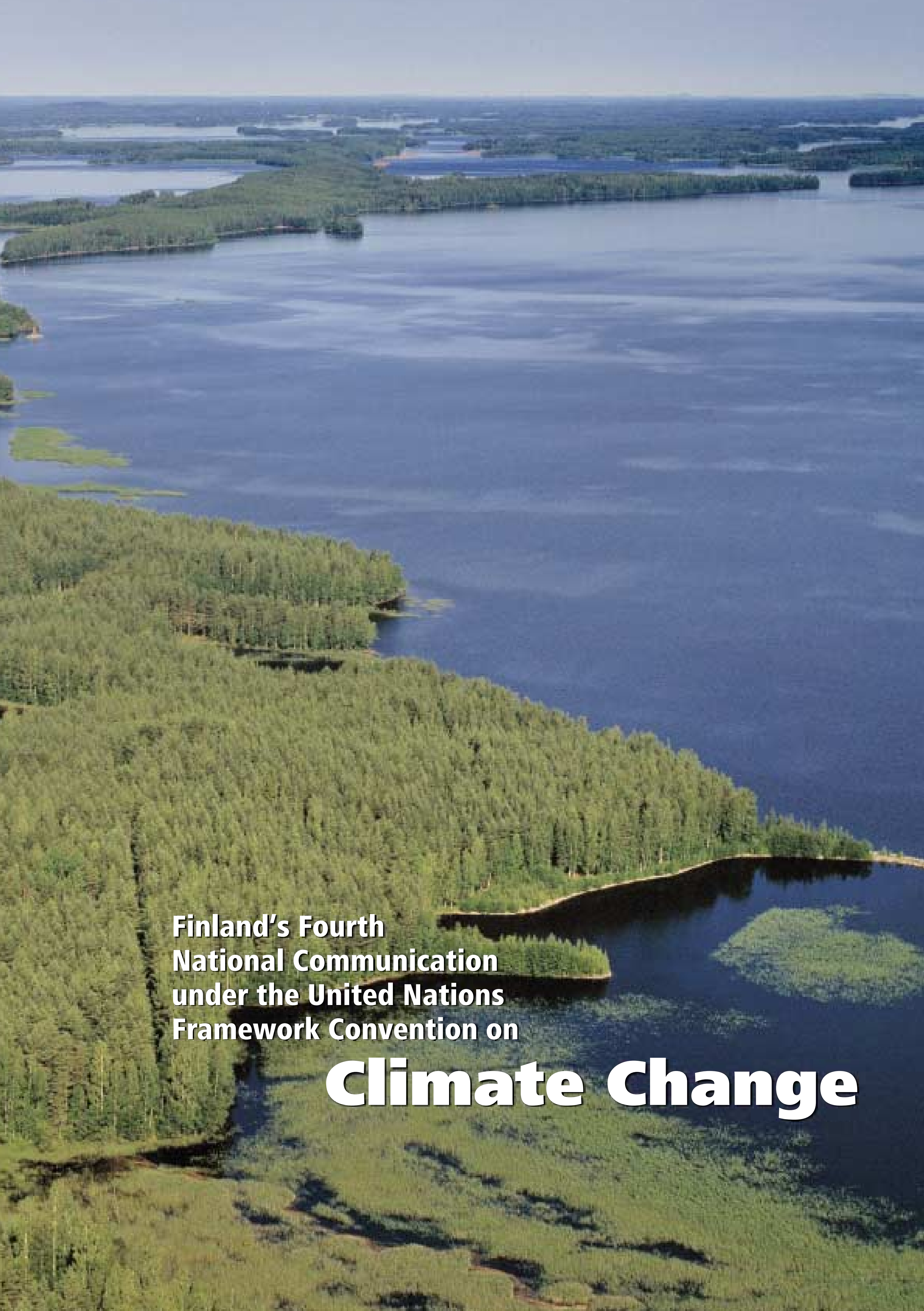

Finland's Fourth National Communication under the United Nations Framework Convention on Climate Change

Finland's Fourth National Communication under the United Nations Framework Convention on Climate Change

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ISBN 951–731–360–8 (volume)
ISBN 951–731–361–6 (pdf)

Printed by: Hämeen Kirjapaino Oy, Tampere 2006

Contents

Foreword

The present document, *Finland's Fourth National Communication to the United Nations Framework Convention on Climate Change (UNFCCC)*, is based on the recently updated National Climate Strategy (National Energy and Climate Strategy). The Government presented its latest thinking in the National Strategy for implementation of the Kyoto Protocol as a White Paper to Parliament in November 2005.

Finland ratified the Climate Change Convention in June 1992 and it entered into force in Finland at the beginning of August 1994. Since then, the Government has implemented various policies and measures to reduce greenhouse gas emissions in Finland and to fulfil its other commitments in climate policy, for example, setting up the necessary administrative frameworks and providing financial assistance to developing countries. The recent governmental climate policy report is more comprehensive than the first strategy of May 2001, with a special focus on fulfilling the Kyoto commitments.

As a Member of the European Union, Finland has agreed with the other Member States on the legally binding commitments of the Kyoto Protocol to reduce greenhouse gas emissions as a whole. Under the burden-sharing agreement between the EU-15 Member States, Finland is committed to stabilising its emissions at the 1990 level in the first commitment period of the Protocol. The European Union as a whole shall reduce its annual emissions by eight per cent on average over a 5-year period from 2008 to 2012 compared to the 1990 base-year emissions.

During the last 15 years, Finland's greenhouse gas emissions have fluctuated considerably owing to economic trends in the energy-intensive industries, the generation of hydropower, electricity imports, and the availability of other non-carbon energy sources. In 2004, Finland's emissions were over 10 per cent above the commitment. We expect that the European Union's Emissions Trading Scheme and our climate policy will considerably reduce Finland's greenhouse gas emissions.

Emission levels have been reduced in Finland by measures aimed at improving energy efficiency, increasing the production and utilisation of renewable energy sources, especially biomass, introducing energy taxation, and curbing methane emissions from waste management, landfills and agriculture. The updated strategy recognises that additional measures need to be taken in energy production and consumption, transport, the building sector, spatial and urban planning, the control of emissions from agriculture and forestry, and waste management.

In addition, the Government has decided to take two further measures to make the strategy more comprehensive: determining how to implement the Kyoto Mechanisms and preparing detailed adaptation plans for adapting to the climate change at an early stage.

One important milestone in implementing the Kyoto Protocol was the establishment of the National System of greenhouse gas inventories in January 2005. Statistics Finland was nominated to act as the National Authority and to independently prepare and send the National Inventory Report to the European Commission and the UNFCCC Secretariat. Finland has been considering the possibility of participating in projects to acquire emission reduction units and allowances under the Kyoto Mechanisms and, for this reason, has nominated other Designated National Authorities for the implementation of the CDM and JI.

The Fourth National Communication is the result of co-operation between Finnish governmental bodies. The preparation committee was composed of the Ministry of Trade and Industry, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry, the Ministry of Education, the Ministry for Foreign Affairs, the Ministry of Finance, the Ministry of the Environment and the Finnish Environment Institute. Dr. Esko Kuusisto from the Finnish Environment Institute acted as the chief editor of the report. Statistics Finland coordinated the work and compiled the report. The Government approved the report to be sent to the UNFCCC after the finalisation of the National Energy and Climate Strategy.

Although a great deal has been done already, much still need to be done to achieve clear, demonstrable progress in emissions reductions and in the protection of the climate in the future.

Helsinki, December 2005

Mr. Jan-Erik Enestam
Minister of the Environment



1 *Executive summary*

1.1 National circumstances

Finland is one of the northernmost countries in the world. With a total area of 338,145 km², it is Europe's seventh largest and the EU's fifth largest country. As much as 74% of the land area is classified as forest land; only nine per cent is cropland. Lakes and various kinds of peatlands are characteristic features of the Finnish landscape.

The climate of Finland is cold, although, on the average, several degrees warmer than in most areas in the same latitudes. Heating requirements are high in winter months. The growing season is short, limiting both agricultural production and forest growth.

The population of Finland is around 5.2 million, making Finland the third sparsest populated country in Europe. The population increase is very slow, and the population is rapidly aging. About one million people live in the Helsinki metropolitan area. There is a strong internal migration from small municipalities to urban areas.

Finland has a highly industrialized economy, which is rapidly integrating with Europe and the world. The key economic sector is manufacturing – principally the wood, metals, engineering, telecommunications, and electronics industries. Trade is important, with exports equalling two-fifths of gross domestic product (GDP). Almost 90% of the paper and board production is exported, and in the base metal industry the share of export products is also high. Thus, a lot of energy is also used to export products. The majority of Finland's exports go to the European Union, other important trading partners being Russia, United States and the emerging market economies like China.

For a number of decades the Finnish economy was characterised by fast growth combined with sensitivity to international cyclical fluctuations. In the early 1990s, Finland fell into a deep recession: the rate of unemployment increased to 17%, and the GDP plummeted by about ten per cent between 1991 and 1993.

The pre-recession level in private consumption was regained in 1997, and companies were also successful in bolstering their financial structures. The governments have targeted the economy as the first priority, trying to reduce employment and the indebtedness of state finances. In recent years, the Finnish economy has been growing fast – between 1997 and 2003 GDP grew by an annual average of 3.6 per cent. In 2003, Finland's gross national product per capita was around EUR 27,500, as compared to EUR 17,700 in 1990.

The recent development has propelled Finland to the top ranks of global comparison studies. For example, Finland was number one in the World Economic Forum's competitiveness ranking in 2001 and 2003, and number two in 2002. Since 2000, most recently in 2005, Finland has also been the leading country in the World Economic Forum's Environmental Sustainability Index (ESI), benchmarking countries on the basis of their national environmental stewardship.

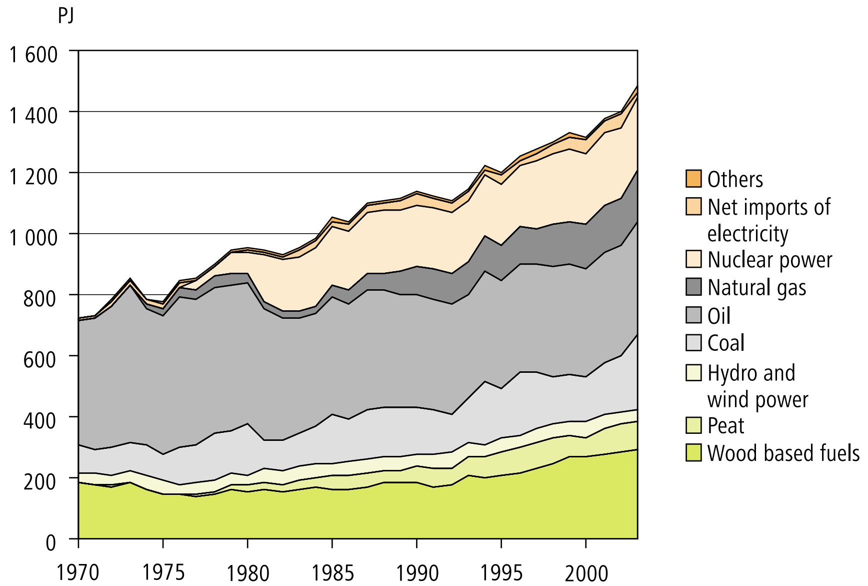
Since Finland is largely dependent on imported fuels, the cornerstones of the Finnish energy policy must be diversified and reliable supply of energy and improved self-sufficiency. Sustainable development, environmental issues and global climate change also call for diversified energy production. The energy intensive basic industries, the cold climate and long distances highlight the significance of energy to the competitiveness of Finland and the welfare of the people.

In 2003, the gross consumption of primary energy in Finland amounted to 1488 PJ (Fig. 1–1). The most notable decrease has taken place in oil consumption, which still accounts for 25% of total primary energy supply. Among the energy sources whose use has recently been increasing are wood-based fuels and natural gas. Owing to the upgrading of the existing nuclear power plants in 1995–1998, the share of nuclear energy in Finland's diversified energy mix has increased. The fifth nuclear reactor is under construction and shall start operating in 2009.

Renewable energy sources covered 22% of total primary energy supply in 2003. In spite of the fluctuation in hydropower, renewables are on an uptrend. This development is mostly due to the increased use of biofuels originating in industrial wood processing.

Combined heat and power production (CHP) provides opportunities for cost-effective use of renewables, both in industry and at district heat plants. The amount of energy Finland saves annually through CHP corresponds to over one tenth of all primary energy used in the country. The share of CHP is over one third of the electricity production, the EU average being 10%. CHP accounts for 75% of the total heat produced in district heating.

Figure 1–1 Gross consumption of primary energy in Finland in 1970–2003.



The energy demand of industry is very high in Finland; in 2003 the industry used 50% of total primary energy and 54% of total electricity. Finnish industry has also worked hard to improve its energy efficiency. Besides, the forest industry relies to an appreciable degree on biomass to meet its energy needs; wood residues, black liquors and other biomass energy sources are effectively utilized.

The Finnish electricity market was gradually opened up for competition with the Electricity Market Act in 1995. Since the autumn of 1998, it has been possible for all electricity consumers, including households, to arrange tender competitions for their electricity purchases. The electricity market reform aimed to improve efficiency and environmental benefits, as the Nordic hydropower capacity is taken into efficient use and the market also allows the so-called green electricity trade.

There are 79,000 km of public roads in Finland, 25,000 km of streets, and 280,000 km of private roads. Finland has 2.6 million automobiles; the number increased by 17.6% in the period 1990–2003. The rail network amounts to a total of 5,900 km. Three-fourths of Finland's foreign trade is carried on by ship, and the harbours are its principal traffic nodes.

There were 4.75 million mobile telephone connections in Finland at the end of 2003, equivalent to 909 per one thousand inhabitants. The number of Internet connections was 1.23 million, i.e. 235 per one thousand.

Finland is the world's northernmost agricultural country. However, the number of people living in rural areas and obtaining their livelihood from agriculture has been shrinking at a very high rate for many years. Between 1990 and 2003, the number of active farms fell from 130,000 to 74,000. At the same time, the average farm size increased from 17.3 to 30.5 arable hectares.

The total volume of stock in Finnish forests amounts to over two billion cubic metres. For decades, the increment of stock has exceeded harvesting volumes and natural drain. Today, the annual increment of all forests is about 87 million cubic metres. Almost half of the original peatland area in Finland has been drained for forestry purposes, which has considerably increased the annual increment of stock. The area of forests strictly protected from fellings totals 1.5 million hectares.

The total consumption of domestic roundwood amounted to 63 million m^3 in 2003. In addition, 16 million m^3 of roundwood was imported. In 1990, the corresponding figures were 50 and 6 million m^3, respectively.

In today's forest sector, Finland's success on the market is based on close cooperation among the forest industry, equipment manufacturers, raw material suppliers and research and development. The forest cluster employs almost 200,000 people in Finland. Its turnover in Finland is about EUR 35 billion and the value added is around EUR 12 billion. The Finnish forest cluster annually invests some EUR 250 million in research and development. The cluster's contribution to the Finnish economy is almost 10% of GDP, about 30% of industrial production and about 35% of net export revenue.

Approximately 119 million tonnes of waste and comparable by-products were generated in Finland in 2003. Of this total amount, the largest quantities are surplus soil from construction (32.7 Mt), waste stone, ore dressing sand and other soil material from mining and quarrying (25.0 Mt), straw and manure from agriculture (21.3 Mt) and wood felling waste from forestry (23.0 Mt). Altogether 12.0 Mt of waste were generated in manufacturing in 2003. The annual volume of solid municipal waste amounted to 2.3 million tonnes.

On average, 40 per cent of all the generated waste are recovered by the national economy as a whole. Wastes like surplus soils from construction, as well as manure and straw, were recovered in large volumes. Manufacturing recovered 70 per cent of its waste, either as energy or as raw material. Good one-third of both the municipal waste and the construction and demolition waste generated were recovered in 2003.

The waste disposal tax was raised to 23 €/ton from the beginning of 2003. In order to support the progress of biological treatment of separately collected biowastes and sludges from municipal waste water treatment plants, the treatment is not subjected to taxation.

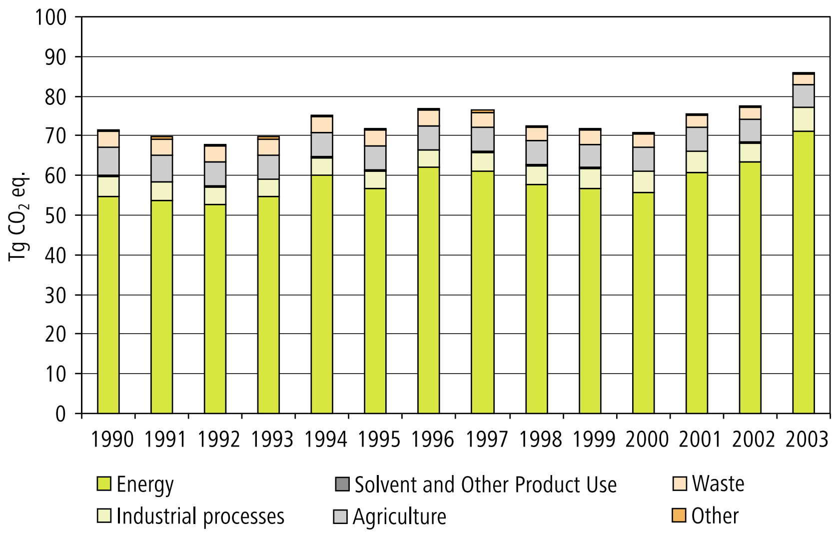
1.2 Greenhouse gas inventory information

Statistics Finland has had the responsibilities of the National Authority for the greenhouse gas inventory since January 2005. In the preparation of the inventory, Statistics Finland co-operates closely with several ministries and has made separate agreements on the production of emission calculations with expert organisations.

Finland's greenhouse gas emissions totalled 86.0 Tg CO_2 eq. in 2003 (Fig. 1–2). This was over 20 per cent more than in the base year 1990 and 11 per cent above the emissions in 2002. The main reason for the exceptionally high emissions in 2003 was the limited availability of hydropower in the Nordic electricity market, which increased coal and peat-fuelled condensing power generation in Finland.

The energy sector is the most significant source of greenhouse gas emissions in Finland with over 83% share of the total emissions. This reflects the high energy intensity of Finnish industry, extensive consumption during the long heating period, as well as energy consumption for transport in a large and sparsely inhabited country. Energy related CO_2 emissions vary mainly according to the economic trend, the energy supply structure, and

Figure 1–2 Greenhouse gas emissions in Finland in 1990–2003 by reporting categories.



climate conditions. Due to these reasons, there was a 16.2 Tg CO_2 (+30%) increase in the energy sector's CO_2 emissions between the years 1990 and 2003 (but only 8.3 Tg CO_2 between 1990–2002). Total energy sector emissions were 16.8 Tg CO_2 eq. higher in 2003 than in 1990.

Greenhouse gas emissions from transport remained rather constant in 1990–2001, but increased by 1.7% in 2002 and by the same amount in 2003. Almost 90% of these emissions originate from road transport, where the volume of passenger transport increased by 13% and the volume of goods transport by 23% in 1990–2003. The CO_2 emissions from passenger transport decreased during 1990–2001, because of improved fuel efficiency of cars, and also due to an increase in the share of diesel-fuelled cars. In recent years the CO_2 emissions from passenger cars have risen above 1990 levels. In goods transport the emissions have increased.

Agricultural greenhouse gas emissions accounted for 6.7% (5.7 Tg CO_2 eq.) of total emissions in 2003. Emissions from agriculture include CH_4 and N_2O emissions. Total emissions from agriculture have a clearly decreasing trend. The annual emissions have decreased by over 19% since 1990 due to decreases in the cultivation of organic soils, in the number of livestock, and in nitrogen fertilizer use.

The emissions from industrial processes including CO_2, CH_4, N_2O and F-gases were in 2003 about 7% of total greenhouse gas emissions in Finland. Emissions from process industry have increased about 9% since the 1990 level, but their share of the total greenhouse gas emissions has remained relatively constant. The share of emissions from solvents and other product use in the Finnish greenhouse gas emissions is small, about 0.1% of the total emissions.

The waste sector accounted for 3.2% (2.8 Tg CO_2 eq.) of total emissions in 2003. Emissions from the waste sector consist of CH_4 and N_2O emissions, and have had a decreasing trend since 1990. Overall, the annual emissions have decreased by over 30% since the 1990 level. The decrease has been mainly due to the preparation and implementation of the new waste law in Finland in 1993.

The LULUCF sector as a whole acts as a CO_2 sink in Finland. The CO_2 emissions from cropland and grassland, as well as forest soils and peat extraction, direct N_2O emissions from fertilisation of forest land and CO_2, N_2O and CH_4 emissions from biomass burning on forest land are much smaller than removals, i.e. the increase in carbon stock in tree biomass and dead organic matter on forest land. In 2003 the LULUCF sector as a whole was a sink of about 17.8 Tg CO_2 eq., which is about one-fifth of the total greenhouse gas emissions from other sectors in Finland.

Emissions from international bunkers amounted to 3.1 Tg CO_2 eq., equivalent to 3.6% of total greenhouse gas emissions in Finland in 2003. About two-thirds of the emission come from marine bunkers and one-third from aviation. The annual emissions from international bunkers fluctuated considerably until 1999, thereafter they have been quite stable.

The emissions of nitrogen oxides decreased by 26%, carbon monoxide by 20%, non-methane volatile organic compounds by 35%, and sulphur dioxides by 59% in 1990–2003.

Quality management and uncertainty estimation are integral parts in the preparation of the greenhouse gas inventory in Finland. In 2003, the total uncertainty in the inventory (including LULUCF) was from –14 to +15% when expressed as the bounds of a 95% confidence interval. The uncertainty without LULUCF was –4 to +8%. The trend uncertainty was –18 to +23 percentage points with LULUCF and –6 to +4 percentage points without LULUCF. The uncertainty by gas was by far the smallest for CO_2, ±2%, and the sectoral uncertainly was smallest for energy, –2 to +3%. Both of these refer to the year 2003. For other gases and sectors, the uncertainties were considerably higher.

1.3 Policies and measures

1.3.1 Policy-making process

Finland ratified the UN Framework Convention on Climate Change (UNFCCC) on 3 May 1994. Finland signed the Kyoto Protocol on 29 May 1998, and ratified it on 31 May 2002, together with the other fourteen EU member states.

Finland joined the European Union at the beginning of 1995. In the field of climate policy, it is recognized that the Common and Co-ordinated Policies and Measures (CCPM) at the Community level are an important cornerstone. However, these measures are a supplement to national climate policy. The Member States are responsible for their obligations under the EU burden sharing agreement; Finland's target is to bring her average annual greenhouse gas emissions down to their 1990 level by the 2008–2012 period.

Finland has an extensive institutional framework for climate policy issues. As to the international climate policy, the Government and the Parliament are in charge of important decisions. The United Nations Framework Convention on Climate Change falls within the administrative responsibility of the Ministry of the Environment.

The Ministerial Working Group on Climate Change and Energy, headed by the Ministry of Trade and Industry, is responsible for e.g. co-ordination of the National Energy and Climate Strategy. The group also prepares Finnish guidelines for international climate negotiations, and ensures planning at the national level and the coherence of Finland's position before matters are discussed in the Cabinet Committee on EU Affairs.

High Level Working Group of Government Officials, again headed by the Ministry of Trade and Industry, has an essential role in the preparation of domestic climate policy issues. Stakeholder involvement and support for the preparation and implementation takes place via the Climate Forum, expert organisations, universities and others. The Climate Forum is a body with representatives from ministries and other Government organisations, regional and municipal administration, industry and NGOs.

The Ministry of the Environment is responsible for a large part of environmental issues, and also for building codes and regional planning. The Ministry of Agriculture and Forestry and the Ministry of Transport and Communications are responsible for climate change issues in their administrative sectors. In addition, the Ministry for Foreign Affairs and the Ministry of Finance are important parties in climate change mitigation. The Ministry of Education finances universities and the whole education system in climate change issues.

Two national organisations are especially relevant to climate change mitigation: Motiva Oy is an independent, non-profit company, whose main task is to provide information on the impact of energy conservation and renewable energy sources to end-users of energy. TEKES, the National Technology Agency in Finland, is the main public financing and expert organisation for research and technological development.

The regional and local authorities make numerous decisions on matters that affect greenhouse gas emissions, such as traffic and land use planning, waste management, and energy consumption and production. These authorities work in many different ways to reduce greenhouse gas emissions; for example, they have their own energy saving programmes and agreements, and they promote the use of renewable energy sources.

Many other stakeholders play an important part in the Finnish climate policy. Non-governmental organisations, including environmental, business, social and research organisations, are involved in different working groups, seminars and official delegations.

1.3.2 Sectoral policies and measures

1.3.2.1 Energy sector

The work for the National Energy and Climate Strategy (NECS) was started in 2003, a special ministerial working group being in charge. The Act on Emissions Trading was drafted in 2004 in close co-operation with the different administrative branches and interest groups involved. A draft plan for the allocation of emissions allowances was submitted to the Commission and the other Member States in March 2004.

The Government presented the National Energy and Climate Strategy to the Parliament at the end of November 2005. The strategy defines the measures for meeting Finland's obligations under the Kyoto protocol. The main measures to be used are allocation of emission allowances under the EU's Emissions Trading Scheme (ETS), domestic measures such as energy conservation and facilitation of the use of renewable energy. Because the costs of mitigation are high in Finland, the Government has decided to acquire emission reductions. The strategy will ensure a reliable supply of energy at competitive prices and improve the efficiency of the use of energy. The strategy will also increase the use of renewable energy.

The general objective of Finland's energy policy is to ensure energy security at competitive prices. The energy supply is quite diversified and energy imports cover about 70% of total use. During the past two decades, energy supply has shifted away from oil and coal towards wood-based fuels, peat, natural gas and nuclear energy. Industry accounts for about half of total energy use and its share is increasing over time.

Direct Government intervention to guide the choice of energy sources is rare, apart from decisions regarding the use of nuclear power. However, economic instruments, i.e. taxation and subsidies, have been used to improve energy efficiency and to promote the development of domestic energy sources such as peat and renewable biomass.

In the 'With Measures' Scenario in the energy sector, the construction of a new nuclear reactor is quantitatively the most efficient way to reduce CO_2 emissions. Emission reduction due to this measure is estimated to be some 8 Tg per year, if the same amount of electricity were produced with coal condensing power, which is the marginal mode of electricity production in Finland.

The electricity market in Finland operates as part of the regional Nordic market; all customers have been able to change their supplier since November 1998. The consumers are also able to select electricity produced from renewable energy sources at a higher price. Energy taxation is one of the pillars of the Finnish energy and climate strategies. Quantitative assessment of the CO_2 emission reductions of the Electricity Market Act and energy taxation is, however, difficult.

The Energy Conservation Programme consists of measures in all sectors of the economy. The programme has a variety of different energy conservation measures, but only part of them have so far been implemented. All of the measures which have been implemented are included in the WM Scenario. When the Programme was drafted, the total effect of energy conservation measures was estimated to be 3–4 Tg in 2010. However, allocation of resources has not come true to the degree planned, so the actual reduction may be somewhat lower.

The Action Plan on Renewable Energy Sources (RES) was approved in 1999. The target was to increase the use of RES by 30% up to the year 2010 in relation to year 2001. The plan also defined a national target of RES for 2010 as 31.5% of the electricity demand. In 2001, bioenergy without peat covered 20% of the primary energy consumption and 10% of the electricity demand in Finland, which are the highest figures in the industrialised countries. The key instruments to promote the use of RES are investment grants, taxation, subsidies and supporting research. The total effect of the Action Plan on CO_2 emissions was estimated to be 4–5 Tg in 2010.

The main policy in the 'With Additional Measures' Scenario in the energy sector will be the allocation of emission allowances under the Emission Trading Directive. It is estimated to reduce the emissions by 0.8 Tg per year in the 2005–2007 period, and by 5.9 Tg per year in the 2008–2012 period.

Finland launched a CDM/JI Pilot Programme in 1999 in order to develop her capacity to apply project-based mechanisms. Under the programme Finland has both bilateral CDM and JI projects. It has been estimated that through the Pilot Programme Finland will acquire Assigned Amount units by 0.4 Tg per year. The additional use of Kyoto Mechanisms by the Government will be 2.0 Tg per year in 2008–2012. Thus the Assigned Amount units will be raised by 2.4 Tg per year in the Kyoto commitment period.

1.3.2.2 Other sectors

In the transport sector, lack of reform of vehicle taxation, immaterialisation of increased energy efficiency of new registered cars and increase in importation of used vehicles from abroad have led to a slight increase of greenhouse gas emissions in recent years. The policies and measures to reduce the emissions in the WM Scenario include voluntary agreements with car industries, differentiation of vehicle taxation, promotion of public and non-motorised transport, eco-driving and energy saving agreements. The overall effect of these policies and measures is estimated to be 1 Tg CO_2 eq. in 2020.

There is not much difference between the WM and WAM scenarios of the transport policy, because most of the measures supporting reduction of CO_2 emissions are already part of the current policy and also already implemented because of other policy reasons. The main areas of action where additional measures might be needed are possible increase of fuel taxation, additional measures to maintain the urban structure and increased use of biofuels. These measures could reduce the CO_2 emissions by 0.5 Tg CO_2 eq. in 2020.

Greenhouse gas emissions from industrial processes are fairly low in Finland and have been quite stable from year to year. However, the share of the F-gases has gone up rapidly and amounted to one-fifth of the emissions from industrial processes in 2003. Without further measures their share will be about 15% by 2010. A new directive on F-gases is under preparation in the European Union. It would e.g. limit the use of these gases in certain applications and set requirements for regular inspections to prevent leakages. The use of F-gases in air conditioning systems of cars would also be limited by the directive. Together, these measures are estimated to reduce F-gas emissions by 0.4 Tg CO_2 eq. in the Kyoto commitment period.

Policies and measures included in the WM scenario in the agriculture sector include Agenda 2000 and nitrate statute. The Agenda contains agri-environmental support measures for 2000–2006; their main focus is not to reduce greenhouse gas emissions but together with the structural change in the Finnish agriculture sector the support has enabled a significant reduction of greenhouse gas emissions in agriculture; they have decreased from 7.1 Tg CO_2 eq. in 1990 to 5.7 Tg CO_2 eq. in 2003.

The agri-environmental programme is under review in 2005. The new programme with improved measures is expected to support achievement of the target set for greenhouse gas emissions from 2006 onwards. In agriculture, a WAM-projection has not been developed. However, the feasibility of additional measures will be assessed.

As to agricultural mineral soils, it is still difficult to assess whether they act as a source or sink of carbon dioxide in Finland. CO_2 emissions from the cultivation of organic soils are estimated to decrease from 1.9 Tg CO_2 in 1990 to 1.0 Tg CO_2 in 2010. Carbon dioxide emissions due to liming would decrease from 0.6 Tg to 0.4 Tg, respectively. Finland is not going to use the activities under Article 3.4 related to the agricultural soils (cropland management, grazing land management and revegetation) in the first commitment period.

The Finnish Forest Research Institute has estimated that the afforestation of agricultural lands and grasslands would create an average annual carbon sink of 0.3–0.6 Tg CO_2 in the 2008–2012 period. On the other hand, the clearing of forest land for agricultural purposes would create a carbon source of 0.3–0.5 Tg CO_2 in the same period. The net effect from these two activities on carbon storages would also be very small. The clearance of forest land for agricultural purposes has been limited, as from 2004 onwards newly cleared land areas have not received agricultural support. The clearance of forests for settlements would cause an annual net source of 0.9 Tg CO_2 in the 2008–2012 period.

The measures related to forest management can be partially taken into account according to the Article 3.4. of the Kyoto Protocol; the ceiling for Finland is 0.59 Tg CO_2/a in 2008–2012. Due to a number of uncertainties and risks, Finland is not going to use this option in the first commitment period.

Government decisions on landfills, waste minimization and recovery measures and the waste tax have lowered considerably Finland's greenhouse gas emissions from waste management in the 1990s. These measures are also included in the WM Scenario of the National Energy and Climate Strategy.

The Revised National Waste Plan, approved by the Finnish Government in 2002, sets quantitative and qualitative targets to be achieved by 2005.

Furthermore, the handling of biodegradable municipal waste at landfills will be reduced, in accordance to the Waste Directive of the EU, to 75% of 1995 levels by 2006, 50% by 2009 and 35% by 2016.

The additional measures included in the WAM -projection in the waste sector cover collection of landfill gas, further minimization and utilization of waste, biowaste strategy and development of waste taxation. The emission reduction of landfill gas recovery is estimated to be 0.1 Tg CO_2 eq. in 2010, the effects from other measures has not been estimated. The preparation of a new National Waste Plan, with targets for 2015, started in 2005. It will be finalised in 2006, and integrated into other relevant plans and programmes.

1.3.3 Taxation and subsidies

Finland was the first country to introduce a CO_2 tax in 1990, initially with a few exemptions for specific fuels or sectors. Since then, however, energy taxation has been changed many times and substantially, from a low but "pure" CO_2 tax to a much higher but much less CO_2-related tax. In 2003, the CO_2 tax was about 15 times higher than in 1990.

Besides its fiscal significance on the Government finances, energy taxation is a central instrument of energy and environmental policy. It aims to curb the growth of energy consumption and steer the production and use of energy towards alternatives causing less emissions.

The current energy taxation scheme has been in use since 1997. Energy taxes are excise duties, and they are levied on traffic and heating fuels, and on electricity. The energy tax divides into basic tax and surtax. The basic tax is fiscal by nature and collected on oil products only. The surtax is collected on oil products, other fossil fuels and electricity. Since 2003, the surtax on fuels has been EUR 18.05 per carbon dioxide tonne. Natural gas is an exception with its 50% reduction in surtax, as well as peat, whose tax and tax subsidies in electricity production were removed in July 2005.

Electricity is taxed at its consumption stage. The tax on electricity is divided into two classes, of which the lower, class II, tax is paid by industry and professional greenhouse cultivation. The energy taxation scheme also includes various subsidies. Of these, the most important ones in terms of energy policy are tax subsidies paid for power production based on renewable energy sources.

In heat generation, solid biofuels like wood fuels, biogas and recovered fuels (REF) are not taxed. Since the beginning of 2003, wind power, hydropower of under 1 MW, electricity produced with wood and wood-based fuels, recycled fuels and biogas are eligible for tax subsidies. These subsidies amounted to EUR 36 million in 2003.

Vehicle and fuel taxation have traditionally been at a relatively high level in Finland by international comparison. In 2003, the state received an income from vehicle taxation of about EUR 1.3 billion and from fuel taxation EUR 2.2 billion. – The waste tax is applied to wastes excluding soils disposed to municipal landfills. In 2003, the tax rate was EUR 23/tonne, in 2005 it was raised to EUR 30/tonne. The tax is paid by the owner of the landfill.

Energy subsidies also constitute an important means of implementing the National Energy and Climate Strategy. They are granted for energy investments, development projects and energy conservation, to promote use of renewable energy sources, and to reduce the environmental impacts arising from energy generation and use. The maximum subsidy for new investments of conventional technology will be 30%. For investments of new technology and of wind and solar technology the maximum subsidy is 40%. Finland's present energy taxation system has three elements, which the EU Commission has interpreted as state subsidies and approved them only temporarily. These include the differentiation of electricity tax, refunding of taxes paid by electricity-intensive industries, and tax subsidies for electricity production.

In order to safeguard international competition of the industry under the EU's Emissions Trading Scheme the electricity tax on industry will be lowered. Tax subsidies for electricity produced from black liquors and other waste fuels of industry will also be removed.

1.3.4 Research and development

There are several important national research and development programmes that have an impact on GHG emissions. Development of energy technology is one of the key activities in national energy and climate policy. Advanced technology and utilisation of technology play an important role in achieving reduction in energy use and emissions. Furthermore, the goal is to increase the export of energy technology.

Development of new technology and promotion of its introduction onto the market is directed at sectors of technology and know-how that are inherent in the Finnish conditions. Thus, promotion of energy conservation and use of bioenergy are in a prominent position.

The Government's support for research and development work is channelled to a great extent via the National Technology Agency (TEKES). This organisation finances projects for developing industrial products and production methods, applied technical research at research institutes and universities as well as joint technology projects run by companies and research institutes. Other funding organisations are the Academy of Finland and the Finnish National Fund for Research and Development (SITRA). Ministries and several foundations also fund climate change related research. The Technical Research Centre of Finland (VTT) is responsible for the implementation of a number of the national energy technology research programmes. Several research institutes and universities carry out research related to climate change mitigation.

1.3.5 Economic impacts

The emission reduction policies will slow down the national economy as compared to a situation without such policies. According to the Government Institute for Economic Research (VATT), GDP is estimated to fall by 0.9% in the Kyoto commitment period if the price of emission allowance under ETS is EUR 20/tCO_2. Private consumption would decrease by 2.2% and investments by 0.3%. With an allowance price of EUR 10/tCO_2, the corresponding reductions would be 0.6%, 1.4% and 0.1%.

The Government's involvement in emissions reductions through the Kyoto mechanisms will reduce the costs to the national economy. In the Kyoto commitment period the reduction will be relatively small, but it will be more clear after it, with the anticipated tightening of reduction targets.

The National Energy and Climate Strategy will induce some changes to the energy taxation system and energy subsidies. If the tax on the electricity used by industry and greenhouse cultivation is assumed to be reduced by 50%, the decrease in the Government's revenue would be EUR 120 million per year. Total energy-related tax income would be around 8% lower in the Kyoto commitment period than in 2003.

The most significant change to Government finances will come from the use of Kyoto Mechanisms. The Government aims to finance the acquisition of some 10 Tg of Kyoto compatible credits in the 2008–2012 period.

The Government's financing for technological research and product development will continue in the Kyoto commitment period. However, the financing will be channelled more towards new technology than berofe, as also will be energy subsidies for investments. Especially in the emissions trading sector only new technology projects will be given energy subsidies.

1.4 Projections and assessment of policies and measures

1.4.1 'With Measures' Scenario

1.4.1.1 Starting points and assumptions

Table 1–1 shows a summary of the essential assumptions of the WM Scenario for three different periods. As to energy production, it is assumed that the fifth nuclear power plant will be completed in the latter half of the year 2009. The natural gas network is assumed to develop so that it reaches the Turku region in south-western Finland at the end of this decade. In the energy production of industry and communities, natural gas is a competitive fuel in the areas where it is supplied.

The production of industrial back pressure power, i.e. combined heat and power (CHP) production, is mainly bound to development in the heat consumption of the forest industry. The use of coal in condensing power plants is assumed to increase until the completion of the new nuclear power unit and to decrease after that. The competitiveness of wood fuels is assumed to improve further, though the WM Scenario does not include assumptions regarding new tax solutions supporting the competitiveness of wood.

In its natural market area, peat mainly competes with wood in CHP production. The consumption of peat will grow in the production of electricity and heat for communities. In industry, the use of peat remains stable but in the production of condensate power peat is not competitive with the assumptions made.

The production of wind power would grow by more than 10 per cent per year in the next few years and by a little less than 10 per cent at the end of the period examined. The proportion of the use of ground heat will grow from the current level especially in detached houses. The utilisation of wastes in the production of district heat will remain at its current level, while the use of methane from landfills will grow clearly.

No quick technological leaps or transfers are expected in the period examined. The best commercial technology will be introduced gradually, and increasingly efficient technology will be commercialised evenly. The real energy taxes have been assumed to remain at their current level. The structure of energy taxation would also remain as it is. The same assumption concerns the taxation of cars.

Use of the EU's emissions trading and Kyoto mechanisms has not been considered in the WM Scenario, although the former is already in opera-

Table 1–1 Starting points and assumptions of the WM Scenario.

	2005–2007	2008–2012	2013–2020
International operating environment	Stable	Stable	Stable
World market prices of fuels	Stable price development	Stable price development	Stable price development
Economic growth	3%/year	2.5%/year	over 2%/year
Population	Slowly growing; aging	Slowly growing; aging	Slowly growing; aging
Nuclear power production	Current	Additional 1600 MW in 2009/2010	No change
Imported electricity, capacity	Current and connection to Estonia 350 MW	No change	No change
Hydro power production	No additions	No additions	No additions
Natural gas network	Current	Turku region	No change
Competitiveness of wood energy	Slightly improving	Slightly improving	Slightly improving
Use of renewable energy	Proportion slightly increasing	Proportion slightly increasing	Proportion slightly increasing
Technological development	Current	Current	Current
Energy saving	Current	Current	Current
Energy taxation and norms	The level of 2005	The level of 2005	The level of 2005
Transport policy	Current	Current	Current
Agricultural policy	According to Agenda 2000	According to Agenda 2000	According to Agenda 2000
EU emissions trading	Not considered	Not considered	Not considered
Kyoto mechanisms	Not considered	Not considered	Not considered

tion and the latter could be fully utilised in the Kyoto commitment period. It was considered more appropriate to exclude these two key measures of the climate policy from the WM Scenario in order to keep it simple and facilitate the comparison with the WAM Scenario.

1.4.1.2 Total consumption of energy and electricity

Total consumption of primary energy will grow from approximately 1,490 PJ in 2003 to 1,580 PJ by 2010, and further to 1,680 PJ by 2020. The average annual growth in the years 2003–2020 is only 0.6 per cent per year, whereas it was over two per cent a year in 1990–2003.

The use of oil, peat and hydropower as energy sources will remain nearly at current levels, implying that their relative shares will decrease. The most significant growth in the WM Scenario will occur in the use of nuclear power; the use of natural gas and wood-based fuels will increase, while the electricity imports will decrease.

Heat consumption in buildings will grow as a result of the growth in building stock by approximately 0.5%/year in the 2003–2020 period. The market share of district heating is estimated to grow in the years

2003–2020 by six percentage points, and the market share of heating with wood will remain at its current level. The proportion of electric heating will decrease by approximately one percentage point and that of oil heating by approximately ten percentage points. The proportion of ground heating will double but still remain modest in relation to the entire market.

In traffic, decrease in the consumption of petrol will continue up to the end of the review period. The majority of diesel fuel is used for goods transportation, and the consumption is thus largely dependent on the development of transport-intensive lines of business in industry and services.

Agricultural production is not assumed to grow in the WM Scenario. Total use of fuels in agriculture will decrease slightly during the period examined. The use of wood and other biofuels will grow, whereas the use of light fuel oil will decrease.

Total consumption of electricity, including electricity transfer and losses due to distribution, will grow from 85.2 TWh in 2003 to approximately 95.5 TWh by 2010 and to approximately 105 TWh by 2020. The average annual growth is about 1.2 per cent, i.e. twice the growth in the consumption of primary energy.

Households will need more electricity mainly due to new machinery, despite of their improved electricity efficiency. The amount of electricity used for heating will remain practically unchanged in the entire review period. Production in service branches will grow relatively strongly, which is also visible in the considerable growth in electricity consumption in the WM Scenario.

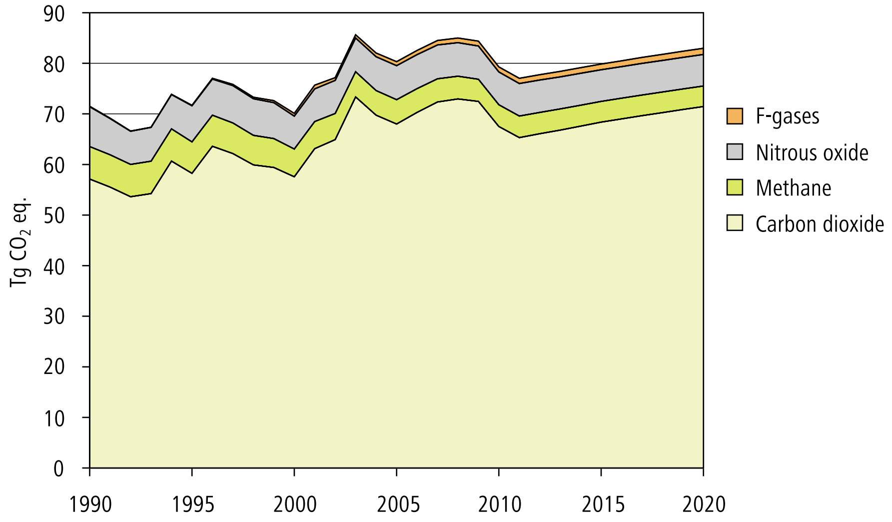
1.4.1.3 Greenhouse gas emissions

Total greenhouse gas emissions in the WM Scenario in the years 1990–2020 are shown in Fig. 1–3. Compared to the base year of 1990, the total emissions are expected to be 14% higher in 2010, and 19% higher in 2020. With regard to carbon dioxide emissions, the corresponding exceedances will be 20% and 27%. On the other hand, increases in the emissions of other greenhouse gases than CO_2 would be small. In particular, the amount of methane from landfill areas will decrease.

In 2003, emissions in the ETS-sector were 57% and those in the non-ETS sector were 43% of the total. The share of the emissions trading sector is estimated to decrease to 54% in 2010 (mainly due to the new nuclear power unit), but then to increase again to 57% in 2020. In the ETS sector, the emissions in 2020 are estimated to be 47.4 Tg CO_2 eq., in the non-ETS sector 34.6 Tg CO_2 eq. The changes from 2003 in the emissions are small, only +2% and –1%, respectively. Compared to the year 1990, the corresponding values are +52% and –10%.

The total emissions in 2010 are above the target level for Finland. The calculations for all greenhouse gases also lead to the conclusion that Finland will not be able to reach her target in the commitment period 2008–2012 with the assumptions of the WM Scenario. The average annual emissions (without LULUCF) in the Kyoto commitment period are estimated to be 79.9 Tg CO_2 eq. Finland's decision regarding Articles 3.3. and 3.4 of the Protocol puts the total emissions up by 0.9 Tg, although the LULUCF as a whole is expected to be a net sink. The average annual emissions in the commitment period 2008–2012 are as follows:

Figure 1–3 Total emissions in the WM Scenario in the years 1990–2020 (without LULUCF).



GHG emissions	79.9 Tg
The net effect of Article 3.3 of the Kyoto Protocol	0.9 Tg
Total	80.8 Tg
AAUs to be used	71.5 Tg
The deficit to be covered	9.3 Tg

The assumptions of the WM Scenario will lead to the result that carbon dioxide emissions from the combustion of fossil fuels and peat will increase along with the increasing consumption of primary energy and electricity. In 2008, the emissions would amount to approximately 68 Tg, after which they will decrease to 63 Tg in 2010 due to the new nuclear power unit, growing thereafter to 66 Tg by 2020. Thus the CO_2 emissions would exceed the level of 1990 by approximately 9 Tg in 2010.

In the WM Scenario, methane emissions are estimated to continue falling as emissions from agriculture will fall and the amount of waste decreases as a result of the waste management decisions. Total emissions of N_2O are estimated to remain at the current level. Emissions of F-gases will amount to about 1.0 Tg CO_2 eq. in 2010, while in 2003 they were 0.8 Tg CO_2 eq.

1.4.2 'With Additional Measures' Scenario

The assumptions concerning development of national economy and on energy prices on the world market were identical in the WAM and WM Scenarios. In addition, the assumptions concerning nuclear power, hydropower, natural gas network and the capacity of cross-border electricity transfer were similar. The differences between the scenarios are in the political sector. Most importantly, the EU emissions trading and the use of Kyoto mechanisms are included in the WAM scenario.

The price of emission allowances will be based on the situation in the energy market. It was assumed that the price will be EUR 15/t CO_2 in 2005–2007 and EUR 20/t CO_2 thereafter. The starting point for the use of additional measures is that their technical implementation requirements and profitability will correspond to those of the emissions trading sector. In other words, this assumption means that in the non-ETS only the measures are implemented that involve costs of less than EUR 15/20 per carbon dioxide ton reduced.

General conclusions concerning the energy sector in the WAM Scenario can be summarized as follows:

- Total use of fossil fuels will be clearly smaller than in the WM Scenario. The use of coal as a primary energy source is estimated to be 57 PJ in 2010 and 61 PJ in 2020, as compared to 104 and 133 PJ in WM scenario. However, more natural gas will be used in the WAM; 210 and 223 PJ in the years referred to, as compared to 189 and 201 PJ in WM Scenario.
- The use of peat will decrease, because the competitiveness of peat in separate electricity production will decrease due to emission trading. In 2010, the total use of peat in the WAM Scenario will be 61 PJ (93 PJ in WM), in 2020 the corresponding values would be 63 PJ and 101 PJ. However, the share of domestic fuels will not decrease, mainly due to a clear increase in the use of wood-based fuels. In the WAM Scenario, energy production by wind power will be 3 PJ in 2010 and 8 PJ in 2020, in the WM Scenario the production estimates are 2 and 4 PJ.

As mentioned earlier, there are no major differences between the WM and WAM scenarios as regards transport policy. The same applies to the agricultural sector. With regard to waste management, there are four additional measures included in the WAM Scenario. As to the F-gases, the WAM Scenario assesses the impact on emissions from the regulations proposed by the Commission.

In 2010 the total emissions are approximately 8 Tg CO_2 eq. smaller in the WAM Scenario than in the WM Scenario. About half of the reduction is due to the decrease in the use of coal, over one-third to smaller use of peat. Emissions from the use of natural gas, as well as emissions from other greenhouse gases are higher in the WAM Scenario.

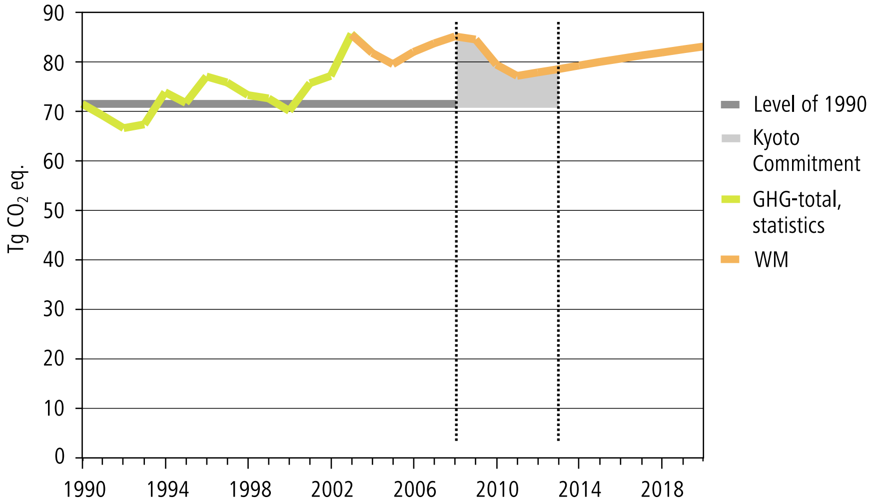
In the emissions trading sector, the WAM emissions are 5.9 Tg/year smaller than the WM emissions in 2008–2012. In the non-ETS, the major differences between the scenarios come from the traffic sector and from the reduced use of F-gases. After the Kyoto commitment period, the emissions from the use of coal will again turn upwards, while further reductions will occur especially in the non-CHP heating emissions.

Because the costs incurred for greenhouse gas reductions are high, Finland will prepare to finance about 10 million tonnes of emissions reductions procured through the use of Kyoto mechanisms in the 2008–2012 period.

Finland will meet her target level of the Kyoto Protocol and EU Burden Sharing Agreement. In the WAM Scenario, greenhouse gas emissions will be 70.1 Tg in 2010. The decision regarding Articles 3.3 and 3.4 raises the emissions by 0.9 Tg to 71.0 Tg. However, emissions in 2010 will not be the average of emissions for the 2008–2012 period.

Figure 1-4 shows the GHG emissions in the WM scenario and the deficit between the WM-scenario and the Kyoto commitment level of Finland.

Figure 1–4 The total GHG emissions in the WM and the deficit between the WM scenario and the Kyoto Commitment of Finland.



The deficit will be covered with measures presented in Chapter 4. About three-quarters will be covered with domestic measures including EU ETS, the rest with Kyoto mechanisms.

1.4.3 Methodology

As mentioned above, preparation of the Energy and Climate Strategy has been made on a sectoral basis. Each ministry has had the responsibility for the scenarios of its own sector. Ministries and research institutes have their own models and calculation systems for assessing the cost-effectiveness of the measures, which have been the starting point for the mitigation measures. The sectoral scenarios have been aggregated by the Ministry of Trade and Industry.

The calculations concerning the energy sector were carried out by the TIMES model, which covers the whole of the Finnish energy production and consumption system, including the industrial, residential, service and transport sectors. In addition, the waste management and agricultural sectors, as well as emissions of fluorinated gases, are also incorporated into the model with emissions reduction measures.

Economic effects were calculated with the help of two CGE-models. The domestic effects of the mitigation measures were studied with the hybrid EV-model, which combines an engineering model of the energy sector and key industrial sectors to a top-down CGE-model. In the EU-context, the GTAP-E-model was used.

In the agriculture sector, the Dynamic Regional Sector Model of Finnish Agriculture DREMFIA was used. This optimisation model is a typical spatial price equilibrium model, except that no explicit supply functions are specified, and foreign trade activities are included.

1.5 Climate change impacts, adaptation and vulnerability

1.5.1 Observed climate changes and scenarios

The mean temperature in Finland increased by 0.76°C in the 20th century. The warming took place during the first two and last three decades of the century, while a slight but statistically insignificant cooling occurred in the time period between them. Most of the warming occurred in spring. The diurnal temperature variation has become smaller, again mainly in spring. A similar trend has been observed widely on the land areas of the Northern Hemisphere, together with an increase of cloudiness.

No significant, nation-wide precipitation trends occurred in the 20th century. The precipitation climate of Finland is characterised by notable interdecadal variability, which partly offsets the statistical detection of trends. There is rather strong evidence that the maximum snow storage has increased in eastern and northern Finland since the late 1980s, while the snow accumulation has decreased in southern and western parts of the country.

The first climate change scenarios for Finland were developed for SILMU, the Finnish Research Programme for Climate Change, in 1991. They were composed of a central "best guess" scenario together with lower and upper estimates representing an unspecified uncertainty range.

A new, more comprehensive set of scenarios for Finland's future climate and its impacts was developed in the FINSKEN project. These scenarios extended up to the year 2100, covering four key environmental attributes: climate, sea level, surface ozone and sulphur and nitrogen deposition. In addition, a fifth set of scenarios was constructed to characterize future socio-economic developments in Finland, as these were considered to be important in determining the adaptive capacity of society to meet the challenges of global change.

Two types of future world were described in FINSKEN: a consumer-driven "A-world" and a community-minded "B-world". In the A-world there is strong economic growth in Finland accompanied by rapid increases in CO_2 concentration, increased ozone pollution and nitrogen deposition, rapid climate warming and increased precipitation. The B-world shows lower economic growth than the A-world, and less rapid increases in CO_2 concentration, temperature and precipitation.

In approximate terms, the annual mean temperature is projected to rise by 1–3 °C and the annual mean precipitation by 0–15% by the 2020s, relative to the baseline period 1961–1990. The corresponding increases by the 2050s are 2–5 °C and 0–30% , while by the 2080s they are 2–7 °C and 5–40%, respectively. The projected temperature and precipitation changes are markedly stronger in the "A-world" than in the "B-world" scenarios.

1.5.2 Impacts of climate change

The impacts of climate change have been extensively studied in Finland. Particularly well studied sectors are agriculture, forests, water resources, fisheries and traffic. In some other sectors like construction, health, insurance and tourism the level of research activity is rather low.

A sample of findings includes:

- Forestry: northward displacement of boreal forests into Tundra and broadleaved into boreal; northern forests already showing increased productivity and estimated to increase by 70 % by the 2080s
- Water resources: increased runoff in winter; reduced runoff in spring/summer; reduced flood risk due to snowmelt
- Agriculture: northward shifts of cropping zones of 120–150 km/°C; Finnish wheat yields increase and become less variable; potato yields increase, especially in central and northern Finland; northward shift in pest distribution and increased number of reproductive cycles
- Transport: snow and ice conditions on roads may require more salting; reduced sea ice should lower operational costs of ports and harbours
- Energy: decrease in heating degree days by 20–30 % by the 2080s; air conditioning: over 100 % increase in cooling degree days by the 2080s; bio-energy: increased production potential; potential benefits for hydropower in winter
- Tourism and recreation: reduced reliability of winter snow cover; Baltic coast may attract more summer beach tourists
- Human health: lengthened transmission period for tick-borne diseases; risks of exposure to harmful UV radiation may increase

1.5.3 Adaptation and vulnerability

The need to draft a programme for adaptation to climate change was identified in Parliamentary responses to the National Climate Strategy submitted to Parliament in March 2001. Work on the National Strategy for Adaptation to Climate Change began towards the end of 2003, and was coordinated by the Ministry of Agriculture and Forestry, with contributions from various ministries and expert organisations. Several top Finnish researchers in the field of climate change and its impacts were involved in this work together with other experts and representatives from various sectors.

The draft strategy was circulated widely for comment, and Finnish stakeholders and citizens were able to contribute through the Internet. The Adaptation Strategy is based on a set of scenarios for future climatic and economic conditions in Finland. The objective of the Adaptation Strategy is to reinforce and increase the capacity of society to adapt to climate change. Adaptation may involve minimising the adverse impacts of climate change, or taking advantage of its benefits.

The general means of adaptation available to authorities include administrative methods and planning, normative and economic-technical methods. The challenges include the fact that climate change, its impacts and adaptation measures will take place over a very long time period, and significant uncertainties are still involved.

Examples of adaptation measures include:

- Forestry: change in forest management practices such as natural regeneration, thinning, timing of harvesting, shortening rotation times
- Water resources: modification of regulation guidelines to account for greater winter storage capacity in regulated lakes; increased dimensioning of flood gates; altered catchment management

- Agriculture: plant breeding; changes in crop species and varieties; changes in cultivation practices; lengthening of the grazing season; changes in land allocation and more flexible land use
- Transport: adjusted winter maintenance of infrastructure; improvements to vehicle design
- Energy: preparedness for changes in hydropower production and regulation practices; preparedness for decreased energy consumption
- Tourism and recreation: use of artificial snow; investment in alternative activities to ski tourism
- Human health: raising public awareness; improvement of monitoring and surveillance systems; reducing vector populations; improved housing design

The need for different sectors to adapt to changes taking place elsewhere is based on different connections. Agriculture, which is sensitive to the climate, will probably be strongly regulated by EU agricultural policy in the future. Tourism, however, is an industry in which the effects of climate change can be directly seen in the preferences and choices of consumers. The effects can be general or can be reflected from one sector to another.

Like in many other industrialized countries, vulnerability to the impacts of climate change is fairly low in Finland. However, the nature and the inhabitants of northern Finland might have rather high risks. Of all the consequences involved with climate change in Finland, those caused by detrimental changes elsewhere in the world may be the most serious ones. Soaring food prices, malnutrition and other health hazards could require immense international efforts with high costs to all wealthy economies.

1.6 Financial resources and transfer of technology

The general objectives of Finnish development cooperation are formulated in the Government Resolution on Development Policy, which was adopted in 2004. The main target will be poverty reduction with emphasis mostly in the least developed countries in general and especially in long-term partner countries (Tanzania, Ethiopia, Mozambique, Kenya, Zambia, Nepal, Vietnam and Nicaragua).

Mitigation of environmental threats is one of the main goals of Finland's development policy. Finland supports a wide range of projects and programmes which aim at preventing environmental degradation, helping the developing countries to solve their environmental problems and giving assistance in sustainable use of their natural resources.

In multilateral cooperation Finland has firmly pursued environmental aspects of development. Finland has actively participated in the UNCED process and supported the implementation of Agenda 21 through various channels. As new and additional resources for solving global environmental problems, Finland contributed in 2002–2004 altogether EUR 19 million to the Global Environment Facility. This contribution brings forward Finland's aims to promote environmental agreements and develop their monitoring.

As to bilateral aid, in 2001–2003 Finland had altogether 13 projects directly under the climate change related assistance. Finland's total contribution is these years was around EUR 16 million. The mitigation-related projects in forestry accounted for the largest part of aid. Support for projects relating to energy and adaptation to climate change was also substantial.

Finland has specific programmes and financial arrangements for transferring environmentally sound technology to developing countries. Examples of Finnish bilateral projects and programmes that are related to transfer of technology include support to meteorological services in Mozambique, development of the meteorological systems in the Caribbean Region, and energy and environment partnership with Central America.

Finland has actively promoted and supported joint environmental programmes in its neighbouring regions. In the 1991–2004 period, the Ministry of the Environment channelled EUR 144 million to environmental cooperation in Estonia, Latvia, Lithuania and north-western Russia. Out of this amount, EUR 103 million was used for investment projects and EUR 41 million for technical assistance projects.

The Baltic States' accession to the European Union in May 2004 changed Finnish-Baltic co-operation into normal cooperation between EU Member States. However, all projects based on earlier commitments will be completed. In addition, support for technical assistance projects may still continue for at least a few years. The situation and development of the new neighbouring countries of the European Union, especially Ukraine and Belarus, also reflect on Finland's adjacent areas. Our new strategy includes co-operation with these countries in projects evaluated case by case.

The Finnish CDM/JI Pilot Programme was launched in 1999 in order to develop Finland's capacity to apply the project-based mechanisms. The Pilot Programme operates under the Ministry for Foreign Affairs and is supervised by an inter-ministerial Steering Committee. The Finnish Environment Institute (SYKE) has been acting as a consultant to the Programme since autumn 2000.

The activities during the pilot phase are divided in three parts: (i) bilateral CDM and JI project activities (approximately EUR 9 million), (ii) investment in the Prototype Carbon Fund of the Word Bank (USD 10 million) and (iii) investment in the Baltic Sea Region Energy Cooperation Testing Ground Facility (EUR 1.75 million).

The Pilot Programme has received over 130 CDM and JI bilateral project proposals. In 2005, the Programme had six bilateral CDM projects and four JI projects ongoing at different stages. All the projects are small. The expected total amount of delivered emission reductions vary between 10–500 Gg CO_2 eq. per project.

Although many challenges and uncertainties still remain, the implementation of several projects shows that application of the project-based Kyoto mechanisms is both possible and feasible. Also the division of activities between bilateral projects and investments in funds can be seen as a successful approach in the Finnish CDM/JI Pilot Programme.

1.7 Research and systematic observation

Climate-related research is carried out in Finland in several research institutes, universities and organizations. A detailed analysis of research activities in this field has not been performed. It is, in fact, rather difficult to distinguish climate-related research from, e.g. energy research or general meteorological research. Widely interpreted, the volume of research is high; e.g. some sixty Doctor's dissertations have been published.

The National Energy and Climate Strategy states that more research is needed in order to understand the causes, mechanisms and impacts of climate change. Another important branch of research is the development of existing and new adaptation and mitigation methods and technologies. The focus in research has moved towards the latter branch and this trend will continue in the coming years.

Most of the research has taken place within extensive research programmes, the first of them habing been SILMU (Finnish Research Programme on Climate Change). The programme was carried out in 1990–1995, the annual budget being EUR 2–3 million. Altogether, the programme comprised over 60 research projects and involved some 200 researchers. The fields of research comprised four sub-groups: atmosphere, water bodies, terrestrial ecosystems and human actions.

Another programme of the Academy of Finland, FIGARE (Finnish Global Change Research Programme) was conducted over a three-year period from 1999 to 2002. The scope was wider than that of SILMU, including e.g. socio-economic aspects and international projects. The total funding was EUR 6.7 million. The programme consisted of 36 research projects in 18 clusters or consortia, and involved some 230 researchers.

As to the mitigation technologies, a major step forward was the CLIMTECH Programme in 1999–2003. Under this programme, technologies that can be applied to control greenhouse gas emissions and climate change were investigated. The programme included both the control and reduction of emissions within Finland as well as the use of Finnish technology to limit emissions elsewhere. The Technical Research Centre of Finland (VTT) was responsible for the implementation of the programme; the costs totalled about EUR 5 million, of which almost EUR 4 million was provided by TEKES, the National Technology Agency. CLIMTECH consisted of 27 projects in six subject fields.

In 2004, TEKES started a new technology programme known as ClimBus (Business Opportunities in Mitigating Climate Change). The budget for this five-year programme totals EUR 70 million, of which the share of TEKES is roughly half. Through the programme, TEKES finances the development of technology and services, and produces new competence and strong international networks among various actors. The programme will cover the years 2004–2008.

To increase the understanding of climate change adaptation and adaptive capacity in Finland, the FINADAPT programme was carried out in 2004–2005. It was coordinated by SYKE, the Finnish Environment Institute, the total budget being around EUR 0.6 million. The primary objective was to estimate the adaptability of Finnish society and environment to the impacts of climate change. The methods included a combination of literature review, expert judgement, modelling and scenario analysis, stakeholder dialogue and survey responses.

Considering the scientific level of Finnish climate change research, two groups with international reputation should be mentioned. The Department of Physics at the University of Helsinki has over 20 years' tradition in aerosol-related atmospheric research. Currently, some 35 scientists are engaged in this area. The Department also hosts the international headquarters of the ILEAPS (Integrated Land Ecosystem – Atmosphere Processes Study) Programme, in connection with the Finnish Meteorological Institute.

In 2000, the University of Joensuu established a Centre of Excellence for Forest Ecology and Management (CEFEM). This Centre aims at enhancing the scientific research on functional and structural dynamics of the boreal forest ecosystem. A special emphasis is put on introducing the impacts of climate change into the long-term dynamics of the boreal forest ecosystem with implications on the sustainable management of forest resources.

As to systematic observations, the Finnish Meteorological Institute is responsible for atmospheric observing systems. The Finnish Institute of Marine Research carries out observations in the marine areas, while the Finnish Environment Institute conducts climate-related observations of inland waters and terrestrial phenomena.

Since the early 1970s, Finland has actively participated in the building of a global meteorological network to observe and monitor the physical and chemical elements of the atmosphere by providing systems for measuring the basic variables. Finland also participates in the Global Atmosphere Watch (GAW) programme of the World Meteorological Organisation (WMO). The Arctic Research Centre of the Finnish Meteorological Institute does important measurements and research in the sensitive high-latitude environment.

During the last ten years, Finland's total contribution to cooperation projects concerning meteorological technology transfer and education/training has been about EUR 15 million. Projects have been carried out in some thirty countries all over the world. The Finnish Meteorological Institute has borne the main responsibility in this work.

1.8 Education, training and public awareness

Climate change issues form an essential part of environmental education in Finland. In official educational strategies, climate change is often dealt with together with other threats to sustainable development. In basic education, all pupils get an insight into climate change and its causes and consequences. Participation in measurements and other practical exercises is of vital importance. At upper secondary schools, a more detailed view of climatic issues is given. The general principle at all levels is that climatic issues are integrated, as a part of sustainable development, into the teaching of all subjects, not only e.g. physics and biology. At universities, the teaching related to climate change is closely tied to the research in this field.

A broad-based Climate Forum led by the Ministry of the Environment has the special task of promoting awareness on climate change issues. The Forum has some 60 members representing different ministries, industry, environmental NGOs, research institutions and labour unions. The meetings are an opportunity for information sharing and exchange of views.

Several ministries have disseminated public information relevant to combating climate change and adjusting to it. The cooperation between different ministries was enhanced in 2002, when a special publicity programme, designed to increase awareness of issues related to climate change in Finland, was started. The programme, called the Climate Change Communications Programme, consists of various publicity campaigns designed to inform the public about the likely impacts of climate change, and what must be done to limit climate change. Campaigns are aimed at various groups and organisations, including energy companies, waste management firms, local authority officials, teachers, and entrepreneurs in the agriculture and forestry sectors. By the end of 2004, the Climate Change Communications Programme had brought forward 132 project proposals, of which 30 were approved. The funding resources granted to them totalled EUR 0.73 million.

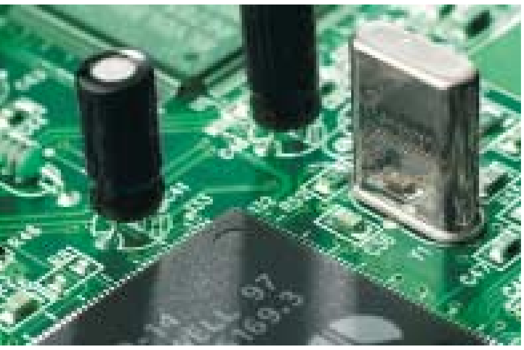
The municipal sector works in Finland in different ways to reduce greenhouse gas emissions and to increase public awareness of climate change issues. The Association of Finnish Local and Regional Authorities – a co-operation and interest body of the municipalities – is running a special climate campaign together with 48 local authorities, who together account for almost half of the population of Finland.

Several environmental NGOs have been active and innovative in arising public awareness. They maintain extensive websites on climate, greenhouse gases and related topics.

Climate change issues have been extensively dealt with in the Finnish media. The discussion and political debate on the construction of a new nuclear power reactor was very lively in Finland in the late 1990s. It also served as a major factor increasing the interest of the media and public awareness on climate issues. A number of cultural events and exhibitions related to climate change have also been arranged in Finland.

Several surveys have been made to find out what Finns think about climate change issues. These surveys have indicated, for example, that people know the global effects of climate change quite well and are worried about them. Heavy rains, floods and storms are considered as a very serious threat by about half of the people, the next most alarming consequences from climate change being increased poverty in developing countries, damages by insects and pathogens, and more serious droughts.

Finland has also participated in several climate-related international efforts in awareness raising. For instance, the Climate Change Communication Programme has had contacts in other European countries. Finland will also actively participate in the International Polar Year 2007–2008, which will be a good opportunity to increase awareness on climate change and its impacts in high latitudes.



2 National circumstances

2.1 Geographic profile

Finland lies between the 60th and 70th parallels of latitude, with a quarter of the country extending north of the Arctic Circle. To the west and south, it has a long coastline with numerous islands along the Baltic Sea. With a total area of 338,145 km^2, it is Europe's seventh largest and the EU's fifth largest country. The land boundary with Sweden is 586 km, with Norway 727 km and with Russia 1,269 km.

Much of the country is gently undulating plateau of old bedrock. Nearly all of Finland locates in the boreal coniferous forest zone, and 74% of the total land area is classified as forest land, while only some 9% is farmed. Finland has over 33,600 km^2 of inland water systems, or about 10% of its total area. There are some 190,000 lakes and 180,000 islands, almost half of the latter along the Baltic Sea coast. High rounded fells form the landscape in Finnish Lapland, the northern part of the country.

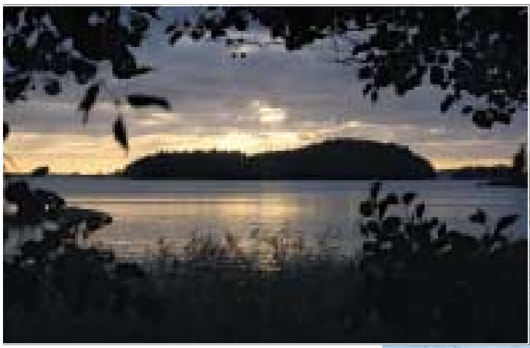
Some land use changes have occurred in Finland since the year 1990 (Table 2–1). The areas of forest land and settlements have increased, while the areas of croplands and wetlands have decreased. New forest land is mainly former agricultural land or wetland, but at the same time settlements have occupied forest. Agricultural land has also been converted to grasslands and settlements.

In fact, Finland's land area increased by at least 50 km^2 in 1990–2003, due to land uplift. This has not been taken into account in Table 2–1.

Table 2–1 Land use in Finland in 1990 and in 1996–2003. The classification is based on the IPCC Good Practice Guidance for LULUCF (2004). The ninth National Forest Inventory was conducted in 1996–2003; the values in the corresponding column can be interpreted as averages within this period. The values for 1990 are backward predictions using observed land use changes on the field plots of the National Forest Inventory (Finnish Forest Research Institute 2005).

Land use classification	1990 (km^2)	1996–2003 (km^2)
Forest land	219 249	224 877
Cropland	22 710	22 188
Grasslands	6 455	4 543
Wetlands	31 522	27 008
Settlements	12 050	12 776
Other land	12 605	13 080
Water	33 553	33 672
Total	338 145	338 145

Figure 2–1 The four seasons in Finland. Due to the long latitudinal extent of the country, the average climatological durations of the seasons vary considerably: summer 45–130 days, autumn 45–85 days, winter 105–210 days, spring 45–60 days.



2.2 Climate profile

The climate of Finland shows characteristics of both maritime and continental climate depending on the direction of air flow. Considering the northern location, the mean temperature in Finland is several degrees higher than that of most other areas on these latitudes, e.g. Siberia and southern Greenland. The temperature is raised by the Baltic Sea, inland waters and, above all, by air flows from the Atlantic, warmed by the Gulf Stream.

The mean annual temperature is about 5.5°C in south-western Finland, decreasing towards the north-east. The 0°C mean limit runs slightly to the south of the Arctic Circle. Temperature differences between regions are the greatest in January, when the difference between southern and northern Finland is about 12°C; in June and July, this figure is only about 5°C.

Heating degree-days, calculated according to 17°C indoor temperature, vary in Helsinki from 3,400 to 4,800 per year. In Rovaniemi, Lapland, the corresponding range is 5,500–7,000. The growing season (mean daily temperatures above 5°C) is short; 170–180 days on the south coast and about 130 days on the Arctic Circle.

The Finnish climate is characterised by irregular rains caused by rapid changes in the weather. Only summer showers and thunderstorms show some sort of regularity, with rain occurring mostly in the afternoon. The mean precipitation in southern and central Finland is between 600 and 750 mm, except on the coast where the rainfall is slightly lower, particularly in Ostrobothnia. In northern Finland, the annual amount is 550–650 mm.

The seasonal variation in precipitation is similar throughout the country, the driest month being March. From then on, precipitation gradually increases until July and August, or until September and October on the coast, after which it decreases towards winter and spring. The lowest annual precipitation may be less than 300 mm in northern Finland, while the maximum annual value elsewhere sometimes exceeds 900 mm. The highest daily rainfall recorded is almost 200 mm, but values in excess of 50 mm are rare. Except in coastal regions, over half of the days have some rain in an average year.

Even in southern Finland, some 30% of the annual precipitation is in the form of snow, which remains on the ground for about four months. In Lapland, the corresponding figures are 50–70% and 6–7 months. The lakes freeze over in October in Lapland and early December in southern Finland. In severe winters, the Baltic Sea may ice over nearly completely, but in mild winters it remains open except for the Gulf of Bothnia and the eastern part of the Gulf of Finland.

The winds in Finland blow most commonly from the south-west and least commonly from the north-east; all other directions occur with equal frequency. The average wind speed is 3 to 4 m s^{-1} inland, slightly higher on the coast, and 5 to 7 m s^{-1} in maritime regions. Cloud cover is especially abundant in Finland in autumn and winter, increasing from the north-west towards the south-east; about 65% to 85% of the sky is then covered in cloud.

2.3 Population profile

The population of Finland was 5.220 million at the end of the year 2003, while at the end of 1990 it was 4.998 million. The average population density is only 17.1 people per square kilometre of land, making Finland the third sparsest populated country in Europe after Iceland and Norway. The population projection for 2010 is 5.310 million, for 2020 it is 5.412 million.

The population is concentrated in the southern parts of the country, with about one million people living in the Helsinki Metropolitan Area. The capital, Helsinki, itself had a population of 559,000 at the end of 2003. The Province of Lapland, although almost one third of the area of Finland, had a population of only 187,000.

There is strong internal migration from small municipalities to urban areas. In the 1990–2003 period, the net migration from rural to urban areas has been 106,000 people. Particularly in Lapland and eastern Finland, many rural communities have had a declining population.

In 2003, the net migration to urban municipalities and urban districts was 4,293 people, much less than in the latter half of the 1990s, when it exceeded 10,000 people per year. A new feature was population loss in central districts (1,141 people), while satellite districts gained 5,319 people. Urban population made up 82.5% of the total population in 2003; the corresponding figure in 1990 was 79.7%.

The population is ageing; the proportion of people aged over 65 in the population was 15.6% in 2003, while in 1990 it was 13.5%. This development will accelerate in the coming years and decades; in 2040 over one quarter of Finland's population is estimated to be older than 65.

The official languages of Finland are Finnish and Swedish, the latter spoken as a mother tongue by 5.6% of the people. Sami is spoken as an indigenous minority language by a small group of people in northern Lapland. The number of foreign citizens living in Finland was about 107,000 at the end of 2003.

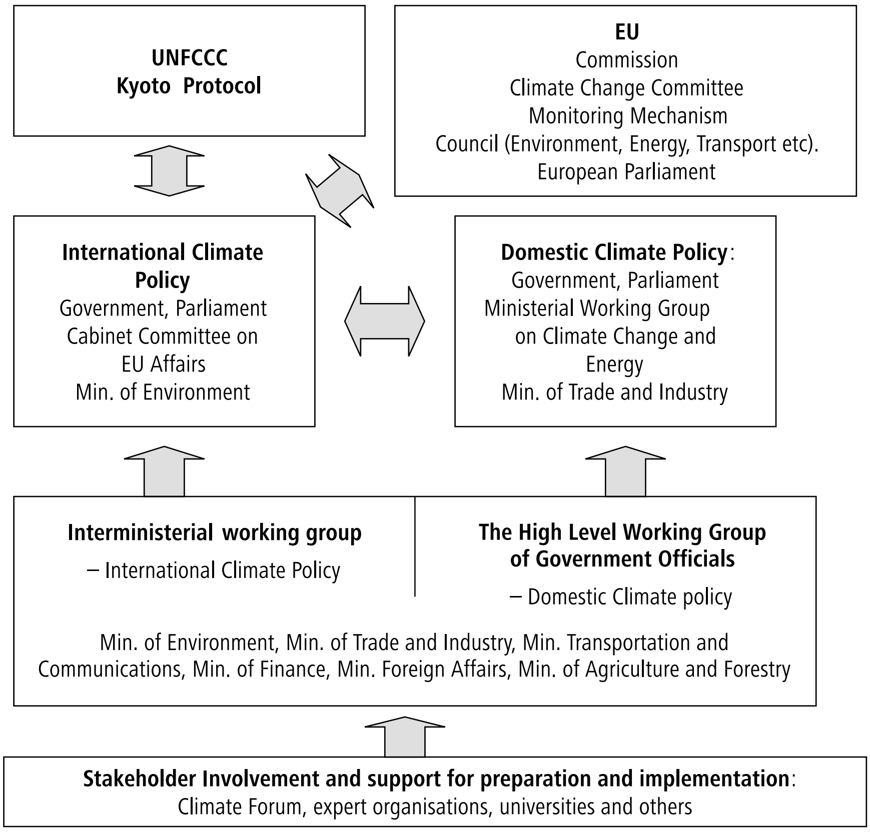
2.4 Government structure

The head of state is the President of the Republic, who is elected for a period of six years and may serve a maximum of two consecutive terms. Tarja Halonen was elected President in February 2000 and the next presidential elections will be held in the year 2006. The Government must enjoy the confidence of the Parliament, which has 200 members elected by universal suffrage every four years. The present Government is a multi-party coalition formed in 2003 and headed by Prime Minister Matti Vanhanen, leader of the Finnish Centre Party.

Finland joined the European Union on 1 January 1995. Finland also joined the Third Phase of the Economic and Monetary Union (EMU) and adopted the common currency in 1999. While remaining militarily non-allied, Finland works actively for the strengthening of the EU's common foreign and security policy.

The Autonomous Territory of the Åland Islands consists of 6,554 islands in the south-western archipelago of Finland. About 95% of its population of 26,300 are Swedish-speaking. The Act on the Autonomy of Åland, last revised in 1991, gives the Legislative Assembly of Åland the

Figure 2–2 The organisation of climate policy in Finland.



right to enact laws on, e.g. municipal taxation, building and planning, and protection of the environment.

The organisation of climate policy in Finland is outlined in Figure 2–2. As to the international climate policy, the Government and the Parliament are in charge of important decisions, which should be in line with EU legislation. Therefore, the Cabinet Committee on EU Affairs is also strongly involved. The United Nations Framework Convention on Climate Change falls within the administrative responsibility of the Ministry of the Environment.

As to the domestic climate policy, the Government and the Parliament obviously also have key roles. The Ministerial Working Group on Climate Change and Energy, headed by the Ministry of Trade and Industry, is responsible for e.g. co-ordination of the National Energy and Climate Strategy. The group also prepares Finnish guidelines for international climate negotiations, and ensures planning at the national level and the coherence of Finland's position before matters are discussed in the Cabinet Committee on EU Affairs.

The High Level Working Group of Government Officials, again headed by the Ministry of Trade and Industry, has an essential role in the preparation of climate policy issues. Stakeholder involvement and support for the preparation and implementation takes place via the Climate Forum, expert organisations, universities and others. The Climate Forum is a body with representatives from ministries and other Government organisations, regional and municipal administration, industry and NGOs. The tasks of the Climate Forum include promotion of awareness of climate issues, enhancement of climate policy implementation as well as making initiatives on climate-related research.

National framework for sustainable development policies

A broad, multi-stakeholder Finnish National Commission on Sustainable Development (FNCSD), with the Prime Minister in the lead, was established in 1993. Since then, different measures on sustainable development have been promoted and co-ordinated within Finnish administration and society at large. The National Programme for Sustainable Development in Finland was prepared and approved by the Government in June 1998. The Programme is designed to promote ecological sustainability and the economic, social and cultural preconditions for achieving this end.

Integration of sustainable development into sectoral strategies and programmes has been an essential objective in Finnish policy making in recent years. The sustainability principle has been an integral element in the sectoral programmes of, for example, the Ministry of Agriculture and Forestry, the Ministry of Transport and Communications and the Ministry of Trade and Industry. Climate change issues form an important part of this principle.

Sectoral programmes have been significant national instruments in e.g. solving environmental problems or promoting and implementing policies and measures accordant with sustainable development. Integration policies have also strengthened the involvement of civil servants from different policy areas in sustainability issues. The principle of sustainable development is present in legislation and normative documents, in national core curricula for education, as well as in various flexible instruments, such as taxation, environmental impact assessment, eco-labelling and voluntary agreements.

In order to review the implementation of the sustainable development policies and impacts of the Government Programme in different sectors in Finland, an evaluation process was launched in 2001. During the process, the need for further action and revision of the current Programme was assessed, too. The challenges defined during the evaluation process and in other recent developments will be elaborated upon in 2005–2006 when new objectives and measures will be determined in preparing a new national strategy for sustainable development. A broad-based Strategy Group has been established with the task to prepare, by June 2006, a proposal for a National Strategy for Sustainable Development which is an ”over-generational” joint transition programme of Finnish administration and Finnish civic society towards a sustainable society.

The greatest challenges in integrating sustainable development in Finland are found from the cross-sectoral, multidimensional policy areas where joint action and common goals from different administrative branches are required.

This applies particularly to the National Climate Strategy 2001 and National Action Plan for Biodiversity. Additional policies and measures are also needed in linking national strategies and programmes to, for example, the European Union's strategy for sustainable development in order to create synergy and potential added value.

Promotion of eco-efficiency and sustainable consumption and production patterns has been one of Finland's priority areas in sustainable development since the Johannesburg Summit in 2002. The promotion of these issues also aims at reducing greenhouse gas emissions. A broad-based multi-stakeholder Committee on Sustainable Consumption and Production was established with a mandate to develop a national, cross-cutting programme on sustainable consumption and production. The aim of the programme was to increase the eco-efficiency of material and energy use throughout the whole lifecycle of products by defining, inter alia, additional objectives and environmental policy measures for Finland. The proposal for a national programme was completed in June 2005.

2.5 Education and research

All children in Finland receive compulsory basic education between the ages of 7 and 16. Ninety-six per cent of the six-year-old children participated in pre-school education in 2004. Education beyond the age of 16 is voluntary, taking the form of a three to four-year course in upper secondary school or two to five years of vocational education. The share of pupils participating in these forms of education was 95.4% in 2004.

The Finnish higher education system comprises two sectors: universities and polytechnics. The network of 20 universities covers the whole country. All universities are state-run. The annual enrolment in universities is about 21,000, almost one third of the age group. The network of 29 polytechnics, which was created in the 1990s, admits annually some 25,000 new students. In 2003, there were about 174,000 degree students at universities and over 129,000 in polytechnic degree programmes. Of the total student population, some 54% are women.

About 37% of the population over 15 years of age have completed upper secondary education, 25% have tertiary education.

In 2003, there were about 174,000 degree students at universities and over 129,000 in polytechnic degree programmes. Of the total student population, some 54% are women. About 31% of the population have completed upper secondary education, 20% have tertiary education.

All schools in Finland are connected to the Internet. The number of people having used the Internet was 2.9 million at the end of 2003; over 80% of them were regular users. The library network is dense in Finland and about one half of the population use the lending services. The circulation of daily newspapers is the highest in the EU, around 530 per 1,000 adult population.

Finland's school system received high scores in the international PISA comparison in 2003. The comparison of 40 countries put Finland at the top in the maths, reading and science tests. PISA is a three-yearly appraisal of 15-year-olds in the principal industrialised countries, organised by the OECD.

In 1996, the Finnish Government adopted a programme for raising the level of funding for research and development from 2.35% of GDP in 1995 to 2.9% by the end of 1999. For public research funding, this meant an increase of around EUR 250 million in annual research spending. This increase was directed to promote the functioning of the national innovation system for the benefit of the economy, employment and business sectors. This programme and the strong investment by the private sector in R&D have meant that the GDP share rose to 2.9% already in 1998. The growth has continued and in 2003 the share was 3.5%. Finland is now among the world leaders in terms of relative input into research.

The private sector's share of research funding has been around 70% in recent years, and the share of university research funding around 20%. The share taken up by State research institutes of sectoral research has declined from about 20% in the early 1990s and now amounts to only about 10%.

Development of researcher education has been one of the main priorities in Finnish science policy over the past decade. In addition to the graduate school system created in 1995, programmes have been implemented to develop post-doctoral research and promote women's research careers. In 2003, the Ministry of Education funded 114 graduate schools and the total number of doctoral students in these graduate schools was over 4,000. Most graduate schools are networks of several universities. In 2003, the annual number of new doctorates was 1,257; two-and-a-half times as many as in 1990. At least sixty doctoral dissertations on climate-related issues have been published in Finland since 1990.

2.6 Building stock and urban structure

Characteristically, Finland is a land of small towns and communities. Large towns are located in the south and west and the size of towns grows smaller towards the north and east. Most of the important towns are located on river estuaries on the coast, or inland at intersections of the lake systems.

The total building stock of Finland has a gross floor area of 470 million m^2, of which residential buildings account for about 50%. Office, commercial and industrial buildings make up less than 40% of the floor area, and the remainder consists of free-time residences, agricultural buildings and other small outbuildings. There were 466,000 free-time residences in Finland at the end of 2003.

Finland's building stock is fairly new: only 19% of the buildings have been constructed before 1950. In residential buildings, the floor space per person was 37 m^2 in 2003, as compared to 19 m^2 in 1970 and 31 m^2 in 1990. The average size of a dwelling is 77 m^2. On average, Finns spend one fifth of their disposable income on housing.

The most common residential buildings are detached houses and blocks of flats, both of which make up slightly over 40% of all dwellings. More than 95% of dwellings have flush toilets, over 98% have sewer and piped water. At present, technically inadequate housing is a problem mainly in rural areas and among the elderly.

Although the use of wood has declined considerably in towns, it is still a popular building material for single-family houses. About 90% of them throughout the country are wood-framed, as are almost all free-time residences. In terms of numbers of buildings, more than 80% of buildings out of the country's overall building stock have wood frames, and in terms of the volume of new construction, more than one-third. The future aim is to have pleasant new urban environments built of wood and promote wood-building technology.

Because of Finland's cold climate, buildings are heated for the greater part of the year. They are insulated so well that the annual amount of heating energy used per cubic metre is of the same order as in countries considerably further south. Since the 1970s, buildings have been fitted with triple glazing and more than two thirds of all new single-family houses have heat recovery equipment.

A number of pilot projects and architectural competitions have been conducted on ecologically sound planning and construction. For example, the Viikki housing area in Helsinki came about because of the need to set models for ecologically sustainable housing. Special ecological criteria were set for determining the minimum standard for environmental quality. Efficient ways of using energy and natural resources, as well as ways of eliminating noxious waste and emissions, have been tested in the construction.

Several new targets were set in the Finnish National Building Policy Programme (2003) to promote sustainable construction, including better know-how pertaining to the lifecycles of building materials and to energy consumption. Other major activities include development of sustainability assessment methods, above all an environmental classification of buildings, and implementation of the EU's Energy Efficiency Directive on Buildings.

The need for new housing is expected to continue at the rate of 30,000 dwellings per year well past the year 2005. The main reasons for this are the changing age structure of the population, decreasing household size and continuing migration to urban centres. A factor slowing down new housing production is shortage of reasonably priced building land in growth areas.

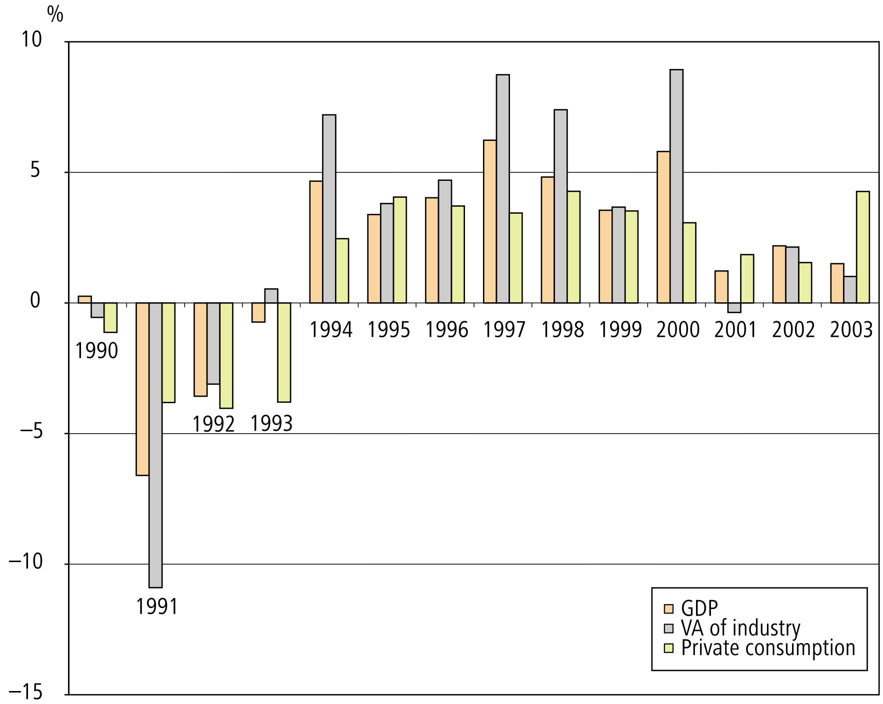
The new Land Use and Building Act came into force at the beginning of the year 2000. It gives the local authorities more extensive powers to make independent decisions in land use planning, while control by the central government is reduced. The act emphasises matters related to community structure and the accessibility of services, and includes many more instruments for dealing with urban development policy than the present legislation.

2.7 Economic profile

Finland has a highly industrialised economy, which is rapidly integrating with Europe and the world. The key economic sector is manufacturing – principally forest, metal, engineering, electrical and electronics industries. Trade is important, with exports equalling two fifths of GDP. Cold climate and energy-intensive industries have led to high energy use and consequent greenhouse gas emissions.

For a number of decades, Finnish economy was characterised by fast growth combined with sensitivity to international cyclical fluctuations. In the early 1990s, however, Finland fell into a recession of unprecedented depth. Gross domestic product plummeted by about 10% between 1991 and 1993.

Figure 2–3 Changes in GDP, value added of industry and private consumption in 1990–2003.



However, the recession gave a boost to the structural changes that became inevitable as Finland progressed towards a more open economy and further integrated into the European Community. Private consumption and GDP eventually began to grow again in 1994 (Figure 2–3) and from 1994 to 2000 the overall growth in GDP was 30%, averaging 5% per annum. In 2001, the fairly rapid growth rate slowed down drastically, but strengthened slightly in 2002–2003.

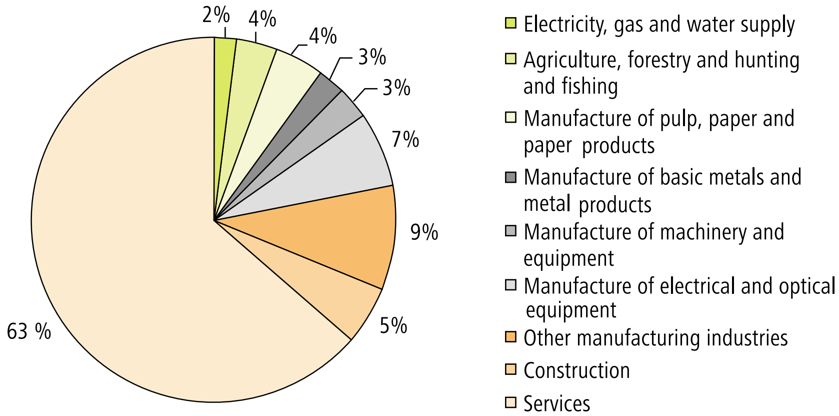
From 1994 to 2000, private consumption grew by 24%. The growth abated slightly thereafter, but grew again in 2003. Growth in the value added of industry turned positive in 1993, and this continued for the rest of the decade, totalling 53% in 1993–2000. In 2001, the growth suddenly came to a halt, being -0.2%, but then turned positive again in 2002.

Finland's GDP per capita at market prices was EUR 27,496 in 2003, as compared to EUR 17,666 in 1990. The proportions of different sectors of GDP are shown in Figure 2–4.

The high growth rate of economy is underpinned by exceptional structural reforms. While in 1990, the exports-to-GDP ratio stood at 23%, by 1999 the figure had climbed to 39% and stayed at that level. Growth of exports has been exceptionally fast in the electronics and electrical industry, which in 1999 accounted for 28% of all exports. Since then, the share of this industry declined to 23% in 2003. In the examined years, the share of the pulp and paper industry stood at 23% and 19%, respectively.

The growth in the electronics and electrical industry was most dramatically illustrated by the emergence of Nokia as the world's largest mobile phone manufacturer and one of the largest European firms measured by

Figure 2–4 Proportions of GDP by industry in 2003. (Statistics Finland 2004)



market capitalisation. Several other Finnish companies have also internationalised through direct investments abroad, and some are among the top five in their respective sectors globally.

Finland's total exports amounted to EUR 46.4 billion in 2003, total imports being EUR 36.8 billion. The surplus, EUR 9.6 billion, was about a quarter smaller than in the three previous years. The majority of the exports go to the European Union, the main countries of destination being Germany (12%), Sweden (10%) and United Kingdom (8%) in 2003. Exports to the United States and Russia also amounted to 8%. Since the late 1990s, the emerging market economies have also become Finland's significant trading partners. For example, imports from China amounted to EUR 1.6 billion in 2003.

The pre-recession level was regained in private consumption in 1997. In the wake of the recession, the propensity of businesses and households to raise loans and invest also remained low for many years. Companies concentrated on bolstering their financial structures while households tried to reduce their debt burden. The adjustment took place over a long time period, but today the financial position of both companies and households is good. Private consumption expenditure at current prices was 69% higher in 2003 than in 1990. On the other hand, income differentials have clearly grown.

In the late 1980s, the unemployment rate was merely three per cent, and many sectors were suffering from a shortage of labour. As a consequence of the recession, the unemployment rate soared to a record 17% in 1994, from where it declined to 10 per cent in 1999, but was still 9% in 2003. Regional differences are large: unemployment rates were 5–10% in southern Finland but 15–17% in Lapland and eastern Finland in 2003.

Finland has a long-standing history of budgetary balance in general government finances, and for decades public debt remained exceptionally low by international standards. The 1990s constitute an anomaly in Finland's peacetime conditions. As a consequence of the recession, the deficit in central government finances relative to GDP increased strongly in the early years of the 1990s, and the debt-to-GDP ratio as defined in EMU terms escalated to almost 60% in 1994. It was still 45% in 2003.

Prime Minister Vanhanen's Government has declared the economy as its first priority. Its primary objectives are improvement of employment and reduction of the indebtedness of central government. It sustains a process for bringing down taxation on labour. The Government has also recognised the crucial importance of implementing a pensions reform; the population is ageing even more rapidly than in most other EU countries.

Recent developments have propelled Finland to the top in global comparison studies. For example, Finland was number one in the World Economic Forum's competitiveness ranking in 2001 and 2003, and number two in 2002. Since 2000, most recently in 2005, Finland has also been the leading country in the World Economic Forum's Environmental Sustainability Index (ESI), benchmarking countries on the basis of their national environmental stewardship.

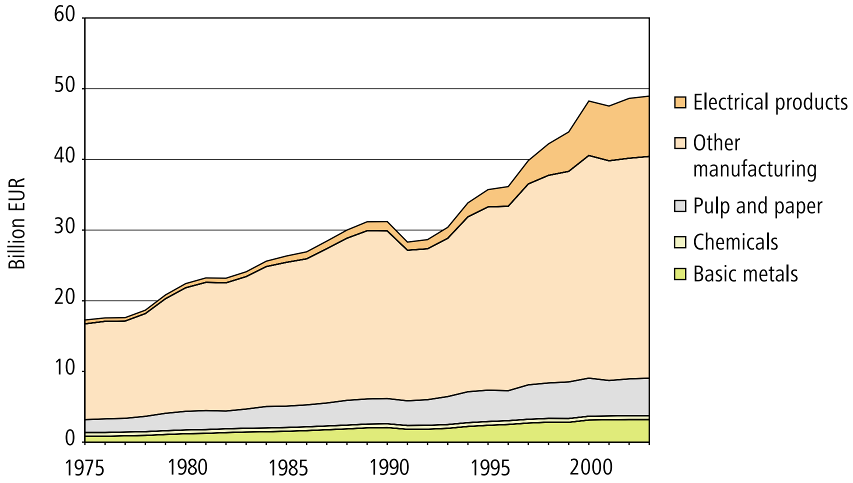
2.8 Industry

The electronics and electrical industry, the forest industry, and the metal and engineering industry are the three strong sectors of Finland's national economy.

Industrial structure has recently undergone a profound change, and one of the fastest in the world, in Finland. Increase in the technology-intensity of the manufacturing sector has been strong, driven mainly by the manufacture of communications equipment. The enterprise volatility rate has also been high, boosting growth of productivity in several industries. The impact of high-tech industries, mainly communications, is significant in Finland, and its relative share is the highest in the OECD countries. On the other hand, the share of medium-high technology sectors is lower than the average. This is influenced by e.g. high GDP share of the forest industry, which is a low-tech industry.

Figure 2–5 shows distribution of the output of Finnish manufacturing industries by sector. In general, the trend in industrial output at constant

Figure 2–5 Output of Finnish industry in 1975–2003, at 2000 prices.



prices is fairly similar to that of GDP. Following the economic recession of the early 1990s, the very rapid expansion of the metal products industry – especially electronics – changed the traditional structure of Finnish industry. Accordingly, industry's energy demand has grown more slowly than its output or GDP.

Finland's road to industrialisation started in the 19th century with the harnessing of forest resources. In today's forest sector, high-quality products and success on the market are based on close co-operation between the forest industry, equipment manufacturers, raw material suppliers, and research and development. The forest cluster employs almost 200,000 people in Finland. Its turnover is about EUR 35 billion and value added around EUR 12 billion. The Finnish forest cluster annually invests some EUR 250 million in research and development. The cluster's contribution to the Finnish economy is almost 10% of GDP, about 30% of industrial production and about 35% of net export revenue. No other country has such a large and diversified concentration of enterprises and expertise based on forest resources.

Environmental technology is also an important and rapidly growing industrial sector in Finland. The turnover of this sector amounted to around EUR 2.1 billion in Finland in 2003. Inclusive of the activities of Finnish firms abroad, the turnover totals close on EUR 3.4 billion. Environmental technology provides jobs for around 9,000 persons in Finland.

As much as one half of the environmental technology turnover is formed of various expert services. Air and climate protection have gained importance in the product ranges of environmental technology companies, but most of the foreign turnover is still composed of technologies and services relating to wastewater and water management. One third of the environmental technology firms have R&D co-operation with foreign research units.

Until the 1980s, Finnish industry was almost entirely Finnish-owned, and legislation laid down strict limits on foreign ownership. For a long time, about one fifth of all industry was State-owned. EU membership in 1995 removed the restrictions on foreign ownership and Nokia, for instance, is nearly 90 per cent foreign-owned, especially by American pension foundations. The State has sold a considerable part of its industrial holdings, as well.

Finnish industry is concerned about the future, especially in the light of the 'China effect'; traditional industry is withering and manufacturing is shifting to countries with lower production costs. It is obvious that the number of jobs in traditional industry will continue to decline.

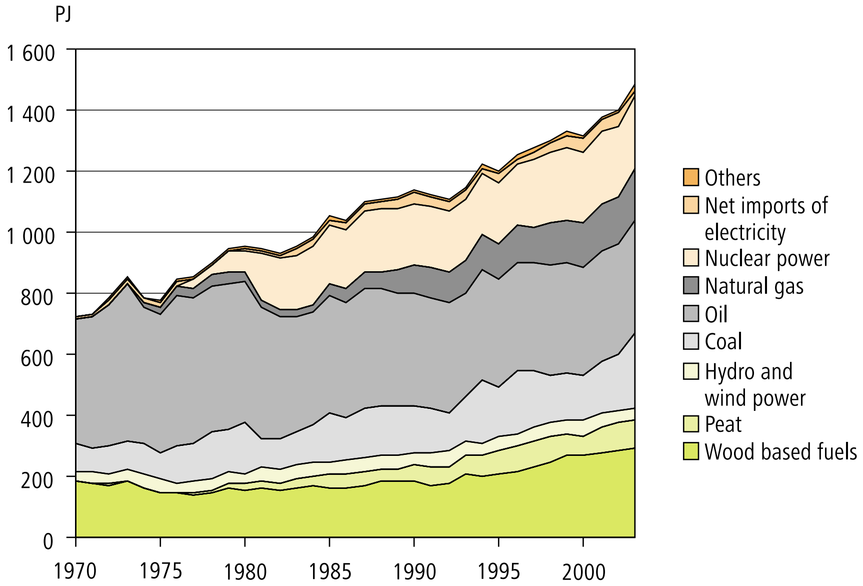
2.9 Energy

2.9.1 Finland's energy supply

Since Finland is largely dependent on imported fuels, the cornerstones of the Finnish energy policy must be diversified and reliable supply of energy and improved self-sufficiency. The energy-intensive basic industries, cold climate and long distances highlight the significance of energy to the competitiveness of Finland and the welfare of the people.

Until the 1960s, Finland's energy policy relied on the electricity produced by hydropower stations and extensive decentralised use of wood.

Figure 2–6 Gross consumption of primary energy in Finland in 1970–2003.



Due to the limited hydro resources, the use of coal and oil started to increase rapidly, and the need to find new energy sources became obvious. A gas pipeline from the Soviet Union to eastern Finland was completed in 1973 and later extended to the Helsinki area and some other cities. The first nuclear power unit was taken into use in 1977, followed by three other units in 1979–1982. The 1970s also brought peat into the Finnish energy mix.

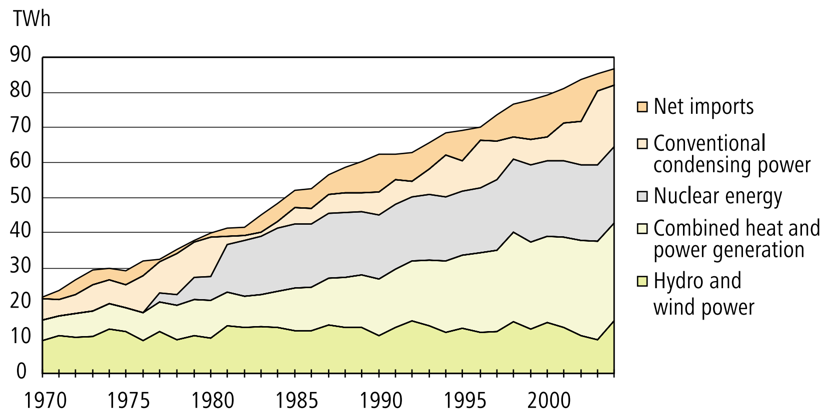
In 2003, gross consumption of primary energy in Finland amounted to 35.5 million tonnes of oil equivalent (Mtoe) or 1,488 PJ (Figure 2–6). The most notable decrease has taken place in oil consumption, which still accounts for 25% of the total primary energy supply. Among the energy sources whose use has recently been increasing are wood-based fuels and natural gas. Owing to the upgrading of the existing nuclear power plants in 1995–1998, the share of nuclear energy in Finland's diversified energy mix has increased.

In the long term, energy dependence, calculated as the share of imported energy of the total primary energy supply (TPES), has decreased from 80% in the late 1970s to 67% today. The incontestable domestic energy sources are wood-based fuels, hydropower, wind power and peat.

Peat is internationally classified as a fossil fuel and CO_2 emissions released during its combustion are taken into account in full in the national greenhouse gas inventories under the UNFCCC. In Finland, peat is regarded as a slowly renewable biomass fuel and in the fuel classification distinguished from fossil fuels (such as coal) as well as from renewable biomass (such as wood). The CO_2 emissions from peat combustion are estimated and reported as for fossil fuels.

The introduction of several nuclear power units in the early 1980s cut coal use for electricity generation dramatically (Figure 2–7). Later, the stagnation of nuclear development increased the exploitation of new sources, such as peat, biomass and natural gas. Still, nuclear energy accounts for over 40% of all fuels used for electricity generation. As to elec-

Figure 2–7 Finland's electricity generation by production mode in 1970–2003.



tricity consumption, the share of nuclear power was 26% in 2003, and the total electricity consumption amounted to 85.2 Twh.

In May 2002, the Finnish Parliament voted narrowly for the construction of the country's fifth nuclear power plant unit. It will be located on the island of Olkiluoto, in the municipality of Eurajoki in western Finland. The plant, owned by TVO (Teollisuuden Voima Oy), is expected to start operation in 2009.

Domestic generation of electricity, 80.4 TWh in 2003, consists of hydropower and some wind power, combined production of heat and power in district heating and in industry, nuclear power, and conventional condensing power. Net imports from the Nordic market and Russia vary considerably from year to year, mainly due to variations in hydropower production. In 1990–2003, the maximum net import was 11.9 TWh (in 2002) and the minimum 3.7 TWh (in 1996). Electricity export averaged only 0.7 TWh in 1990–2002, but was as high as 7.0 TWh in 2003 because Sweden and Norway had very scarce hydro resources.

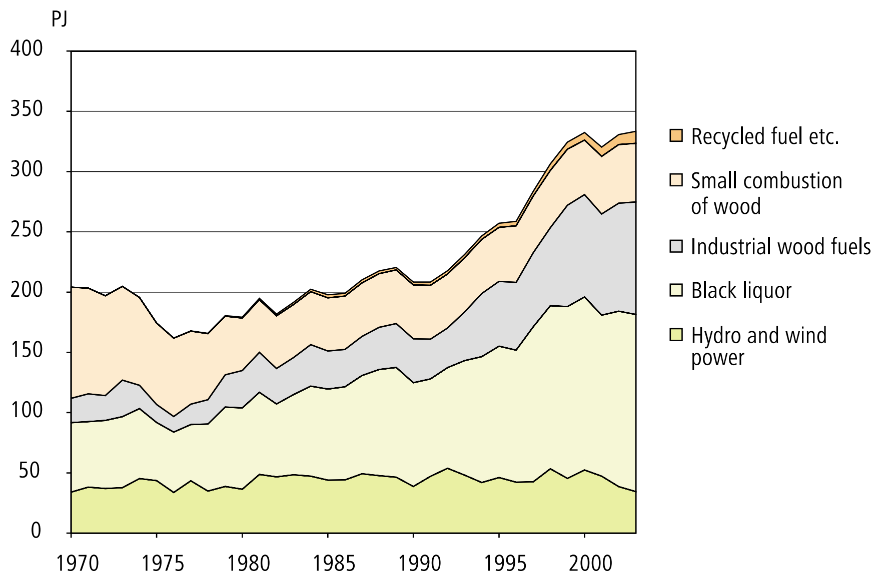
For decades the demand and supply of electricity were rising more rapidly than GDP. Since 1994, alongside the structural change in the economy, the situation has been the reverse and the electricity-intensity of the economy has decreased.

Renewable energy sources covered 22% of the TPES in 2003 (Figure 2–8). In spite of the fluctuation in hydropower, renewables are on an uptrend. This development is mostly due to increased use of the biofuels originating in industrial wood processing. In the EU, the share of renewable energy is 6%, on the average.

Combined heat and power production (CHP) provides opportunities for cost-effective use of renewables, both in industry and at district heat plants. The amount of energy Finland saves annually through CHP corresponds to over one tenth of all primary energy used in the country. The share of CHP is over one third of the electricity production, the EU average being 10%.

Installed wind power capacity increased rapidly in Finland in the 1990s as a result of the Government's support programme. In 1992, the capacity was still only about 1 MW, but in 2003 it was around 50 MW. Finnish manufacturers have successfully developed technical solutions to prevent ice formation on the wings of wind power stations.

Figure 2–8 Use of renewable energy and biomass in Finnish energy production in 1970–2003.



The relatively large dependence on fossil fuels and peat results in considerable carbon dioxide emissions in Finland. Thanks to the hydro, nuclear and biomass primary energy sources, and to the efficiency of co-generation of heat and power, the CO_2 emissions per total primary energy unit are, nevertheless, lower than in several other countries in Europe.

The energy intensity index of the Finnish national economy, calculated as total primary energy supply per unit of GDP, decreased slightly in the 1980s, increased thereafter, but started to decrease again in 1994 (Figure 2–9). The latter development partly reflects the structural change in industry.

Figure 2–9 Energy and electricity intensity indices in Finland in 1975–2003.

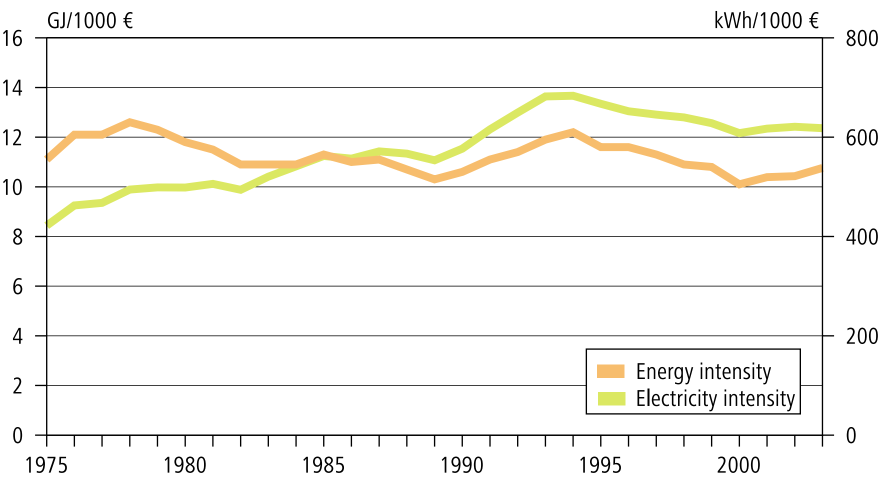
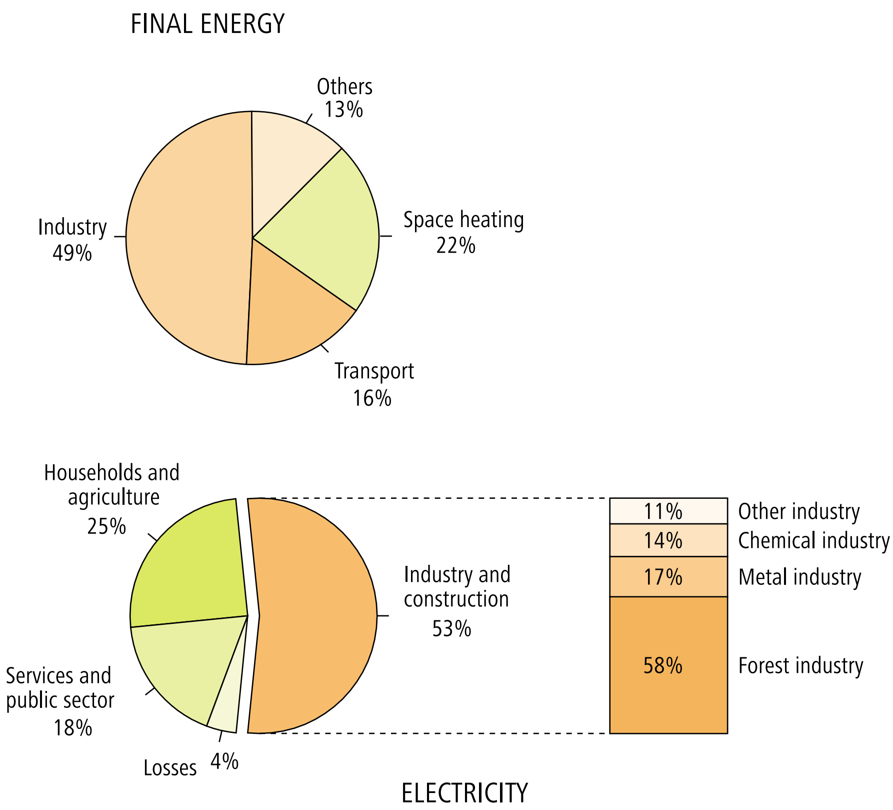


Figure 2–10 Final energy and electricity consumption by sector in 2003.



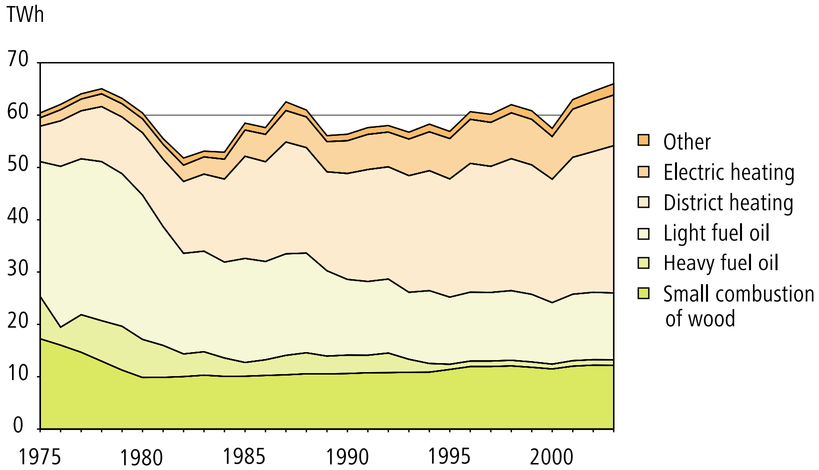
2.9.2 Energy use in industry

The energy demand of industry is very high in Finland; in 2003 industry used 50% of the total primary energy and 54% of total electricity in Finland (Figure 2–10). A considerable number of the energy-intensive industries are export-oriented. Almost 90% of paper and board production is exported, and the share of export products is also high in the basic metal industry.

Because of its high energy demand, Finnish industry has also worked hard to improve its energy efficiency. For example, in 1980-1990 industrial output rose by a third, while the consumption of energy only rose by some 20%. Besides, the forest industry relies to an appreciable degree on biomass to meet its energy needs; wood residues, black liquors and other biomass energy sources are effectively utilised. All Finland's pulp mills are self-sufficient in heating energy and all of them produce energy in excess to their own requirements. In many industrial localities, the energy left over from the pulping process is channelled to the municipal district heating network.

In search of higher profit margins, industry has increasingly outsourced its electricity generation on the open electricity market. Electricity intensity, defined here as electricity consumption per value added in the pulp and paper, basic metal and chemical industries, improved by almost 10% in the 1990s, but has declined slightly thereafter. The overall energy intensity improved in the pulp and paper industry by around 20% in 1990–2003.

Figure 2–11 Energy sources for heating residential, commercial and public buildings in 1975–2003.



2.9.3 Energy use for space heating

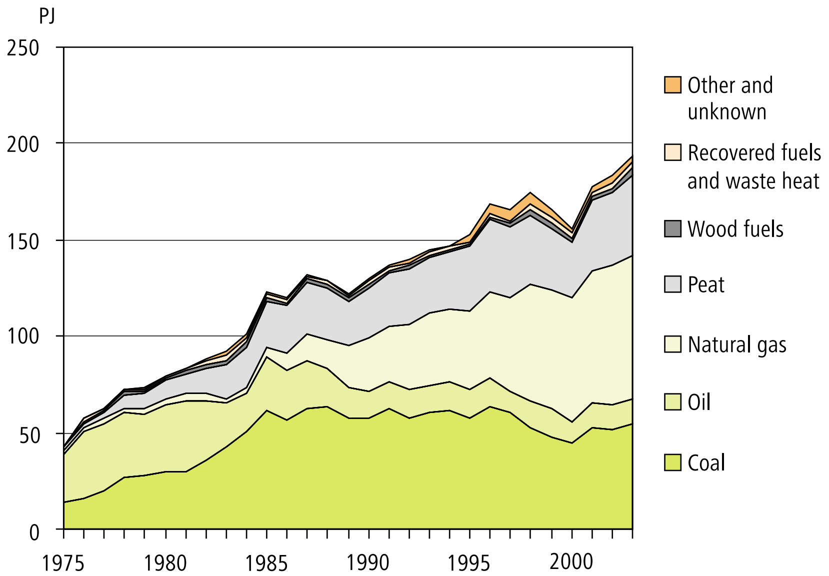
Because of the country's northerly location, Finland uses a lot of energy for space heating. This is the source of the majority of CO_2 emissions by households and by the public and tertiary sectors. However, during the past three decades it has been possible to reduce the consumption of energy per unit of heated space by 40%. This has been largely due to the standards used in the construction industry, which were tightened considerably especially in the 1970s. Energy conservation has received technical support from advanced insulation and window solutions as well as from the development of combined heat and power production (CHP) and district heating, heat-recovery, air-conditioning and ventilation systems.

Since 1990, the composition of energy sources for heating have changed markedly (Fig. 2–11). The use of heavy fuel oil has decreased by 69% and the use of light fuel oil by 12%. At the same time, the energy from natural gas and from heat pumps has more than doubled, although their shares are still rather small. Small combustion of wood has increased by 15%, electric heating by 25% and district heating by 32%.

The share of district heating was 42% of the total heating energy in 2003 . It is the principal heating system in blocks of flats, with half of the total building stock relying on it. Since the 1980s, light fuel oil has lost some of its market share to electric heating and later also to heat pumps in detached houses. Small-scale combustion of wood is often a secondary heating system, but in rural areas it is also used as the principal heating source. Heat pumps have recently become as common as oil heating.

A wide range of fuels is used to produce district heat (Figure 2–12). Coal and oil are being replaced by natural gas. Peat, an indigenous fuel, remains competitive especially in inland areas. Government and industry efforts have helped to increase the use of wood fuel, mostly by-products from the forest industry. The district heating network now covers most of the areas with cost-efficient potential for district heating.

Figure 2–12 Fuels used in district heating and in combined district heating and electricity production in 1975–2003.



CHP accounts for 75% of the total heat produced in district heating; practically all potential for CHP is exploited. CHP improves efficiency, especially when compared to separate condensing power production. CHP is also an efficient way to cut the CO_2 emissions from energy production.

2.9.4 Recent changes on the energy market

The Finnish electricity market was gradually opened up for competition with the Electricity Market Act in 1995. Since the autumn of 1998, it has been possible for all electricity consumers, including households, to arrange tender competitions for their electricity purchases. The electricity market reform aimed to improve efficiency and environmental benefits, as the Nordic hydropower capacity is taken into efficient use and the market also allows the so-called green electricity trade.

The opening up of the market has strongly influenced electricity trade. Before the opening, distribution electricity installations and large-scale consumers concluded long-term delivery contracts on wholesale with electricity producers. Nowadays, most of the wholesale trade in electricity takes place at the Nordic Power Exchange, Nord Pool, whose ELSPOT market price sets the electricity price in the Nordic countries. Besides at the power exchange, electricity is traded on the so-called OTC market, and directly between the buyer and the seller.

The development in the forms of electricity trade has resulted in fluctuations in the price of electricity on the Nordic market according to hydropower production capacity, which is dependent on precipitation and on the electricity consumption rate. For example, in the summer of

2002, the price was around €15/MWh, but the serious drought and cold weather caused it to rise to around €100/MWh in January 2003.

Major restructuring also occurred on the Finnish electricity market in 1997 when the transmission grids of two companies, IVO (Imatran Voima Oy) and TVO (Teollisuuden Voima Oy), were merged into a single national grid company, Finngrid. The Energy Market Authority has placed Finngrid under the so-called system operator responsibility. Finngrid maintains the national power balance management and ensures that the Finnish power system is maintained and used in a technically appropriate manner. Together with the other Nordic grid operators, Finngrid is also responsible for safeguarding the necessary reserves for the operation of the power system.

The national climate targets also have an effect on the role of natural gas in Finnish energy policy. In 2001, the National Climate Strategy set the aim that energy producers should fully exploit the construction potential for CHP, and that natural gas or renewable energy sources should be chosen as the main fuel for such capacity.

At present, Finland has only one natural gas supplier, Russia, and does not have a connection to the natural gas network of any EU Member State. This situation means that Finland has exemptions from the common EU rules for the internal market in natural gas. Finland's Natural Gas Market Act, which entered into force in 2000, provides large-scale consumers buying at least 5 million cubic metres of natural gas per year the possibility of mutual secondary market trading in the natural gas they have purchased from an importer operating in Finland. A separate market place, operated by Kaasupörssi Oy, has been established for trading on the secondary market.

The Finnish natural gas network covers the south-eastern and southern parts of the country. In this area the share of natural gas of the fuels used in CHP amounts to around one third. Development of the market requires extension of the natural gas network to western Finland.

The long-term objective in developing the Finnish energy market is to increase the alternatives for supplying natural gas. This is important in terms of safeguarding both the supply and the functioning of the market. Possibilities for developing and diversifying the supply of natural gas in Finland have been the subject of a number of studies, but no decisions have been made as yet.

The Energy Department of the Ministry of Trade and Industry monitors continuously the functioning of other energy markets, such as those of oil and heating, too. The Ministry controls both the competitive situation and the security of energy supply on them. When necessary, it makes initiatives to improve the functioning of the markets.

Emissions trading in the EU will inevitably become a significant factor on the energy market. The Emissions Trading Act is applied to carbon dioxide emissions from combustion installations with a rated thermal input of more than 20 MW and from smaller combustion installations connected to the same district heating network, from mineral oil refineries and coke ovens, as well as from certain installations and processes of the steel, mineral and forest industries. An installation belonging to the sphere of emissions trading needs an emissions permit; in Finland, the number of installations needing a permit is around 530.

2.9.5 Energy taxes and subsidies

Energy taxation is a substantial source of revenue for the State, as it obtains annually nearly EUR 3 billion as excise duty levied on energy, which is about 9% of all tax revenue. Besides its fiscal significance, energy taxation is a central instrument of the energy and environmental policy. It aims to curb the growth of energy consumption and steer the production and use of energy towards alternatives causing less emissions.

The current energy taxation scheme has been in use since 1997. Energy taxes are excise duties, and they are levied on transport and heating fuels, and on electricity. In addition to the energy tax, a security of supply fee is charged for energy products. The energy tax divides into basic tax and surtax. The basic tax is fiscal by nature and is collected on oil products only. The basic tax on gasoline and diesel oil is graded according to their quality and environmental characteristics. Surtax is collected on oil products, other fossil fuels and electricity. The surtax on fuels is determined according to their carbon content. From 2003 onwards, the surtax on fuels has been €18.05 per carbon dioxide tonne. Natural gas is an exception to this with its 50% reduction in the surtax, as well as peat, whose tax is not based on carbon content. Electricity is taxed at its consumption stage. The fuels used for power production are tax-free.

The tax on electricity is divided into two classes of which the lower, class II, tax is paid by industry and professional greenhouse cultivation. Other consumers pay the higher, class I, tax. The energy taxation scheme also includes various subsidies. Of these, the most important ones in terms of energy policy are tax subsidies paid for power production based on renewable energy sources.

Besides the effect of the taxes that steer energy use and fuel choices, the energy taxation scheme has other elements aimed at promoting the targets of the energy and climate policy. In a broad sense, these can be called tax subsidies. Tax subsidies paid for power production and tax refunds to energy-intensive companies are State aid proper. In addition to these, certain characteristics of the taxation scheme aim to favour selected sources of energy and modes of production. Among such characteristics are exceptions to the general calculation criterion of the carbon dioxide tax (natural gas, peat) and calculation rules concerning taxation on combined heat and power production. However, these are not counted as direct subsidies.

The subsidies for power production were introduced in connection with the tax reform in 1997. A changeover from taxation on production fuels to taxation on electricity consumption was effectuated then. The aim was to compensate with a so-called small power plant aid the weakening competitiveness small power plants using renewable energy and peat had to face. The tax subsidy model thus established has later been utilised more generally as a means of promoting electricity produced with renewable sources of energy in particular. The aid was last extended from 2003 onwards and at present covers nearly all power production based on renewable energy sources, except for large hydropower units.

Since the beginning of 2003, the amount of the tax subsidy has no longer been linked to the electricity tax classes. In 2003, the tax subsidies had three levels: the subsidy for wind power and for electricity produced with forest chips was 0.69 cents/kWh, for electricity produced with recycled fuels 0.25 cents/kWh and for others 0.42 cents/kWh. In 2003, a little over EUR 50 million was paid as taxation subsidies for power production.

Tax refund to energy-intensive industries has been considered necessary so that energy taxation can be used as a means of steering without an unreasonable burden on companies consuming lots of energy. The refunds paid amount annually to around EUR 15 million.

The European Commission has approved the tax subsidies for power production in Finland until the end of 2006. The authorisation for the refund scheme for energy-intensive companies is valid until the end of 2011.

2.10 Transportation

2.10.1 Transport network

The Finnish transport network consists of the infrastructure needed for road, rail, water and air traffic, the main parts of which belong to the Trans-European Network of the European Union. The network of roads and streets comprises 79,000 km of public roads (65% paved) maintained by the National Road Administration, 25,000 km of streets maintained by municipal and other local authorities, and 220,000 km of private roads. Finland has about 600 km of motorways and 150 km of semi-motorways. The rail network amounts to a total of 5,900 km, of which nearly half, 2,400 km, is electrified. This network is the densest in Europe if calculated per capita of population.

Three quarters of Finland's foreign trade are carried by sea, with harbours as the principal traffic nodes. The network of ports is dense but most of them are small and traffic flows are highly fragmentary. Icebreakers form an important part of the transport infrastructure, eight of these being responsible for assisting freighters and passenger ships into 23 harbours that are kept open all the year round. Given a normal winter, the harbours in the Bothnian Bay require icebreakers for half the year, while in the Gulf of Finland they are needed for about three months.

Finland has a dense network of airports, with a total of 25 regularly maintained by the Civil Aviation Administration and another four maintained by municipalities. About 95% of the country's international air traffic operate via Helsinki-Vantaa Airport.

The harsh winter conditions raise the costs of building, maintaining and operating the transport infrastructure in Finland. Penetration of frost into the ground means that all construction has to be dimensioned and insulated properly to cope with the problem of freezing. Salt has to be spread on the roads to prevent icing, and this means that protective layers have to be built into road structures in areas where groundwater is used for domestic supply. Snow clearance, sanding, salting and the repair of frost damage are further sources of additional costs.

The majority of Government spending on transport in Finland goes to the building and maintenance of roads, railways and waterways, the 2003 budget for which was almost EUR 1.2 billion. Allocations under this heading have diminished by over 10% from what they were in 1990, and there has been a clear shift of emphasis away from the building of new routes to the maintenance of existing ones.

The need for replacement investments is increasing rapidly, as it is obvious that the quality of the transport infrastructure cannot be maintained given the present level of financing. Thus, the Ministerial Working Group on Transport Infrastructure, which submitted its report in December 1998, recommended additional funding of EUR 100 million per year. As this has not led to any significant increase in transport infrastructure investment funding, a new Ministerial Working Group on Transport Infrastructure listed in its recent report from February 2004 the major projects the scarce resources should be concentrated on, and additional funding should be raised using private resources (e.g. so-called shadow tolls).

The rail network degenerated badly in the 1980s, and finances for track maintenance have been increased during the present decade. About EUR 235 million were spent on this in 2004, around one third more than ten years earlier. In 2003, some EUR 55 million were spent on the maintenance of and new investments in airports and air routes and about EUR 100 million on shipping channels.

2.10.2 Freight transport

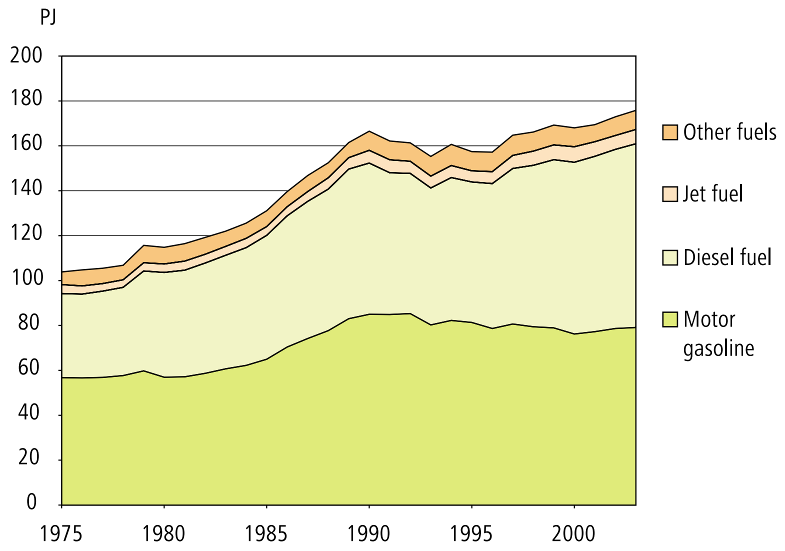
More freight is transported per capita in Finland than anywhere else in Europe. The volume of freight traffic kilometres is almost double the EU average, mainly because of the long haulage distances and the industrial structure. Finnish industry has traditionally inclined towards heavy industries, such as the timber, paper and metal industries, which all need transport for their raw materials and products.

Road haulage is the most important form of transport for Finland's internal goods traffic (Table 2–2). More than two thirds of all freight are transported by road; rail transport accounts for 23%, a distinctly greater proportion than the EU average, while the inland waterways' share is about 8%.

Table 2–2 Shares of different modes in domestic freight traffic in 1970–2003.

	Tonne-kilometres in goods transport (million tonne-km)					
	1970	**1980**	**1990**	**1995**	**2000**	**2003**
Goods transport total	23 421	31 917	38 691	35 810	41 487	40 770
Railway transport	6 270	8 335	8 357	9 293	10 107	10 047
Road transport	12 800	18 400	26 300	23 239	28 616	27 795
Waterway transport	4 350	5 180	4 032	3 275	2 760	2 926
Air transport	1	2	2	3	4	2

Figure 2–13 Consumption of transport fuels in Finland in 1975–2003.



In 1990, motor gasoline accounted for 51% of transport fuel consumption in Finland, while the share of diesel oil was 40%. The number of cars and the volume of road transport actually decreased between 1990 and 1996. Consumption of diesel oil began to rise in the late 1990s, following growth in the demand for freight transport. Since the year 2003, the use of diesel oil has been higher than the use of motor gasoline (Figure 2–13).

Measured in euros, more than 60% of Finnish foreign trade deliveries are destined to the European Union and EFTA countries and about 7.5% to Russia. Taking all the border crossing points together, over 250,000 heavy goods vehicles and almost 1,320,000 private cars crossed from Finland into Russia in 2003.

Figure 2–14 Development of public transport and passenger car transport in 1980–2003. The indices are based on passenger-kilometres, which totalled 48,060 million in 1980 and 73,240 million in 2003.

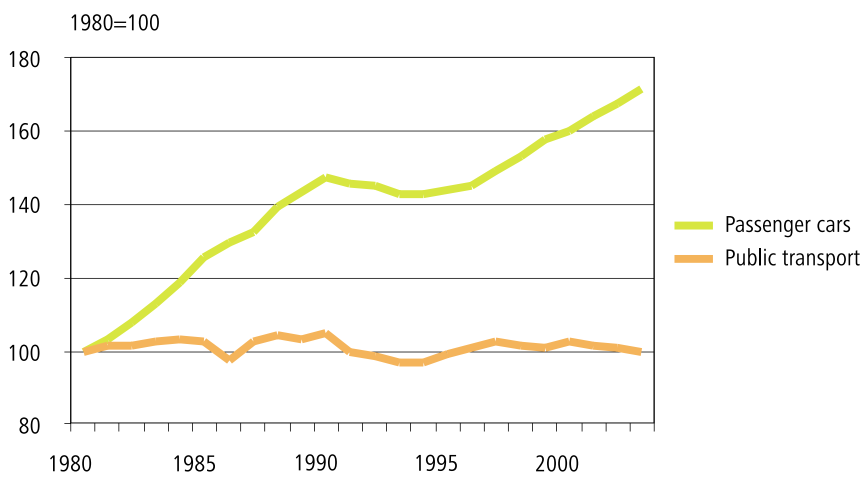


Figure 2–15 Around two thirds of commuting travellers choose public transport in City of Helsinki; every day some 132,000 passengers use train. (Photo: Ministry of Transport and Communications)

Having her own merchant fleet is important to Finland. The Ministry of Transport and Communications has proposed that the State should begin to use procedures permitted by the EU to support Finnish sea transport in the same way as certain other Member States. Two thirds of Finland's overseas freight traffic goes by sea.

Although little freight is carried by air, its share of the value of foreign trade is more than one tenth. Highly processed products, such as electronics, are transported by air. Growing exports of consumer goods and electronics, including mobile phones, are increasing the share of air transport.

2.10.3 Passenger transport

An average Finn uses 83 minutes per day to travel, and covers a distance of 45 kilometres. Around 80% of the distance is nowadays travelled by passenger cars, whereas in 1980 the public transport still covered one half of the total (Figure 2–14). Of the public transport in 2003, the share of buses was 60% and the share of trains 26%.

Finns travel more than people in the other EU Member States. The reasons for this are the long distances, the dispersed settlement structure and trips to free-time residences. The total volume of passenger traffic is forecast to grow by 30% from the present situation by 2020.

As already pointed out, buses are the most popular form of public transport since even sparsely populated areas can be reached by bus. Trains are preferred for long-distance journeys from town to town and for commuter traffic in the Helsinki Metropolitan Area (Fig. 2–15). Helsinki also has a metro and a tram network. Travel between the south of Finland and Lapland is mostly by air.

Finland has 2.6 million automobiles; the number increased by 17.6% in the 1990–2003 period. There are nearly 2.3 million passenger cars in Finland, i.e. 433 per 1,000 inhabitants. Although the passenger car stock is renewing, the average age of passenger cars is in Finland one of the highest in the EU15.

The proportion of passenger cars classified as low emission was 63% in 2003, as compared to 4% in 1990. For other cars, the corresponding proportions were 27% and 0%.

Migration to population centres, especially certain city areas, continues in Finland. In these areas, public investments are made to promote pedestrian and bicycle traffic. Today, the adult population in Finland make more than one fifth of their journeys by bicycle or on foot. Cycling in wintertime is becoming more popular as well.

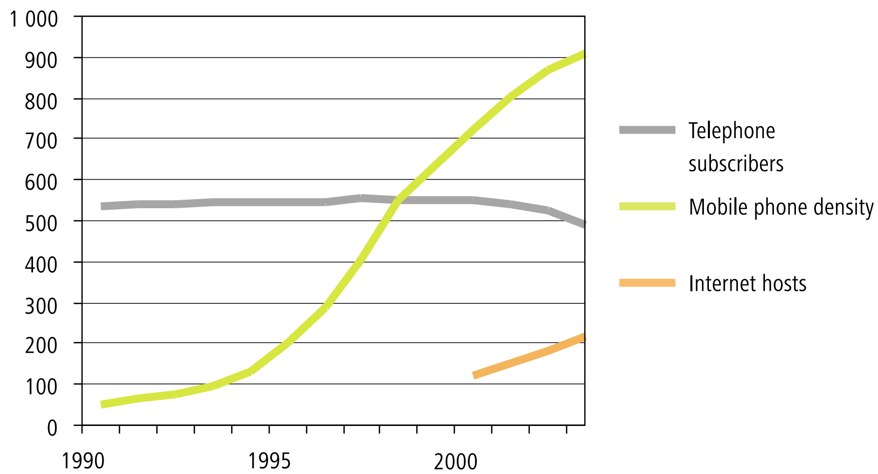
The State helps to fund public transport by buying services from companies in the sector. The State mainly finances uneconomic but essential rail and bus services in sparsely populated areas.

The development of transport networks improves traffic safety. In accordance with the Government's resolution, the aim is to reduce the number of fatalities to less than 250 by 2010. In 2003, 379 people died in road traffic accidents, i.e. about seven deaths per 100,000 people. Road traffic safety is in Finland among the five best in European countries.

2.10.4 Telecommunications

Finland has made international headlines as an information society in recent years. There were 4.75 million mobile telephone subscriptions in Finland at the end of 2003, equivalent to 909 per one thousand inhabitants. The number of Internet subscriptions was 1.23 million, i.e. 235 per 1,000 (Figure 2–16).

Figure 2–16 Numbers of telephone subscribers, mobile telephones and Internet hosts in Finland in 1990–2003 (per thousand inhabitants).



Finland was the first country to grant licences for third generation mobile networks. Four telecommunications companies received a licence to construct a 3G mobile network. Operations were launched in September 2004.

In the next few years, the telecommunications and information technology sectors will continue to grow rapidly in Finland. Over the coming years, the major change in mass media will be digitisation of radio and television transmissions. Digital television services started in autumn 2001; analogue transmission will finish in 2007.

2.11 Agriculture

Finland is the world's northernmost agricultural country. However, the number of people living in rural areas and obtaining their livelihood from agriculture has been shrinking at a fast pace for many years. Between 1990 and 2003, the number of active farms fell from 130,000 to 74,000. At the same time, the average farm size increased from 17.3 to 30.5 arable hectares. Total agricultural production has remained at the same level since the early 1990s.

There is agriculture all over Finland, though up in the northern part of Lapland it is mainly reindeer husbandry. As Finland is nearly 1,100 kilometres long from north to south, there are considerable regional variations in the climate. The thermal growing season (the period with an average daily temperature of over +5°C) varies from nearly 6 months in the south to between 2 and 3 months in the north. The total effective temperature sum is between 500 and 1,300°C, and the average total precipitation in the summer months is between 180 and 220 mm. In Continental Europe, the growing season is 260 days long and in southern parts of the Continent more than 300 days. This means that the growing season in Finland is too short for the cultivars grown elsewhere and frost-resistant varieties have been developed. However, Finnish cultivars do not yield as much as those in central and southern Europe. The harsh Finnish winters also reduce productivity as they restrict the cultivation of winter cereals.

Most crop production farms are in the south, whereas cattle breeding is concentrated in central, eastern and northern parts. Although milk is produced all over Finland, even in the northernmost parts of Lapland, the main production areas are in Ostrobothnia, North Savo and North Karelia, which account for more than half of all the milk produced in Finland. Pig and poultry farming are concentrated in the west and south, and most cereals come from southern and south-western Finland. Fodder cereals can be grown throughout the country except for the extreme north.

Most of the Finnish agricultural products come from family farms. Almost 90% of active farms belong to private persons and 11% to estates and family enterprises. The rest are owned by co-operatives, corporations, companies, the Finnish Government, local authorities and parishes. The average age of farmers is almost 50 years, full-time farmers being younger than those farming part-time.

About half of the active farms practice crop production as their main line. Most of these produce cereals (72%), a little over a fifth (22%) cultivate other crops and the rest practice horticulture. Dairy production is the main production line on almost 30% of the farms. About 7% of the farms specialise in beef production and 6% in pig husbandry. The shares of poultry farms and organic farms are around 2% each. About 2% of the farms practice horse husbandry and the shares of sheep husbandry, forestry, and reindeer herding are about 1% each.

The cultivated arable land area was 22,120 km^2 in 2003. The share of grassland crops was 28%, barley 24%, oats 19% and wheat 9%. These shares have remained fairly stable since 1990. By comparison, the number of dairy cows decreased in this period from 490,000 to 334,000.

The total annual consumer expenditure on food and beverages in Finland is about EUR 13 billion. The gross value of domestic agricultural and horticultural production was about EUR 3.4 billion in 2003. In the same year, the value added produced by agriculture and horticulture to the Finnish national economy totalled about EUR 1.2 billion, which is 1.3% of the total GDP of all sectors. In 1990, the corresponding share was 3.7%.

Agriculture and horticulture are closely linked to the food processing industry; over four fifths of their output go to this industry. The gross value of the food industry was about EUR 8.8 billion in 2003, which is a little less than 9% of the gross value of all industrial production. The value added produced by the food industry was EUR 2.0 billion in 2003, which is 6.3% of the value added produced in the whole of Finnish industry.

There are three kinds of agricultural support in Finland. The EU's Common Agricultural Policy (CAP) support for arable crops and animals is closely linked to the market arrangements of the EU, and financed in full from the EU budget. It accounts for one quarter of all agricultural support. The share of support for rural development co-financed by Finland and the EU is about 40%. The third type is national aid, its share of the total support package is about one third.

Income from the sale of agricultural products accounted for 51% of farmers' total income in 2001. Subsidies accounted for 41%, and non-agricultural activities and other sources for 9%.

Sales of fertilisers to farms decreased by 10–15% in 1990–2003. The use of fungicides and herbicides increased. Fuel consumption in agriculture declined slightly, from 29 PJ in 1990 to 26 PJ in 2003. Oil and natural gas account for about 80% of the total; the former is used for engines, natural gas mainly in horticulture. The remaining energy comes mainly from wood, used for heating.

2.12 Forests

2.12.1 A land of forests

The total forest land area of Finland is 224,837 km^2 according to the definition of the FAO. It is based on the ninth National Forest Inventory (NFI9) in 1996–2003 and on observed land use changes on the field plots, and is estimated to correspond to the year 2000.

There are about twenty indigenous tree species growing in Finland, the most common ones being pine (*Pinus silvestris*), spruce (*Picea abies*) and birch (*Betula pendula* and *B. pubescens*). Usually, two or three tree species dominate a forest stand. Naturally pure pine stands are found on rocky terrain, on top of arid eskers and on pine swamps. Natural spruce stands are found on richer soil. Birch is commonly found as an admixture, but can occasionally form pure stands.

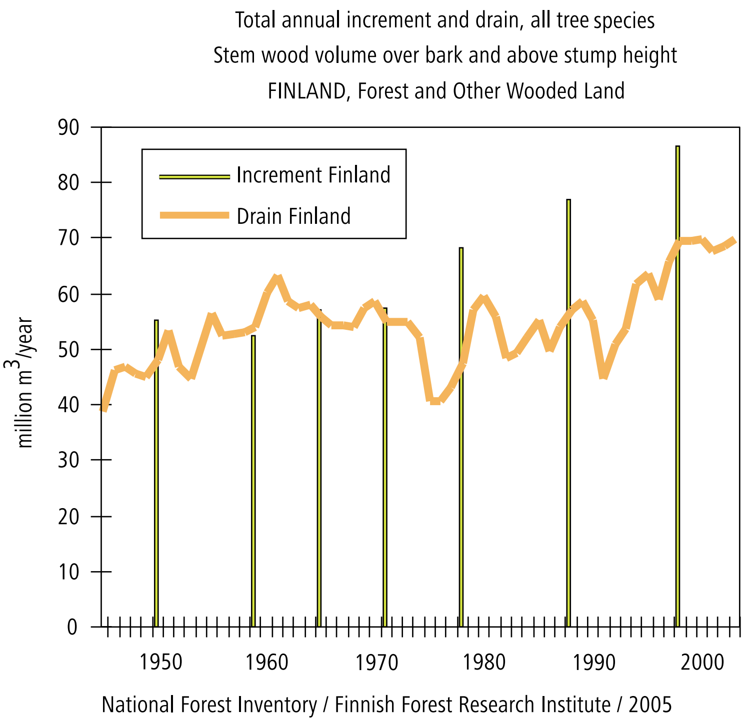
Good half of the forest land area consists of mixed stands. Rarer species are found mostly as solitary trees. The south-western corner and the south coast of Finland have a narrow zone where oak, maple, ash and elm grow.

Today, about one third of Finnish forests are regenerated naturally and two thirds artificially. Natural regeneration is based on seeding from trees already growing on the site, usually by leaving a number of seeding trees standing at felling. Artificial regeneration requires the removal of old trees from a site. A new stand is established on the clear-felled area, either through seeding or planting. Every year, over 150 million seedlings are planted in the forests.

2.12.2 Forest resources and management

The total volume of the stock in Finnish forests amounts to 2090 million cubic metres. For a long time, the increment of the stock has exceeded harvesting volumes and natural drain (Fig. 2–17). In 1990–2003, the annual increment varied between 74 and 87 million cubic metres, whereas the annual total drain was 45–70 million cubic metres. The drain includes cutting removals, harvesting losses and natural mortality of trees.

Figure 2–17 The total annual increment and drain of stemwood in Finland in 1946–2003.



Of the total area treated annually with fellings, thinnings account for roughly one half and other cuttings, e.g. clear fellings and seed and shelterwood fellings, for the other half.

Thanks to the grown increment, it has been possible to increase the drain continuously. This is a result of improved forest management practices and improvement measures, such as forest ditching. About half of the original peatland area of Finland has been drained for forestry purposes. Today, natural peatlands are no longer subjected to drainage ditching; the activities are now concentrated on maintaining previously drained areas and the forests established there. Due to changed forest management practices, the annual increment of the growing stock has gone up by some 30 million cubic metres, i.e. over fifty per cent, since the early 1950s.

Total removals from forests amounted to 61.1 million m^3 and total drain to 69.9 million m^3 in 2003. In 1990, the corresponding figures were 48.9 and 55.1 million m^3, respectively.

Until the early 1900s, wood was mainly consumed as fuel in Finland, but today the share of fuelwood is only around 5% of the total consumption. Of the industrial wood, the chemical pulp industry used 44%, sawmills 35%, mechanical pulp industry 15%, and plywood and other industries 6%.

The raw material value of the volume of wood harvested annually has recently been EUR 1.3–1.8 billion. Roughly 80% of this sum is returned to the private persons and families who own the forests; private forest owners number more than 400,000. Changes in society, such as urbanisation, cause changes in forest ownership as well. An increasing number of forest owners are city or town dwellers and live on paid wages. The number of women among them is also growing.

Finnish forest owners have easy access to expert advice concerning the management of their forests. There are about 250 forest management associations which provide the forest owners with advisory services on forest management and felling, as well as other types of related services. The associations' task, prescribed in law, is to promote private forestry while securing its economic, ecological and social sustainability.

Much of the forest harvesting is carried out mechanically, and only some thinning and felling for special purposes is done manually. Forest industry companies generally buy their timber as standing sales, i.e. the company takes care of the logging. The forest owner can also opt for delivery sale, performing the felling himself and delivering the timber to a road-side landing.

The forest industry companies do not have logging machines of their own, which means that they use small contractors for felling and thinning. Logging is based on the so-called assortment system. This means that a tree trunk is cut immediately after felling into saw-timber and pulpwood, based on its quality and diameter. Roundwood transports make up a major part of all haulage on Finnish roads. Hauliers and their employees transport about 60 million tonnes of timber annually.

In addition to logging, forestry involves forest management and improvement work. About EUR 200 million are invested every year in forest regeneration, young stand management, fertilising, improvement ditching and construction of forest roads. About three quarters of this are financed by the forest owners themselves and the rest is covered by State subsidies.

2.12.3 National forest programme

Finland's National Forest Programme was approved by the Government in March 1999. This Programme is designed to meet the demands set by international forest policy, but it will also have far-reaching effects in Finland.

The National Forest Programme sets a vision for sustainable forest management in Finland in 2010:

- Forests secure sustainable development
- Forests are healthy and diverse
- Market-oriented, profitable forestry and forest industry provide jobs and livelihood
- Forests have an inaugurating spiritual and cultural effect
- Finnish forestry know-how is top class
- Finland takes an active part in international forest policy.

The Programme is implemented and monitored in broad co-operation between the public and private sectors. The Ministry of Agriculture and Forestry, supported by the Forest Committee, has been responsible for the Programme as a whole. The national and 13 Regional Forest Committees have representatives from different administrative sectors, industries, NGOs and expert organisations.

The investments and production capacity of forestry have developed as envisaged in the National Forest Programme. Annual investments in forest management and improvement have gone up to about EUR 250 million, which is EUR 50 million more than in 1998. However, the use of domestic industrial roundwood has not grown in recent years despite the increase in the production volume of the forest industry. According to the Programme, the target for domestic roundwood use was up to 68 million cubic metres in 2003. Imports of roundwood have consequently grown significantly; most of it comes from Russia. In 2000–2003, use of forest chips for energy increased from 0.7 million to 2.1 million cubic metres.

2.12.4 Forest protection

During the past few decades, forest protection and biodiversity have received special attention alongside timber production in managed forests. In addition, thanks to numerous protection programmes and decisions, protected forest areas have almost trebled over the last 30 years. Depending on the degree of protection, the share of protected forests and forests under restricted forestry use varied in 2002 between 4.1%–7.7% on forestland and between 7.2%–12.1% on forest and poorly productive forestland.

The Forest Biodiversity Programme for southern Finland (METSO) is implemented jointly by the Ministry of Agriculture and Forestry and the Ministry of the Environment. The measures of this Programme include e.g. natural values trading, which was started in the Region of Satakunta in 2003. By the end of the year, over 140 landowners had offered sites for trading; with the available funding of EUR 0.4 million, altogether 228 hectares were protected for ten years. Contracts were made especially for heath forests with decaying trees.

Another measure of METSO aims at protecting forest biodiversity, basing on landowners' own initiative and voluntary action. The two ministries organised a two-stage competitive tender in 2003. In addition, there will be a research project of the Finnish Environment Institute concerning evaluation of the co-operation networks.

A revision of the indicators for sustainable forest management in Finland was started in autumn 2003. The previous indicators dated only from 2001, but the revision was considered necessary due to new perspectives introduced by new information, research results and international forest co-operation. The Finnish indicators are based on the Pan-European Criteria and Indicators for Sustainable Forest Management, which were updated and revised at the Ministerial Conference in Vienna in 2003.

2.13 Waste

2.13.1 Waste generation and treatment

Approximately 119 million tonnes of waste and comparable by-products were generated in Finland in 2003 (Table 2–3). Of this total amount, the largest quantities are surplus soil from construction (32.7 Mt), waste stone, ore dressing sand and other soil material from mining and quarrying (25.0 Mt), straw and manure from agriculture (21.3 Mt) and wood felling waste from forestry (23.0 Mt). Altogether 12.0 Mt of waste were generated in manufacturing in 2003, of which the largest quantities were waste wood and bark, slag from the basic metal industry, wastes from the chemical industry, especially gypsum, and liquid wastes from the food industry. Especially calculated per capita, the Finnish volume of waste can be regarded as large by European comparison.

The annual volume of solid municipal waste amounted to 2.3 million tonnes. Smaller amounts than those listed above were generated as ash and slag from energy production, construction materials from new building and demolition, and as sludge from wastewater treatment.

On average, 40% of all the generated waste are recovered by the national economy as a whole. In terms of volume this represents over 50 million tonnes. Wastes like surplus soils from construction, as well as manure and straw, were recovered in large volumes. Manufacturing recovered 70% of its waste, either as energy or as raw material. Good one third of both the municipal waste and the construction and demolition waste generated were recovered in 2003.

Over one half of industrial waste comes from the forest industry. The next largest generators of industrial waste, in order of generated amount, were the chemical industry, basic metal industry, manufacture of metal products, food industry and manufacture of non-metallic mineral products. Changes in the volumes of waste generated in different industries and in their relative shares were, in fact, surprisingly small in the past decade, and reflected cyclical or output volume variations rather than structural changes in waste generation or production.

The main municipal waste types are packaging waste, organic waste and waste paper. Nearly 500 kg of municipal waste per capita are generated in Finland annually, of which households generate annually just under 200 kg. Good one third (39%) of municipal waste is recovered, while the rest (1.6 Mt) is landfilled.

Table 2–3 Generation and treatment of waste in Finland in 2003.

Economic activity	Total	Recycling	Energy recovery	Other treatment	Landfill
	1 000 tonnes				
Waste from production					
Agriculture[1)]	21 300	21 140	–	–	160
Forestry[2)]	22 950	–	1 400	21 550 [3)]	–
Mining and quarrying	25 000	6 000	–	19 000 [4)]	–
Manufacturing	11 953	3 092	4 110	663	4 088
Energy supply	1 488	750	11	–	727
Construction	34 120	9 240	–	24 360	520
– house building[5)]	1 420	540	–	360	520
– surplus soil [6)]	32 700	8 700	–	24000 [9)]	–
Municipal waste, total	2 325	663	207	55	1 400
– of which:					
domestic waste	981	299	91	25	566
other solid municipal waste	1 344	364	116	30	834
Municipal sewage sludge [7)]	150	96	2	42	10
Total	**119 286**	**40 981**	**5 730**	**65 670**	**6 905**
– of which:					
hazardous waste	1 310	179	103	273	755
packaging waste [8)]	451	221	55	14	161

[1)] Manure, wet weight, [2)] Logging waste, fresh weight, [3)] Proportion left on site, [4)] Disposal, sedimentation, [5)] Without surplus soil, [6)] Estimate, [7)] Calculated as dry matter, [8)] Without recycled packaging, [9)] Landfill for surplus soil

A total of 1.2 Mt of packaging was used in Finland in 2003. Considering that about two thirds of all packaging is reused, the real annual total volume of packaging waste was approximately 0.45 Mt. Over one half of the packaging waste is paper or fibre, although their share of the packaging that is used is notably smaller than this. The rate of paper recovery for recycling is one of the highest in Europe in Finland, approximately 75% in 2003.

The current rate of return of glass bottles for beer and soft drinks is 98%. Returning and reusing bottles saves raw materials, keeps emissions down in the packaging industry, and reduces both littering and the amounts of packaging waste ending up in landfills.

Landfill sites are still important waste disposal and treatment places. However, decreasing their number and raising the level of waste treatment on them along with a strong reduction of the volume of landfilled organic waste are common European waste management targets. By the year 2001, the number of operating landfill sites had fallen to 276 in Finland, whereas ten years earlier they had numbered twice as many as this. Operating and closed landfill sites in Finland presently number almost 1,900. A total of

approximately 8 Mt of different kinds of waste from production and consumption were landfilled in 2000. Approximately 60% of this total originated from industry.

Expressed in terms of dry matter, the sludge from municipal wastewater treatment plants totalled 0.16 Mt in 2000. The "real" volume, that is the wet weight, of the sludge was approximately 1.1–1.2 Mt. Sludge from wastewater treatment plants is used for soil improvement in public green area building and agriculture. Under 10% of the sludge was landfilled.

The total amount of hazardous waste generated in 2000 was 1.2 Mt. The largest groups of hazardous waste are wastes from the processes of metallurgy and inorganic chemistry, waste oils, solvents, and wastes from thermal processes. Some hazardous waste is treated and recycled by the producers themselves, while some is treated at the national hazardous waste disposal plant or at other hazardous waste treatment plants.

The Finnish municipal solid waste strategy is based on source separation of waste for recovered fuel production and separate biowaste treatment. The biowaste treatment is mainly based on composting. In addition, there is one anaerobic digestion plant in Finland which treats about 25,000 tons of biowaste and 15,000 tons of sludge annually.

At present there is only one operating municipal solid waste incinerator, with the capacity of 50,000 t/a. In addition, source separated municipal waste is used for energy recovery through co-firing in industrial and municipal power and district heating plants.

About 140,000 tons of biowaste were treated in biological treatment plants in 2002. This was about 15% of the total amount of organic waste. The total number of biowaste treatment plants is going to be raised from about 50 operating in 2002 to 80 by the year 2005.

The waste disposal tax was raised to €23/tonne from the beginning of 2003. In order to support the progress of biological treatment of separately collected biowastes and sludges from municipal wastewater treatment plants, the treatment is not subjected to taxation.

2.13.2 National waste planning

The Revised National Waste Plan, approved by the Finnish Government, came into effect in September 2002, and will remain effective until the end of 2005 or until a new national plan has been approved. The Plan is based on the Waste Act and on waste directives of the EU. The Plan describes the current state of the waste management field in Finland, and sets quantitative and qualitative targets to be achieved by 2005.

Quantitative targets have been set on the prevention of wastes, and to improve waste recovery rates. The targets for reduction and recovery rates vary by type of waste. Where municipal waste, housing construction and industrial wastes are concerned, 15% less waste should be generated annually by 2005 compared to 1994, contributing to real growth in GDP. For hazardous wastes, the target is 15% reduction in comparison to the benchmark year of 1992.

By 2005, at least 70% of all municipal, construction and industrial waste should be recovered, while average recovery rates for hazardous wastes should be at least 30%. There is no quantitative target for reducing the numbers of contaminated sites, and the main goal in this area is to prevent the contamination of more sites.

Qualitative targets have been set to reduce the hazards associated with wastes, and to prevent any risks to the environment or public health from wastes or waste management. The goals set in the Waste Plan are mainly guidelines rather than legally binding limits, but they are expressed in such concrete terms that they should give strong signals to all sectors of society about how they should plan their activities to prevent and reduce waste.

Reaching the targets set in the Waste Plan can be economically beneficial to everyone concerned, since this will lead to considerable savings through reduced use of primary raw materials and lowered energy consumption. These measures will also help to cut emissions.

Work has started on a new national waste plan and is expected to be ready by the end of 2006. It is anticipated that the scope of the new plan will be shifted towards industrial ecology to cover the issues of quantitative and qualitative waste prevention.

LITERATURE

Energy Market Authority. 2005. Electricity Market Act (386/1995) – unofficial translation 7 April 2005. *Http://www.energiamarkkinavirasto.fi/select.asp?gid=128&pgid=128*

Finnish Forest Research Institute. 2005. Maankäytön ja maankäytön muutosten seurannan ja raportoinnin kehittäminen kasvihuonekaasuinventaarion näkökulmasta. (Development of the monitoring and reporting of LULUCF from the perspective of the GHG inventory), 36 p. (in Finnish)

Finnish Forest Research Institute. 2005. Finnish Statistical Yearbook of Forestry. METLA, Helsinki, 413 p.

Finnish Meteorological Institute. 2005. Climate statistics (Internet pages)

Government of Finland. 2002. Decision in principle on an action programme to protect biodiversity in forests in southern Finland, the western parts of the province of Oulu and the south-western region of the province of Lapland (METSO). Government of Finland, Helsinki, 16 p.

Ministry of Agriculture and Forestry. 1999. Finland's National Forest Programme 2010. Ministry of Agriculture and Forestry, Publications 2/1999, 40 p.

Ministry of Agriculture and Forestry. 2005. Maankäytön seurantajärjestelmien kehittäminen. Työryhmämuistio 2005:5.

Ministry of the Environment. 2002. Revised National Waste Plan for the period up to 2005. Helsinki, 26 p.

Statistics Finland. 2003. Environmental Statistics. Environment and Natural Resources 2003:2, 208 p.

Statistics Finland. 2004. Statistical Yearbook of Finland 2004. Helsinki, 718 p.

Statistics Finland. 2004. Transport and Communications Statistical Yearbook of Finland 2004, Transport and Tourism 2004:14, 214 p.



3 *Greenhouse gas inventory information*

3.1 *National system for greenhouse gas inventories*

In accordance with the Resolution of the Finnish Government of 30 January 2003 on the organisation of climate policy activities of Government authorities, Statistics Finland[1] assumed the responsibilities of the National Authority for Finland's greenhouse gas inventory 1.1.2005. Finland's National System was among the first to be established in accordance with the requirements of the Kyoto Protocol (Article 5.2), and of the decision 280/2004 of the European Parliament concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol. The legal basis of Finland's National System is defined by the above mentioned resolution, an agreement between the Ministry of the Environment and Statistics Finland on operating the national system for estimating greenhouse gas emissions under the Kyoto Protocol and on reporting requirements under the climate convention, as well as on regulations concerning Statistics Finland (Statistics Finland Act (48/1992) and Statistics Act (280/2004)).

The roles and responsibilities of expert organisations participating in the preparation of the inventory are defined in agreements between Statistics Finland and Finnish Environment Institute (SYKE), MTT Agrifood Research Finland, Finnish Forest Research Institute (METLA), VTT (Technical Research Centre of Finland) and the Civil Aviation Administration. The resources for inventory preparation for the three first mentioned participating expert organisations are channelled through the relevant ministries' performance guidance (Ministry of the Environment, Ministry of Agriculture and Forestry). The contribution by VTT and the Civil Aviation Administration is based on annual contracts with Statistics Finland. The continuance of the contribution is ensured with longer term framework agreements. In addition, other ministries participating in the preparation of the climate policy take care in their administrative branches that the data collected in the management of public administration duties can be used in the emission inventory.

In accordance with the Government Resolution, the ministries produce the data needed for international reporting on the content, enforcement and effects of the Energy and Climate strategy. Separate agreements have been made on co-operation between Statistics Finland and relevant minis-

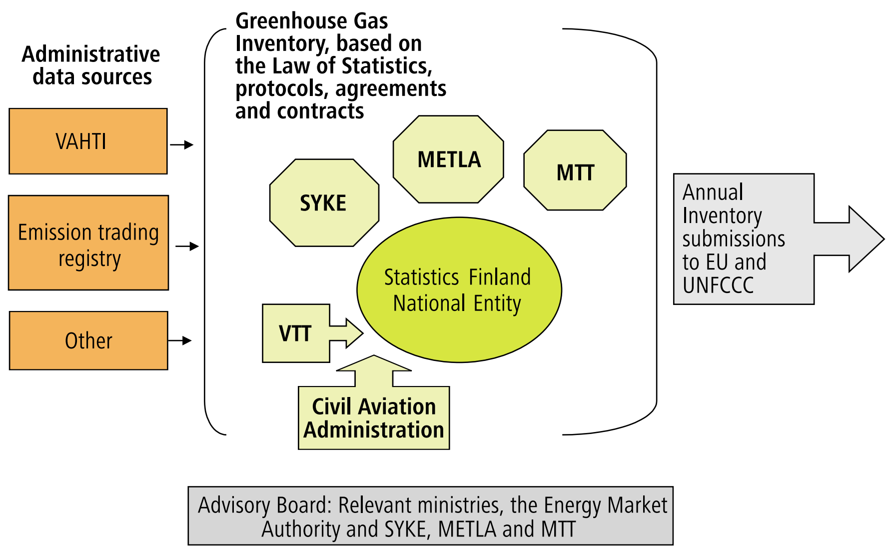
1 A detailed description of Finland's National System can be found on web-page of the Greenhouse Gas Inventory Unit at Statistics Finland: www.stat.fi/greenhousegases.

tries. The structure of the estimation system corresponds to the horizontally organised preparation of Finland's climate policy. Statistics Finland assists in the technical preparation of the policy reporting.

The structure of the National System is shown in Figure 3–1. Statistics Finland is responsible for the inventory compilation and submission, and calculates the estimates for the Energy and Industrial Process (except for the so-called F-gases: HFC, PFC and SF_6) sectors. The Finnish Environment institute prepares the emission estimates on the F-gases, NMVOC emissions (excluding combustion sources) and for the Waste sector. MTT Agrifood Research Finland estimates the agricultural emissions, also the CO_2 emissions reported in the Land Use, Land-Use Change and Forestry sector (LULUCF). Finnish Forest Research Institute has the overall responsibility for estimates in the LULUCF sector. VTT and Civil Aviation Administration provide data for the emissions from transportation. All participating organisations take part in an inventory working group supporting the annual inventory process. Statistics Finland has also set up an Advisory Board to which representatives from the expert organisations and the responsible ministries are invited. The Advisory Board decides about changes to the division of responsibilities in the National System and controls the quality of the inventory[2]. In addition, the Advisory Board coordinates longer term research programmes related to the development of the inventory and reporting, as well as international co-operation in this area (UNFCCC, IPCC, EU), including inventory reviews.

In September 2005, the staff of the Greenhouse Gas Inventory Unit at Statistics Finland comprised seven persons.

Figure 3–1 The National System for greenhouse gas inventory in Finland.



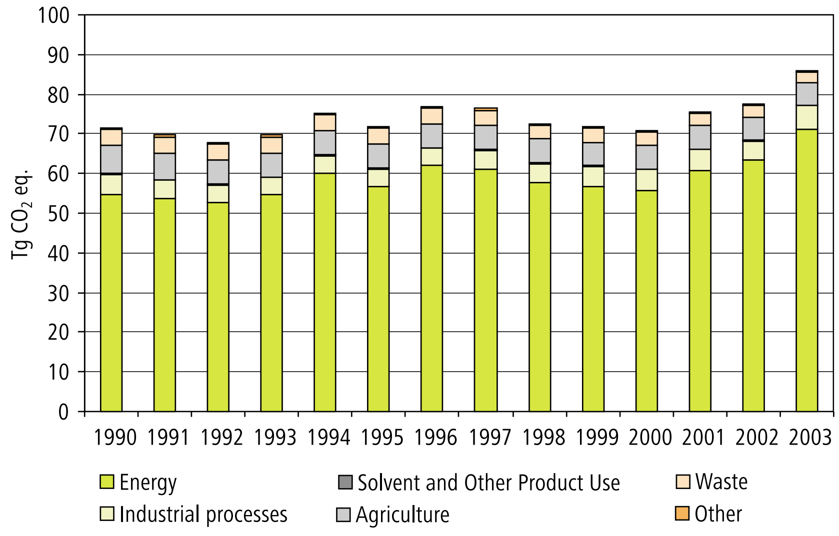
2 Statistics Finland approves the national inventory submission independently and no official consideration by ministries is required. Statistics Finland compiles also the report for the establishment of Finland's assigned amount under the Kyoto Protocol. This report will be accepted by the government.

The annual inventory process is guided by the inventory principles: transparency, comparability, completeness, accuracy and timeliness of reporting. The methodologies, activity data collection and choice of emission factors are consistent with the guidance in the Revised 1996 IPCC Guidelines and the IPCC good practice guidance reports. Tier 2 and Tier 3 level methods are used frequently. Detailed activity data is used for most categories and emission factors and other parameters are based on national research and other data. For large point sources in the Energy and Industrial Processes sectors, the estimates are based on plant and process specific data. The Compliance Monitoring Data System VAHTI – a tool for the Regional Environment Centres for processing and monitoring environmental permits – is the central data source for plant and process specific data. The methods, activity data collection and emission factors and other parameters are defined in detail in the reporting protocols annexed to the description of Finland's national system (see footnote 1).

3.2 Summary of emissions

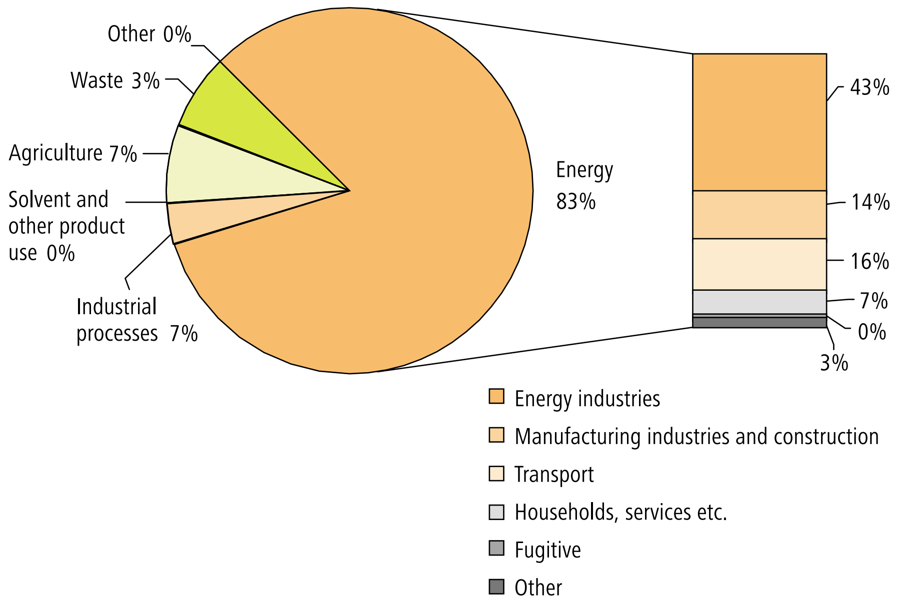
A summary of the Finnish national emissions and removals for 1990–2003[3] is presented in Figure 3–2. More detailed information on the emissions and removals by sector and gas can be found in the Common Reporting Tables (Summary 1.A, Summary 2 and Table 10) in Annex 1. In 2003, Finland's greenhouse gas emissions totalled 86.0 Tg CO_2 eq., which exceeded the level for the year 1990 by over 20% (14.5 Tg).

Figure 3–2 Greenhouse gas emissions in Finland in 1990–2003 by reporting sector.



3 The emissions and removals presented in this National Communication are consistent with those included in the Draft Report to facilitate the estimation of Finland's assigned amount under the Kyoto Protocol, submitted to the European Commission mid January 2006. Minor revisions may take place before the official submission of the inventory to the UNFCCC by 15 April 2006.

Figure 3–3 Composition of Finnish greenhouse gas emissions in 2003.

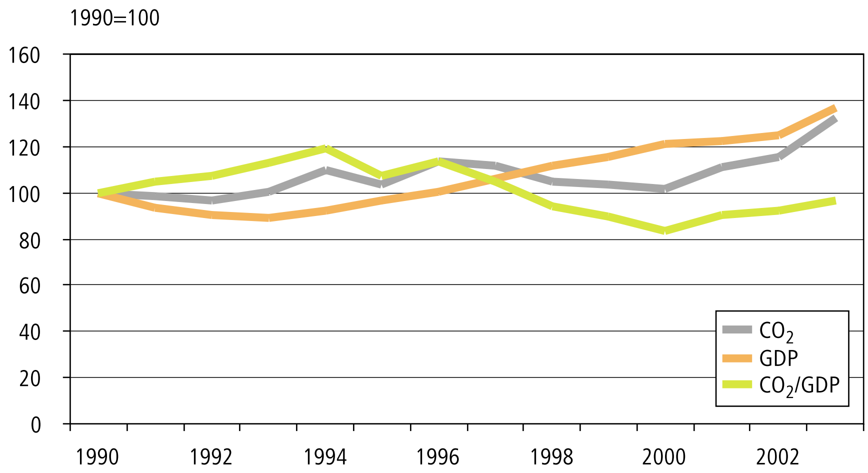


The energy sector is the most significant source of greenhouse gas emissions in Finland with an 83% share of the total emissions in 2003 (Figure 3–3). This reflects the high energy intensity of Finnish industry, extensive consumption during the long heating period, as well as energy consumption for transport in a large and sparsely inhabited country. Energy related CO_2 emissions vary mainly according to the economic trend, energy supply structure, and climate conditions. Due to these reasons, there was a 16.2 Tg CO_2 (+30%) increase in the energy sector's CO_2 emissions between the years 1990 and 2003 (but only 8.3 Tg CO_2 between 1990–2002). The total energy sector emissions were 16.8 Tg CO_2 eq. higher in 2003 than in 1990.

The total carbon dioxide intensity of the Finnish economy increased in the early 1990s but started to decline in the latter half of the decade (Figure 3–4). The change has taken place as growth in the economy has shifted to less energy-intensive activities such as the electronics industry. Relative to GDP, carbon dioxide emissions were at their lowest in 2000 but have been growing since then. In recent years, and especially in 2003, the growth has been caused by a structural change in the supply of electricity. Shortage of hydropower on the Nordic electricity market led to increased use of coal and other fossil fuels in electricity generation. This is the main reason for the significant increase in Finnish greenhouse gas emissions compared to the previous years.

Agriculture is the second most significant sector of greenhouse gas emissions in Finland. In 2003, agricultural emissions accounted for approximately 6.7% (5.7 Tg CO_2 eq.) of the total emissions. Emissions from agriculture include CH_4 and N_2O emissions. The total emissions from agriculture show a clearly declining trend. The annual emissions have diminished by more than 19% since 1990 due to decreases in the

Figure 3–4 Energy-based carbon dioxide intensity of Finnish economy in 1990–2003.



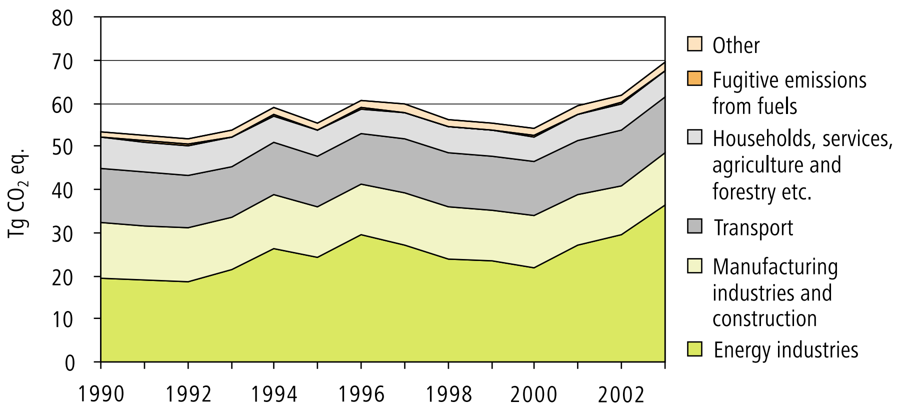
cultivation of organogenic land, in the number of livestock, and in nitrogen fertiliser use. Finland's EU membership has imposed many structural and other changes to agriculture due to changes in agricultural policies and subsidies. The emission reductions can largely be attributed to declining livestock numbers, reductions in fertiliser use and changes in the manure handling.

Emissions from industrial processes, including CO_2, CH_4, N_2O and F-gases, were in 2003 about 7% of the total greenhouse gas emissions in Finland. Emissions from the processing industries have increased by about 9% (~0.50 Tg CO_2 eq.) from the 1990 level, but their share of the total greenhouse gas emissions has remained relatively constant. The share of solvents and other products in the Finnish greenhouse gas emissions is small, about 0.1% of the total emissions.

The waste sector accounted for 3.2% (2.8 Tg CO_2 eq.) of the total emissions in 2003. Emissions from the waste sector consist of CH_4 and N_2O emissions, and these have shown a decreasing trend since 1990. Overall, the annual emissions have decreased by over 30% from the 1990 level. The decrease has been mainly due to the preparation and implementation of new waste legislation in Finland in 1993.

The LULUCF sector acts as a net sink for carbon dioxide emissions, currently absorbing approximately 20% of the annual emissions from the other sectors. The net sinks, 17.8 Tg CO_2 eq. in 2003, are mainly due to increases in carbon stocks in forests.

Figure 3–5 CO_2 emissions from fuel combustion by category in 1990–2003.



3.3 Emissions by sector

3.3.1 Energy

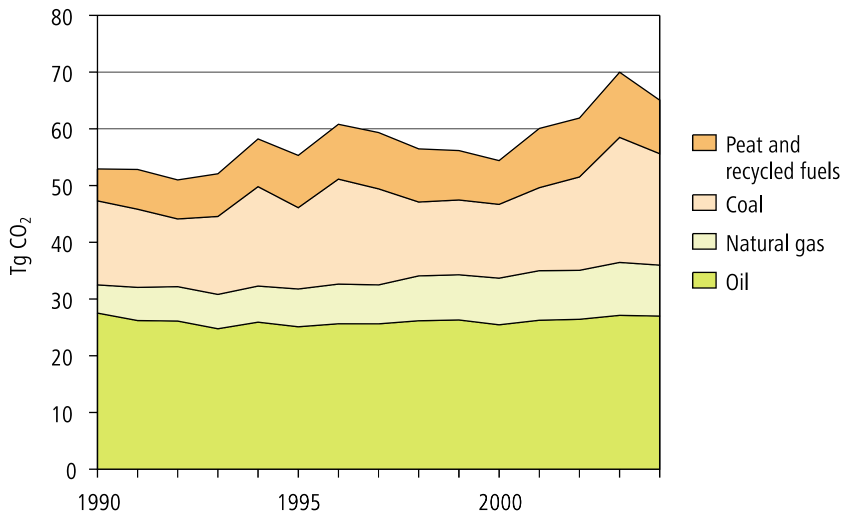
Energy-related activities are the primary source of anthropogenic greenhouse gas emissions in Finland. In 2003, the emissions from the energy sector were 71.3 Tg CO_2 -eq., by far the highest in the 1990–2003 period. The largest emission source in the energy sector, CO_2 from fuel combustion (69.6 Tg in 2003), accounted for 80.9% of the total national emissions.

As mentioned earlier, the main driver for the high emissions in 2003 was the weather, i.e. a persistent drought in the Nordic countries and the soaring price of electricity on the Nordic electricity market. Consequently, domestic electricity production in Finland increased by 12% when compared to the year 2002. The use of coal increased by over 40%, equivalent to over 5 Tg of CO_2 emissions. Net import of electricity decreased by 59% and the production of domestic hydro power by 12%. In 2002, Finland's net import of electricity from Sweden was 4.0 TWh; in 2003, the net export was 6.4 TWh. From Russia, Finland imported 7.9 TWh of electricity in 2002, and 11.3 TWh in 2003.

The estimated N_2O emissions from the energy sector accounted for 1.4% of Finland's total emissions in 2003. These emissions arise mainly from fluidised bed combustion and transportation. Energy-related CH_4 emissions are mainly due to incomplete combustion and accounted for only 0.5% of the total national emissions in 2003. The share of fugitive fuel emissions (CO_2 and CH_4), from oil refineries, flaring, and distribution and transmission of natural gas was 0.2% of the total emissions.

Energy industries caused most of the emissions in the energy sector, more than 50% in 2003 (Figure 3–5). Manufacturing industries and construction produce much energy themselves, and their share of the emissions was also significant, 17%. The share of transportation was about 19%. Liquid fuels accounted for about 39%, solid fuels for 32%, gaseous fuels for 13% and other fuels (peat) for 16% of the energy-related CO_2 emissions in 2003 (Figure 3–6).

Figure 3–6 CO_2 emissions from fuel combustion by fuel in 1990–2004.



Energy consumption has grown in Finland by almost 75% since the energy crisis in the mid-1970s. The growth stagnated for a few years in the early 1990s when Finland experienced a severe recession, but has continued after that. The growth in energy consumption was 24% during 1990–2003; in the same period, CO_2 emissions from fuel combustion increased by 31%. For the 1990–2002 period, the corresponding percentages were 23 and 16. The latter values reflect better the real trend, i.e. CO_2 emissions have grown at a slower rate than energy consumption due to a shift from coal and peat to natural gas, upgrading of existing nuclear power plants, and improved energy efficiency. In 2003, the Nordic drought was severe and, consequently, hydropower production was exceptionally low.

CO_2 emissions from manufacturing industries were slightly lower in 2003 as compared to 1990, but there is no clear trend. About one half of these emissions come from the iron and steel industry and one quarter from the pulp and paper industry. Methane and nitrous oxide emissions from manufacturing industries have varied from year to year but, again, there are no clear trends.

Greenhouse gas emissions from the transport sector remained fairly constant in 1990–2001, but increased by 1.7% in 2002 and in 2003. Almost 90% of these emissions originate from road transport, where the volume of passenger transport increased by 13% and that of goods transport by 23% in 1990–2003.

CO_2 emissions from passenger transport decreased during 1990–2001 because of improved fuel efficiency of cars, and also due to an increase in the share of diesel-fuelled cars. The recent turn towards higher CO_2 emissions in the transport sector is due to several factors. Subsidies for public transport have been cut and the measures to promote non-motorised pedestrian and cycle traffic have been inefficient. Average distances from home to work have increased in large urban areas because affordable housing is not available in the vicinity of city centres. The share of large cars has increased; a considerable number of used cars with low fuel efficiency have also been imported particularly from Germany.

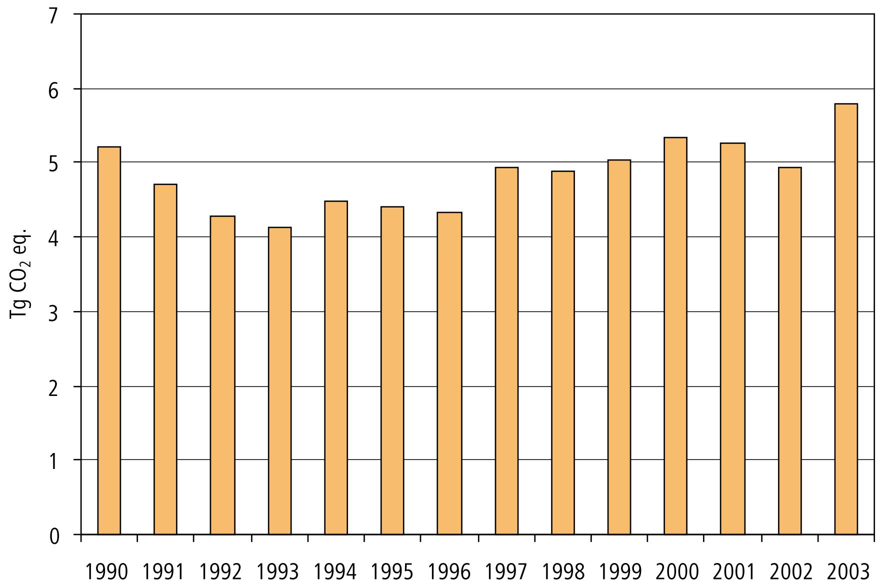
3.3.1 Industrial processes

Industrial greenhouse gas emissions contributed 7% to the total emissions in Finland in 2003. The contribution of CO_2 was around 63%, N_2O around 25% and that of F-gases around 12%. The most important sources were CO_2 emissions from metal production, N_2O emissions from nitric acid production and CO_2 emissions from mineral products (cement production and lime and soda ash production and use) with their respective shares of 39%, 21% and 20% of the total industrial greenhouse gas emissions.

F-gas emissions comprised together about 0.8% of the total greenhouse gas emissions in Finland. This relatively small share is explained by the absence of certain large industrial point sources that account for most of the F-gas emissions globally.

The emissions from industrial processes decreased in the early 1990s mainly due to the economic recession but have gone up since (Figure 3–7).

Figure 3–7 Emissions from industrial processes in 1990–2003.



The most significant change is an increase in the emission of F-gases, which is now more than six times as high as in 1990. N_2O emissions have decreased to some extent.

CH_4 emissions have increased by over 60%, but their contribution to the total industrial emissions is very small. Industrial CO_2 emissions decreased considerably at the beginning of the 1990s, but have increased since 1996 and are currently approximately at the same level as in 1990.

The annual production of nitric acid has varied from about 430 to 550 Gg during the 1990–2003 period. Adipic acid is not produced in Finland. Emissions from hydrogen production were approximately 147 Gg in 2003, which was 0.2 % of Finland's total emissions. Natural gas is the most common raw material in hydrogen production in Finland. Theoretically, all the carbon contained in hydrocarbons will be emitted as CO_2 in the processes, but in practice a small amount of the feedstock does not react.

In 1990, practically all the emissions from F-gases originated from SF_6, while in 2003 its share was only 3%. The use of HFCs has increased considerably in refrigeration and air conditioning equipment; this use accounted for 82% of all F-gas emissions in 2003.

3.3.3 Solvent and other product use

The only direct greenhouse gas source identified in this sector is the use of N_2O in industrial, medical and other applications. In Finland, N_2O is used in hospitals and by dentists to relieve pain and calm fear, and for detoxification. In addition to its medical use, N_2O is also used for other purposes, but no specific data are available on this.

All delivery is currently based on the import of the gas to Finland. Throughout the 1990s, these N_2O emissions were fairly constant at around 0.2 Gg per year, or less than 0.1% of the total national emissions.

In this category, Finland also reports indirect greenhouse gas emissions (NMVOC), half of which are due to paint application, the other half coming from a large number of sources. The NMVOC emissions in this category have declined by 45% since the year 1990. The indirect CO_2 emissions caused by the oxidation of the NMVOCs in the atmosphere are also included in the inventory. In this sector these amount to approximately 64 Gg CO_2 in 2003, which is about 0.07% of the total greenhouse gas emissions.

3.3.4 *Agriculture*

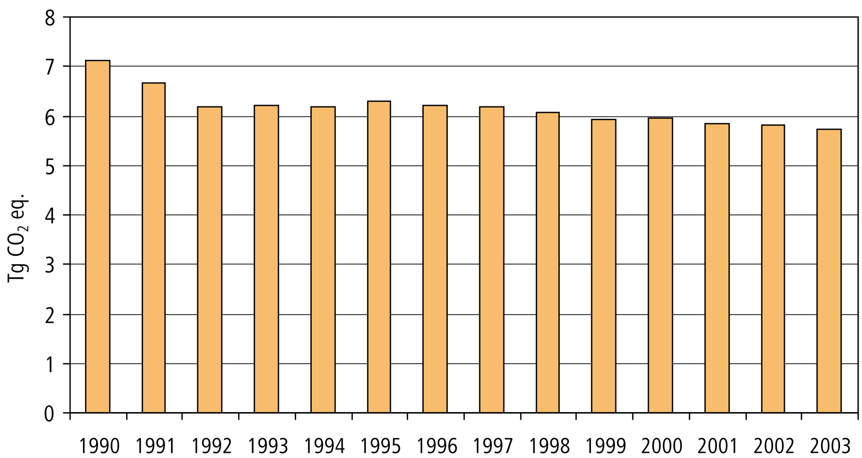
Agricultural greenhouse gas emissions in Finland consist of CH_4 emissions from enteric fermentation of domestic livestock and CH_4 and N_2O emissions from manure management. In addition, direct and indirect N_2O emissions from agricultural soils are included. Direct N_2O emissions from agricultural soils include emissions from synthetic fertilisers, manure applied to soils, biological nitrogen fixation of N-fixing crops, crop residues, sewage sludge application and cultivation of organic soils. Indirect N_2O emission sources include atmospheric deposition and nitrogen leaching and runoff to watercourses.

In 2003, Finland's agricultural greenhouse gas emissions were 5.7 Tg CO_2 eq. After the energy sector, agriculture is the second largest greenhouse gas emission source category with its 6.7% share of the total emissions in 2003. In 1990, the agricultural emissions were 7.1 Tg CO_2 eq.

Agricultural emissions have decreased by more than 19% over the 1990–2003 period (Figure 3–8). One reason for this is the change in the economic structure, followed by an increase in the average farm size and a decrease in the number of small farms. These changes also caused a decrease in the livestock numbers except for that of horses, which has increased in recent years. The reduced use of nitrogen fertilisers and improved manure management, resulting from the measures taken by the farmers as part of an agro-environmental programme aiming to minimise nutrient loading of watercourses, have also decreased the emissions.

Nitrous oxide emissions from agricultural soils are a considerable emission source accounting for 58% of the total agricultural emissions and 3.9% of Finland's total greenhouse gas emissions in 2003. However, these emissions have decreased by 23%, from 13.9 Gg in 1990 to 10.5 Gg in 2003. The main reasons for this reduction are the decreased number of animals which affects the amount of nitrogen excreted annually to soils, the decreased amount of synthetic fertilisers sold annually and the decreased area

Figure 3–8 Trend in agricultural emissions in 1990–2003.



of cultivated organic soils. Some parameters, e.g. the annual crop yields affecting the amount of crop residues produced annually, cause the fluctuation in the time series, but this fluctuation does not have much effect on the overall N_2O trend.

Methane emissions from enteric fermentation of domestic livestock, 76.7 Gg in 2003, accounted for 28% of the total agricultural emissions. The emissions have decreased by 16% since 1990 due especially to the diminishing number of cattle. For example, the number of dairy cattle declined from 490,000 in 1990 to 334,000 in 2003.

Nitrous oxide and methane emissions from manure management were 1.8 Gg N_2O and 12.2 CH_4 Gg in 2003, respectively. The share of the former was 9.6% and that of the latter 4.4% of the total agricultural emissions. Nitrous oxide emissions from manure management have decreased by 17% over the time period of 1990–2003; methane emissions fluctuated but there has been a minor overall increase in emissions from manure management in this period. This is due to an increase in the number of animals kept in slurry-based systems. The fluctuation in emissions is related to both changes in animal numbers, which are largely dependent on agricultural policy, and changes in the distribution of the used manure management systems. Slurry-based systems increase methane emissions per animal by a factor of ten compared to solid storage or pasture, but decrease nitrous oxide emissions by a factor of twenty.

3.3.5 Land use, land-use change and forestry

In the LULUCF sector emissions to atmosphere and removals from the atmosphere (so called sinks) are reported from the following land-use categories: Forest land, Cropland, Grassland and Wetlands (peat extraction areas). In the Forest land category carbon stock changes in tree biomass, dead organic matter and soil organic matter are included in the reporting. In the other land-use categories only carbon stock changes in soil organic matter are reported. In addition direct N_2O emissions from the fertilisation of forest land, CO_2, N_2O and CH_4 emissions from forest fires and CO_2 emissions from liming of agricultural land are reported.

The LULUCF sector as a whole acts as a net CO_2 sink in Finland (Figure 3–9). This means that the emissions are smaller than the removals within the sector. Most of the removals come from forest growth; the tree volume increment exceeds annual harvesting and natural mortality. Also the dead organic matter pool on forest land has been a significant sink during the reporting period. The largest emissions in the LULUCF sector in 2003 came from changes in soil organic matter in organic forest and agricultural soils (croplands). In 2003, the LULUCF sector as a total was a sink of about 17.8 Tg CO_2 eq., which is about one fifth of the total greenhouse gas emissions from other sectors in Finland.

Tree growth has increased in Finland. The increment in the stem volume was some 11% higher in 2003 than in 1990 (Table 3–1). The main reasons for the enhanced growth are more efficient forest management practices and forest improvement measures, for instance, drainage ditching. In addition, the share of young forests currently at the stage of rapid growth has increased especially in northern Finland.

The annual variations in the drain have been considerable, the range has been from 44.6 to 70.0 million m^3. The drain is the decrease in growing

Figure 3–9 **Greenhouse gas removals (sinks) and emissions (sources) in the LULUCF sector in 1990 and 2003. Sinks in forest land include carbon stock increase in tree biomass and dead organic matter. Also mineral forest soils acted as a net sink both in 1990 and 2003. Emissions came from organic forest soils, forest fires and N fertilization on forest land. In the Cropland category liming as well as mineral and organic soils were in 1990 net sources, but in 2003 mineral soils were a net sink. In the Grassland category both mineral soils and organic soils acted as a net sink in 1990, but in 2003 mineral soils were a net source. The Wetland category includes emissions from peat extraction areas.**

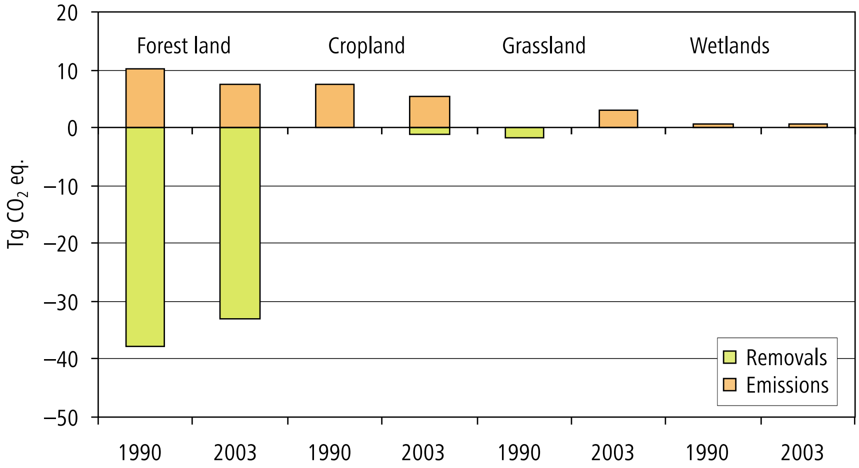


Table 3–1 Stem volume increment and drain, as well as CO_2 uptake and release by trees in Finland in 1990–2003.

Year	Volumes (million m³)			Tg CO_2		
	Increment	Drain	Balance	Uptake	Release	Balance
1990	77.5	55.1	22.4	100.7	72.1	28.6
1991	77.5	44.6	32.9	100.7	58.6	42.1
1992	77.9	51.0	27.0	101.2	66.7	34.5
1993	78.7	53.8	24.9	102.1	70.4	31.7
1994	78.4	61.7	16.8	101.7	80.6	21.2
1995	79.4	63.6	15.8	103.0	83.1	19.9
1996	79.4	59.0	20.4	103.0	77.0	26.1
1997	82.8	65.8	17.0	107.4	85.9	21.5
1998	86.3	69.4	16.9	111.8	90.4	21.3
1999	86.7	69.4	17.3	112.2	90.4	21.8
2000	86.7	70.0	16.7	112.2	91.1	21.1
2001	86.7	67.7	19.0	112.2	88.2	24.0
2002	86.7	68.7	18.0	112.2	89.5	22.8
2003	86.7	69.9	16.8	112.2	90.9	21.3

stock due to fellings and unrecovered natural losses. Fellings consist of commercial and other roundwood removals and harvesting losses. Recently, commercial removals have been 53–56 million m^3 annually. They were much lower in the early 1990s due to the recession in Finland and the poor global market situation.

Non-commercial roundwood removals refer to logs for contract sawing and fuelwood used in dwellings. The estimate for contract sawing is around one million m^3 and that for fuelwood use around five million m^3 per year. Accordingly, total annual roundwood removals have recently ranged from 59 to 62 million m^3. The rest of the drain consists of natural losses and of parts of stems left in the forest. The former is around 2.8 million m^3/a, the latter varies from 4 to 10% for pine, from 5 to 12% for spruce and from 10 to 31% for broadleaves.

The uptake and release of carbon dioxide by the growing stock has varied according to the increment and drain, the annual balance being 20–42 Tg CO_2/a (Table 3–1). Since the latter half of the 1990s, fellings have been exceptionally high compared to the long-term average.

Total drain figures and corresponding emissions of CO_2 are estimated annually from the statistics on cutting removals reported by the forest industry companies in Finland. The estimates of households' use of timber are based on inquiries, the estimate of cutting waste is obtained from timber quality requirements and taper curve models. The volume of natural losses is based on estimates in the National Forest Inventory (NFI).

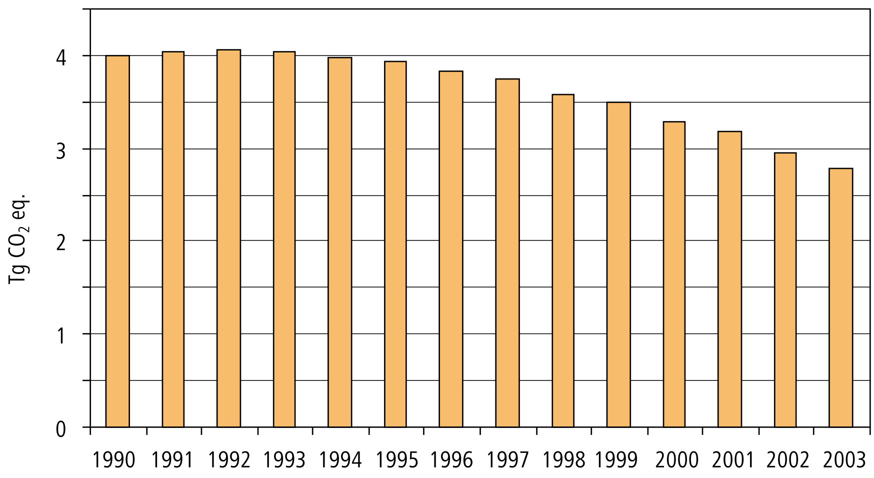
The volume increment of the growing stock of trees is estimated using field measurements on the sample plots of the NFI. The measurements concern the increment of the tree stem volume. Average increment for the five years preceding the time of measurement is applied. Finnish forests have been measured nine times with National Forest Inventories. The first inventory was carried out in 1921–1924. The tenth NFI began in 2004. In the tenth NFI, one fifth of the plots in the entire country will be measured per year, thus all plots will have been measured in five years. The forest resource statistics for the entire country can be updated annually. There are a number of reasons for this change, the greenhouse gas inventory being one of them.

3.3.6 Waste

In the Finnish inventory, emissions from the waste sector cover CH_4 emissions from solid waste disposal sites including solid municipal, industrial, construction and demolition wastes and municipal and industrial sludges. CH_4 and N_2O emissions from composting are also covered. In addition, the emissions from this sector include methane emissions from wastewater and uncollected domestic wastewaters, and nitrous oxide emissions generated from nitrogen input in fish farming as well as from domestic and industrial wastewaters discharged into waterways.

The total emissions from the waste sector were 2.8 Tg CO_2 eq. in 2003. This was 3.2% of the total greenhouse gas emissions in Finland. Methane from solid waste disposal caused over ninety per cent of the emissions. Since 1990, the waste sector's emissions have decreased by more than 30% (Figure 3–10). The decrease has been mainly due to the implementation of the new waste legislation in Finland in 1993; in addition, the economic recession in the early 1990s reduced the amount of waste. The new waste legislation strives to

Figure 3–10 Trend in the waste sector's emissions in 1990–2003.



minimise waste generation, increase material recycling, as well as reduce the amount of waste disposed of at landfills through alternative treatments like composting and waste-to-energy concepts.

At the beginning of the 1990s, around 80% of the generated municipal waste was taken to landfills. Since the implementation of the new waste legislation, minimisation of waste generation, recycling and reuse of waste material and treatment methods alternative to landfills have been endorsed. Similar developments have occurred in the treatment of industrial waste, and municipal and industrial sludges.

The emissions (CH_4 and N_2O) from wastewater treatment have declined as well, although not substantially. CH_4 emissions were 0.13 Tg CO_2 eq. and N_2O emissions 0.11 Tg CO_2 eq. in 2003, down by 13% and 21% from 1990, respectively.

Landfill gas recovery was practised to a negligible degree at the beginning of the 1990s. In 1998, the recovery exceeded 10 Gg CH_4, and was already 32 Gg CH_4 in 2003.

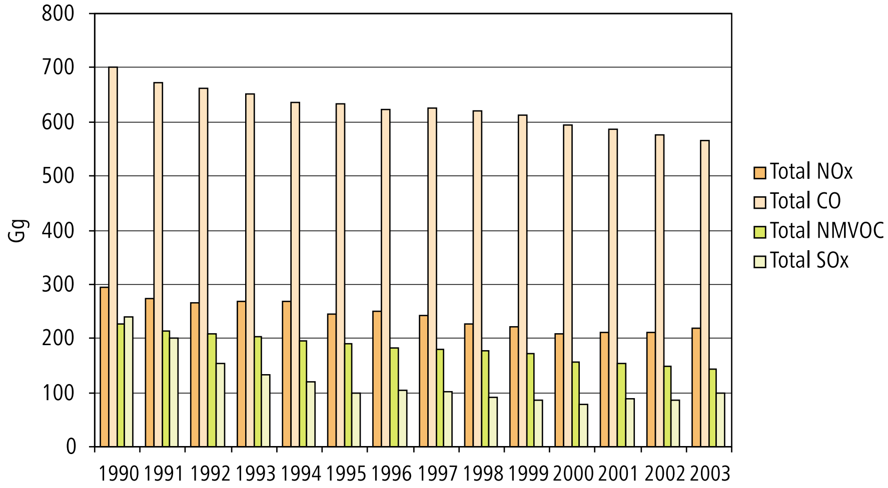
Emissions from composting are estimated to be approximately 0.1 Tg CO_2 equivalent in 2003. This is about 0.1% of the total national greenhouse gas emissions. The emissions from composting have grown threefold between 1990 and 2003.

NMVOC emissions from solid waste disposal sites and wastewater handling are also estimated in the Finnish inventory.

3.3.7 International bunkers

Emissions from international bunkers amounted to 3.1 Tg CO_2 eq., equivalent to 3.6% of the total greenhouse gas emissions in Finland in 2003. About two thirds of the emissions come from marine bunkers and one third from aviation. The annual emissions from international bunkers fluctuated considerably up to 1999, whereafter they have been fairly stable.

Figure 3–11 Finnish NMVOC, CO, NO_X and SO_2 emissions in 1990–2003.



3.3.8 NMVOC, CO, NO_x and SO_2 emissions

The trends in the emissions of non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), nitrogen oxides (NO_X) and sulphur dioxide (SO_2)[4] are presented in Figure 3–11. All of them show declining trends; emissions of NO_X decreased by 26%, CO by 20%, NMVOC by 35%, and SO_2 by 59% in the 1990–2003 period.

Nitrogen oxides were generated exclusively in the energy sector. The total emissions were 218 Gg in 2003. The transport sector was responsible for 39% of the emissions. Energy industries, and manufacturing industries and construction, generated 28% and 20% of the emissions, respectively.

Carbon monoxide emissions, totalling 564 Gg, originated also exclusively in the energy sector, where transport generated 65% and other branches (including small scale combustion in the residential energy sector as well as off-road machinery in forestry, agriculture and fishery) 21% of the total emissions.

The non-methane volatile organic compounds totalled 144 Gg in 2003. Over two thirds of the total emissions were generated in the energy sector, where transport generated 47%, other sectors 34% (including small scale combustion in the residential energy sector as well as off-road machinery in forestry, agriculture and fishery) and fugitive emissions from fuels 11% of the sectoral emissions. One fifth of the NMVOC emissions originated from solvent and other product use and 8% from industrial processes.

Sulphur dioxide emissions totalled 99 Gg, out of which 89% originated in the energy sector where energy industries generated 64%, and manufacturing industries and construction 22% of the sectoral emissions.

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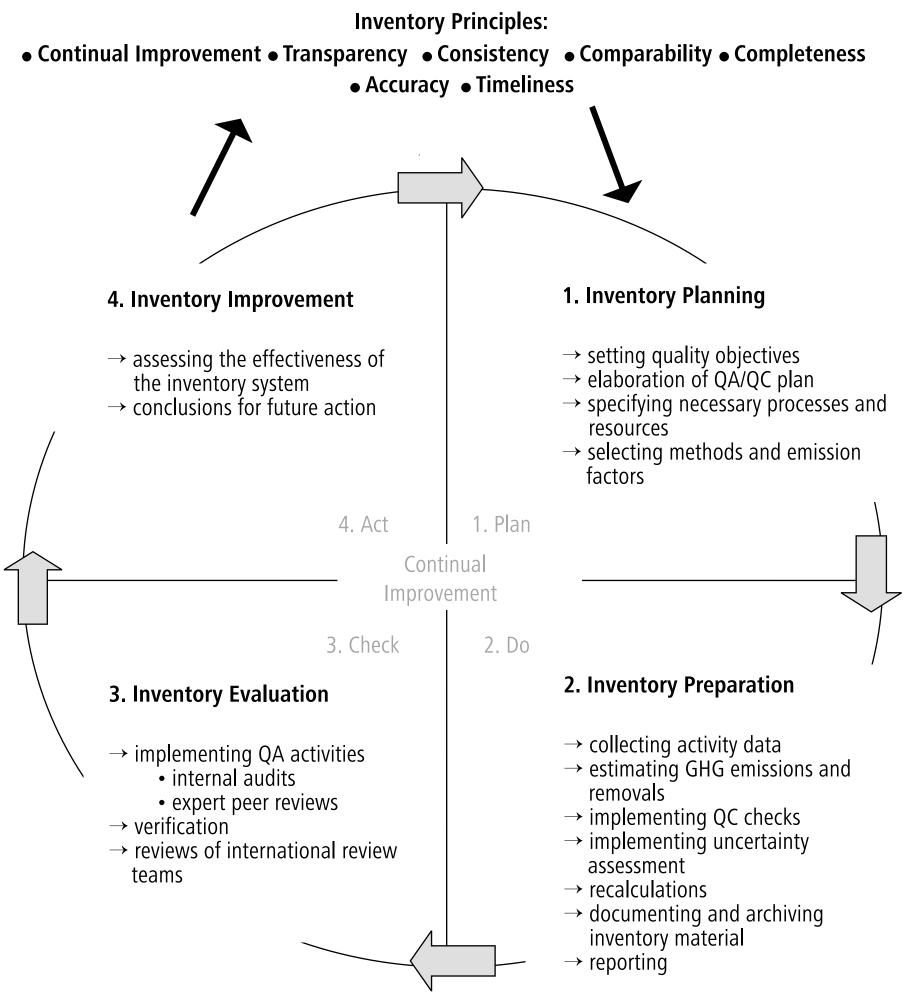
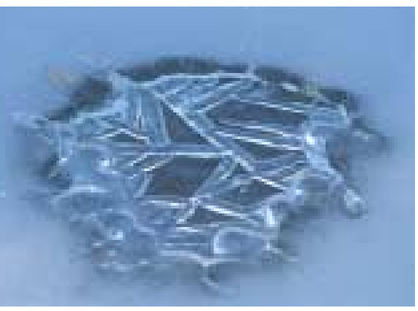
4 The estimates of NMVOC, CO, NO_X and SO_2 have not been updated to correspond to the recalculations made for the CO_2, CH_4 and N_2O emissions in Finland's most recent inventory (see footnote 3). These estimates will therefore be revised in the inventory submission to the UNFCCC by 15 April 2006.

Figure 3–12 Quality management process of the Finnish greenhouse gas inventory.



3.4 Quality management and uncertainty



Quality management and uncertainty estimation are integral parts in the preparation of the green-house gas inventory. Quality management of the inventory is a continuous process that starts from the consideration of the inventory principles: transparency, consistency, comparability, completeness, accuracy and timeliness (Figure 3–12). The setting of concrete annual quality objectives is based on this consideration. The next step is elaboration of the QC plan and implementing the appropriate quality control measures (e.g. routine checks, documentation) focused on meeting the set quality objectives and fulfilling the requirements. In addition, quality assurance procedures are planned and implemented. In the improvement phase of the inventory, conclusions are made on the basis of the realised QA/QC process and its results.

A quality manual of the national greenhouse gas inventory system, including guidelines, annual plans, templates, descriptions of methodologies and work processes, and checklists of QA/QC procedures is in preparation and will be in place by the end of 2005.

The uncertainty estimate of the Finnish inventory is done using the KASPER model developed at the VTT Technical Research Centre of Finland (Monni and Syri 2003). The model uses Monte Carlo simulation to combine uncertainties and is thus in accordance with the Tier 2 method presented by the IPCC Good Practice Guidance. The first version of the model was developed for the 2001 inventory. The current version covers all sectors of the inventory (Monni et al. 2004). The results of the uncertainty analysis are used to identify the key categories[5] of the inventory, and hence to facilitate systematic improvement of the inventory.

The total uncertainty in the 2003 inventory (including LULUCF[6]) was from –14 to +15% when expressed as the bounds of a 95% confidence interval (per cent relative to the mean value). The uncertainty without LULUCF was –4 to +8%. The trend uncertainty was –18 to +23 percentage points with LULUCF and –6 to +4 percentage points without LULUCF. The trend uncertainty was found to be very sensitive to the assumption of correlations between different years. When the uncertainty estimate was performed using the Tier 1 method, the corresponding uncertainties were ±16 (level) and ±19 percentage points (trend) with LULUCF.

In 2003, the uncertainties by gas were as follows: ±15% for CO_2 with LULUCF, ±2% for CO_2 without LULUCF, ±20% for CH_4, –40 to +100% for N_2O and –10 to +20% for HFCs, PFCs and SF6 together. The uncertainties by sector were as follows: energy, –2 to +3%; industrial processes, –20 to +40%; solvent and other product use, –30 to +40%; agriculture, –40 to +120%; LULUCF, ±50% and waste, ±40%.

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5 A key category is a source or sink category that is prioritised within the national inventory system because its estimate has a significant influence on the country's total inventory of direct greenhouse gases in terms of the absolute level of the emissions, the trend in emissions, or both. The results of the key category analysis for the year 2003 are given in Annex 1.

6 The uncertainty estimates as well as the key categories analyses are based on the inventory submission to the UNFCCC in 2005.

LITERATURE

Ministry of the Environment. 2002. Final report of the greenhouse gas working group. Recommendations for development of the national system for greenhouse gas inventories. January 2000. *The Finnish Environment 548*. 152 p. (In Finnish)

Monni, S. and Syri, S. 2003. Uncertainties in the Finnish 2001 Greenhouse Gas Emission Inventory. *VTT Research Notes 2209.*, 132 p. http://www.vtt.fi/inf/pdf/tiedotteet/2003/T2209.pdf

Monni, S., Syri, S. and Savolainen, I. 2004. Uncertainties in the Finnish greenhouse gas emission inventory. *Environmental Science and Policy 7(2)*, pp. 87-99.

Oinonen, T. 2004. Finnish 2002 inventory of HFC, PFC and SF6 emissions. *The Finnish Environment 686*, 61 p. http://www.environment.fi/publications.

Pipatti, R. 2001. Greenhouse gas emissions and removals in Finland. *VTT Research Notes 2094*. 154 p. Http://www.inf.vtt.fi/pdf/tiedotteet/2001/T2094.pdf

Statistics Finland. 2004. Statistical Yearbook of Finland 2004, 718 p.

Statistics Finland. 2005. National Inventory Report to the UNFCCC.

Statistics Finland. 2005. Greenhouse Gas Emissions in Finland 1990-2004. National Inventory Report to the European Union – 15 January 2006. 264 p.

Tomppo, E. 2005. The Finnish National Forest Inventory, methods and data analysis using field data only. Finnish Forest Research Institute. A manuscript for a book to be published by Kluwer.

Tuhkanen, S. 2002. Mitigation of greenhouse gases from waste management in Finland. Methane (CH_4) emissions from landfills and landfill gas recovery. *VTT Research Notes 2142*, 46 p.



4 *Policies and measures*

4.1 *Policy-making process*

4.1.1 *Global level*

Finland is an active participant in international cooperation for solving global environmental problems and to promote international environmental policy. Finland ratified the UN Framework Convention on Climate Change (UNFCCC) on 3 May 1994. Finland signed the Kyoto Protocol on 29 May 1998, and ratified it on 31 May 2002, together with the other fourteen EU member states.

- Finland has signed numerous international environmental declarations and agreements within the United Nations. These include:
- UNECE Convention on Long-range Transboundary Air Pollution (1979)
- Convention for the Protection of the Ozone Layer (1985)
- Montreal Protocol (1987)
- Rio Declaration on Environment and Development, and Agenda 21 (1992)
- Statement of Principles for the Sustainable Management of Forests (1992)
- Convention on Biological Diversity (1994)
- Convention to Combat Desertification (1995)

Finland is also a member of the International Energy Agency (IEA). Finland also participates actively in the work of the International Civil Aviation Organization (ICAO) and the International Maritime Organization (IMO) with the aim to prepare mechanisms to reduce GHG emissions from international aviation and shipping.

Finland participates in both multilateral and bilateral development co-operation that often has direct links to climate change mitigation. For instance, Finland finances climate change mitigation through the Global Environment Facility (GEF). More information on Finland's development co-operation is given in Chapter 7, which also includes description on the Finnish CDM/JI Pilot Programme, launched in 1999 in order to develop Finland's capacity to apply project-based mechanisms.

There is also intensive co-operation with the other Nordic countries and the countries in the Baltic Sea region in the fields of environmental protection and climate change mitigation. The Testing Ground for Flexible Mechanisms of the Kyoto Protocol (TGF) was established in 2003 by the Nordic countries to provide financial assistance for concrete projects by purchasing emission reduction credits. The Baltic region is also the first in the world to adopt common goals for sustainable development according to the Baltic 21 process started in 1996.

4.1.2 EU level

Finland joined the European Union at the beginning of 1995. In the field of climate policy, it is recognized that the Common and Co-ordinated Policies and Measures (CCPM) are an important cornerstone at the Community level. However, these measures are a supplement to national climate policy. The Member States are responsible for their obligations under the EU burden sharing agreement; Finland's target is to bring her average annual greenhouse gas emissions down to their 1990 level by the 2008–2012 period.

The climate strategy at the EU level follows the European Climate Change Programme (ECCP) launched in June 2000. The goal is to identify and develop necessary elements to implement the Kyoto Protocol. The ECCP contains a range of EU-level policies and measures for cutting greenhouse gas emissions, the most important being the Emissions Trading Scheme (ETS) that started operating within the EU in January 2005. Recent legislature of the EU includes e.g. the following:

- Directive on the promotion of renewable energy sources (Sept. 2001)
- Directive on energy performance of buildings (Jan. 2003)
- Promotion of the use of bio-fuels for transport (May 2003)
- Directive on GHG emissions trading within the Community (Oct. 2003)
- Directive on taxation of energy products (Oct. 2003)
- Decision for monitoring Community GHG emissions and for implementing the Kyoto Protocol (Feb. 2004)
- Directive on the promotion of cogeneration (CHP) (Feb. 2004)
- Linking project-based mechanisms to GHG emissions trading (Oct. 2004)

Finland was the first country in the world to introduce a CO_2-tax in 1990. In October 2003, the European Union passed a directive towards this aim, including e.g. elements related to the minimum rates of taxation for different fuels and electricity, and measures promoting the use of renewables.

4.1.3 National level

Institutional framework

Finnish regulations, policies and measures are strongly affected by the directives, policies and measures of the EU in several ways.

Finland has an extensive institutional framework for environmental management. The Ministry of the Environment is responsible for a large part of the environmental issues, while the Finnish Environment Institute monitors and assesses the implementation of environmental policies and provides information to the public. The Ministry of the Environment is also responsible for building regulations and regional planning.

The Ministry of Agriculture and Forestry, the Ministry of Trade and Industry and the Ministry of Transport and Communications are responsible for climate change issues in their administrative sectors. Moreover, the Ministry of Trade and Industry has also been responsible for co-ordinating the development of the National Energy and Climate Strategy. In addition, the Ministry for Foreign Affairs and the Ministry of Finance are important parties in climate change mitigation. The Ministry of Education finances universities and the whole education system in climate change issues.

Two national organisations are especially relevant to climate change: Motiva Oy is an independent, non-profit company that is funded and directed mainly by the Ministry of Trade and Industry.

Motiva's main task is to provide information on the impact of energy conservation and renewable energy sources to end-users of energy. Motiva's expertise includes down-to-earth methods, communication and the commercialisation of products that serve energy efficiency. Motiva was founded in 1993; its number of personnel was 27 in 2004.

TEKES, the National Technology Agency in Finland, is the main public financing and expert organisation for research and technological development. TEKES finances industrial R&D projects as well as projects in universities and research institutes. This agency especially promotes innovative, risk-intensive projects. TEKES funds, about EUR 400 million annually, come from the state budget via the Ministry of Trade and Industry. The personnel is around 300.

Other financing institutions also play an important role in the climate policy; the role of the Academy of Finland as a research financer should be particularly mentioned.

Legislation and regulations

Greenhouse gas emissions are impacted directly or indirectly by a large number of national laws, degrees and regulations. These have been discussed in Chapter 2, and will also be discussed later in this Chapter. A short summary of the most relevant legislation is given below:

- Waste Act (1993), with amendments in 2004, regulates the planning, establishment, construction, use, management, closure and aftercare of landfills with effect on CH_4 emissions. A decree on waste incineration was given in 2003.
- Electricity Market Act (1995)
- Environmental Protection Act (2000) regulates substances indirectly relevant to climate change although basically addressing other aims
- Land Use and Building Act (2000); its main principles, i.e. economically efficient land use and settlement structure, economical use of natural resources and promotion of functionality of settlements and good practices in building, contribute to the aims of climate change mitigation
- Decrees on building regulations such as heat insulation, indoor climate and ventilation of new buildings (2002)
- Act on the Repair and Energy Aid for Housing (2003)
- Emissions Trading Act (2004).

Legislation to link the project-based mechanisms to greenhouse gas emissions trading as well as legislation required for the use of Kyoto mechanisms are under preparation. These will be ready in spring 2006.

4.1.4 Regional level

Regional Environment Centres (RECs), established in 1995 and supervised by the Ministry of the Environment, have a prominent role in the regional collection of information on environmental issues. They are also involved in land use planning and environmental education as well as in campaigns to reduce greenhouse gas emissions.

Three permit authorities and the thirteen RECs make decisions about environmental permits for large and medium-sized industrial enterprises. Municipal authorities handle permits for smaller plants. At the moment, the permits do not directly include licence conditions related to GHG emissions. Energy efficiency and BAT are, however, considered. RECs also prepare regional programmes, which give guidance on environmental and land use planning.

Finnish law requires regional planning to be executed by Regional Councils (RCs). The use of land for different purposes, e.g. recreation and transport or urban activities, is guided in regional plans. The regional plan acts as guidelines for plans at municipal level and for other detailed planning of land use. For instance, several RCs have completed regional inventories of GHG emissions and sinks.

There are also a number of other authorities. For example, Regional Forestry Centres, supervised by the Ministry of Agriculture and Forestry, have the responsibility for sustainable forest management, among other tasks.

4.1.5 Municipal level

The political decision-making system in Finland is widely decentralized. Local authorities make numerous decisions on matters that affect GHG emissions, such as traffic and land use planning, waste management and energy consumption and production. Municipalities also give environmental permits to smaller plants and are major property owners.

Municipalities work in a variety of ways to reduce greenhouse gas emissions. For example, they have their own energy saving programmes and agreements, and they promote the use of renewable energy sources.

The Association of Finnish Local and Regional Authorities (AFLRA) promotes and co-ordinates a climate protection campaign of municipalities. The purpose of the campaign, Cities for Climate Protection (CCP), is to encourage cities and municipalities to plan and initiate their own actions to reduce local greenhouse gas emissions. CCP Finland is part of the campaign organized by the International Council for Local Environmental Initiatives (ICLEI). There are 48 municipalities participating in the CCP Finland at the moment, and they cover almost half of the Finnish population. The campaign consists of five main stages:

- Inventory of emissions and sinks
- Emission projection for the year 2005 or 2010
- Setting goals for emission reductions
- Making a plan for emissions reduction
- Implementation.

About 40 municipalities and four regions have calculated their greenhouse gas emissions. More than 20 municipalities and cities have also prepared their climate strategies or action plans (e.g. City of Kuopio 2003). A wide array of local and regional workshops and national conferences have been and will be arranged covering such issues as energy, land use, traffic and waste management. In addition, 70 municipalities and 15 joint municipal boards have signed voluntary agreements with the Ministry of Trade and Industry to improve energy efficiency and to promote the use of renewable energy in their operations.

4.1.6 Role of NGOs, industry and other interest groups

Major stakeholders play an important part in the Finnish policy-making process. Non-governmental organisations, including environmental, business, social and research organisations, are involved in different working groups, seminars and official delegations. Many stakeholders are also participate in the work of the Climate Forum, established by the Ministry of the Environment. The Forum is a discussion body of some 50 representatives of different stakeholders.

As to the environmental NGOs, especially the Finnish Association for Nature Conservation, Greenpeace, Friends of the Earth, WWF Finland, Dodo and Natur och Miljö are active in climate issues. Industry participates and co-operates actively in climate change mitigation. Particularly, voluntary agreements between the Government and industry are considered an important instrument. They cover the use, production, transfer and distribution of energy. Companies joining such an agreement must first perform an energy audit, appoint an energy manager and prepare an energy conservation plan. Second, they must implement the measures identified in the plan and report annually to the sectoral association. The government will provide funding for the energy audits and for the investments of companies participating in the agreements.

At the beginning of 2003, the voluntary agreements covered 81% of all industrial energy consumption. Industries are also significant users of renewable wood-based energy sources. Almost half of all fuel used by industries is wood-based. Many companies also participate in the EMAS (Eco-management and Audit Scheme) Programme of the EU or use environmental management systems based on ISO 14 000 standards.

4.2 Sectoral policies and measures

4.2.1 National Energy and Climate Strategy

In 2001, the Finnish Government prepared a National Climate Strategy, containing a programme of measures designed to meet Finland's obligations under the Kyoto Protocol, as described in Finland's Third National Communication. The strategy compiled separate programmes drafted by the Ministry of Trade and Industry, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry and the Ministry of the Environment. A special ministerial working group led by the Ministry of Trade and Industry was responsible for the strategy as a whole.

In late 2003, a revision of the National Climate Strategy was begun, mainly to incorporate the EU's Emissions Trading Scheme into the general policy framework. In addition, there was a need to include in the new strategy issues that had remained undecided, such as the role of the Kyoto mechanisms and sink activities under Articles 3.3 and 3.4 of the Kyoto Protocol.

The revision was organised in the same way as the preparation of the earlier strategy, with a special ministerial working group being in charge.

As to the different sectors, the Ministry of the Environment has been responsible for assessments and calculations related to the heating energy of buildings, working machinery and the waste sector. The Ministry of Transport and Communications has studied the use of fuel and electricity in transport and the emissions from this sector, and the Ministry of Agriculture and Forestry has had the responsibility for scenarios in agriculture, land use, and land-use change and forestry. The Ministry of Trade and Industry has made calculations for emissions from energy production, industry, construction, and households and services. In addition, this ministry has also been responsible for the adjustment of sectoral calculations and considerations related to the diversity and safety of energy production, in accordance with the national energy policy. The National Strategy for Adaptation to Climate Change is an integral part of the National Energy and Climate Strategy.

A special challenge has been to integrate the ETS into the political framework, including the assessment of its impacts on different sectors of the economy. During 2003, work was carried out to investigate how other economic control measures, such as energy taxation and subsidies, can be adapted to the situation in which emissions trading will be applied. The Act on Emissions Trading and a national plan for allocating emission allowances were drafted in close co-operation with the different administrative branches and interest groups involved. The Government bill was presented to the Parliament in April 2004, and a draft plan for the allocation of emissions allowances was submitted to the Commission and the other Member States in March 2004 (Ministry of Trade and Industry 2004).

As regards to flexible mechanisms of the Kyoto Protocol, Finland launched a CDM/JI Pilot Programme in 1999 in order to develop Finland's capacity to apply the project-based mechanisms. Under the programme Finland has both bilateral CDM- and JI-projects and investments in the Baltic Sea region's Testing Ground Facility (TGF) and the World Bank Prototype Carbon Fund (PCF).

The Government presented the new National Energy and Climate Strategy (NECS) to the Parliament at the end of November 2005. The strategy defines the measures needed to meet Finland's obligations under the Kyoto protocol. The main measures are allocation of emission allowances under the EU's Emission Trading Scheme, domestic measures such as energy conservation and facilitation of the use of renewable energy. Because the costs of mitigation are high in Finland, the Government has decided to acquire emission reductions. The strategy will ensure a reliable supply of energy at competitive prices and improve the efficiency of the use of energy. The strategy will also increase the use of renewable energy (Government of Finland 2005).

4.2.2 Energy

4.2.2.1 Policies and measures in the 'With Measures' Scenario

The general objective of Finland's energy policy is to ensure energy security at competitive prices. The energy sources in Finland are diversified and energy imports cover about 70% of total use. During the past two decades, energy supply has shifted away from oil and coal towards wood-based fuels, peat, natural gas and nuclear energy. Industry accounts for about half of total energy use and its share is increasing over time. The forest industry is the largest energy consumer, but it produces more than 40% of its energy needs from waste wood and other by-products (i.e. black liquor). The proportion of wood and wood-derived products of the total energy supply is the highest in Europe.

Direct government intervention to guide the choice of energy sources is rare in Finland. However, economic instruments, i.e. taxation and subsidies, have been used to improve energy efficiency and promote the development of domestic energy sources such as peat and biomass. Peat, in particular, as an indigenous energy resource, is given substantial support through R&D and investment subsidies, and tax exemptions. The decision to build nuclear power was done by private companies, but had to be accepted by the Government and the Parliament.

Table 4–1 shows the major policies and measures included in the 'With Measures' scenario in the energy sector. The construction of a new nuclear reactor is quantitatively the most efficient way to reduce CO_2 emissions. Emission reduction due to this measure is estimated to be some 8 Tg, if the same amount of electricity were to be produced with coal condensing power, which is the marginal mode of electricity production in Finland.

The electricity market in Finland operates as a part of the regional Nordic market; all customers have been able to change their supplier since November 1998, but consumers have been quite passive. Market liberalization resulted in situation in which power plants are operated according to their cost-efficiency. In a wet hydrological year in the Nordic countries, the price of electricity is low because of large hydropower production. In a dry hydrological year the price is higher and the marginal mode of production is condensing power. GHG emissions fluctuate according to hydrological conditions, but on the whole, the deregulation of the market seems to have had a positive effect on emission reduction.

Consumers are also able to select electricity produced from renewable energy sources. However, "green electricity" products have not gained a remarkable market share. The consumers do not see electricity as concerning an active buying decision, and the suppliers do not have long experience in an active electricity market.

Energy taxation will be discussed in detail in Sections 4.3 and 4.12.2. This instrument is one of the pillars of the Finnish energy and climate strategies. The high level of energy taxation is obviously an efficient method to control energy consumption, but quantitative assessment is again difficult.

The Energy Conservation Programme consists of measures in all sectors of the economy. The programme has a variety of different energy conservation measures, but only part of them have yet been implemented. All of the measures which have been implemented are included in the WM Scenario. The most significant potential is estimated to come from energy use for heating in the housing sector (Forsström & Honkatukia 2001). Because of the slow turnover of the housing stock, however, the average fuel efficiency of housing is expected to improve relatively slowly. As to the consumption of electricity, the efficiency of electric appliances could be increased by stricter norms, both in households and, more significantly, in different services.

When the Energy Conservation Programme was drafted, the total effect of energy conservation measures was estimated to be 3–4 Tg in 2010. However, allocation of resources has not come true to the extent planned, so the actual reduction may be slightly lower.

Table 4–1 **Major policies and measures affecting greenhouse gas emissions in the energy sector in the 'With Measures' Scenario in 2000–2020.**

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimation of mitigation impact			
						2000	2005	2010	2020
1.Construction of a new nuclear power unit	Increased supply of electricity	CO_2	Regulatory, economic	New nuclear power reactor under construction (in use in 2009)	Teollisuuden Voima (private energy company)	n.a.	n.a.	About 8 Tg, depending on the fuel replaced	n.a.
2. Electricity Market Act	Increased competition	CO_2	Regulatory	Implemented in 1995, last modified in 2003	Ministry of Trade and Industry	n.a.	n.a.	n.a.	n.a.
3. Energy taxation	Reduced energy consumption, improved competitiveness of renewables	CO_2	Fiscal	Implemented in 1997, last modified in 2003	Ministry of Finance	n.a.	n.a.	n.a.	n.a.
4. Energy Conservation Programme	Reduced energy consumption	CO_2	Technical, regulatory, economic, educational	Started in 1992, last modification in 2003	Ministry of Trade and Industry, Motiva, Ministry of Finance, Ministry of the Environment	n.a.	n.a.	The total effect was estimated to be 3–4 Tg	n.a.
5. Action Plan for Renewable Energy Sources	Reduced GHG emissions	CO_2, CH_4, N_2O	Fiscal, technical, educational, economic	Started in 1999	Ministry of Trade and Industry	n.a.	n.a.	The total effect was estimated to be 4–5 Tg CO_2 eq.	n.a.

One of the most important measures of the Energy Conservation Programme is Voluntary Agreement Scheme on Energy Efficiency. Motiva has run the scheme since 1997 under the Ministry of Trade and Industry; at present the scheme covers around 85% of the total industrial energy use and over 50% of the building stock of the service sector. It has been estimated that the total effect of voluntary agreements would be some 2 Tg CO_2 eq. in 2010.

The Action Plan on Renewable Energy Sources (RES) was approved in 1999. The target was to increase the use of RES by 30% up to the year 2010 in relation to year 2001. The plan also defined a national target of RES for 2010 as 31.5% of the electricity demand. In 2001, bioenergy without peat covered 20% of the primary energy consumption and 10% of the electricity demand in Finland, which are the highest figures in the industrialised countries. National incentives concerning taxation and subsidies of RES are being updated because of a number of reasons, including GHG emissions trading.

The key instruments for promoting the use of RES are investment grants, taxation, subsidies and supporting research. The total effect of the Action Plan on Renewable Energy Sources on CO_2 emissions was estimated to be 4–5 Tg in 2010.

The role of peat in the Finnish energy system

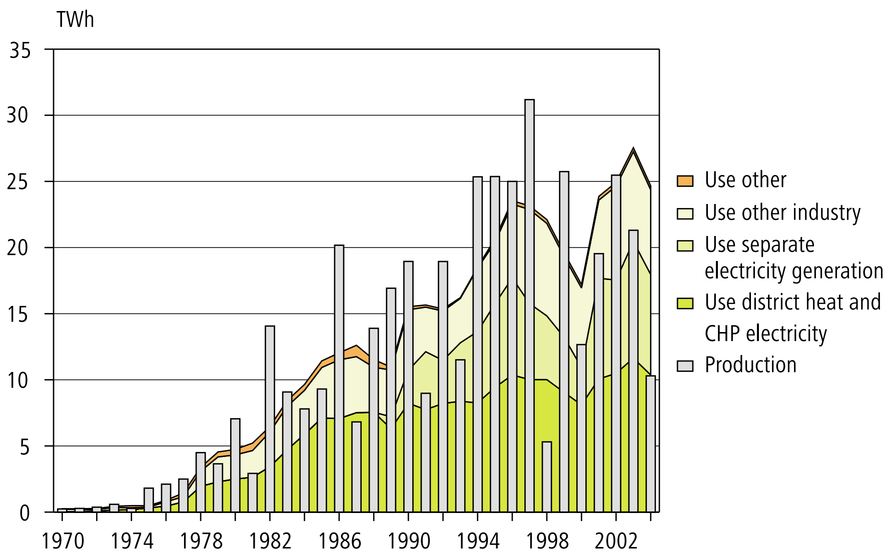
Peat is a significant ingredient in the Finnish energy mix. The annual use of this domestic energy source has been in the order of 20–25 TWh in recent years. The production chain employs over 7,000 people, particularly in northern and eastern Finland, where the unemployment rate is higher than in other parts of the country.

The production and use of peat have lately been the topic of many discussions and studies, triggered particularly by the effects of the EU's Emissions Trading Scheme, and by concern about the security of supply as a result of the adverse production conditions in the summer of 2004. Due to exceptionally rainy weather, the production in that summer season was only 40% of the target. In Finland, peat is regarded as a slowly renewable biomass fuel and distinguished from fossil fuels as well as from renewable biomass in the fuel classification.

A working group set by the Ministry of Trade and Industry proposed in June 2005 a large set of identified measures focused, for example, on energy taxation and other subsidies, handling of peat in the greenhouse gas emissions balance, land use planning and environmental permitting in the peat production sectors, promotion of entrepreneurship in the mechanical industry and peat sector, research and development, as well as preparedness against weather-related risks and delivery disturbances. In the long term, keeping the operating environment competitive is a prerequisite for the continuity of production.

The co-use of peat and wood chips has recently increased in CHP plants in Finland, and this trend is likely to continue. For purely technical reasons, the co-use is beneficial; the presence of wood decreases the sulphur dioxide emissions from peat, while peat reduces corrosion caused by wood-burning.

Figure 4–1 Production and use of energy peat in Finland in 1970–2004.



4.2.2.2 Policies and measures in the 'With Additional Measures' Scenario

Table 4–2 shows the major policies and measures included in the WAM scenario in the energy sector. The EU ETS covers almost the whole energy sector, with only small district heating plants and space heating outside its scope. So the allocation of emission allowances under the EU's Emission Trading Directive is the main additional measure in the energy sector. The reduction of emissions due to the ETS is estimated to be 0.8 Tg per year in the 2005–2007 period. In the second ETS-period, 2008–2012, the reduction is estimated to be 5.9 Tg per year. This is the deficit between the WM-scenario and the amount of emission allowances allocated under EU ETS. Installations may either reduce this amount by doing domestic measures or buy emission allowances under EU ETS.

Finland launched a CDM/JI Pilot Programme in 1999 in order to develop her capacity to apply the project-based mechanisms. Under the programme Finland has both bilateral CDM and JI projects and investments in the Baltic Sea region's Testing Ground Facility (TGF) and the World Bank Prototype Carbon Fund (PCF). It has been estimated that through the Pilot Programme Finland will aquire ERUs and CERs by 0.4 Tg per year. The additional use of Kyoto mechanisms by the Government will be 10 Tg in 2008–2012. Thus the Assigned Amount will be raised by 2.4 Tg per year in the Kyoto commitment period.

Table 4–2 Major policies and measures affecting greenhouse gas emissions in the energy sector in the 'With Additional Measures' Scenario in 2005–2020.

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimation of mitigation impact		
						2005	2010	2020
1. Allocation of ETS allowances for the period 2005–2007	Reduced GHG emissions	CO_2	Economic	Implemented in 2004		0.8 Tg	n.a.	n.a.
2. Allocation of ETS allowances for the period 2008–2012	Reduced GHG emissions	CO_2	Economic			n.a.	5.9 Tg	n.a.
3. The use of Kyoto mechanisms (Pilot Programme)	Reduced GHG emissions	CO_2	Economic	Pilot Programme 1999–2006	Ministry of Trade and Industry, Ministry of Environment, Ministry for Foreign Affairs	n.a.	0.4 Tg	n.a.
4. The use of Kyoto mechanisms	Reduced GHG emissions	CO_2	Economic	Adopted in 2005	Ministry of Trade and Industry, Ministry of Environment, Ministry for Foreign Affairs	n.a.	2.0 Tg	n.a.
5. Measures to promote energy conservation and use of renewables	Reduced energy consumption	CO_2	Economic	Under implementation	Ministry of Trade and Industry, Ministry of the Environment	n.a.	1.0–2.0 Tg (most of the reduction lies in the emission trading sector)	n.a.

In the WAM Scenario, total conservation of the energy in 2015 is expected to be about 5% of the consumption of energy in the WM Scenario. Most of the emissions reduction achieved by energy conservation comes from the emission trading sector and is thus included in the allocation of allowances in Table 4–2. Measures to promote energy conservation outside the emissions trading sector include, for example, promotion of low-energy construction, including information guidance and development activity (e.g. support for experimental building of detached house areas). Most of the measures to promote renewables lie in the ETS sector and are thus included in the allocation of emission allowances in table 4–2.

4.2.3 Transport

Climate change policy is an integrated part of the transport policy both at the national level and within the European Union, when aiming at restraining the growth of transport and thereby reducing the negative environmental impacts from it. However, many of the transport policy measures supporting reduction of greenhouse gas emissions are taken primarily for reasons other than climate change policy. Such reasons are especially objectives for improving traffic safety (limiting traffic speeds), maintaining and developing public transport services, promoting cycling and walking (national health aspects), developing vehicle and fuel taxation (fiscal targets), or EU and other international standards for vehicle emissions (reduction of exhaust emissions and improving air quality).

As regards the EU transport policy, promotion of sustainable modes of transport is one of the main objectives that has been also enforced in the Commission White Paper of year 2001 *"European Transport Policy till 2010: Time to decide"*. Recently adopted Community legislation or topical proposals for new Community legislation, such as e.g. third railway package, promotion of freight transport logistics, intermodal transport (Marco Polo programme), or short sea shipping as well as the Eurovignette Directive, also support mitigation of climate change.

The policies and measures in the transport sector in the WM Scenario are outlined in Table 4–3. Among the most important and efficient measures taken at the Community level to reduce transport related greenhouse gas emissions are the voluntary agreements the European Commission has made with car manufacturers (ACEA, JAMA and KAMA). The aim is that average CO_2 emissions of new registered cars should not exceed the level of 120 g/km for diesel cars and 140 g/km for petrol cars.

As to national transport policy, the newest version of the environmental management programme was recently adopted (Ministry of Transport and Communications 2005), covering the years 2005–2010. Similarly to the two previous programmes, it is also based on ISO standard 140001 containing environmental goals and targets for transport sector, measures for reaching these targets, sharing responsibilities, i.e. who should do and what, timetables, as well as monitoring system with follow-up indicators.

Since the adoption of the first environmental management programme in 1994, one of the main objectives has been to maintain transport related carbon dioxide emissions at the level of 1990. This target is not binding but provides guidance for action in the transport sector. Reaching the target does not seem to be easy judging by the rapid growth of CO_2 emissions in the last couple of years.

Table 4–3 **Major policies and measures affecting GHG emissions in the transport sector in the WM scenario in 2000–2020.**

Transport	Objective	GHG	Status	Implementing entity	Estimation of mitigation impact			
					2000	2005	2010	2020
1.Voluntary agreement with European, Japanese and Korean car industries	Reduction of CO_2 emissions of passenger cars: 140 g/km by 2008/2009	CO_2	Existing	EU with car industry	n.a.	Instead of decreasing, the CO_2 emissions have increased by approximately 0.1–0.2 Tg.	n.a.	n.a.
2. Promotion of public and non-motorised transport	Increasing share of public and non-motorised transport	CO_2, N_2O	Existing, new measures proposed	National Government in co-operation with local authorities	n.a.	n.a.	n.a.	0.1–0.2 Tg CO_2 eq.
3. Eco-driving	Adoption of eco-efficient driving skills and habits	CO_2	Proposed	National Government in co-operation with driving schools	n.a.	n.a.	n.a.	0.5 Tg. Permanent decrease in energy consumption due to eco-driving is expected to be around 5–10% (for those drivers that adopt eco-driving).
4. Energy saving agreements	Adoption of energy saving agreements between administration and transport operators	CO_2	Existing, new agreements under preparation	National Government in co-operation with transport operators	n.a.	n.a.	The aim of voluntary energy saving agreements is estimated to be 5 % energy saving by year 2010 compared to 2003	Around 1% reduction per year
Effect of transport measures in total					**n.a.**	**n.a.**	**n.a.**	**1.0 Tg CO_2 eq (if all fully implemented and achieved)**

Measures supporting reduction of transport related greenhouse gas emissions are defined in the environmental management programme and also included in the National Energy and Climate Strategy. These measures can be classified as following:

- **Economic instruments** with the aim to reform annual vehicle taxation to encourage purchase of low consumption and energy saving cars and to promote and subsidise public transport
- **Voluntary energy saving agreements** with the transport carriers and EU agreement with car manufacturers
- **Promotion of sustainable modes of transport:** public transport, cycling, walking, rail freight transport, shipping and combined transport
- **Promotion of eco-driving:** providing additional and enforced eco-driving training. A new eco-driving campaign ("Malttia teille/Be patient on the road") has been launched, with the aim to train 1,500 professional HDV drivers and 1,000 passenger car drivers

- **Regulatory measures** with the aim to guide development of new agglomerations with the help of public transportation system plans and intention agreements in such a way that agglomerations are connected with well-functioning public and non-motorised transport facilities
- **R&D measures**, especially with the aim to increase knowledge in the area of information technology, logistics, interaction between transport and land use planning and Mobility Management with Green Commuter Plans
- **Information, education and motivation**, such as eco-driving, campaigns aiming at awareness-raising and changing transport behaviour, especially the campaign ***"Moving Finland"*** (to promote Mobility Management) and the above mentioned ***"Be patient on the road - eco-driving"*** –campaign.

Despite the emphasis having been put on the role of public transport, its share has decreased in recent years compared to passenger car traffic. Public funding for public transport has actually decreased in the past few years. Promotion of cycling and walking, including necessary investments for cycle path network, has been left to municipalities.

In August 2005, the Government decided to allow tax deductions for employer-paid public transport tickets from the beginning of 2006. This is estimated to lead to increasing use of public transport in commuter traffic if employers become encouraged by the tax deduction to start buying tickets for their employees.

In addition, Finland has not developed economic instruments, especially differentiation of vehicle taxation in accordance with energy consumption, into that direction that was identified already in the National Climate Strategy 2001. In that year it was estimated that the introduction of differentiation of vehicle taxation in accordance with energy consumption and in conjunction with the voluntary energy saving agreements between the European Commission and car manufacturing industry (ACEA-JAMA-KAMA) should reduce transport-related CO_2 emissions in Finland by approximately 2 Tg by year 2008. However, a working group is at present developing methods for making the annual vehicle tax dependent on CO_2 emissions.

The immaterialisation of energy efficiency of new registered cars and increase in importation of used vehicles from abroad have led into an approximate emissions increase of 0.3–0.4 Tg per year since 2001. In 2001, Finland decided to lower taxation of imported used vehicles because of a decision of the European Court of Justice, as the European Communities considered that taxation in Finland was discriminatory from the point of free movement of goods within the European Union.

Following this decision of the Court, Finland was also obliged to lower taxation on new vehicles in order to diminish the growing imports of used, energy inefficient cars from abroad. Nevertheless, importing of used vehicles has continued especially from Germany. Moreover, the general reduction in vehicle taxes has led the Finns to buying bigger and less energy efficient new cars. Contrary to other EU countries, where the energy consumption of new registered cars is falling, the energy consumption of new registered cars in Finland has risen since 2001; it was 168 g/km for diesel cars and 182 for petrol cars in 2004.

The volume of travelled vehicle kilometres is also increasing in Finland. People are driving more with their new cars. People are also moving further and further away from city centres to afford bigger dwellings at reasonable prices. It seems that whereas in the past people used to move to the first circle of municipalities around big cities, they are now moving to the second or even third circle to find reasonably priced housing. This means longer journeys and it is even more difficult to reach people with attractive, cost-efficient and frequent public transport facilities.

As a conclusion it could be stated that, bearing in mind the intermediatory role of the transport sector, it seems that other policy sectors (such as fiscal, housing, land use planning, employment etc.) have bigger impact on transport demand than transport policy and quite often these other policies seem to lead to increased demand for transport. Therefore, a broader inter-sectoral policy approach is needed in order to find an appropriate balance between different policy targets and to reduce the greenhouse gas emissions as a whole.

There is not that much difference between WM and WAM scenarios (Table 4–4) on transport policy because most of the measures supporting reduction of CO_2 emissions are already included in the current policy and implemented because of other policy reasons. The main areas of action where possible additional measures are needed are possible increase of fuel taxation and additional measures to maintain the urban structure taking into account the fact that people are driving more with their new cars and moving further away from city centres. The Ministry of Trade and Industry has set up a working group to investigate possibilities of reaching the targets of the EC Directive on the use of biofuels in the transport sector. The working group should present its report with recommendations, and estimates on impacts of biofuels on reduction of CO_2 emissions by the end of February 2006.

Table 4–4 Major additional policies and measures included in the WAM Scenario in the transport sector 2005–2020.

Transport	Objective	GHG	Status	Implementing entity	Estimation of mitigation impact		
					2005	2010	2020
1. Differentiation of vehicle taxation in conjunction with voluntary energy saving agreements of the car industry	Promotion of purchase and use of energy-efficient vehicles	CO_2	Proposed	National Government	n.a.	n.a.	Expected to lead to an annual reduction of around 1.5% in CO_2 emissions if differentiation will lead to consumer behaviour changes.
2.Increase of fuel taxation	Reduction of passenger car traffic and GHG emissions	CO_2	Planned	Ministry of Finance	n.a.	n.a.	n.a.
3. Additional measures to maintain urban structure	Concentration and maintenance of urban structure	CO_2	Planned	Government with regional and local authorities	n.a.	n.a.	n.a.
4. Biofuels	Increased use of biofuels in transport	CO_2	Planned	Ministry of Trade and Industry	n.a.	n.a.	n.a.
Effect of additional transport measures in total					**n.a.**	**0.5 Tg**	**0.5 Tg**

4.2.4 Industrial processes

GHG emissions from industrial processes are fairly low in Finland and they have been quite stable from year to year. About 40% of the total emissions from this sector are N_2O emissions from nitric acid production; possibilities for reducing these emissions have been studied. The CO_2-emissions come mainly from cement and lime production; these emissions are within the ETS. Emissions from the fuel used as a raw material in industrial processes are included in the emissions from energy production.

The level of F-gas emissions has risen rapidly and amounted to one-fifth of the emissions from industrial processes in 2003. Without further measures their share will be about 15% by 2010. A new directive on F-gases is under preparation in the European Union. It would e.g. limit the use of these gases in certain applications and set requirements for regular inspections to prevent leakages. The use of F-gases in air conditioning systems of cars would also be limited by the directive. Together, these measures are estimated to reduce F gas emissions by 0.4 Tg CO_2 eq. in the Kyoto commitment period.

4.2.5 Agriculture

The objectives for the Finnish agricultural policy are based on the view that the permanent competitive handicap due to natural conditions (such as short growing period, low temperatures, frosts and problematic drainage conditions) must be compensated for in order for the domestic production to succeed and to make agriculture sustainable and multifunctional. The concept of sustainable and multifunctional agriculture takes into account the greenhouse gas emissions and possible needs for adaptation measures along with other environmental and socio-economic considerations. These objectives can be reached by the common agricultural policy of the EU as well as through national measures.

In 2000 a new agricultural policy, Agenda 2000, became fully effective in Finland as the five-year EU transitional period came to an end in 1999. The objective is to secure the income level of farms and develop the profitability and efficiency of the production of farms taking into account environmental considerations and expansion of the industrial basis of the countryside, which maintains viability and contributes to better management of rural areas.

One part of the programme is the agri-environmental support for 2000–2006 based on the Council Regulation (1257/1999). The main focus is not to reduce greenhouse gas emissions, but the support together with the structural change in Finnish agriculture have enabled a significant reduction of greenhouse gas emissions from agriculture; they decreased from 7.1 Tg CO_2 eq. in 1990 to 5.7 Tg CO_2 eq. in 2003.

The agri-environmental support is an essential tool for promoting sustainable development in agriculture. About 90% of Finnish farmers are implementing the measures of the support programme. The objectives are to decrease nutrient load on the environment, especially on the surface and ground waters, and to maintain the biodiversity of animal and plant species and the rural landscape. The measures also aim at maintaining or improving the productive capacity of agricultural land. The agri-environmental programme is under review in 2005. The new programme with improved measures is expected to support achievement of the GHG emissions targets from 2006 onwards.

Table 4–5 Policies and measures included in the WM Scenario in the agriculture sector 2000–2020.

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimation of mitigation impact			
						2000	2005	2010	2020
1. Agenda 2000, including agri-environmental measures	To promote environmentally sound agricultural production	CO_2, CH_4, N_2O	Economic	Implemented	Ministry of Agriculture and Forestry	n.a.	n.a.	n.a.	n.a.
2.Nitrate statute	To reduce N_2O emissions	N_2O	Regulatory	Implemented	Ministry of Agriculture and Forestry	n.a.	n.a.	n.a.	n.a.

No WAM-projection has not been developed for agriculture. However, the feasibility of additional measures will be assessed. The aim is to examine how production of biomass on fields, and other renewable energy forms, such as biogas, could be promoted on farms. In addition, low-tillage measures will be explored.

4.2.6 Land use, land-use change and forestry

This sector affects the mitigation of climate change in three different ways:

- By protecting and increasing existing carbon storages and sinks
- By creating new carbon storages and sinks
- By replacing fossil-based energy, raw materials and products with biomass.

In 2003, the net sink reported under this sector was 17.8 Tg CO_2 eq., corresponding to one fifth of the national greenhouse gas emissions without LULUCF. In 1990–2003, this sink has varied between 9.1 and 37.0 Tg, mainly depending on the level of commercial roundwood removals. The carbon content of forestry products has not been estimated in the national GHG inventory; the role of bioenergy in curbing GHG emissions is reflected in the inventory via the energy sector.

The basic framework for forest management is set by forest legislation. In recent years, forest policy has continued to emphasise other means than legislative ones (e.g. extension, education, forest management planning, criteria and indicators, innovations, etc.) to promote sustainable forest management and to meet multiple objectives set by different stakeholders and society in general. The role of forests in the protection and enhancement of sinks and reservoirs of greenhouse gases can best be ensured and protected through sustainable forest management that meets the multiple purposes and objectives. A number of forest-related policies and measures have been implemented and further elaborated.

The Environmental Programme for Forestry in Finland (1994) includes a strategy for sustainable forestry, together with targets for the year 2005. A group of experts has monitored realisation of the programme's objectives; many of the targets were attained already in 2000, and progress has been made with the rest.

All thirteen Forestry Centres have compiled Regional Forestry Target Programmes. The programmes contain an overall description of forests and forestry and of the needs and objectives for development. They also contain a description of the biological diversity of forests, needs for wood production, description of forestry enterprises and recommendations for promoting employment opportunities created by forestry. An assessment of the economic, ecological and social impacts of the implementation of the Regional Target Programme is included in each programme. These programmes have enabled a bottom-up approach in the preparation of the National Forest Programme.

The main idea of the National Forest Programme (NFP) is that a competitive forest cluster combined with the fact that forests are a renewable resource, provides an excellent foundation for sustainable development. The programme recognises the economic, ecological, social, and cultural aspects of sustainable forest management. It also sets the objectives for the forest sector:

- To increase the forest industry's annual use of domestic roundwood by 5–10 million cubic metres by the year 2010
- To double the value of the wood industry's exports to EUR 4.2 billion per year
- To increase the annual use of wood for energy production by 5 million cubic metres
- To further develop the ecosystem management of commercial forests; the support for ecosystem management will be increased
- To take into account and advance hunting, reindeer husbandry, picking of wild berries and mushrooms, landscape and cultural values, outdoor recreation and tourism within forest management and protection
- To advance forestry know-how and innovative activities within the forest sector by means of developing research, implementation of the results and training
- To raise silvicultural and forest improvement investments to their former level of approximately EUR 250 million per year; efforts will be focused particularly on forest planning and on advising and training forest owners
- To assess the need for and further develop forest protection in southern Finland taking into account the ecological, economic, financial and social aspects.

The Government and different stakeholders jointly carried out an initiative "Time for Wood" from 1996 to 2000. The purpose of this campaign was to facilitate the increased use of wood, improve employment in the woodworking industry and improve education and training in the woodworking branch. A similar campaign was continued in 2001–2005.

The Finnish Forest Certification System (FFCS) was finalised in 1999, and revised in 2003. All Regional Forestry Centres now possess a certificate for sustainable forest management according to the requirements of the new national FFCS. There are 22 million forest hectares now under the FFCS umbrella in Finland; these are owned by a total of 311,500 forest owners.

Implementation of articles 3.3 and 3.4 of the Kyoto protocol

Finland is strongly committed to sustainable forest management, and sustainable and multifunc-tional agriculture. The government policies and private initiatives and practices are directed to this end. The article 3.3. of the Kyoto Protocol states that the net changes in greenhouse gas emissions by sources and removals by sinks resulting from direct human-induced land-use change and forestry activities, limited to afforestation, reforestation and deforestation since 1990, measured as verifiable changes in carbon stocks in each commitment period, shall be used to meet the commitments.

The Finnish Forest Research Institute has made the following estimates (METLA 2004):

- The afforestation of agricultural lands and grasslands would create an average annual carbon sink of 0.3-0.6 Tg CO_2 in the period 2008–2012. On the other hand, the clearing of forest land for agricultural purposes would create a carbon source of 0.25–0.50 Tg CO_2 in the same period. The net effect of these two activities to the carbon storages would also be very small. The clearance of forest land for agricultural purposes has been limited, as from 2004 onwards newly cleared land areas have not received agricultural support.
- The clearance of forests for settlements would cause an annual net source of 0.9 Tg CO_2 in the period 2008–2012.

Article 3.4. of the Kyoto Protocol allows the Annex I Parties to consider additional human-induced activities, whose greenhouse gas emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories can be included into the inventories. Measures related to forest management can be partially taken into account; the ceiling for Finland is 0.59 Tg CO_2/a in 2008–2012. Due to a number of uncertainties and risks, Finland is not going to use this option in the first commitment period.

As to the agricultural mineral soils, it is still difficult to assess, if they act as a source or sink of carbon dioxide in Finland. The CO_2 emissions from the cultivation of organic soils is estimated to decrease from 1.9 Tg CO_2 in 1990 to 1.0 Tg CO_2 in 2010. New research may cause changes both to the area of these soils and to the emission factors. CO_2 emissions due to liming would decrease from 0.6 Tg CO_2 in 1990 to 0.4 Tg CO_2 in 2010. Finland is not going to use the option related to the agricultural soils in the first commitment period. The same applies to the options of grazing land management and revegetation.

4.2.7 *Waste management*

Government decisions on landfills and the collection and recovery of waste paper, the waste tax and the adoption of the National Waste Plan lowered considerably GHG emissions from waste management in the 1990s. The mitigation impacts of individual policies and measures cannot be estimated, particularly because there was no 'without measures' scenario available for waste management (Table 4–6).

The Revised National Waste Plan, approved by the Finnish Government in 2002, set quantitative and qualitative targets to be achieved by 2005, as described in Section 2.13.2.

Furthermore, the handling of biodegradable municipal waste at landfills will be reduced, in accordance to the Waste Directive of the EU, to 75% of the 1995 levels by 2006, 50% by 2009 and 35% by 2016. The collection of methane would be extended to those closed landfills, where emissions are considerable.

The taxes on waste handling at landfills will be tightened stepwise to encourage the use of biodegradable waste as material and energy. In addition, the possibilities of extending waste taxes to cover the incinerable industrial waste will be considered.

With regard to waste management, the additional measures included in the WAM projection cover the pre-treatment and initial sorting of waste and the impact of the reduction of treatment of waste at landfill in accordance with the implementation of the EC Landfill Directive, and the influence of intensified waste prevention and collection of landfill gas (Table 4–7). The projection restricts the treatment of biodegradable waste at landfills and the growth of the volume of waste and promotes the treatment of landfill gases. The emissions reduction of these measures is estimated to be 0.13 Tg CO_2 eq. in 2010.

Preparation of a new National Waste Plan, with targets for 2015, started in 2005. It will be finalised in 2006, and integrated into other relevant plans and programmes.

Table 4–6 Major policies and measures included in the WM Scenario in the waste sector 2000–2020.

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimation of mitigation impact			
						2000	2005	2010	2020
1.Government decision on landfills	To reduce CH_4 emissions	CH_4	Regulatory	Implemented	Ministry of the Environment	n.a.	n.a.	0.1 Tg CO_2 eq.	n.a.
2. Waste minimisation, collection and recovery of waste paper and other waste fractions	To reduce CH_4 emissions	CH_4	National waste plan, regulatory	Implemented	Ministry of the Environment	n.a.	n.a.	n.a.	n.a.
3. The waste tax	To reduce CH_4 emissions	CH_4	Fiscal	Implemented	Ministry of Finance	n.a.	n.a.	n.a.	n.a.

Table 4–7 Major additional policies and measures included in the WAM Scenario in the waste sector in 2005–2020.

Policy or measure	Objective	GHG	Type of instrument	Status	Implementing entity	Estimation of mitigation impact		
						2005	2010	2020
1.Landfill gas recovery	To reduce CH_4 emissions	CH_4	Regulatory	Implemented	Ministry of the Environment	n.a.	0.1 Tg CO_2 eq.	n.a.
2. Further waste minimization, increased utilization of source-separated waste fractions as material and energy	To reduce CH_4 emissions	CH_4	Regulatory	Planned	Ministry of the Environment	n.a.	n.a	n.a.
3. Biowaste strategy	To reduce CH_4 emissions	CH_4	Regulatory, economic, technical, informa-tional	Proposed	Ministry of the Environment	n.a.	n.a	n.a.
4. Development of waste taxation	To reduce CH_4 emissions	CH_4	Regulatory, fiscal	Implemented	Ministry of Finance	n.a.	n.a	n.a.

4.2.8 International bunkers

Finland actively participates in international co-operation within the ICAO and IMO with the aim of preparing mechanisms to reduce greenhouse gas emissions from international aviation and shipping.

4.3 Taxation and subsidies

Finland was the first country to introduce a CO_2 tax in 1990, initially with few exemptions for specific fuels or sectors. Since then, however, energy taxation has been changed many times and substantially, from a low but "pure" CO_2 tax to a much higher but much less CO_2-related tax. In 2003, the CO_2 tax was about 15 times higher than in 1990.

Besides its fiscal significance on Government finances, energy taxation is a central instrument of energy and environmental policy. It aims to curb the growth of energy consumption and steer the production and use of energy towards alternatives causing less emissions.

The energy taxation is regulated by the Act on Excise Duty on Electricity and Certain Fuels (1260/1996) and the Act on Excise Duty on Liquid Fuels (1472/1994). The Ministry of Finance is responsible for energy taxation legislation. The Ministry of Trade and Industry participates in the drafting of energy taxation, so that the taxation would support the targets of energy and climate policy as efficiently as possible. The Ministry of Trade and Industry also issues further provisions e.g. on the criteria for calculating tax subsidies for power production. The National Board of Customs and the Regional Customs Districts are in charge of tax collection and payment of tax subsidies.

The current energy taxation scheme has been in use since 1997. Energy taxes are excise duties, and they are levied on traffic and heating fuels, and on electricity. The energy tax divides into basic tax and surtax. The basic tax is fiscal by nature and it is collected on oil products only. The basic tax on petrol and diesel oil is graded according to their quality and environmental characteristics. Surtax is collected on oil products, other fossil fuels and electricity. The surtax on fuels is determined according to their carbon content.

Since 2003 the surtax on fuels has been EUR 18.05 per carbon dioxide tonne. Natural gas is an exception to this with its 50% reduction in the surtax, as well as peat, whose tax and tax subsidies in the electricity production were removed in July 2005.

Electricity is taxed at its consumption stage. The tax on electricity is divided into two classes, of which the lower, Class II, tax is paid by industry and professional greenhouse cultivation. Other consumers pay the higher, Class I, tax. The energy taxation scheme also includes various subsidies. Of these, the most important ones in terms of energy policy are tax subsidies paid for power production based on renewable energy sources.

In heat generation, solid biofuels like wood fuels, biogas and recovered fuels (REF) are not taxed. Since the beginning of 2003, wind power, hydropower under 1 MW, electricity produced with wood and wood-based fuels, recycled fuels and biogas have been eligible for tax subsidies. Since the beginning of 2003 the amount of the tax subsidy is no longer linked to the electricity tax classes. The tax subsidies have three levels: the subsidy for wind power and electricity produced with forest chips is 0.69 cents/kWh, for electricity produced with recycled fuels 0.25 cents/kWh and for others 0.42 cents/kWh. In 2003, some EUR 36 million was paid as taxation subsidies for power production (see Table 4–11).

Vehicle and fuel taxes have traditionally been relatively high in Finland by international comparison. In 2003, the state received revenue of about EUR 1.3 billion from vehicle taxation and EUR 2.2 billion from fuel taxation (Fig 4–2). The fuel taxation contains a differentiation scheme according to which the price of diesel fuels is differentiated taking into account the sulphur content. Sulphur-free petrol and diesel oil have a lower rate of fuel tax.

The waste tax is applied to wastes excluding soils disposed to municipal landfills. In 2003, the tax rate was EUR 23/tonne, in 2005 it was raised to EUR 30/tonne. The tax is paid by the owner of the landfill.

Energy subsidies also constitute an important means of implementing the National Energy and Climate Strategy. They are granted for energy investments, development projects and energy conservation, to promote use of renewable energy sources, and to reduce the environmental impacts arising from energy generation and use. The maximum subsidy for new investments of conventional technology will be 30%. For investments of new technology and of wind and solar technology the maximum subsidy is 40%.

The Energy Tax Directive of the European Community entered into force in 2004. It strives for harmonisation of energy taxation in the Member States. The Directive did not have major effects in Finland, for instance, because the required minimum tax levels were already exceeded. Peat was left outside the Directive; thus the taxation of this fuel can be decided nationally.

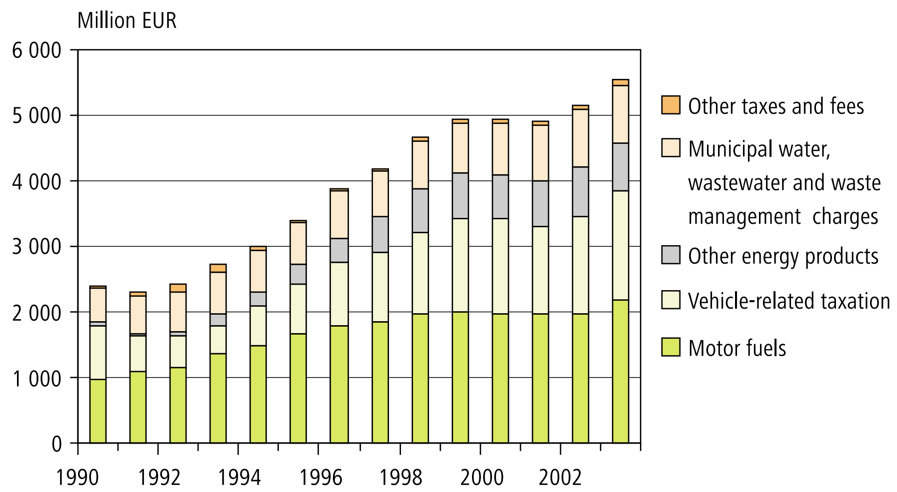
Finland's present energy taxation system has, however, three elements, which the EU Commission has interpreted as state subsidies and approved them only temporarily. These include the differentiation of electricity tax, refunding of taxes paid by electricity-intensive industries, and tax subsidies for electricity production.

In the Government Programme of 2003 it was emphasized that the structure of taxation will be revised so as to promote sustainable development. Accordingly, ecological tax reforms will reduce the use of non-renewable natural resources and prevent environmental damage. At the same time, recycling and ecological efficiency of products, their consumption and energy use will be promoted. Ways of cutting subsidies detrimental to the environment and to sustainable development will be explored according to the Programme.

The Government Programme states further that energy and environmental taxes will be developed to improve the state of the environment and to make it more feasible to reduce taxes on labour. The Programme stresses that changes in energy and electricity taxes will be made taking into account any decisions reached in the EU and with a view to safeguarding the international competitiveness of businesses. It also points out that excise duties on fuel will be instrumental in encouraging more prudent use of fossil fuels, while at the same time Finland's special transport conditions will be taken into account.

In order to safeguard international competition of industry under the EU's Emissions Trading Scheme electricity tax of industry will be lowered. Tax subsidies for electricity produced by black liquors and other waste fuels of industry will also be removed.

Figure 4–2 Trends in energy taxes and other environment-related taxes in 1990–2003.



4.4 Other cross-sectional policies and measures

Several cross-sectoral policies and measures also affecting GHG emissions can be identified, including national programmes and policies related to biodiversity, sustainable development, regional structure, ecologically sustainable construction, protection of the ozone layer, transboundary air-borne pollution and co-operation in environmental protection in neighbouring areas.

National sustainable development policies and activities in Finland are guided by the Government Programme for Sustainable Development from 1998. Implementation of the Programme was assessed in 2000–2002, and a national evaluation report on sustainable development in Finland was published in 2003. In December 2004, the Finnish National Commission on Sustainable Development decided to launch a process leading to a new national strategy on sustainable development which is due to be ready by the end of May 2006.

As a response to the outcomes of the Johannesburg Summit (2002) on the promotion of eco-efficiency and sustainable consumption and production patterns, a national programme proposal for sustainable consumption and production was prepared and adopted by a multi-stakeholder Committee on Sustainable Consumption and Production in June 2005. The key objectives of the programme are to increase the efficiency of the usage of materials and energy through all stages of product life cycles, and to promote environmental education and development, and adoption of environmental technologies.

Other policies and measures affecting GHG emissions include environmental management systems and environmental labels and declarations. A particularly important cross-sectoral factor is development of the urban structure, which has long-term effects on greenhouse gas emissions.

The urban and regional planning activities of municipalities and provinces shall be monitored with a view to reducing emissions, in order to ensure that the objectives of the Land Use and Building Act (132/1999) will be met. The Act aims at a safe, healthy, environmentally-friendly and socially well-functioning city structure in which the availability of public transport services and non-motorised transport should be taken into account.

The main trends in the urban and regional structure in Finland are, on the one hand, increasing urban sprawl, and on the other, concentration of the population in a few urban regions, mainly the Helsinki metropolitan area, Tampere, Turku and Oulu, inclusive of the cities themselves as well as their surrounding communities. This means increasing challenges to the co-ordination of transport and land use planning in future. These challenges should be met, on the one hand, by increasing co-operation between the authorities responsible for transport and land use planning, and on the other hand, by producing research knowledge that can be used in planning.

The main urban areas in Finland have been developed on the basis of availability of public transport services. As population in these cities is relatively dense, it has been so far possible to maintain a relatively high level of public services even though passenger car traffic has continued to increase.

However, as the trend seems to be for people to move further away from city centres to surrounding municipalities, people are also less easily within frequent public transport connections. This trend has increased passenger car traffic in recent years. According to the Passenger Transport Surveys of the

Ministry of Transport and Communications, the average length of daily trips has kept growing; in the early 1990s it was around 12 km, but around 16 km in 2000. If the existing trend of urban sprawl continues at the same rate, the annual volume of vehicle kilometres in passenger traffic inside cities and city regions will be 36% higher in 2010 than in 1990. This increase is equivalent to 6 billion vehicle kilometres or 0.3 Tg of CO_2 emissions annually.

Since 1996, Finnish municipalities have implemented so-called transportation system plans. These are long-term strategic plans, which are aimed at developing the entire travel-related system. Transportation system planning creates a foundation for assessing the need to develop the transport network and services. Transport system planning has been carried out for all 12 major urban areas in Finland.

The intention agreements between the Government, municipalities and regional councils provide an instrument for the implementation of transportation system plans in urban areas. Municipalities are responsible for maintaining and developing the transport infrastructure inside urban agglomerations. With the intention agreements the Government provides funding for the implementation of such transport projects that are in accordance with the transportation system plans. With the help of intention agreements the Government has some possibilities for guiding the transport planning of municipalities, which can otherwise autonomously decide about their local transport planning. Thus far, 15 intention agreements have been made.

4.5 Research and development

There are several important national research and development programmes that have an impact on GHG emissions. Development of energy technology is one of the key activities in national energy and climate policy. Advanced technology and utilisation of technology play an important role in achieving reductions in energy use and emissions. Furthermore, the goal is to increase the export of energy technology.

The Government contributes to determined development of new technology for energy generation and use. Supporting energy technology R&D with Government funds serves the strategic goals of national energy policy. Public support is directed at the development, commissioning and commercialisation of new, environmentally benign technology. Development of new technology and promotion of its introduction to the market is directed at sectors of technology and know-how that are inherent in Finnish conditions. Thus, promotion of energy conservation and use of bioenergy are in a prominent position.

The Government's support for research and development work is channelled to a great extent via the National Technology Agency (TEKES), which operates under the Ministry of Trade and Industry. TEKES finances and organises projects for developing industrial products and production methods, applied technical research at research institutes and universities as well as joint technology projects run by companies and research institutes.

In 2004, TEKES provided EUR 171 million for the financing technology programmes. Thanks to the programmes, many new successful products and processes have been developed. Durations of the programmes ranges from three to five years; their volumes range from EUR 20 million to 150 million. TEKES usually finances about half of the costs of the programmes, the second half coming from participating companies. Many of the completed programmes have been assessed by foreign evaluators. Selective project funding is also an important part of TEKES operations. Funding and expert services are channelled to business R&D projects run by companies, research institutes, and universities. Annual financing of selective projects is of about the same magnitude as the financing of technology programmes.

Other funding organisations are the Academy of Finland and the Finnish National Fund for Research and Development (SITRA). Ministries and several foundations also fund climate change related research. The Technical Research Centre of Finland (VTT) is responsible for the implementation of a number of national energy technology research programmes. VTT carries out both its own technical research work and testing and work commissioned by companies and the public sector.

Finnish energy research and development is organised into national research programmes where all the relevant parties, such as industrial companies, research institutes and universities, are involved. The developers of Finnish energy technology form an energy cluster. The energy technology programmes of TEKES and VTT that were active in 2003–2004 include:

– Engine Technology Programme ***ProMOTOR***, 1998–2003
– Energy and the Environment in Transportation ***MOBILE2***, 1999–2003
– Fusion Technology Programme ***FUSION***, 2003–2006
– Process Integration Technology Programme, 2000–2004
– Wood Energy, 1999–2003
– Business Opportunities in the Mitigation of Climate Change Technology Programme ***ClimBus***, 2004–2008
– Distributed Energy Systems Technology Programme ***DENSY***, 2003–2007
– Recycling Technologies and Waste Management Technology Programme ***Streams***, 2001–2004
– Small-Scale Production and Use of Wood Fuels, 2002–2006
– Development of renewable forms of energy production and improving the effectiveness, 2001–2003
– Mechanical pulping processes – a new process concept for mechanical pulping, with the aim of considerably reducing the daily per capita consumption of energy ***AMP***, 2002–2005

SITRA's Environmental Programme (2004–) aims at rising the standard of the Finnish environmental technology sector and its international competitiveness. The programme also provides a national forum for the development and introduction of innovative methods.

Bioenergy technologies are given a high priority within the overall energy R&D work. New energy technology for the growing markets of waste management has been developed and there have been specific technology programmes also for wind and solar energy.

In addition, several TEKES funded construction technology programmes have relevance in climate change mitigation. These include:

– The Building Services Technology Programme ***CUBE***, 2002–2006
– Construction and Services Technology Programme ***Infra***, 2001–2005 (to be continued by a new INFRA 2010 Programme covering years 2006-2008)
– Value Networks in Construction Technology Programme ***Sara***, 2003–2007
– Wood Material Science Research Programme, 2003–2006

The Ministry of Transport and Communications has financed the following ongoing studies and projects having relevance for the improvement of energy saving and reduction of transport related carbon dioxide emissions:

- Development of a monitoring system of the energy consumption of heavy duty vehicles (improvement of energy consumption per tonne kilometre and passenger kilometre) ***EMISTRA***, 2003–2005
- Efficient ways and measures for reducing the energy consumption of heavy duty vehicles ***HDEnergy***, project, 2003–2005
- Development of modelling schemes for climate change, 2004–2006
- Promotion of the adoption of new energy efficient service concepts and methods, including Mobility Management, biofuels and eco-driving, 2005–2007

Other ministries and organisations have also funded climate related research, e.g. Ministry of Agriculture and Forestry has funded research on biogas technology in agriculture in past few years.

Some research programmes, especially those mainly funded by the Academy of Finland and sectoral research institutes, are described in Section 8.2.

4.6 Use of the Kyoto mechanisms

The Finnish CDM/JI Pilot Programme was launched in 1999 in order to develop Finland's capacity to apply the project-based mechanisms. The structure and results of the programme will be described in Section 7.6. Overall, the activities of the Pilot Programme are estimated to generate some 2 Tg of Kyoto compatible credits (ERUs, AAUs and CERs) under the first commitment period of 2008–2012.

According to the European Commission, the marginal costs of GHG emissions reductions are in Finland third highest in the EU countries. The Energy and Climate Strategy states that Finland will utilise the Kyoto mechanisms to reduce emissions. The Government aims to finance the acquisition of some 10 Tg of Kyoto compatible credits in the 2008–2012 period.

The responsibility for the management of the Kyoto mechanisms will be distributed between three ministries. The role of the Ministry of Trade and Industry and its administrative sector would be that of a co-ordinator. In addition, keeping of registers and relating tasks would be entrusted to the Energy Market Authority. The Ministry of the Environment will be responsible for the Joint Implementation (JI) and Emissions Trading (ET) actions. The Ministry for Foreign Affairs will be responsible for the Clean Development Mechanism (CDM).

4.7 Capacity-building, education, training and awareness-raising

Capacity-building, education, training and awareness-raising are discussed in detail in Chapter 9.

A leading principle of the Government's activities in climate policy is to inform the public about all activities and decisions in an open, transparent way. A broad-based Climate Forum led by the Ministry of the Environment has the special task of promoting awareness on climate change issues.

Several ministries have disseminated public information relevant to combating the climate change and adjusting to it. This activity has taken place both as campaigns and on a continuous basis. The information provided is based on sector-specific work in each ministry. The ministries have environmental websites with up-to-date information about a variety of issues related to climate change. Co-operation between the different ministries was enhanced in 2002, when a special publicity programme, the Climate Change Communications Programme, designed to increase awareness of issues related to climate change in Finland was started. The programme consists of various publicity campaigns designed to inform the public about the likely impacts of climate change, and what must be done to curb climate change.

Climate change issues form a part of environmental education in Finland. In official educational strategies, climate change is often dealt with together with other threats to sustainable development.

There are, however, a few activities that have a more direct impact on GHG emissions. Motiva's role is especially important in this area, as its task is to motivate companies and private consumers to use energy more efficiently by increasing knowledge of the opportunities for more economic and environmentally friendly operations. This will eliminate unnecessary use of energy and facilitate the introduction of new methods and techniques. Motiva's main task is the implementation of the Government's Energy Conservation Programme.

4.8 Effect of policies and measures on longer-term trends

The international scene on emissions reductions after the year 2012 is not yet clear. However, it can be anticipated that the emissions limitation and reduction targets will be tightened. For example, a tightening by 30% by 2020 would imply that Finland should reach reductions of about 30 Tg CO_2 eq. through domestic measures and the Kyoto mechanisms.

The costs of Finland's reduction targets will also depend on the overall commitment of the European Union and on global solutions. In general, the combined effect of longer-term targets, Kyoto mechanisms and domestic measures is still inadequately known and further research is needed.

4.9 Policies and measures no longer in place

Most of the policies related to GHG emissions have been maintained in recent years with some modifications. However, energy investment grants have become limited to renewable energy sources and energy efficiency, as well as to investments in new technology. The earlier peat support has been considerably decreased; energy taxes of peat and the tax subsidies for peat in electricity production were removed in July 2005.

4.10 *Interactions of domestic policies and measures with EU legislation*

A list of domestic policies and measures implemented under Community legislation is presented in Table 4–9. If the policy and/or measure has already been taken in Finland, but enforced by Community legislation, it is indicated in the table.

Table 4–9 Common and Co-ordinated Policies and Measures (CCPM) of the European Union implemented or under implementation in Finland.

CCPM	Measure/policy in Finland	Status in Finland	Quantitative reduction or qualitative category	Note
Taxation of energy products, Council Directive 2003/96/EC	Energy Taxation Act on Excise Duty on Electricity and Certain Fuels (1260/1996) Act on Excise Duty on Liquid Fuels (1472/1994)	Implemented in 1997, latest change in 2003 (raised tax rates, extension of tax subsidies)		National PAM already in force but enforced by a CCPM
Emissions Trading Directive 2003/87	Emissions Trading Act (683/2004)	Implemented	0.8 Tg CO_2 annually in 2005–2007	
Directive 2002/91/EC on the energy performance of buildings	Two new laws are under drafting. Some amendments will be made in the existing Land Use and Building Act.	Under implementation		National PAM already in force but enforced by a CCPM
Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market	New action plan for renewable energy sources, Act No 1129 on certification and notification of the origin of electricity, Government Decree No 1357 on certification of the origin of electricity	Implemented in 2003		The Action Plan is partly under the Directive 2001/77/EC
The Act is mainly under directive IEM 96/62/EC and partly under Directive 2001/77/EC	Electricity Market Act (386/1995)	Implemented in 1995, last modified in 2003		National PAM already in force but enforced by a CCPM
Council directive 1999/31/EC of 26 April 1999 on the landfill of waste	Government decisions on landfills (861/1997)	Implemented		National PAM already in force but enforced by a CCPM
Council Regulation (EC) No 1783/2003	Horizontal Rural Development Programme in Continental Finland (2000–2006)	Under implementation. Implementation started in 2005.		Programme modification approved by the Commission in April 2005.
Shifting the balance between modes of transport, in particular towards rail transport 2001/12/EC, 2001/13/EC, 2001/14/EC	Railway Act, which entered into force on 15 March 2003.	Implemented in 2003		
Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport	National report sent on 30 December 2004.	Under implementation		

4.11 Non-GHG mitigation benefits

The measures covered by the Energy and Climate Strategy will promote positive development in many areas of environmental protection, as described before, regardless of the scenario and the energy production solution. These measures will help to reduce acidification and ozone concentrations in the troposphere, and are aimed at controlling urban sprawl.

The effect of the chosen energy production alternative on, for example, acidification will only be observable in the long term, well after the follow-up period provided in the Kyoto Protocol. The climate strategy will not affect the current positive trend as far as the emissions of particles and volatile organic matter are concerned.

4.12 Economic impacts

4.12.1 Impacts on the economy as a whole

The emission reduction policies will slow down the national economy compared to a situation without such policies. According to the Government Institute for Economic Research (VATT), the GDP is estimated to diminish by 0.9% in the Kyoto commitment period if the price of emission allowance under ETS is EUR 20/t CO_2. Private consumption would fall by 2.2% and investments by 0.3%. With an allowance price of EUR 10/t CO_2, the corresponding reductions would be 0.6%, 1.4% and 0.1%.

The Government's involvement in the emissions reduction through the Kyoto mechanisms will reduce the costs to the national economy. In the Kyoto commitment period the reduction will be relatively small, but it will be clearer after it with the anticipated tightening of reduction targets.

Regional impacts will be manifested mainly via the use of biofuels; wood, peat and agricultural biofuels. New production and employment opportunities will be generated in rural areas.

4.12.2 Impacts on government finances

The National Energy and Climate Strategy will induce some changes to the energy taxation system and energy subsidies. EU ETS is partly an overlapping method of control with energy taxation. That is why the electricity tax applied to industry and greenhouse cultivation will be lowered. This will decrease the total energy related income to some extent in the Kyoto Commitment period.

The most significant change to Government finances will come from the use of Kyoto mechanisms. The Government aims to finance the acquisition of some 10 Tg of Kyoto compatible credits in the 2008–2012 period.

The Government's financing for technological research and product development will continue in the Kyoto commitment period. However, the financing will be channelled towards new technology more than before, as also will be energy subsidies for investments. Especially in the emissions trading sector, only new technology projects will receive energy subsidies.

LITERATURE

City of Kuopio. 2003. Kuopion ilmastostrategia (The Climate Strategy of Kuopio), 38 p (in Finnish)

Energy Market Authority. 2005. Electricity Market Act (386/1995) – unofficial translation 07.04.2005. *Http://www.energiamarkkinavirasto.fi/select.asp?gid=128&pgid=128*

European Commission, 2001. Climate relevant pieces of the Acquis communautaire, Information sheets. Directorate General Environment, Brussels.

Finnish Forest Research Institute. 2005. Maankäytön ja maankäytön muutosten seurannan ja raportoinnin kehittäminen kasvihuonekaasuinventaarion näkökulmasta. (The development of the monitoring and reporting of LULUCF from the viewpoint of GHG inventory), 36 p. (in Finnish)

Government of Finland. 2004. Government decision on the proposal for a national allocation plan by virtue of section 34 of the Emissions Trading Act (683/2004). Helsinki, 34 p.

Government of Finland. 2005. Outline of the energy and climate policy for the near future – national strategy to implement the Kyoto Protocol. Government report to Parliament, 24 November 2005. Helsinki, 46 p. and Appendices I–IV.

Helynen, S. 2004. Bioenergy policy in Finland. *Energy for Sustainable Development VIII(1)*, pp. 36–46.

Honkatukia J., Kemppi H. and Kerkelä L. 2005. Arvioita ilmasto- ja energiastrategian kansantaloudellisista vaikutuksista (Estimates on the effects of NECS on the national economy). VATT-keskustelualoitteita 116. Government Institute for Economic Research (VATT). (in Finnish)

METLA. 2004. Selvitys Suomen metsiä koskevista nieluarvioista (The carbon sinks of the Finnish forests). Maa- ja metsätalousministeriön tilaama muistio, 23 p. (in Finnish)

Ministry of Agriculture and Forestry. 1999. Finland's National Forest Programme 2010. Ministry of Agriculture and Forestry, Publications 2/1999, 40 p.

Ministry of Agriculture and Forestry. 2005. Maa- ja metsätalouden päästöt ja nielut sekä Kioton pöytäkirjan artiklojen 3.3 ja 3.4 toimenpiteiden soveltaminen Suomessa (The sources and sinks of greenhouse gases in agriculture and forestry in Finland, and the use of the measures related to the Articles 3.3. and 3.4. of the Kyoto Protocol). Helsinki, 22 p.

Ministry of the Environment. 2002. Revised National Waste Plan for the period up to 2005. Helsinki, 26 p.

Ministry of Trade and Industry. 2001. National Climate Strategy Finland, Government Report to Parliament, MTI Publications 5/2001, Helsinki. 99 p.

Ministry of Trade and Industry. 2004. The electricity customer's lot: the status of the deregulated Finnish electricity market – consequences. MTI Publications 4/2004, Helsinki, 114 p.

Ministry of Trade and Industry. 2004. EU:n päästökaupan, energiaverotuksen ja energiantuotannon tukien yhteensovittaminen (The co-ordination of EU emissions trading, energy taxation and energy subsidies). MTI Publications 35/2004, Helsinki, 95 p.

Ministry of Trade and Industry. 2004. Implementation of the national climate strategy. MTI Publications 4/2004, Helsinki, 57 p.

Ministry of Trade and Industry. 2005. Turpeen energiakäytön asema Suomen energiajärjestelmässä (The role of the energy use of peat in the Finnish energy system). MTI Publications 14/2005, Helsinki, 97 p.

Ministry of Trade and Industry. 2005. Kioton mekanismien hallinnoinnin työnjako ja resurssit (The division of responsibilities in the administration of the Kyoto mechanisms). MTI Publications 3/2005, Helsinki, 65 p.

Ministry of Trade and Industry. 2005. Teknologiaa kasvihuonekaasupäästöjen vähentämiseen: taustatyö kansallisen ilmastostrategian päivitystä varten (Technology for the mitigation of greenhouse gas emissions; background report for the National Climate Strategy). MTI Publications 1/2005, Helsinki, 182 p.

Ministry of Trade and Industry. 2005. Energiatutkimuspolitiikan muutos Suomessa (The change of the energy research policy in Finland). MTI Publications 5/2005, Helsinki, 124 p.

Ministry of Transport and Communications, 2000. Towards intelligent and sustainable transport 2025, Publications of the Ministry of Transport and Communications, 1/2000, Helsinki.

Ministry of Transport and Communications, 2001a. New Stimulus for Cycling – A Proposal for a Cycling Policy Programme, Reports and Memoranda B 5/2001, Helsinki (English Summary).

Ministry of Transport and Communications, 2001b. Incorporating Walking into Transport Policy - A Proposal for a Walking Policy Programme, Reports and Memoranda B 6/2001, Helsinki (English Summary).

Ministry of Transport and Communications, 2001c. Public Transport Strategy. Publications and reports 2/2001.

Ministry of Transport and Communications. 2004. Promoting Pedestrian and Bicycle Traffic in Finland. The JALOIN programme 2001–2004. Publication 66/2004, 21 p.

Ministry of Transport and Communications, 2005. Environmental Guidelines for the Transport Sector until 2010. Programmes and strategies 5/2005, Helsinki, 40 p.

Perälä P., Lehtonen H., Niemi J., Esala M. and Regina K. 2004. Maatalouden kasvihuonekaasupäästöjen arvioitu kehitys vuoteen 2025 sekä arvio kehityksestä vuoteen 2050 (The estimated development of greenhouse gas emissions in agriculture in 2025 and 2050). Agrifood Research Finland, 18 p.

Suomen Kuntaliitto. 2000. Kunnat ilmaston puolesta (Municipalities for Climate) Ed. by Terhi Miettinen, 67 p. (in Finnish)

Statistics Finland. 2003. Environmental Statistics. Environment and Natural Resources 2003:2, 208 p.

Statistics Finland. 2004. Statistical Yearbook of Finland 2004. Helsinki, 718 p.



5 *Projections and assessment of policies and measures*

5.1 *Assessment of the previous scenarios*

The First National Communication (NC1) of Finland reported a scenario that originated from the strategic work of the Government at the beginning of the 1990s. This scenario, called the Base Scenario, assumed an unchanged energy policy; energy taxation, energy investment subsidies and support to energy research were assumed to stay at their 1990 levels in real terms. Moreover, a prudent view was taken concerning the possibilities of future electricity imports. It was seen that in certain circumstances the demand for electricity would have to be wholly covered by indigenous production and electricity imports might gradually be replaced by coal-fired power plants. So the base scenario cannot be regarded as a 'business as usual' or 'without measures' scenario but a threat scenario. It is obvious that these assumptions lead to high emission levels (CO_2 emissions from fuel combustion), as can be seen in Figure 5–1.

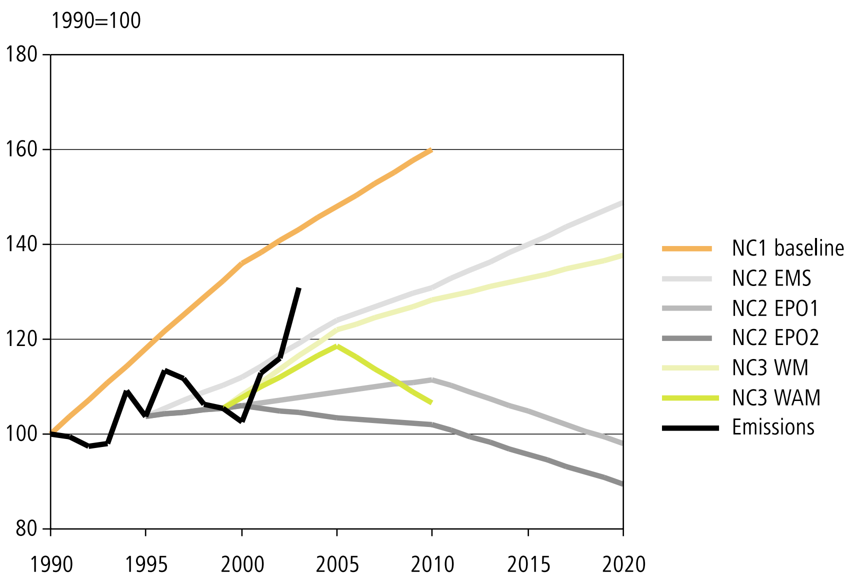
The increase of emissions of the base scenario never materialised. Nearly half of the difference between the emissions in the base scenario and actual emissions in the 1990s can be explained by abundant electricity imports. Electricity generation capacity on the Nordic market was in most years high in comparison with electricity demand. Therefore, production of coal-fired condensing power in Finland remained relatively low. One-quarter of the difference between the base scenario and the actual emissions was due to a change in the fuel mix in electricity and heat production. The capacity of the existing nuclear plants was increased in the second half of the 1990s, the use of natural gas increased substantially in the CHP plants and wood-based fuels increased their share in municipal CHP plants and also in industry. The last quarter of the difference is a result of several factors, the most important of which are energy conservation, mild weather conditions in the 1990s and the severe economic recession in the first half of the 1990s. The role of policies and measures was also important in this positive development, but their mitigation impact in relation to the base scenario cannot been quantified in detail.

Three scenarios were presented in NC2. The energy market scenario (EMS) described a situation where trends in energy economy were market-based without national or international measures influencing these trends in excess of the effects the market would otherwise have under the energy policy conditions. The point of departure in the other scenarios (EPO) was that in order to curb CO_2 emissions, energy demand would be reduced by strengthening control measures. In addition, energy production was assumed to be steered, for example, by means of taxation so that the energy supply balance would contain less coal. Two different varieties were presented; one in which the use of wood and natural gas was increased (EPO1); and one in which more nuclear power was built (EPO2).

The three scenarios of NC2 formed a wide range, but actual emissions have already fallen outside this range, both below and above. The very low emissions of 2000 were mainly due to exceptionally abundant precipitation in Norway. Consequently, the price of electricity on the Nordic market was very low and Norway's net electricity exports set a new record, 19 TWh. A completely opposite water situation explains a considerable part of Finland's high CO_2 emissions in 2003. The emissions decreased by almost 3.5 Tg in 2004, but were still clearly second highest since 1990. In the first half of 2005, the emissions were 6 Tg smaller than in the first half of 2004; this large reduction was partially explained by the six-week labour dispute in the forest industry.

In NC3, two scenarios were given. Methodologically, the formulation of the scenarios and the computation of the results entered a new stage; complicated models and the expertise of several research institutes were utilised. Basic assumptions and features of the scenarios, the process of their formulation and the models used were described in detail in Chapter 5 of NC3. The main difference was a considerable reduction in the use of coal in the 'With Additional Measures' scenario, and an increase in the use of natural gas or use of additional nuclear power capacity. The difference between the WM and WAM scenarios was very small until 2005, because the additional measures were assumed to have a real impact on emissions only after that year.

Figure 5–1 Scenarios presented in Finland's previous National Communications for CO_2 emissions from fuel combustion. The scenarios are given relative to the emissions of 1990, as estimated in the 2003 inventory (53.3 Tg). Absolute values are not used, because the base year emissions have changed; they were 53 Tg in NC1, 52.6 Tg in NC2 and 53.9 Tg in NC3.



5.2 With measures scenario for 2005–2020

5.2.1 Scenario formulation

Two scenarios have been formulated in the National Energy and Climate Strategy for the 2005–2020 period. The WM (With Measures) Scenario will be presented in this section, the WAM (With Additional Measures) Scenario in Section 5.3. The WM Scenario describes development in which the currently implemented and adopted measures affecting different sectors are maintained and continued as such. As to the energy sector, these include e.g. regulations affecting the heat economy of buildings, energy taxes and subsidies, financing of research and testing related to energy technology, and other decisions already made that affect the structure of the energy market (electricity import capacities, nuclear energy capacity). Scenarios have also been developed for other sectors and included in the calculations.

The WM Scenario takes no stand on how probable or acceptable its final result will be. Neither does it assess the probabilities of the basic variables, such as economic growth or development of fuel prices on the world market. The scenario describes one development vision that has as few internal conflicts as possible and that has been calculated setting out from chosen starting points. The scenario is not actually a prognosis, but rather, from the point of view of development of greenhouse gas emissions, the development path that should be prevented by taking appropriate additional measures in time.

The scenario has been complemented by considerations of sensitivity. These have assessed how much the results would change if some essential hypotheses of the calculation were changed in one direction or another.

The calculations have been drafted by a working group consisting experts from the ministries that are essential for the climate policy. The group has reported to the ministerial working group responsible for the drafting of the National Energy and Climate Strategy.

5.2.2 The starting points of the WM Scenario

Table 5–1 shows a summary of the essential assumptions of the WM Scenario for the 2005–2007, 2008–2012 and 2013–2020 period. The international operating environment is assumed to be stable; fuel prices on the world market follow the estimates of the International Energy Agency (IEA) and the studies completed for the European Commission.

Economic growth and its structure have a central position in the calculation of energy consumption and emissions. In the long term, economic growth is mainly determined by the size of labour force and the productivity of work. The most significant factor with a deep effect on the development of the national economy in Finland is the ageing of the population. Another factor that affects the availability of labour is the amount of structural unemployment. The calculations resulted in a slightly declining economic growth which is, however, expected to stay at over 2% per year up to the 2020s.

It is estimated that services will grow slightly more quickly than gross domestic product in the whole period examined, which increases the proportion of services in the national economy. The industrial production structure will become less energy and capital intensive. The fastest growing industry will still be the electrical and electronics industry, which is estimated to grow by an average of 3.5 per cent per year in the period examined. The average growth of production in energy intensive lines of business, the forest industry, the chemical industry and the manufacture of basic metals is estimated to remain clearly below the average level of industrial growth, which will reduce their proportion of industrial production. In the manufacture of basic metals, the production capacity will, however, grow significantly at the beginning of the examined period.

The WM Scenario assumes that the fifth nuclear power plant will be completed in 2009. The average availability of nuclear power would drop to some extent after 2010 as the four earlier plants become older.

The Finnish natural gas network is assumed to expand so that it will reach the Turku region in south-western Finland at the end of this decade. In the energy production of industry and communities, natural gas is a competitive fuel in the areas where it is supplied.

The production of industrial back pressure power, i.e. combined heat and power (CHP) production, is mainly bound to development in the heat consumption of the forest industry. Another assumption made in the WM Scenario is that construction of new plants for CHP production of electricity and heat will go up to some extent mainly because the proportion of the use of natural gas in these plants increases.

Table 5–1 Starting points and assumptions of the WM Scenario.

	2005–2007	2008–2012	2013–2025
International operating environment	Stable	Stable	Stable
World market prices of fuels	Stable price development	Stable price development	Stable price development
Economic growth	3%/ year	2.5%/year	over 2%/year
Population	Slowly growing; aging	Slowly growing; aging	Slowly growing; aging
Nuclear power production	Current	Additional1600 MW in 2009/2010	No change
Imported electricity, capacity	Current and connection to Estonia 350 MW	No change	No change
Hydro power production	No additions	No additions	No additions
Natural gas network	Current	Turku region	No change
Competitiveness of wood energy	Slightly improving	Slightly improving	Slightly improving
Use of renewable energy	Proportion slightly increasing	Proportion slightly increasing	Proportion slightly increasing
Technological development	Current	Current	Current
Energy saving	Current	Current	Current
Energy taxation and norms	The level of 2005	The level of 2005	The level of 2005
Transport policy	Current	Current	Current
Agricultural policy	According to Agenda 2000	According to Agenda 2000	According to Agenda 2000
EU emissions trading	Not considered	Not considered	Not considered
Kyoto mechanisms	Not considered	Not considered	Not considered

The use of coal in condensing power plants is assumed to increase until the completion of the new nuclear power unit and then to decrease after that. Towards the end of the period the use of the coal capacity will grow again but will still remain below the level before the expansion of nuclear power.

The competitiveness of wood fuels has greatly improved in the past few years due to technological development and made tax solutions. The competitiveness is assumed to improve further, though the WM Scenario does not include assumptions regarding new tax solutions supporting the competitiveness of wood. The utilisation of black liquor and waste wood in the forest industry is assumed to remain at the current level, which means that their production and use develop at the same pace as the production of the forest industry.

In its natural market area, peat mainly competes with wood in CHP production. Basing on the price assumptions of the WM Scenario, industrial waste wood and the most advantageous proportion of wood chips can compete with peat. However, when large amounts of fuel are needed, peat is the main fuel in most plants, with wood complementing with the used price relations. The consumption of peat will grow in the production of electricity and heat for communities. In industry, the use of peat remains stable but in the production of condensate power peat is not competitive with the made assumptions.

The form of electricity production with the relatively strongest growth in the WM Scenario is wind power. During the whole examination period, 30 MW of new wind power capacity is estimated to be generated annually. With these assumptions the production of wind power would grow by more than 10 per cent per year in the next few years and by a little less than 10 per cent at the end of the examined period.

The proportion of ground heat and other types of heat pump solutions, and solar heat in the heating of new buildings will grow from the current level especially in detached houses. The utilisation of wastes in the production of district heat will remain at its current level. The utilisation of landfills, waste water treatment plants and other sources of methane emissions will clearly grow, but its significance to the complete picture is not great.

Technological development is assumed to continue in the energy and other sectors alike. No quick technological leaps or transfers are expected in the examined period. The best commercial technology will be introduced gradually, and increasingly efficient technology will be commercialised evenly. In practice, it has been seen that, for example, commercial technology with the best energy efficiency is not always introduced. In such cases, other properties of the consumable, its price and the defects of the market do not necessarily support the choice of energy-efficient products. In the WM Scenario, this so-called efficiency shaft is assumed to remain at the same level also in future.

Real energy taxes have been assumed to remain at their current level. In other words, inflation would be the only factor increasing them. The structure of energy taxation would also remain as it is. The same assumption concerns the taxation of cars.

Population migration in Finland can be characterised by regional concentration in growth centres, on the one hand, and by simultaneous decentralisation at the edges of and around the centres, on the other. The regional and urban structure is mainly controlled by land use planning at the provincial and municipal levels. Besides, the national regional structure is also affected by, among other things, structural changes in industry, priorities of business life, development of traffic systems and measures related to regional policy. In the WM Scenario, the policy affecting the regional and urban structure is not assumed to change compared to the current situation.

The WM Scenario of transport mainly follows the current transport policy outlines, such as promotion of sustainable development and restriction of growth in transport, planning of urban structures and land use, and development of logistics, public transportation and non-motorised traffic. The WM Scenario sets out to reach the climate policy targets mainly by using the above-mentioned measures of transport policy and through the agreement with the Commission and the automobile industry improving the energy efficiency of vehicles.

The starting point for estimating future agricultural production in the WM Scenario is that the agricultural policy will continue to be implemented between 2007 and 2020 according to the decisions of the Agriculture and Fisheries Council of the summer of 2003 regarding the reform of the Common Agricultural Policy (CAP) of the EU. After 2007, the relative significance of income support compared to the total amount of subsidy is assumed to decrease. Agrifood Research Finland MTT has prepared scenarios for agriculture. Compared to earlier scenarios, minor changes are due to changes in agricultural policies and the use of new greenhouse gas inventory guidelines (IPCC Good Practice Guidance for LULUCF).

In forestry, the National Forest Programme forms the backbone of the national forest policy. The aim of the National Forest Programme is to meet domestic and international requirements in order to develop forest management and protection along such lines that forests will provide the Finns with as much work and sources of livelihood as possible. At the same time, forests shall remain healthy, vital and diverse and provide recreation for the people. The Finnish Forest Research Institute has prepared projections for emissions and removals in forest land based on the National Forest Programme.

Use of the EU emissions trading and Kyoto mechanisms has not been considered in the WM Scenario, although the former is already in operation and the latter could be fully utilised in the Kyoto commitment period. It was considered more appropriate to exclude these two key measures of the climate policy from the WM Scenario in order to keep it simple and facilitate comparison with the WAM Scenario.

5.2.3 Total consumption of energy

The total consumption of primary energy will grow from approximately 1,490 PJ in 2003 to 1,580 PJ by 2010, and further to 1,680 PJ by 2020. Growth of the consumption will clearly slow down compared to 1990–2003, even without the exceptionally high value for 2003. The average annual growth in the years 2003–2020 is only 0.6 per cent per year, whereas in 1990–2003 it was over two per cent a year (Table 5–2).

Use of oil, peat and hydropower as energy sources will remain at nearly their current levels, implying that their relative shares will decrease. The most significant growth in the WM Scenario will occur in the use of nuclear power, which will gain six percentage points. The use of natural gas and wood-based fuels will increase, while electricity imports will decrease.

Industrial consumption of fuel oils is estimated to increase by around one-fifth in the period examined. The use of liquefied gas will increase in the forest industry and in the manufacture of basic metals. Steam coal is es-

Table 5–2 Consumption of primary energy source by sources in the WM Scenario in absolute and relative amounts in 2003–2020.

	Primary energy (PJ)				Proportions (%)			
	2003	2010	2015	2020	2003	2010	2015	2020
Traffic fuels	161	171	170	168	10.9	10.8	10.4	9.7
Other oil	212	216	211	206	14.3	13.7	12.9	11.8
Coal-based fuels	195	104	106	133	13.1	6.6	6.5	8.8
Natural gas	169	189	195	201	11.4	12.0	11.9	12.0
Peat	98	93	97	101	6.6	5.9	5.9	6.2
Wood-based fuels	289	308	320	333	19.4	19.5	19.6	20.3
Nuclear power	238	339	377	377	16.0	21.5	23.1	22.0
Hydropower	34	48	49	50	2.3	3.0	3.0	2.9
Wind power	0	2	3	4	0.0	0.1	0.2	0.3
Others	72	79	83	86	4.8	5.0	5.1	5.3
Electricity import	17	29	25	18	1.2	1.8	1.5	0.6
Total consumption	**1 487**	**1 577**	**1 635**	**1 678**	**100**	**100**	**100**	**100**

timated to only be used in industry in the coming years for the production of cement, and in small amounts in the manufacture of metals and in the chemical industry. The use of coke, as well as furnace and coke oven gases will increase as a result of increasing steel production. The use of natural gas is estimated to increase by about 0.6% per year during the examined period. The most significant increase in the use of natural gas is expected in the forest industry. Industrial use of peat will remain at approximately the current level, while the use of wood-based fuels will grow considerably, by almost one-third in 2003–2025.

Heat consumption in buildings will grow as a result of growth in the building stock by approximately 0.5% per year in the 2003–2020 period. Decrease in specific consumption due to renewal of the building stock will slow down the growth in heating need. In the years 2003–2020, the market share of district heating is estimated to grow by six percentage points, and the market share of heating with wood will remain at its current level. The proportion of electric heating will decrease by approximately one percentage point and that of oil heating by approximately ten percentage points. The proportion of ground heating will double but still remain modest in relation to the entire market.

More than 90 per cent of the energy consumption in traffic consists of petrol and diesel oil in road traffic. The decrease in the consumption of petrol that started in the early 1990s will continue until the end of the review period. In future, consumption will reduce thanks to clearly improving fuel economy of new passenger cars. The majority of diesel fuel is used for goods transportation and the consumption is thus largely dependent on the development of transport-intensive lines of business in industry and services. However, the share of new diesel-driven passenger cars is also expected to rise.

Agricultural production is not assumed to grow in the WM Scenario. Total use of fuels in agriculture will decrease slightly during the period examined. The use of wood and other biofuels will grow, whereas the use of light fuel oil will decrease. Use of fuels in construction activity currently amounts to around 4 PJ, and is estimated to remain at approximately the same level.

5.2.4 *Total consumption and production of electricity*

Total consumption of electricity, including electricity transfer and losses due to distribution, will grow from 85.2 TWh in 2003 to approximately 95.5 TWh by 2010 and to approximately 105 TWh by 2020 (Table 5–3). The average annual growth is approximately 1.2 per cent, i.e. twice the growth in the consumption of primary energy.

Basing on the assumptions of the WM Scenario, total electricity consumption will grow by 10 TWh between 2003 and 2010, and by around 10 TWh in the years 2010–2020. During the entire 18-year period examined, electricity consumption would thus grow by almost one-quarter from the current level. This is a clearly slower rate than in the past; e.g. in 1995–2005 the growth was almost 20 per cent.

Households will need more electricity mainly due to new machinery, despite of their improved electricity-efficiency. The amount of electricity used for heating will remain practically unchanged in the entire review period. In service branches, production will grow relatively strongly, which is also visible in the considerable growth in electricity consumption in the WM Scenario. However, considering that the services sector accounts for more than 60 per cent of production in the national economy, its proportion of total electricity consumption is very modest.

Table 5–3 Electricity consumption in each sector in the WM Scenario in 2003–2020.

	TWh				Proportions (%)			
	2003	**2010**	**2015**	**2020**	**2003**	**2010**	**2015**	**2020**
Industry	45.0	52.8	56.4	59.4	52.8	55.3	56.1	56.8
– process industry	37.0	43.8	47.1	49.7	43.4	45.9	46.8	47.5
– other industry	8.0	8.9	9.4	9.7	9.4	9.4	9.3	9.3
Households	12.5	13.9	14.8	15.4	14.7	14.6	14.7	14.7
Heating	8.8	9.1	9.2	9.2	10.3	9.6	9.1	8.8
Services	13.7	15.1	15.6	16.1	16.1	15.8	15.5	15.4
Other sectors	1.7	1.7	1.6	1.6	2.0	1.8	1.6	1.5
Losses	3.4	3.0	3.0	2.9	4.0	3.1	3.0	2.8
Total consumption	**85.2**	**95.5**	**100.5**	**104.6**	**100**	**100**	**100**	**100**

Table 5–4 The structure of the electricity supply in the WM Scenario in 2003–2020.

	TWh				Proportions (%)			
	2003	**2010**	**2015**	**2020**	**2003**	**2010**	**2015**	**2020**
Hydropower	9.5	13.3	13.5	13.8	11.2	13.9	13.4	13.2
Wind power	0.1	0.5	0.8	1.1	0.1	0.5	0.8	1.1
CHP, heating	15.1	18.7	20.0	21.2	17.8	19.6	19.9	20.3
CHP, industry	12.7	15.0	15.6	16.8	14.9	15.7	15.5	16.1
Nuclear power	21.8	31.1	34.6	34.6	25.6	32.6	34.4	33.1
Conventional condensate power	21.0	8.9	9.1	12.1	24.7	9.4	9.1	11.6
Total production	80.4	87.5	93.5	99.6	94.3	91.6	93.0	95.2
Net imports	4.9	8.0	7.0	5.0	5.7	8.4	7.0	4.8
Total supply	**85.2**	**95.5**	**100.5**	**104.6**	**100**	**100**	**100**	**100**

Table 5–4 shows the structure of electricity supply. The new nuclear power unit is assumed to start operation in 2009, which can be seen as significant growth in nuclear power production at the turn of the decade. CHP production will increase in both communities and industry. Production of conventional condensate power will decrease due to the new nuclear unit, but it will start growing again later. Net imports of electricity will decrease to 5 TWh. Production of hydropower will remain at approximately the current level (the production in 2003 was well below the average). The shares of wind power and other new modes of electricity production will increase and reach 1.1 TWh in 2020.

5.2.5 Greenhouse gas emissions

5.2.5.1 Summary of total emissions

Total emissions in the WM Scenario in the years 1990–2020 are shown in Figure 5–2 and emissions by gas and sector in 2005-2020 are given in Table 5–5.

Compared to the base year 1990, the total emissions are expected to be 14% higher in 2010, and 19% higher in 2020. With regard to carbon dioxide emissions, the corresponding exceedances will be 20% and 27%. On the other hand, the increase in the emissions of greenhouse gases other than CO_2 would be small. In particular, the amount of methane from landfill areas will decrease.

In 2003, emissions in the ETS-sector were 57% and those in the non-ETS sector 43% of the total. The share of the emissions trading sector is estimated to decrease to 54% in 2010 (mainly due to the new nuclear power unit), but then to increase again to 57% in 2020. In the ETS sector, the emissions in 2020 are estimated to be 47.4 Tg CO_2 eq., in the non-ETS sector 34.6 Tg CO_2 eq. The changes to the emissions in 2003 are small, only +2% and –1%, respectively. Compared to the year 1990, the corresponding values are +52% and –10%.

Figure 5–2 Total emissions in the WM Scenario in the years 1990–2020 (without LULUCF). The annual changes have been estimated up to the year 2011; the gradual decrease of emissions in 2008–2011 is mainly due to increase in nuclear power production.

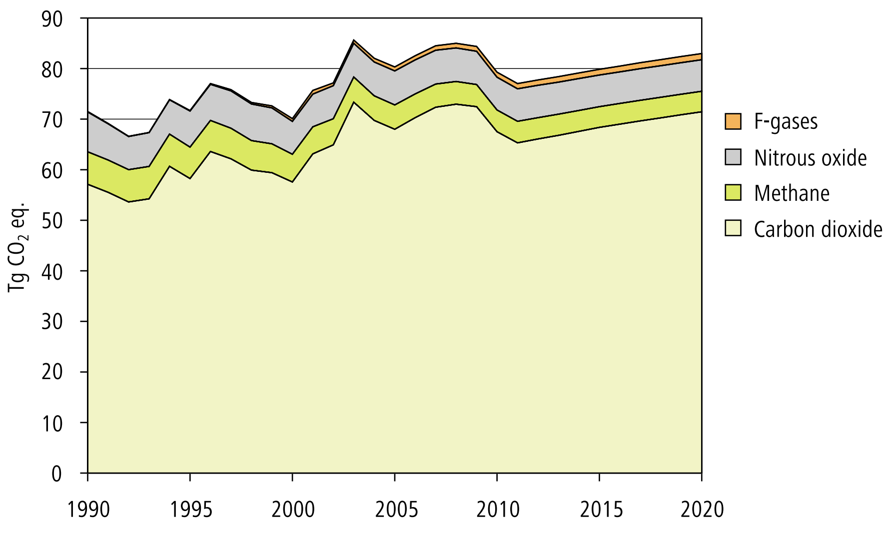


Table 5–5 Emissions by gas and by sector in WM-projection, Gg CO_2 eq. (without LULUCF).

2005	CO_2	CH_4	N_2O	SF_6	HFCs	PFCs	Total
Energy	50 402	386	586				51 375
Transport	13 059	50	580				13 689
Industrial processes	3 721	15	1 533	34	742	13	6 058
Agriculture		1 787	3 617				5 404
Waste		2 458	503				2 961
Total	**67 182**	**4 696**	**6 819**	34	**742**	**13**	**79 486**

2010	CO_2	CH_4	N_2O	SF_6	HFCs	PFCs	Total
Energy	48 893	399	607				49 899
Transport	13 340	30	553				13 924
Industrial processes	4 517	15	1 698	43	930	16	7 220
Agriculture		1 557	3 161				4 718
Waste		2 202	490				2 692
Total	**66 751**	**4 203**	**6 510**	43	**930**	**16**	**78 453**

2015	CO_2	CH_4	N_2O	SF_6	HFCs	PFCs	Total
Energy	49 780	400	618				50 799
Transport	13 248	30	517				13 794
Industrial processes	4 584	15	1 785	49	1 061	19	7 513
Agriculture		1 512	2 869				4 381
Waste		2 046	478				2 524
Total	**67 612**	**4 003**	**6 267**	49	**1 061**	**19**	**79 012**

2020	CO_2	CH_4	N_2O	SF_6	HFCs	PFCs	Total
Energy	52 703	403	645				53 751
Transport	13 340	30	480				13 850
Industrial processes	4 654	15	1 876	53	1 155	20	7 774
Agriculture		1 555	2 755				4 309
Waste		1 950	466				2 416
Total	**70 698**	**3 953**	**6 221**	53	**1 155**	**20**	**82 100**

Presentation of the estimates in gigagrams has been chosen to illustrate the results from the model calculations and to show the projected development also in the smaller emission sources. The actual accuracy of the numbers is smaller than given in the table.

The total emission estimate of the WM Scenario includes some uncertainty factors that may change the calculated emissions in either direction. The WM development of vehicle catalysts will not be dependent on Finland.

Calculations for all greenhouse gases lead to the conclusion that greenhouse gas emissions will be above the target level in the commitment period 2008–2012 with the assumptions of the WM Scenario. The average annual emissions (excluding LULUCF) in the Kyoto commitment period are estimated to be 79.9 Tg CO_2 eq. Finland's decision regarding Articles 3.3. and 3.4 of the protocol lifts the total emissions up by 0.9 Tg, although the LULUCF as a whole is expected to be a net sink. The average annual emissions in the Commitment period 2008–2012 are as follows:

GHG emissions	79.9 Tg
The net effect of Article 3.3 of the Kyoto Protocol	0.9 Tg
Total	80.8 Tg
AAUs to be used	71.5 Tg
The deficit to be covered	9.3 Tg

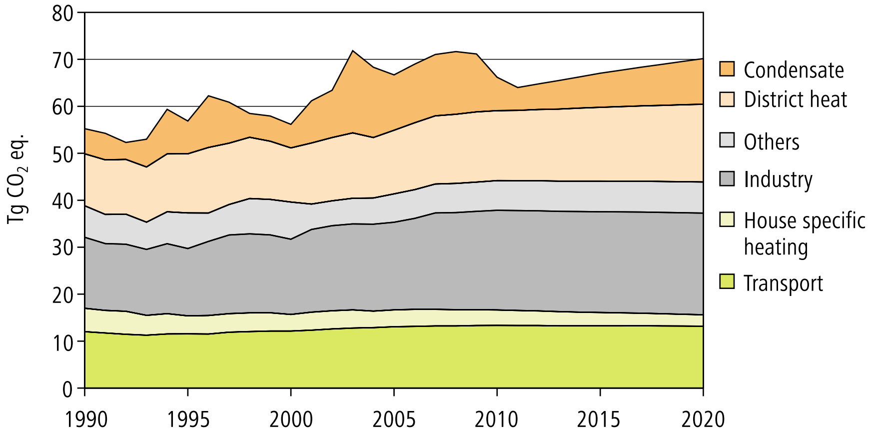
5.2.5.2 Energy-based carbon dioxide emissions

The assumptions of the WM Scenario will lead to the result that carbon dioxide emissions from the combustion of fossil fuels and peat will increase along with the increasing consumption of primary energy and electricity. In 2008, the emissions would amount to approximately 68 Tg, after which they will decrease to 63 Tg in 2010 due to the new nuclear power unit, growing thereafter to 66 Tg by 2020. Thus the CO_2 emissions would exceed the level of 1990 by approximately 9 Tg in 2010.

Figure 5–3 shows emissions according to the calculations of the WM Scenario for each sector. The production of condensate power and district heating have been defined as separate sectors, the latter covering both separate heating boilers and CHP plants. The industrial sector also includes emissions from industrial CHP and other types of process electricity production, but not those from the production of bought electricity.

The fastest increasing emissions include those of industry and the district heating sector. Industrial emissions will mainly increase due to the growth in production enabled by increased capacity in the manufacture of basic metals. Emissions will also increase in the forest industry along with growing production.

Figure 5–3 CO_2 emissions of energy production and use for each sector in the WM Scenario in the years 1990–2020.



The emissions of CHP production will increase, but those of house-specific heating will correspondingly decrease. Although the consumption of heating energy will grow, the heat will more often be produced in regional heating plants and district heating plants. Increasing electric heating will decrease emissions in house-specific heating, but increase them in electricity production.

Some fossil fuels related to an industrial process that are difficult to replace are included. These include the use of coke, because in steel manufacturing it is not only a fuel but also a material that is tied to the end product. Another example are by-products of oil refining, such as refinery gases. In refineries, crude oil not only generates oil products but also refinery gases that can be utilised in energy production.

5.2.5.3 Other CO_2 emissions

Emissions from industrial processes are mainly caused by the combustion of limestone ($CaCO_3$) and the manufacturing of hydrogen (Table 5–6). These emissions have amounted to approximately 3.5 Tg per year, and will reach 4.6 Tg after 2005 because of increasing chemical and metal production.

Table 5–6 CO_2 emissions from other sources than combustion of fossil fuels and peat in the WM scenario in 1990–2020.

	CO_2 emissions (Tg)				Index, 1990=100			
	1990	2003	2010	2020	1990	2003	2010	2020
Mineral Products	1.31	1.18	0.99	1.09	100	90	76	83
Chemical Industry	0.13	0.16	0.77	0.77	100	123	592	592
Metal Production	2.01	2.19	2.75	2.78	100	109	137	138
Other Production	0.02	0.02	0.02	0.02	100	100	100	100
Total	**3.47**	**3.54**	**4.50**	**4.64**	**100**	**102**	**130**	**134**

The actual accuracy of the numbers is smaller than given in the table. The type of presentation is chosen to show the projected development also in the smaller emission sources.

5.2.5.4 Methane

In 2003, methane emissions in Finland amounted to approximately 5.0 Tg CO_2 eq., while in 1990 they were 6.4 Tg CO_2 eq. Emissions from waste formed over half of the total emissions in 2003. They include emissions from landfills and wastewater treatment. A little more than a third of all emissions come from livestock husbandry, mainly cattle breeding.

Approximately 10 per cent of all methane emissions come from incomplete combustion of fuel, which is mainly a problem caused by fireplaces and small heating boilers. Methane emissions in power plants and heating centres are very small. Approximately half of all methane emissions from combustion are caused by the burning of wood in fireplaces.

In the WM Scenario, methane emissions are estimated to continue falling as emissions from agriculture will fall and the amount of waste decreases as a result of waste management decisions (Table 5–7). According to the Ministry of the Environment, the current development would lead to methane emissions in waste management of approximately 2.2 Tg CO_2 eq. in 2010. In the

Table 5–7 Methane emissions in the WM scenario in 1990–2020.

	CO_2 eq. (Tg)				Index, 1990=100			
Methane (CH_4)	**1990**	**2003**	**2010**	**2020**	**1990**	**2003**	**2010**	**2020**
Waste management	3.80	2.60	2.20	1.95	100	68	58	51
Agriculture	2.15	1.87	1.55	1.55	100	98	81	81
Fuel combustion	0.40	0.46	0.43	0.43	100	115	108	108
– transportation	0.10	0.06	0.03	0.03	100	60	30	30
– other[1]	0.30	0.40	0.40	0.40	100	133	133	133
Industry (metal, chemical)	0.01	0.01	0.02	0.02	100	100	200	200
Total	**6.41**	**4.95**	**4.20**	**3.95**	**100**	**80**	**68**	**64**

[1] Mainly small-scale combustion of fire wood
The actual accuracy of the numbers is smaller than given in the table. The type of presentation is chosen to show the projected development also in the smaller emission sources.

WM Scenario, methane emissions of agriculture are assumed to continue to fall by 2010 to a level which is 26% below the level of 1990. Methane emissions from energy production are estimated to remain as they were in 2003.

5.2.5.5 Nitrous oxide

Finnish emissions of N_2O amounted to 7.9 Tg CO_2 eq. in 1990 and 7.0 Tg CO_2 eq. in 2003. Close on 50% came from agriculture, approximately 20% from combustion processes and 10% from transport, particularly from catalysts. Industrial emissions amounted to a little less than 20 per cent of the total emissions. They came from the manufacture of nitric acid. Solvents and waste produced a few per cent of all N_2O emissions.

In energy production, N_2O emissions come mainly from fluidised bed combustion and from the combustion of sewage sludge, i.e. from combustion at low temperatures. Fluidised bed combustion enables high efficiency and relatively low emissions when using low-quality fuel. The fact that these boilers are becoming more common will, on the one hand, promote the use of biofuels but, on the other hand, increase nitrous oxide emissions.

Table 5–8 Emissions of nitrous oxide in the WM Scenario in 1990–2020.

	CO_2 eq. (Tg)				Index, 1990=100			
Nitrous oxide (N_2O)	**1990**	**2003**	**2010**	**2020**	**1990**	**2003**	**2010**	**2020**
Agriculture	4.96	3.88	3.16	2.75	100	78	64	55
– agricultural lands	4.29	3.32	2.70	2.40	100	68	55	49
– manure management	0.67	0.55	0.46	0.35	100	82	69	52
Combustion processes	0.43	0.64	0.61	0.64	100	149	142	149
Manufacturing of nitric acid	1.66	1.42	1.70	1.88	100	86	102	113
Transport	0.17	0.53	0.55	0.48	100	312	324	282
Other[1]	0.71	0.57	0.51	0.49	100	80	72	69
Total	**7.93**	**7.04**	**6.53**	**6.24**	**100**	**89**	**82**	**79**

[1]Solvents, waste
The actual accuracy of the numbers is smaller than given in the table. The type of presentation is chosen to show the projected development also in the smaller emission sources.

The emission factors of bubbling fluidised bed combustion and wood combustion are relatively high.

In the WM Scenario, total emissions of N_2O are estimated to remain at the current level, but there is some pressure towards growth in the emissions. Agricultural N_2O emissions are not expected to change much in the WM Scenario. Direct N_2O emissions of transport are assumed to grow moderately (Table 5–8).

Even in the WM Scenario, increased use of biofuels and, therefore, growing number of fluidised bed combustion boilers also cause pressure for increasing emissions. Renewal of the boiler base and possible additional measures aimed at reduction of NO_X emissions will lower the N_2O emissions.

5.2.5.6 F-gases

Emissions of F-gases have increased strongly in the past few years. In 2003, they amounted to 0.8 Tg CO_2 eq. The WM Scenario assumes that the emissions in 2010 would amount to approximately 1.0 Tg CO_2 eq. (Table 5-9). A majority of the emissions are caused by the fact that both fixed air conditioning and cooling systems and those installed in vehicles are becoming more common. Their proportion of the current emissions of F-gases is over 65 per cent.

Table 5–9 Emissions of F-gases in the WM Scenario in 1990–2020.

	CO_2 eq. (Tg)				Index, 1990 =100			
	1990	2003	2010	2020	1990	2003	2010	2020
F-gases	0.09	0.81	0.99	1.23	100	936	1050	1367

The actual accuracy of the numbers is smaller than given in the table. The type of presentation is chosen to show the projected development also in the smaller emission sources.

5.2.7 Considerations of the sensitivity of the WM Scenario

The examination of the development of carbon dioxide emissions proves that their estimated development is decisively dependent on a few factors. The key factors are assumptions of the growth rates of production in energy-intensive lines of business (pulp and paper industry, manufacture of metals and chemical industry).

The following sensitivity considerations demonstrate how energy consumption and, thus, carbon dioxide emissions due to combustion would develop if the future trends of the key factors deviated from the assumptions of the WM Scenario.

These considerations examine how the final results would be affected if the growth speeds in energy-intensive lines of business deviated from the WM Scenario by one percentage point per year (WM+1% and WM–1%).

The sensitivity considerations aim to describe the uncertainties to which changes in energy demand and thus in the factors defining the development of CO_2 emissions would lead. From the point of the National Energy and Climate Strategy, growth of industrial production is to a large extent a given factor. However, it can also be said that national energy or climate policy can also affect the competitiveness factors that influence both the requirements on industrial development and the relation between own electricity production and imported electricity.

The energy-intensive lines of business include the pulp and paper industry, manufacture of metals and the basic chemicals industry (excluding oil refinery). The rate of their annual growth of output from 2003 onwards was also assumed to be one percentage point faster or slower than in the WM Scenario, while those of other lines of business correspond with the WM Scenario. In this case, GNP would also only change to the extent that these three lines of business changed. Because these lines only account for approximately 8 per cent of GNP, the annual growth pace of GNP would slow down by only 0.1 percentage point from 2.4 per cent in the WM–1% scenario. In reality, GNP would decrease more because of the interdependencies of lines of business and the economic derivative effects they cause.

The results of the sensitivity analysis are summarised in Figure 5–4 and Table 5–11. Greenhouse gas emissions as a whole will clearly exceed the target level of the years 2008–2012 if production in energy-intensive lines of business grows faster than assumed. If the growth of energy-intensive industries remains modest, the emissions would remain below the values of the WM Scenario, but still above the value for the base year of 1990.

Figure 5–4 Greenhouse gas emissions in the WM emission path and by various sensitivity considerations.

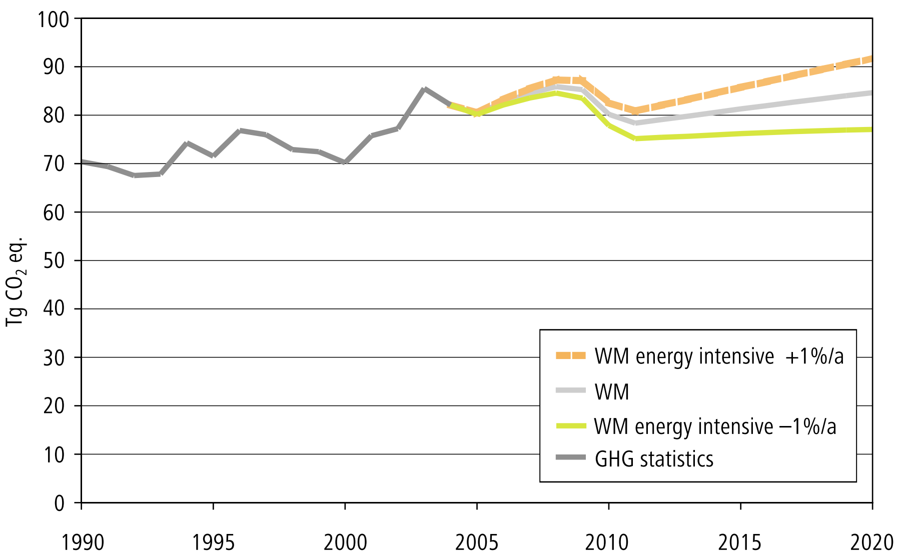


Table 5–11 Greenhouse gas emissions in the WM emission path and by various sensitivity considerations (Tg CO_2 eq.)

Sensitivity consideration	2003	2010	2020
WM	86.0	79.0	82.6
WM energy-intensive industry +1%/year	86.0	81.4	90.3
WM energy-intensive industry –1%/year	86.0	76.7	76.6

The actual accuracy of the numbers is smaller than given in the table. The type of presentation is chosen to show the projected development also in the smaller emission sources.

5.2.8 Comparison of WM and BAU Scenarios

The WM Scenario was compared to the BAU Scenario, which was the 'with measures' scenario presented in Finland's Third National Communication. Some background assumptions, like long-term economic growth, are fairly similar in these scenarios, but there are also differences. The development in the volumes of the forest and metal manufacturing industries are also quite similar, but the chemical industry is growing more rapidly and the electrical and electronics industry more slowly in the WM Scenario. Gross domestic product is a little more than one per cent lower in the WM Scenario, mainly due to the years of slow growth at the turn of the millennium and to the slower growth in the electronics industry.

Electricity consumption is approximately 4 TWh higher in the WM Scenario than in the BAU Scenario both in 2010 and in 2020. This is mainly due to the higher electricity demand in services and households in the former scenario.

The greatest change in the structure of the electricity supply is the increasing production of nuclear power in the WM Scenario thanks to additional capacity in 2009. District heat production in communities has also been estimated higher in the WM Scenario. Mainly for these reasons, the conventional condensate production remains in the WM Scenario over 10 TWh below the figures of the BAU Scenario.

Table 5–12 Primary energy consumption in WM and BAU Scenarios in the years 2010 and 2020 (PJ) and the true consumption in 2003.

	2003	2010		2020	
		WM	BAU	WM	BAU
Oil in total	373.5	387.2	349.5	374.5	341.5
Coal, coke, furnace and coke oven gases	244.2	158.9	248.6	192.8	279.3
Natural gas	169.2	188.9	220.4	201.2	267.2
Nuclear power	238.1	339.4	237.3	377.0	232.2
Net imports of electricity	17.5	28.8	20.5	18.0	20.5
Hydropower and wind power	34.7	49.4	48.3	53.6	49.4
Peat	98.4	92.9	71.3	101.5	73.0
Wood-based fuels	289.2	308.0	294.0	333.0	319.7
Others	22.7	23.3	6.5	26.4	6.5
Total	**1 487.4**	**1 577.2**	**1 496.4**	**1 677.8**	**1 589.3**

Table 5–13 Greenhouse gas emissions in the WM and BAU Scenarios in 2010 and 2020, (Tg CO_2 eq), and the actual emissions in 2003.

WM Scenario	2003	2010		2020	
		WM	BAU	WM	BAU
Carbon dioxide	73.3	66.8	71.6	70.7	76.9
Methane	5.0	4.2	3.9	4.0	3.5
Nitrous oxide	7.0	6.5	7.1	6.2	7.2
F-gases	0.8	1.0	1.4	1.2	2.4
Total	**86.0**	**78.5**	**84.0**	**82.1**	**90.1**
Sinks (Art. 3.3)		0.9		0.9	
Total GHG emissions and sinks (Art. 3.3)		**79.4**	**84.0**	**83.0**	**90.1**

The actual accuracy of the numbers is smaller than given in the table. The type of presentation is chosen to show the projected development also in the smaller emission sources.

The comparison of primary energy consumption in the WM and BAU Scenarios is shown in Table 5–12. Mainly due to higher electricity consumption and increased industrial production, the consumption of primary energy is higher in the WM than in the BAU Scenario. The increased nuclear power production reduces the use of coal as a primary energy source.

Greenhouse gas emissions in 2010 are more than 7 Tg lower in the WM Scenario, in 2020 the difference would be 8 Tg (Table 5–13). This is mainly a result from the replacement of fossil fuels with increased nuclear power production. Emissions of nitrous oxide and F-gases are also expected to be lower in the WM Scenario. The change in the calculation method has increased the estimate of the development of methane emissions in the WM Scenario, and methane emissions are thus not comparable in the scenarios.

5.3 With additional measures scenario for 2005–2025

5.3.1 The starting points of the WAM Scenario

The assumptions on the development of the national economy and on energy prices on the world market were identical in the WAM (With Additional Measures) Scenario and in the WM Scenario. In addition, the assumptions concerning nuclear power, hydropower, natural gas network and the capacity of cross-border electricity transfer were similar. The differences between the scenarios are in the political sector (see Tables 4–2, 4–4, 4–7). Most importantly, the EU emissions trading and the use of Kyoto mechanisms are included in the WAM Scenario.

Domestic measures defined in the strategy together with the EU's emissions trading will decrease the total consumption of energy and change the energy balances from that of the WM Scenario. The price of emission allowances is a central element in the WAM Scenario. The price of energy depends on the price of emission allowances. Higher price of allowances will decrease the demand for energy and increase the competitiveness of renewable energy; energy conservation will also be more efficient. It was assumed that the price will be EUR 15/t CO_2 in 2007–2007 and EUR 20/t CO_2 thereafter.

The starting point for the use of additional measures is that their technical implementation requirements and profitability would correspond with those of the emissions trading sector. In other words, this assumption means that in the non-ETS only those measures are implemented which generate costs of less than EUR 15–20 per carbon dioxide tonne reduced. In practice, such an accurate criterion will not be achieved, because the profitability of the reduction measures on the use of fuels by transport and agricultural machines or the use of electricity in households and services as a function of electricity price is difficult, if not impossible to estimate.

5.3.1.1 Energy

The policies and measures included in the WAM Scenario in the energy sector were discussed in Section 4.2.2.2., and summarised in Table 4–2. Total consumption of energy will be 4% lower in the WAM Scenario than in the WM Scenario in 2020. Increased competitiveness of renewable energy due to EU ETS changes energy balances so that the share of renewables will grow from 23% in 2003 to 27% in 2010. General conclusions on the energy sector in the WAM Scenario can be summarised as follows:

Total use of fossil fuels will be clearly lower than in the WM Scenario (Table 5–14). The use of coal as a primary energy source is estimated to be 57 PJ in 2010 and 61 PJ in 2020, as compared to 104 and 133 PJ in the WM Scenario. However, more natural gas will be used in the WAM; 210 and 223 PJ in the years referred to, as compared to 189 and 201 PJ in the WM Scenario.

The use of peat will decrease, mainly because the competitiveness of peat in separate electricity production will diminish due to emissions trading. In 2010, total use of peat would be 61 PJ in the WAM Scenario (93 PJ in the WM), in 2025 the corresponding values would be 66 PJ and 101 PJ. However, the share of domestic fuels will not decrease, mainly due to a clear increase in the use of wood-based fuels. In the WAM Scenario, energy production by wind power will be 3 PJ in 2010 and 10 PJ in 2025, in the WM Scenario the production estimates are 2 and 4 PJ.

Table 5–14 Consumption of primary energy source by sources in the WAM Scenario in absolute and relative amounts in 2003-2020.

	Primary energy (PJ)				Proportions (%)			
	2003	**2010**	**2015**	**2020**	**2003**	**2010**	**2015**	**2020**
Traffic fuels	161	169	168	166	10.8	11.0	10.6	10.3
Other oil	212	196	188	180	14.3	12.7	11.9	11.1
Coal-based fuels	195	57	46	61	13.1	3.7	2.9	3.8
Natural gas	169	210	215	220	11.4	13.6	13.6	13.6
Peat	98	61	57	63	6.6	4.0	3.6	3.9
Wood-based fuels	289	338	343	357	19.4	21.9	21.7	22.1
Nuclear power	238	339	377	377	16.0	22.0	23.9	23.3
Hydropower	34	48	49	50	2.3	3.1	3.1	3.1
Wind power	0	3	5	8	0.0	0.2	0.3	0.5
Others	72	91	97	106	4.8	5.9	6.1	6.6
Electricity import	17	31	34	27	1.1	2.0	2.2	1.7
Total consumption	**1 487**	**1 543**	**1 579**	**1 615**	100	100	100	100

Table 5–15 Electricity consumption in the WM and WAM Scenarios in 2003–2020.

	TWh			
	2003	**2010**	**2015**	**2020**
WM scenario	85.2	95.5	100.6	104.6
WAM scenario	85.2	93.3	98.0	101.8

Table 5–16 Supply of electricity in the WAM Scenario in 2003–2020 (TWh).

	TWh				**Proportions (%)**			
	2003	**2010**	**2015**	**2020**	**2003**	**2010**	**2015**	**2020**
Hydropower	9.5	13.3	13.5	13.8	11.2	13.9	13.4	13.2
Wind power	0.1	0.9	1.5	2.2	0.1	0.5	0.8	1.1
CHP, heating	15.1	19.7	21.0	22.3	17.8	19.6	19.9	20.3
CHP, industry	12.7	15.2	15.8	17.0	14.9	15.7	15.5	16.1
Nuclear power	21.8	31.1	34.6	34.6	25.6	32.6	34.4	33.1
Conventional condensate power	21.0	4.5	1.7	3.8	24.7	9.4	9.1	11.6
Total production	80.4	84.7	88.7	94.4	94.3	91.6	93.0	95.2
Net imports	4.9	8.6	9.3	7.4	5.7	8.4	7.0	4.8
Total supply	**85.2**	**93.3**	**98.0**	**101.8**	100	100	100	100

The price of electricity is assumed to be higher in the WAM scenario due to ETS. This with the enforced energy conservation measures will decrease the demand for electricity by 2 TWh in 2010 and 3 TWh in 2020 (Table 5–15) .

Production of wind power as well as the production of electricity from CHP plants will increase more rapidly in the WAM Scenario than in the WM Scenario because of increased competition. Net imports of electricity will also be higher in the WAM than in the WM Scenario. These changes together with decreased consumption of electricity will reduce the need for conventional condensing power. Therefore, the production of condensing power is estimated to be at a fairly low level in the Kyoto commitment period and thereafter (Table 5–16).

5.3.1.2 Other sectors

As mentioned in Section 4.2.3, there are no major differences between the WM and WAM Scenarios for the agricultural sector. Measures in the transport sector will reduce emissions by 0.7 Tg CO_2 eq. in 2010.

With regard to waste management, there are four additional measures included in the WAM Scenario (Table 4–7). As to F-gases, the WAM scenario assesses the impact of the regulations proposed by the Commission on emissions.

5.3.2 Summary of emissions

Emissions by sector and gas in the WAM Scenario are presented in Table 5–17. In 2010 the total emissions are approximately 8 Tg CO_2 eq. smaller in this scenario than in the WM Scenario. About half of the reduction is due to decrease in the use of coal, over one-third due to reduced use of peat. Emissions from the use of natural gas, as well as emissions from other greenhouse gases are higher in the WAM Scenario.

In the emissions trading sector, the WAM emissions are 5.9 Tg/year smaller than the WM emissions in 2008–2012. In the non-ETS, the major

Table 5–17 Emissions by gas and by sector in WAM-scenario, Gg CO_2 eq. (without LULUCF)

2005	CO_2	CH_4	N_2O	SF_6	HFCs	PFCs	Total
Energy	48 111	486	622				49 219
Transport	12 890	54	544				13 488
Industrial processes	3 702	15	1 479	65	584	17	5 862
Agriculture		1 787	3 617				5 404
Waste		2 455	503				2 958
Total	**64 703**	**4 798**	**6 765**	65	**584**	**17**	**76 931**

2010	CO_2	CH_4	N_2O	SF_6	HFCs	PFCs	Total
Energy	41 612	507	645				42 763
Transport	12 663	30	553				13 246
Industrial processes	4 480	15	1 639	61	553	16	6 765
Agriculture		1 557	3 161				4 718
Waste		2 128	490				2 618
Total	**58 756**	**4 237**	**6 488**	61	**553**	**16**	**70 110**

2015	CO_2	CH_4	N_2O	SF_6	HFCs	PFCs	Total
Energy	40 163	520	656				41 340
Transport	12 598	30	516				13 144
Industrial processes	4 540	15	1 723	58	521	15	6 872
Agriculture		1 512	2 869				4 382
Waste		1 860	478				2 338
Total	**57 300**	**3 938**	**6 243**	58	**521**	**15**	**68 075**

2020	CO_2	CH_4	N_2O	SF_6	HFCs	PFCs	Total
Energy	42 027	537	684				43 248
Transport	12 663	30	479				13 172
Industrial processes	4 606	15	1 811	54	490	14	6 991
Agriculture		1 555	2 755				4 310
Waste		1 631	466				2 097
Total	**59 296**	**3 768**	**6 195**	54	**490**	**14**	**69 818**

Presentation of the estimates in gigagrams has been showen to illustrate the results from the model calculations and to show the projected development also in the smaller emission sources. The actual accuracy of the numbers is smaller than given in the table.

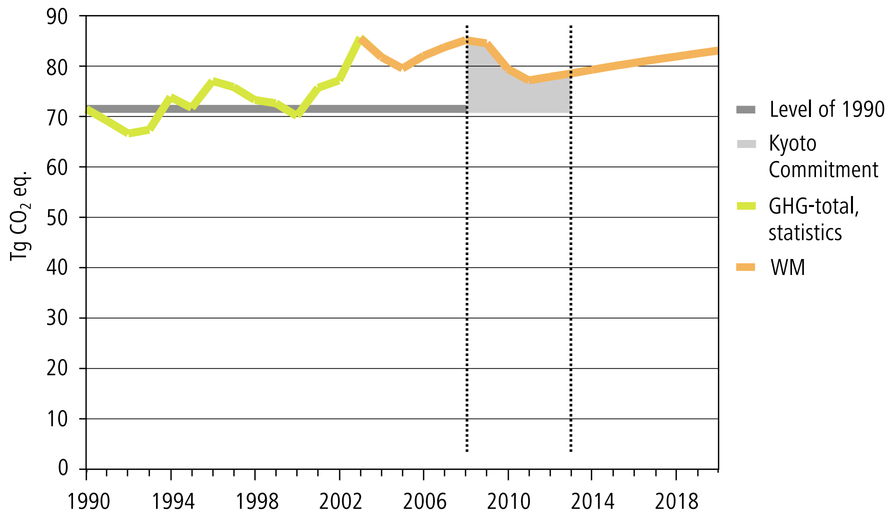
differences between the scenarios come from the traffic sector and from reduced use of F-gases After the Kyoto commitment period, emissions from the use of coal will again turn upwards, while further reductions will occur especially in emission form non-CHP heating.

Because the costs incurred for greenhouse gas reductions are high, Finland will prepare to finance about 10 million tonnes of emissions reductions procured through the use of Kyoto mechanisms in the 2008–2012 period.

Finland will meet her target level of the Kyoto Protocol and EU Burden Sharing Agreement. In the WAM Scenario, greenhouse gas emissions will be 70.1 Tg in 2010. The decision regarding Articles 3.3 and 3.4 puts up the emissions by 0.9 Tg to 71.0 Tg. However, emissions in 2010 will not be the average of emissions in the 2008–2012 period.

Figure 5–5 shows the GHG emissions in the WM scenario and the deficit between the WM scenario and the Kyoto commitment of Finland. The deficit will be covered with measures presented in Chapter 4. About three-quarters will be covered with domestic measures including EU ETS, the rest with Kyoto mechanisms.

Figure 5–5 The total GHG emissions in the WM and the deficit between the WM scenario and the Kyoto Commitment of Finland.



5.4 Methodology

As mentioned above, preparation of the Energy and Climate Strategy has been made on sectoral basis. Each ministry has had the responsibility for the scenarios of its own sector. Ministries and research institutes have their own models and calculation systems for assessing the cost-effectiveness of the measures, which have been the starting point for the mitigation measures. The sectoral scenarios have been aggregated by the Ministry of Trade and Industry.

In order to study the effects of economic and environmental impacts, two separate studies were launched. The calculations concerning the energy sector were carried out with the TIMES model, which has been developed under the IEA ETSAP programme. The overall structure of the model is shown in Figure 5–6. The EU trading scheme is described in the model and the impact of emissions trading on the Finnish energy system is calculated with several assumed CO2 market prices. The model covers the whole of the Finnish energy production and consumption system, including the industrial, residential, service and transport sectors. In addition, the waste management and agricultural sectors, as well as emissions of fluorinated gases, are also incorporated into the model with emission reduction measures.

The TIMES model includes emissions of all Kyoto Protocol greenhouse gases. Both investments and operating costs are counted in the cost calculation. The model is relatively detailed at the technology level. The model searches for a solution that offers the least cost to fulfil the demand requirements and other constraints such as given emission limits.

Economic effects were calculated with the help of two CGE models. Domestic effects of the mitigation measures were studied with the hybrid EV model, which combines an engineering model of the energy sector and key industrial sectors to a top-down CGE model. In the EU context, the GTAP-E model was used.

The EV model shares certain key parameters with the GTAP model and it is relatively straightforward to take the GTAP-E results on Finnish exports and world prices as inputs for the model. The key modelling target in setting up the EV model has been to capture the essential process-level features and peculiarities of Finnish energy use. The model thus relies heavily on engineering data about the details on fuel use, the often fuel-specific processes that are used in the production of heat and electricity, as well as in process industries. Production in these industries is modelled along bottom-up, or engineering, descriptions of the processes. The model also makes a distinction between different electricity and heat generation technologies. This is essential for the analysis of the Finnish energy sector, which contains a lot of combined heat and power generation, as well as communal district heating.

The model contains a specific process description for the energy sectors, the pulp and paper industry, and the basic metal industries, where the processes are identified both according to the specific product (electricity, heat or CHP; quality of paper; type of metal) and the fuels used (different types of oils, coke, natural gas, coal, peat, biomass and wood). The model also takes heat, hydropower and nuclear power into account, contrary to the GTAP-E model.

The GTAP model (Global Trade Analysis Project) is a multi-region, applied general equilibrium model, which contains a detailed database on international trade and country-wise descriptions of economies based on input-output data. The model has been widely utilised to study trade and environmental policies.

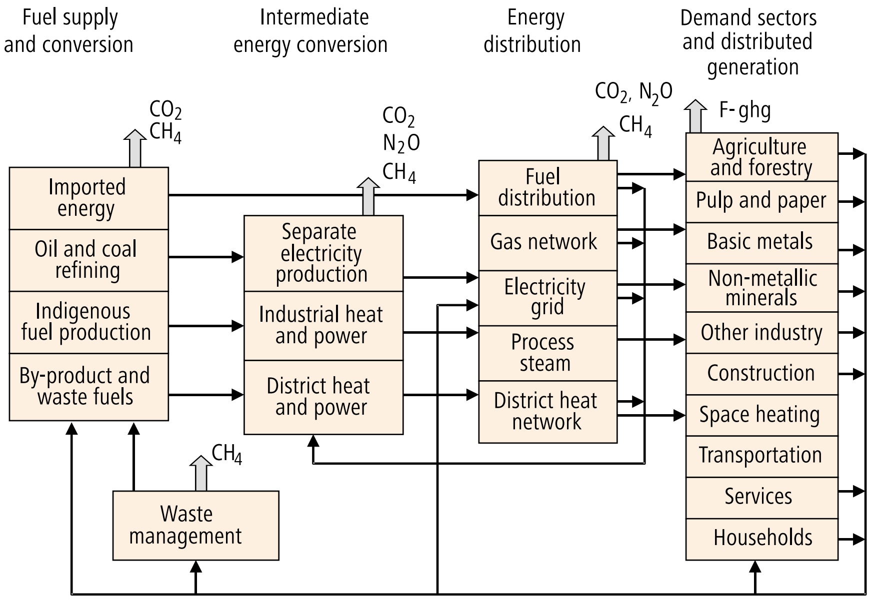
In the model, private households and government are treated as a single decision-making economic agent called regional household. Private households supply productive factors (land, labour and capital) to producers and obtain factor income in return. Government revenues come from household income taxes, producers' taxes, and taxes on international transactions (minus subsidies if they exist). Regional income is defined as the sum of private households' factor income and government revenues minus depreciation of capital stock. Regional income in excess of regional expenditure is saved and used as investments by producers.

There are five energy commodities: coal, gas, oil, petroleum products and electricity. Emission trade can thus be readily studied with the model but quite a lot of data are needed on the business-as-usual development of regional economies. Here, the recent Shared Analysis Project baseline for the world economy has been adopted, with updates based on national communications for European countries.

The Dynamic Regional Sector Model of Finnish Agriculture DREMFIA (Lehtonen 2001, 2004) was used in the agricultural sector. Annual land use and production decisions from 1995 till 2020 were simulated with an optimisation model which maximises producer and consumer surplus subject to regional product balance and land constraints. Products and intermediate products may be transported between the regions (Finland is divided into 17 regions). The optimisation model is a typical, spatial price equilibrium model, except that no explicit supply functions are specified and foreign trade activities are included.

The model provides effects of various agricultural policies on land use, animal production, farm investments and farmers' income. Endogenous investments in different production techniques are modelled using the concept of technology diffusion.

Figure 5–6 Simplified structure of the TIMES model. The model has been extended to cover all greenhouse gases and practically all emission categories that should be reported under the Kyoto Protocol (Lehtilä 2003).



LITERATURE

Elektrowatt-Ekono Oy. 2003. Emissions trading and the Nordic electricity market. Elektrowatt-Ekono OY, Espoo.

Electrowatt-Ekono Oy. 2004. Tuulivoimatavoitteiden toteutumisnäkymät Suomessa (The outlook of wind energy utilisation in Finland). Electrowatt-Ekono OY, Espoo. (in Finnish)

Electrowatt-Ekono Oy. 2005. Ilmastostrategian aluetaloudelliset vaikutukset (Regional impacts of NECS). (in Finnish)

Electrowatt-Ekono Oy. 2005. Turpeen kilpailukyky lauhdesähkön tuotannossa päästökauppatilanteessa (The competitiveness of peat in the production of condensation power production in Finland). Electrowatt-Ekono OY, Espoo. (in Finnish)

Forsström, J. and Lehtilä, A. 2005. Skenaarioita ilmastopolitiikan vaikutuksista energiatalouteen – Kansallisen ilmasto- ja energiastrategian taustaselvitys. (Scenarios on the effects of climate policy on the energy policy – a background paper for the NECS) VTT Working Papers 36. (in Finnish)

Government of Finland. 2005. Outline of the energy and climate policy for the near future – national strategy to implement the Kyoto Protocol. Government report to Parliament, 24 November 2005. Helsinki, 46 p. and Appendices I-IV.

Honkatukia J. and Forsström J. 2003. Energiaverotuksen asema EU:n laajuisen päästökaupan yhteydessä (The role of energy taxes on the EU emissions trading) VATT-tutkimuksia 102. Government Institute for Economic Research (VATT). (in Finnish)

Honkatukia J., Kemppi H. and Kerkelä L. 2005. Arvioita ilmasto- ja energiastrategian kansantaloudellisista vaikutuksista (Estimates on the effects of NECS on the national economy). VATT-keskustelualoitteita 116. Government Institute for Economic Research (VATT). (in Finnish)

Kara, M. 2004. Päästökaupan vaikutus pohjoismaiseen sähkökauppaan – ehdotus Suomen strategiaksi.(The effects of emissions trading in the Nordic Electricity Market – a proposal for the Finnish strategy). VTT Processes, Espoo. (in Finnish)

Kekkonen V. and Pursiheimo E. 2005. Selvitys sähkön tuontimahdollisuuksista Suomeen pohjoismaisilta sähkömarkkinoilta (A survey on the electricity import to Finland from the Nordic Electricity Market). VTT Working Papers 16. Espoo. (in Finnish)

Lehtilä A. and Tuhkanen S. 1999. Integrated cost-effectiveness analysis of greenhouse gas emission abatement. The case of Finland. VTT Publications. Espoo.

Lehtilä, A. 2003. EFOM/TIMES. Description of Energy System Modeling Methodology. VTT Energy Systems, 15 p.

Lehtonen, H. 2001. Principles, structure and application of dynamic regional sector model of Finnish agriculture. PhD thesis, Systems Analysis Laboratory, Helsinki University of Technology. Agrifood Research Finland, Economic Research Publ. 98, Helsinki, 265 p.

Lehtonen, H. 2004. Impacts of de-coupling agricultural support on dairy investments and milk production volume in Finland. Acta Agriculturae Scandinavica, Section C 1(1), pp. 46–62.

Ministry of Agriculture and Forestry. 2005. Finland´s National Strategy for Adaptation to Climate Change. Publications of the Ministry of Agriculture and Forestry 1/2005, 190 p.

Ministry of Trade and Industry. 2005. Reporting of implemented policies and measure under the Decision 280/2004/EC. Finland: projections and assessment of policies and measures. Helsinki, 29 p.

Motiva Oy. 2004. Uusiutuvan energian edistämisohjelma 2003-2006 – Toteutustilanne ja näkymät (The promotion programme of renewable energy in Finland – current situation and future views). Motiva Oy.

Mäkelä, K., Laurikko, J. and Kanner, H. 2002. Suomen tieliikenteen 2002 laskentajärjestelmä Liisa 2001.1 (The Liisa 2001.1 Model for the emission calculations in the transportation sector in Finland). VTT Research Notes 2177.

Määttä, K. 2005. Selvitys päästökaupasta aiheutuvan sähkön hinnannousun windfall-voiton verotuksesta (A survey on the taxation of the windfall benefits due to the EU emissions trading), Helsinki. (in Finnish)

National Economic Research Associates. 2002. Evaluation of Alternative Initial Allocation Mechanisms in a European Union Greenhouse Gas Emissions Allowance Trading Scheme. National Economic Research Associates.

Statistics Finland. 2005. Greenhouse Gas Emissions in Finland 1990–2003. National Inventory Report to European Commission. The Common Reporting Formats (CRF 1990–2003).

Technical Research Centre of Finland. 2005. Liikenteen biopolttoaineiden tuotanto- ja käyttömahdollisuudet Suomessa (The possibilities for production and utilization of biofuels in transportation in Finland). VTT Research Notes 2288. Espoo. (in Finnish)

TEKES. 2003. Ilmasto haaste teknologialle. Näkemyksiä ja tuloksia Climtech-ohjelmasta. (Climate – a Challenge to Technology. Views and results from the Climtech Programme). (in Finnish)



6 Climate change impacts, adaptation and vulnerability

6.1 Finland's climate – how is it changing?

6.1.1 Observed changes

A comprehensive assessment of observed changes in Finland's temperature and precipitation was made by Tuomenvirta (2004). The assessment was based on about 300 temperature and 700 precipitation data series, which were thoroughly homogenised. The longest series exceeded 150 years but the systematic analysis was mainly focused on the 20th century.

According to linear trend tests, the mean temperature in Finland increased by 0.76°C in the 20th century. The warming took place during the first two and last three decades of the century, while a slight but statistically insignificant cooling occurred in the time period between them. There was also some evidence of warming in the late 19th century, but the number of observation stations was too small for a reliable analysis.

Most of the warming occurred in spring. The mean temperature in March-May over the whole country was 1.8°C higher in 1963–2002 than in 1847–1876. The diurnal temperature variation had become smaller, again

Figure 6–1 The winter of 1988–1989 was very mild and ice cover on Finnish lakes remained thin. High wind broke the ice in Lake Pyhäjärvi in south-western part of the country on 30 March – the earliest breakup ever observed in the large lakes in Finland.

mainly in spring. A similar trend has been observed widely on the land areas of the Northern Hemisphere, together with an increase of cloudiness.

The warmest year on record was 1938, when the average over the whole country was 2.4°C higher than the mean for the reference period of 1961–1990. The second warmest year was 1989 (Fig. 6–1), and the third warmest 2000. By far the coldest was 1867, the year of the great famine, with the nationwide average 3.4°C below the reference period.

No significant, nation-wide precipitation trends were found. This is in contradiction with a 15–20% increase of precipitation in Sweden in the 20th century. Both countries have had changes in instrumentation and observation practices. The wettest year in Finland was 1974, with a nation-wide mean of 740 mm, while the driest was 1941, with only 394 mm. In addition to significant year-to-year variation, the precipitation climate of Finland is also characterised by notable interdecadal variability, which partly offsets the statistical detection of trends.

No comprehensive assessments of trends in other meteorological variables have been made in Finland. As to snow conditions, however, there is fairly strong evidence that the maximum snow storage has increased in eastern and northern Finland since the late 1980s, while in southern and western parts of the country the snow accumulation has decreased.

6.1.2 Scenarios

The first climate change scenarios for Finland were developed for SILMU, the Finnish Research Programme for Climate Change, in 1991. SILMU was a multidisciplinary programme of the Academy of Finland, and common scenarios were considered necessary in order to make the results of different research projects comparable. Three scenarios of temperature and precipitation change were developed for SILMU, based on GCM results over Finland: a central, "best guess" scenario together with lower and upper estimates representing an unspecified uncertainty range.

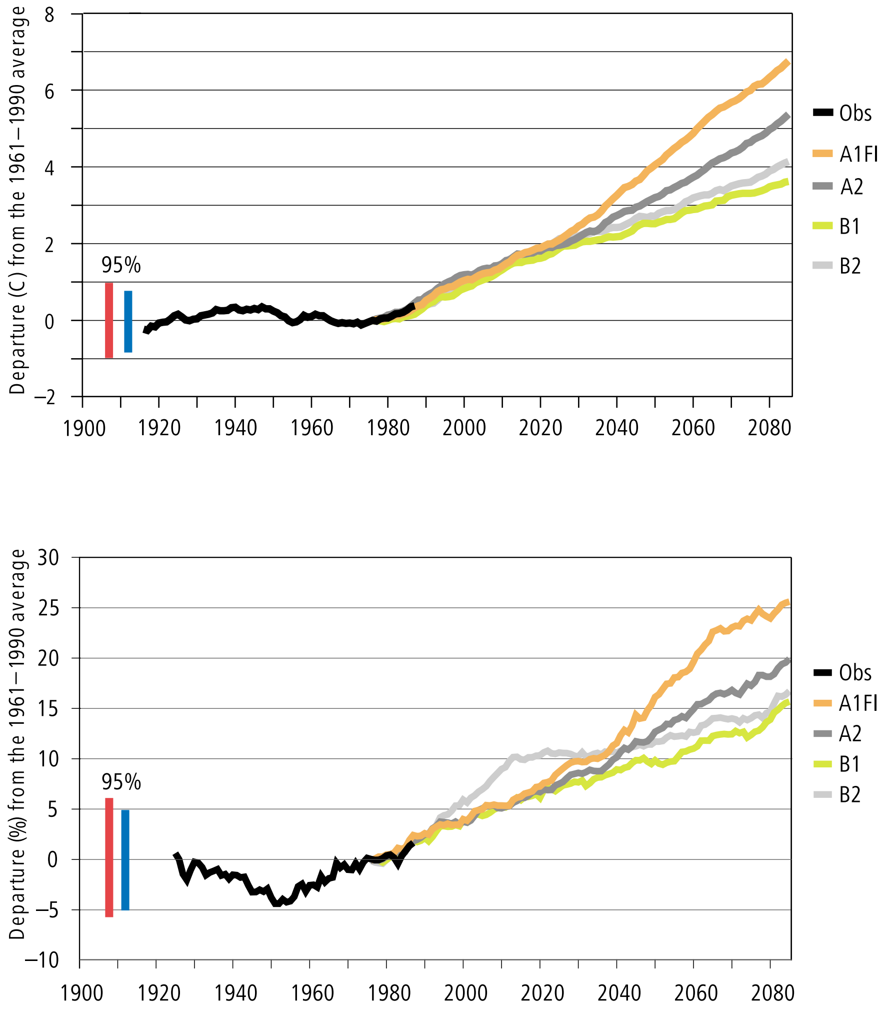
A new, more comprehensive set of scenarios for Finland's future climate and its impacts was developed in the FINSKEN project. This project was initiated in 2000 as part of the Finnish Global Change Research Programme (FIGARE) of the Academy of Finland. The project developed scenarios up to 2100 for four key environmental attributes:

- Climate
- Sea level
- Surface ozone
- Sulphur and nitrogen deposition.

In addition, a fifth set of scenarios was constructed by the Government Institute for Economic Research (VATT) to characterise future socio-economic developments in Finland, as these were considered to be important in determining the adaptive capacity of society to meet the challenges of global change (Kaivo-oja et al. 2004).

One of the key objectives of FINSKEN was to develop scenarios that are mutually consistent. The consistency was pursued by relating all scenarios to the same global driving factors. Two types of future world were described in FINSKEN: a consumer-driven "A-world" and a community-minded "B-world". In the A-world there is strong economic growth in

Figure 6–2 **Changes in Finnish mean temperature and precipitation as deviations from the average in 1961–1990. The curves represent 30-year rolling averages. Observed changes are shown as thick black curves, the different FINSKEN scenarios (A1FI, A2, B2 and B1) in different colours. The vertical bars (red and blue) represent natural climate change between 30 year periods, indicating the 95% range of variation in two different model tests (Jylhä et al. 2004).**



Finland accompanied by rapid increases in CO_2 concentration, increased ozone pollution and nitrogen deposition, rapid climate warming and increased precipitation. The B-world shows lower economic growth than the A-world, and less rapid increases in CO_2 concentration, temperature and precipitation. After initial increases, ozone pollution and deposition are unlikely to exceed present levels and will probably be much lower by the end of the century. Both the A- and the B-world are further divided into two subscenarios.

All four scenarios for Finland's temperature and precipitation up to 2080 are shown in Fig. 6–1. In the next two decades, the warming will be quite slow and differences between the scenarios insignificant. In approximate terms, the annual mean temperature is projected to rise by 1–3°C and the annual mean precipitation by 0–15% by the 2020s relative to the baseline period of 1961–1990. The corresponding increases by the 2050s are 2–5°C and 0–30%, while by the 2080s they are 2–7°C and 5–40%, respectively. The projected temperature trends are markedly stronger than those observed during the 20th century.

Seasonally, the projected precipitation changes and their statistical significance are the largest in winter and the smallest in summer. On the other hand, the projected relatively small summertime warming is at least as statistically significant as the larger warming in the other seasons. It seems very likely that changes in mean climate are associated with changes in climate extremes as well.

The FINSKEN scenarios will be further elaborated on; future research should focus on:

- Disseminating, maintaining and updating the current set of scenarios
- Extending the set to include other socio-economic and environmental characteristics (e.g. non-forest land uses, social preferences, infrastructure, adaptation capacity)
- Refining the set to address alternative scenario construction methodologies and broader issues relating to uncertainty
- Establishing the credibility and broad acceptance of global change scenarios through continuous interaction and dialogue with stakeholders throughout the process of scenario development
- Exploring a wider range of policy-related scenarios to compare with the SRES reference scenarios (e.g. greenhouse gas stabilisation scenarios; normative, target-based scenarios)
- Incorporating global change scenarios within an integrated assessment framework to facilitate analysis of future global change impacts and potential response measures in Finland.

6.2 Impacts of climate change

6.2.1 Agriculture

The potential of agricultural production is primarily limited in Finland by temperature. Other factors restricting production include solar radiation and precipitation, either direct or through the availability of nutrients and water. Soil factors also affect production. The growing season is estimated to lengthen by three to five weeks from the present by 2050. With the exception of northern Finland, the growing season will become longer particularly in autumn.

The effects of increased temperature and precipitation on soil will be evident as changes in the nutrient economy and structure. As temperature and dampness increase, the decomposition of organic material becomes accelerated. The risk of erosion, as well as that of nutrients becoming released and leached into waters, will increase. Compaction of clay soil, which is particularly common in southern Finland may increase and cultivation may become more difficult if the ground frost period shortens. The need for irrigation water will increase, and the availability of water may become more difficult. Climatic warming may increase stress arising from dryness and heat during the growing season.

Increased concentrations of greenhouse gases will affect the physiological functions of plants. Increased carbon dioxide concentrations will promote photosynthesis, improve the efficiency of water use in plants and impose changes on the distribution of photosynthesis products between different parts of plants, as well as on the density and quality of plant tissue. The combined effects of air pollutants (ozone) and UV radiation on ecosystems may become intensified.

The overwintering of plants may be hampered in southern Finland when the depth of snow decreases. The alternation between melting and freezing caused by mild winters is most harmful for the overwintering of plants; plants can suffocate beneath the ice cover. The risk of spring frost may also increase.

Noxious insects will benefit from a warmer climate and longer growing season. Their overwintering and reproduction will be successful more often, and they will have time to produce more generations for each phase of the host plant's exposure. The risk of plant disease epidemics, particularly various types of fungi and moulds, as well as potato blight, may increase. They may also occur earlier. Climate change will not have any direct effect on the spreading of viral diseases, but the living conditions of the vectors spreading them, such as plant lice, will improve.

The production of cereals and grass is currently limited by the shortness of the growing season, occasional frost and drought in early summer. The harvest potential is estimated to increase but it is difficult to estimate changes in harvests without knowledge of the varieties that will be used in future. If the cultivation of new varieties spreads to the north, the length of the day will impose a challenge to plant breeding.

The shortened indoor feeding season of farm animals will allow the grazing season to be lengthened. The well-being of animals will improve if outdoor grazing is increased but increased grazing may cause increased burdens on water. The need to store feedstock will be reduced. The risk of animal diseases may increase, even though the risk is believed to be very low. Diseases associated with the quality of water and feed may become more common. The milk yield of dairy cattle, as well as the growth of beef cattle and poultry will be reduced if temperatures in the barns housing the cattle rise very high.

A systematic presentation of possible effects of climate change in the agricultural sector is presented in Table 6–1.

Table 6–1 Summary of the anticipated effects of climate change on agriculture and food production in Finland.

Disadvantage	Advantage
– Increased erosion and risk of nutrients leaching – Compaction of clay soil may hamper cultivation if ground frost is reduced – The combined effects of air pollutants (ozone) and UV radiation on ecosystems will become intensified – The risk of insect damage and plant diseases will increase – Effects of increased extreme phenomena on the quantity and quality of harvests from fields – Overwintering of plants may become more difficult – The need for irrigation water may increase	+ Production potential of plants will increase + Plant cultivation boundaries will move farther north + Horticultural production will benefit + Outdoor grazing can be increased + Overwintering of perennial plants will probably become easier

Figure 6–3 A FIGARE measuring site of the Agrifood Research Finland (MTT) at Jokioinen, south-western Finland. Methane and nitrous oxide emissions were measured in all seasons in 2000–2002.

In Finland's cold climate, the role of agricultural soils as a sink and source of greenhouse gases is different from that at lower latitudes. In the FIGARE Programme, fluxes of methane, nitrous oxide and carbon dioxide were studied on different agricultural soils in southern and northern Finland (Martikainen et al. 2002). The annual N_2O-N emissions varied from 4 to 37 kg ha^{-1} on organic soils and from 2 to 8 kg ha^{-1} on mineral soils. The emissions were higher than those used in the IPCC calculation method. Type of soil and crop had some effect on the fluxes. Emissions of N_2O-N during winter were on average 57% of the annual fluxes. Soil freezing-thawing cycles enhanced N_2O production in organic soil, especially at very low temperatures. The changes in microbial communities associated with soil freezing and thawing were generally low. Soil had a high capacity for immobilising nitrate even at low temperatures (Fig. 6–3).

Irrespective of the crop type, the organic soil studied in southern Finland was annually a net source of carbon dioxide. The annual net emissions were 1,500 and 7,500 kg CO_2 ha-1 for grass and barley, respectively. Respiration in the peat soils was 2–3 times that in the mineral soils. The fluxes of methane were generally small.

6.2.2 Forestry

6.2.2.1 Forest boundaries and productivity

Climate changes are likely to modify substantially the boreal forests in Finland. The two most important coniferous trees, *Pinus sylvestris* and *Picea abies*, are likely to invade tundra regions under warmer conditions. These changes would be accompanied by a lesser dominance of both species in southern Finland with a concurrent increase of deciduous trees.

Climate projections suggest a displacement of climatic zones suitable for boreal forests by 150–550 km over this century. This shift is, however, faster than the estimated potential of many species to migrate (20–200 km per century) or the capability of many soils to develop a new structure.

Climate change is likely to have considerable direct and indirect impacts on the productivity of Finland's forests. This is basically because the elevation of CO_2 is enhancing photosynthesis under the optimal temperature and supply of nutrients and water. However, this response may be acclimatised to the CO_2 elevation or regulated down in the course of years.

Climate change impacts on tree growth are closely related to stomatal functions and transpiration. Elevated CO_2 results in a partial closure of stomata with a consequent reduction in transpiration but temperature increase is likely to have an opposite influence. Therefore, the combined effect of these two factors on water use efficiency might be small.

In Finnish climatic conditions, regeneration of trees is mainly limited by low summer temperatures. Model computations have shown that at the northern timberline in Finland a temperature rise alone may enhance natural regeneration of Pinus sylvestris. However, even with a combined elevation of CO_2 and temperature the growth of seedling stands was slow, which indicated that the northward advance of the timberline would probably be very slow.

In SILMU it was estimated that the annual growth of trees would increase by over a third within a few decades. Part of this increase will be due to improved forestry, part will be caused by higher atmospheric CO_2 content, higher temperatures and longer growing seasons.

The enhancement of growth will be most pronounced in northern Finland. By the end of this century, nearly half of Finland's forest resources could be located in northern Finland, whereas currently they are divided between southern and northern Finland at a ratio of about 70% and 30%, respectively. If the species composition of trees is managed to make optimal use of the changed conditions, 60–80% of the forests in southern Finland may consist of birch (mainly Pendula) by the year 2100. Norway spruce will decline in the south, but increase in the north. The warming may also decrease the amount of Scots pine in southern Finland.

6.2.2.2 Risk of forest damages

Milder winters may increase the risk of damage caused by insect pests overwintering in the egg form in tree canopies, because the eggs may hatch early (Fig. 6–4). However, there might be some counteracting effects, especially through changes in the activity of natural enemies. Moreover, the risk of damage from fungi, fire and wind may be greater as a result of milder winters, less snow and shorter periods of frozen soil.

The timing of budburst in spring is closely related to temperatures. The budburst is preceded by low chilling temperatures during winter. Even under elevated temperatures, the chilling requirements of trees are likely to be fulfilled, and earlier budburst may be expected. Some model simulations suggest that climate warming may lead to serious frost damage due to too early budburst.

Figure 6–4 The development of leaf spots caused by certain pathogens was monitored by digital photographs at METLA's Suonenjoki Research Station. An image analysis programme was used to analyse the number and size of the spots and to calculate the diseased leaf area. (Photo: Erkki Oksanen/METLA)

The amount of snowfall out of total wintertime precipitation may be reduced in Finland, which would lower the risk of damage to trees. On the other hand, there is the possibility of more episodes of wet snowfalls where snow accumulates on branches. In northern Finland, greater snow accumulation due to an increase in total wintertime precipitation may also occur.

6.2.2.3 Timber yield

Forests are a key source of income in Finland. In forest management, the structure and functioning of the forest ecosystem are controlled with specific aims, e.g. timber is grown for sawlogs or pulpwood usually within an appropriate time horizon. In thinnings, the canopy closure is disturbed to allow an increase of radiation, the canopy's interception of precipitation is reduced and more water infiltrates to the soil. Thus the nutrient cycle in the soil is enhanced.

Model calculations have indicated that the total annual stemwood growth of Finnish forests may increase by up to 40% in the period 1990–2100, with the main increase north of the 63rd latitude. These calculations take into account the increases of annual mean temperature and precipitation, and the growth of atmospheric CO_2 concentration. Sustainable cuttings can increase by one fourth from the present level. The share of hardwood timber would increase from the current 10% up to 30%. Some studies have given more modest stemwood growth rates, 10–15% in southern Finland and 25–35% in northern Finland.

In practice, the future of Finnish forests will be largely dependent on management practices. It is essential that the needs of suitable raw material for the forest industry can be satisfied. Therefore, forest management has to be flexible enough to react to the demands set by climate change, as well as to other challenges.

The mechanical and chemical properties of timber and wood are related to temperature and moisture conditions. With the annual rings becoming thicker, the overall density of wood might decrease. Enhanced growth may also improve branch growth with an increase of knots in wood and a reduction in the mechanical strength of sawn timber.

Optimally, timber should be processed within only a few weeks after logging. The carrying capacity of forest soil is of crucial importance for successful logging and transportation. Increasing precipitation may result in problems, such as a shorter soil frost period. To avoid these problems, there is a need to develop logging systems to match the changing conditions.

6.2.2.4 Other forest products

The game resources of Finland are quite rich; there are 34 mammal and 26 bird game species. By far the most important is elk, the annual number of animals hunted is around 60,000–70,000 and the meat value totals some EUR 40 million. Because the winter population is around 120,000, the harvest plays a major role in elk population dynamics. Elk is not only a valuable game animal but it causes considerable forest damages and traffic accidents.

The elk will mainly benefit from a warming climate and thinning snow cover. Thus, food will be more easily available and the management of the population will become even more important than today. Several game birds and small mammals are also likely to find the future winter climate comfortable and their populations might increase, and the large annual variations attenuate.

The annual biological yield of wild berries is 500–1,000 million kg, with lingonberry, billberry and cloudberry the economically most significant species. However, only 5–10% of the yield is picked, mainly for home use, the annual market supply being only about 5 million kg. Commercial use of wild mushrooms is much less, around 0.2 million kg.

The adaptation of berries into the Finnish climate is based on two factors: they are tolerant of near-zero temperatures during the growing season and they have a good ability for winter dormancy. Climate change might imply that fairly warm spells occur even in mid-winter and particularly in early spring. These warm spells can break the winter dormancy, leading to severe damage when temperatures drop back to sub-zero.

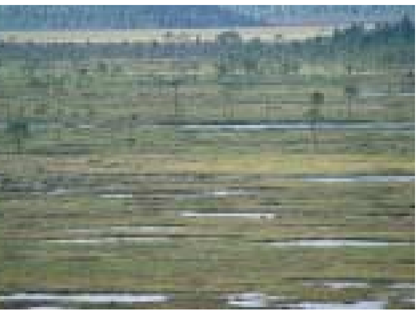
Thick snow cover insulates the twigs of the berry species from severe cold. Thinning snows together with the occurrence of cold spells might be harmful. In summer, new insects and pathogens will be a risk factor.

A summary of the effects of climate change in the forestry sector is presented in Table 6–2.

Table 6–2 **Summary of the anticipated effects of climate change on forestry in Finland. Some of the effects are clear advantages or drawbacks but the direction of some effects is still unclear or dependent on the intensity of climate change.**

Disadvantage	Direction of the effect unclear or simultaneous disadvantage and advantage	Advantage
– Increased risk of nutrients leaching – Increased risk of wind damage and weakened anchoring of trees to the soil as ground frost declines – The combined effects of air pollutants (ozone) and UV radiation on ecosystems will become intensified due to climate change – The risk of pests and forest pathogens will increase – Potentially reduced ground frost will make forest harvesting more difficult – Extension of the thawing season will impose additional needs on machine capacity and wood storage – The quality of coniferous wood may suffer	• The proportions of tree species will change • The tree line will move farther north	+ Increases in carbon dioxide concentration, temperature and precipitation will add to the productivity of the boreal belt + Felling opportunities will increase + Plants will have access to more nutrients + The seed yield of trees will improve and natural regeneration in infertile habitats in Northern Finland will become easier.

6.2.3 Peatlands



Several environmental stressors influence wetland systems in Finland. Climate change may become the most prominent one of them in future. Changes in temperature, precipitation and evapotranspiration may have a considerable impact on the hydrology of wetlands and, consequently, the load of organic and inorganic matter from the catchment. Furthermore, continued increase in atmospheric CO_2 will affect the quantity and quality of primary production as the photosynthesis of most submerged macrophytes and the emergent littoral vegetation are limited by CO_2.

The present area of undisturbed peatlands in Finland is about 4 million hectares. These peatlands sequester carbon dioxide in most of the years, but they may be CO_2 sources if the summer is dry. Methane is emitted at considerable rates particularly in wet summer seasons. Emissions of N_2O from undisturbed peatlands are of minor importance.

Approximately 5.7 million hectares of peatlands have been drained for forestry in Finland. The soils of drained peatlands emit more CO_2 than undisturbed peat soils; 25–45% of these emissions are due to root breathing, 20–35% come from the decomposition of new litter and 35–45% from the decomposition of old peat. As a whole, the majority of the drained peatlands are carbon sinks because of the significant increase of wood biomass. Methane emissions can stop completely after drainage, while N_2O emissions may increase in some bog types.

Some 0.7 million hectares of peatlands have been drained for agriculture, most of it having occurred soon after World War II. Today, the area of drained peatlands in cultivation is estimated to be about 250,000 hectares. Both abandoned and cultivated peatlands are considerable sources of N_2O; it seems that these emissions may still be large 20–30 years after abandonment. A significant share of the emissions occurs in winter.

Changes in peatlands as a consequence of increased atmospheric CO_2 levels have been studied in Finland in e.g. the BERI programme. Elevated CO_2 levels seemed to moderately increase CH_4 fluxes from peat. Net CO_2 uptake of *Sphagnum* mosses increased so that the temperature/light optimum was shifted to a higher value. However, the photosynthetic process in mosses became acclimated to a high CO_2 concentration under prolonged exposure (Saarnio et al. 2000).

6.2.4 Water resources

In most of Finland the annual runoff has increased, on average 0.5 mm a^{-1}, but in parts of southwest Finland the average increase of annual runoff has been up to 1.0 mm a^{-1} during the 20th century. In the north, no trend in winter flow is observed. In southern and central Finland, especially the winter flow has increased during the period. Autumn flows have also been on the increase in southern and central Finland.

There is, however, no marked trend in the longest streamflow series in Finland, i.e. that of Lake Saimaa to River Vuoksi, situated in south-eastern Finland. This series starts in 1847. The reason for the absence of trend, at least partly, is the heavy slash-and-burn agriculture that was practised in large areas in the southern parts of the drainage basin in the middle of the 19th century. This deforestation considerably decreased evapotranspiration in these areas for more than half a century.

The most serious 20th century drought in Finland occurred in 1940–1942. Mean annual countrywide discharge was only 49% of the long-term average in 1941 and 57% in 1942. These were the two driest years of the whole century. The drought in 2002–2003 hit most of Norway, Sweden and Finland with a considerable reduction of hydropower production – and a substantial increase in the price of electricity. In Sweden, the second half of 2002 was one of the driest in a hundred years, in southern Finland the precipitation in August 2002–April 2003 was less than half of the average.

From the point of hydropower, in flood forecasting, for instance, changes in snow storage are very relevant. Due to the mild winters, this storage has declined in southern parts of the Nordic region since the late 1980s. For example, in the river basins in southern Finland, the maximum water equivalents in 1991–2002 were 20-30% smaller than in 1961–1990. In central Finland, no trend is observed in snow storage. In eastern and northern Finland, the maximum water equivalent of snow has grown quite clearly.

Three different research programmes have studied changes in runoff in future. Their results show fairly large variations. In the Nordic CCEP project (Saelthun et al. 1998) the annual runoff of the Kemihaara sub-basin at the Kemijoki drainage basin was found to increase by 2% in 30 years,

whereas in the SILMU project no essential changes at the annual level were found. In the ILMAVA project (2002), however, the runoff was estimated to increase by 5–8%. In the Oulujoki drainage basin the CCEP project reported almost no change in runoff, while ILMAVA resulted in an increase of 2–7%. In the Vuoksi drainage basin the changes in runoff varied between –1…+4% (CCEP), –2% (SILMU) and 0–8% (ILMAVA). These differences were due to differences of climate scenarios, especially in precipitation. Evaporation also affects the results considerably. Summers will become drier due to the increase of both evapotranspiration and lake evaporation during the lengthened warm season.

With the projected warming, the snow cover diminishes or almost vanishes in southern Finland and its duration will shorten. Frequent thawing periods result in increased occurrence of winter floods and decreased spring floods. Summers will become drier due to the longer summer season and thus increase total evapotranspiration and lake evaporation.

Long lake routes are typical of the Finnish Lake District. In the SILMU project it was found that the change in maximum flood in a large, lake-rich watershed depends strongly on the location of the site in the lake route. In upper basins of these watersheds the maximum discharges will decrease by 20–60% due to smaller spring floods. The decrease diminishes downstream in the lake chains, and the last collector lake, Saimaa, will have higher floods than today because meltwaters and precipitation accumulate there in winter when no evaporation takes place. The flood peak in Saimaa will be reached in April–May in the future climate, while it now occurs in July–August.

The results of all projects indicate that climate change is advantageous for hydropower production in Finland due to seasonal distribution changes and increased runoff. In the CCEP, the predictions show a 4% increase in hydropower production in the 30-year simulation period, in SILMU the increase was estimated to be 2% and in ILMAVA 7–11%. The increase is the highest in northern Finland. The changed use of the reservoirs can have unexpected environmental effects as the present fairly fixed pattern of operation – empty in late winter, rapid filling in spring, high in summer and full in autumn – has to be changed to a more flexible mode.

Flood risks and dam safety are affected by climate change. According to the HadCM2 simulation, the one, five and 14-day design precipitation values may go up by 35–65% by the end of this century compared to 1961–1990 (Tuomenvirta et al. 2000). The increase is the largest in the period from January to June. This would lead to a dramatic increase of design flood; e.g. for a 2,000 km^2 subcatchment of the Kyrönjoki River in Ostrobothnia the increase of peak discharge was estimated to be 70% (Vehviläinen 2001).

Winter floods and lack of snow cover will make the agricultural soils of southern Finland susceptible to increased leaching of nutrients. However, according to modelling results, this increase will be relatively small and can be controlled with proper protective measures.

Nitrate leaching from forest areas may increase significantly. Total nitrogen deposition in the boreal forest is substantial. With the high scenario of SILMU, the simulated nitrogen leaching would double before the year 2050 but the effects of enhanced forest growth can balance this increase.

The duration of ice cover in lakes will become shorter. It has already decreased by around ten days in Finnish lakes during the 20th century,

Table 6–3 Summary of the anticipated impacts of climate change on water resources in Finland.

Disadvantage	Advantage
– Extreme phenomena will become more common – Winter floods will become more common – The possibility of large-scale floods will increase (damage to industry and buildings, disadvantages to water management, epidemics) – Floods will impair water quality – Increased occurrence of drought will impair agriculture and forestry, water supply, hydroelectric power production, water traffic and recreational use of water – Drought will cause oxygen depletion in water systems and impair the living conditions of fish – Milder winters will increase scattered load in areas dominated by agriculture and forestry	+ Increased total precipitation and decreased spring floods will increase the amount of energy produced by hydroelectric power + Increased rains will carry oxygen-rich water into water systems

like elsewhere in the Northern Hemisphere (Magnusson et al. 2000). In the latter half of next century, the middle parts of the largest lakes in southern Finland may even stay ice-free throughout the winter. In summer, the surface water temperatures will rise by about as much as air temperatures.

The spring peak of phytoplankton will occur earlier and become clearly greater than today. The littoral zone is likely to be more sensitive to the effects of climate change than the pelagic ecosystem. A doubling of atmospheric CO_2 content and an increase of 2–3°C in water temperatures more than doubled the growth of some littoral macrophytes in an artificial greenhouse lake (Kankaala et al. 2000).

A systematic presentation of climate change effects on water resources is presented in Table 6–3.

6.2.5 The Baltic Sea

The long term mean sea level has declined during the 20th century at all Finnish tide gauge locations, mainly due to land uplift. However, this decline slowed markedly during the last 20 years of the century, due to changes in the water balance of the Baltic Sea. There has also been an increase in short-term, sub-annual sea level variability (Johansson et al. 2004). The magnitude of extremely high sea levels increased up to the 1970s, whereafter it has declined somewhat up to the present. However, new record high water levels were measured along the coasts of the Gulf of Finland in January 2005.

As discussed in Section 6.1.2, a new set of scenarios of mean sea level for sites along the Finnish coast during the 21st century was constructed in the FINSKEN project. The effects of global mean sea level, local land uplift and the water balance of the Baltic Sea were taken into account in the development of these scenarios (Johansson et al. 2004). The effect of the water balance was estimated with the North Atlantic Oscillation (NAO) index. In most cases the rise in the water level is expected to balance the land uplift in the Gulf of Finland, and the past declining trend of the relative sea level is not expected to continue. In the Gulf of Bothnia, the stronger land uplift rate still results in a fall of the relative mean sea level in future. The uncertainties in the scenarios are substantial. Scenarios for the intra-annual variability of the sea level were constructed by extrapolating the 20th century trends of increasing variability.

The ice season in the Finnish waters of the Baltic Sea normally lasts 5–7 months. According to the central SILMU scenario, ice cover would appear about 20 days later in 2050 and melt 10 days earlier than today. The ice conditions of the Baltic were also studied in the FIGARE Programme (Haapala et al. 2002). Two different coupled ice-ocean models were used to simulate the present and future ice conditions in around 100 years from now. Present day ice conditions and interannual variability were realistically reproduced by the models. The simulated range of the maximum annual ice extent in the Baltic in both models was 180,000 to 420,000 km^2 in the control simulation and 45,000 to 270,000 km^2 in the scenario simulation. These wide ranges clearly depict the large interannual variation of Baltic ice conditions.

The range of the maximum annual ice thickness was from 32 to 96 cm and from 11 to 60 cm in the control and scenario simulations, respectively. In contrast to earlier estimates, sea ice is still formed every winter in the northern Bothnian Bay and in the easternmost parts of the Gulf of Finland. Overall, the simulated changes of quantities, such as ice extent and ice thickness, as well as their interannual variations were relatively similar in both models, which is remarkable because the model systems were developed independently. This increases the reliability of future projections of ice conditions in the Baltic Sea.

The input of nitrogen to the coastal waters is expected to increase in winter. Before the onset of spring, nutrients will be transported further from the coast, with a consequent risk of eutrophication and algal blooms over a large area. The reduction of nitrogen loading will obviously be one of the crucial measures required to prevent harmful effects of climate change in the Baltic.

6.2.6 Fisheries

Climate factors have a strong direct or indirect global effect on the health, productivity and distribution of fish. Changing distributions of fish, increased or decreased growth, heightened susceptibility to communicable diseases, new diseases and parasites, and changing ecosystems have an impact on fisheries. Changes in the runoff have also been found to have effects on fish populations, thus having an impact on fisheries.

In Finland, the impact of climate change on occupational and leisure fishing and fisheries as a whole will be reflected through the impact on fish stocks. In the long run, climatic warming may have a significant effect on the state of waters, fish stocks, fishing and fish farming but, in the short run, other factors such as market conditions, fishing restrictions, increase of the grey seal population, reduced fishing capacity and natural variation of fish stocks will have a significantly greater impact than climate change on occupational and leisure fishing.

The composition of Finland's fish stocks may change either direct or indirect as waters become warmer, but also through the natural routes of distribution and through human activity in the form of active planting. Cold water species may decline particularly in small and shallow waters in southern Finland, while warm water species will benefit and spread further north.

Fish stocks in minor rivers and lakes are more sensitive to changes in temperature and precipitation than the stocks of major rivers and lakes. Changes in precipitation and temperature due to climate change will probably affect the numbers, distribution and mutual relationships of fish populations both direct and through other changes in the ecosystem.

In most cases, the early stages of development of young fish will benefit from the warming of waters, which may increase the amount of plentiful age groups in several species, further increasing the amount of prey available to predatory fish. On the other hand, the warming of waters may result in prey species being hatched at a different time than previously, which may cause problems to the nutriment supply for fry.

As to the Baltic Sea, a potential change in the salt concentration may cause substantial changes. The present salt concentration only limits the distribution of a few freshwater species in our coastal waters but is the most essential factor for saltwater fish. Even a small increase in salt concentration could have great impacts on the fish populations of the Baltic Sea and on the improvement of living conditions for saltwater species. These include commercially important species like Baltic herring, sprat, cod and flatfish. Professional fishing could benefit if the catches of these species became more abundant.

The most important cultivated fish in Finland is rainbow trout, for which warming could be more of a disadvantage than and advantage. The warming of waters may increase the production of fish farming facilities if the temperature increases at a time favourable for growth. Extended heat waves have been observed to weaken growing results.

6.2.7 Biodiversity

Some 10% of the animal and plant species in Finland are endangered. Over one third of these species live in forests, while 28% live in man-made, cultivated habitats. For most of the endangered species, anticipated climate change is not the main threat; their habitats are undergoing harmful changes due to land use change and other direct anthropogenic factors.

Warming is an obvious risk to the species that are not able to migrate to cooler habitats. This is the case particularly with the species living in northern Finland or on the numerous islands of the Baltic Sea or Finnish lakes. Increased summer drought is a hazard to plants and insects living on rock outcrops or other habitats with thin soil cover.

In southern Finland, invading species can decrease the habitats of native species, and the population of invaders may expand rapidly if natural enemies are lacking. Many native species living in the south, on the other hand, will have possibilities for finding favourable living conditions further north if the climate is warming.

In the forests, the amount of decayed wood is likely to increase, thus creating suitable habitats for a number of endangered species. The same is true with forest litter, particularly the fallen leaves of deciduous trees.

Milder winters are welcomed by several overwintering bird species, and by herbivorous mammals.

Changes in the northernmost Finland will affect the occurrence of permafrost in palsa mires. The extent of palsa has lessened greatly during the past few decades. The defrosting of palsa and the diminishing of water moulds increases the coverage of vegetation but reduces the populations of birds and insect groups that benefit from the palsa mires.

Overall, the total number of species living in Finland is more likely to increase than decrease as a consequence of climate change. At the same time, however, some species characteristic to Finland, like relict cold water fish and other reminders of the Ice Age, may become extinct.

6.2.8 Energy

The energy sector is in the limelight of climate change. The most important impacts will come from the reduction of greenhouse gases and the development of mitigation methods. However, even the direct impacts of climate change will be significant in this sector in Finland.

The seasonal variations in energy demand may attenuate in future if requirements for heating decrease and needs for cooling increase. This does not necessarily mean any reduction in peak electricity demand because very cold spells can still occur in mid-winter. The increase of water temperatures implies a small decline of efficiency in condensation power plants.

Increase of extreme weather events is a potential hazard to the electricity transmission system. Severe power cuts have occurred fairly frequently in the Nordic countries in recent years. This might speed up the installation of earth cables in urban areas and the implementation of new measures to protect air cables from damage.

Table 6–4 The anticipated effects of climate change in the energy sector in Finland.

Disadvantage	Direction of the effect unclear or a simultaneous disadvantage and advantage	Advantage
– The predictability of hydroelectric power production will decrease to some extent. – Peat production will become more difficult in rainy summers. The predictability of peat production may decrease further. The condition of the road network may deteriorate. – The deteriorating condition of roads may also hamper the use of wood and field-grown biomass for energy. – The share of back-pressure power may slightly decrease. The use of energy for cooling and air conditioning in summer may increase.	• Increased mean temperature and reduced need for heating	+ Amount of energy produced by hydropower will increase. + Peat production may increase in dry summers and with the extended production season. + The growth of wood and field-grown biomass for energy use will probably increase. + Energy consumption for heating will decrease. Seasonal variations in demand may slightly stabilise. + The increased need for cooling can probably be partially utilised in back-pressure power production.

The effects of climate change on hydropower production in Finland may be considerable, as already discussed in Section 6.2.4. Peat production is very sensitive to weather conditions; in a rainy summer the production can be only a fraction of that in a sunny summer. The scenarios of variations of summer weather are still quite uncertain and estimation of the net effect of climate change on peat production is difficult. However, lengthening of the season seems likely.

A summary of the effects of climate change in the energy sector is presented in Table 6–4.

6.2.9 Industry

Like in the energy sector, the indirect impact of climate change through mitigation methods and greenhouse gas reduction targets will be much more important to industry than direct influences.

There are two main pathways of direct influence. In some branches of industry, the sources of raw materials may be altered by the changing climate. These include the forest industry; both the quantity and quality of raw wood may change. This can have implications to the selection of processes and the assortment of products, perhaps even to the location of factory units. The food processing industry may also face changes if regional shifts take place in the cultivation of different plants or if e.g. milk production moves further northwards.

Second, the transport of industrial raw materials and products may become more vulnerable to adverse weather conditions. In the forest industry, this may also include seasonal shifts in the supply of raw wood if the durations of difficult road conditions in spring increase. Severe storms may also induce peaks in the supply of raw wood.

6.2.10 Transport and communications

Climate change is likely to affect all modes of transport in Finland, but with different ways and intensities. Several studies have focused on winter because adverse traffic conditions are much more common then than in other seasons. The maintenance costs of roads and highways are expected to increase in January-February due to heavier snowfalls and frequent need for de-icing. In November, December and March, the costs would decrease mainly because the proportion of rainfall will get higher. On forest roads, the decline in frost depth can be harmful for winter transport. The net change in maintenance costs over the whole cold season may be small.

Winter is also a challenge to pedestrians and cyclists. The number of slipping accidents has been on the increase and the costs from them to healthcare are very high. The situation may get worse in coming years with an ageing population, particularly if the freezing-thawing cycles become more frequent.

The ice season is expected to shorten considerably in the Baltic. Along the south-western coasts, the freezing might become delayed by 1½ months and the disappearance of ice by one month during this century. In the Gulf of Bothnia, the maximum ice thickness may decrease by 20–30 cm. For winter traffic, these changes are not necessarily always favourable. The heaviest storms often occur in winter months; if the sea is open, waves may be very high. If there is ice, storms create thick ice belts and high ridges on shipping lanes and harbour mouths.

Heavy rains will increase erosion and risk of landslides along roads and railways. It also increases skidding hazard. Temporary flooding of underpasses will become more frequent. In July 2004, when it rained up to 150 mm in a few days, these kinds of problems occurred widely in southern and central Finland.

Air traffic will suffer from heavy storms and maintenance costs of airfields will increase in mid-winter. Frequent use of de-icing chemicals may cause environmental problems.

In telecommunications, the networks based on air cables may be vulnerable to storms and icy rains. The same applies to the automatic safety systems of different modes of transport. Ice and wind loads on masts may also be higher than in the present climate.

A summary of the effects of climate change in the transportation sector is presented in Table 6–5.

Table 6–5 The anticipated effects of climate change in the transportation sector in Finland.

Disadvantage	Direction of the effect unclear or a simultaneous disadvantage and advantage	Advantage
– The risk of collapse of railway beds and roads will increase – Floods and heavy rains will damage the structures of road and rail networks, maintenance problems could be expected particularly on gravel roads – The functionality of drainage arrangements based on today's dimensioning will be endangered – Bridge and culvert structures are dimensioned to convey present runoffs – Problems may be caused to railway and navigation safety equipment – Difficult weather conditions will increase in all forms of traffic (road, rail, sea, air) – The sensitivity of interference in traffic will increase – The rectification of and preparation for functional disturbances will impose additional costs – Increased need for antiskid treatment all over the country; for example, the need to apply de-icing salt to roads will extend to the north – Potentially increasing formation of pack-ice and thick sludge belts will impair marine traffic – Windiness, storms and heavy rain will cause damage to overhead cable networks and breaks in underground cables	• The impacts may change the attractiveness of different forms of traffic • The need for de-icing salt will increase in some places and decrease in others, so the total cost is unclear • Ice and snow conditions may vary significantly between years	+ Shortening of the ice-covered period will bring savings in navigation and harbour maintenance costs + Thinning of the snow cover and shortening of the snowy-winter will bring savings in winter maintenance to the road and rail network and at airports

6.2.11 Land use planning and construction

Buildings are made to last for a minimum of 50–100 years – thus, climate change scenarios for the whole of the 21st century are very relevant in this sector. Decisions in land use planning have an even longer time frame, they may have a fundamental influence in a community for many generations to come.

A warmer Finland needs less energy for heating the building stock in winter, while the need for cooling and air-conditioning increases in summer. More frequent and intense precipitation accelerates corrosion and induces a higher wetting load on the walls and roofs of buildings. If the number of freezing-thawing cycles increases, which is likely, porous materials like bricks and plastered surfaces will be put to a severe test.

Today's building code might need adjustments if extreme wind velocities increase. The changes in wind climate may also increase the frequency of inclined rains, thus creating a need to restructure e.g. the openings of air intake systems. Despite milder winters, the snow loads may increase in eastern and northern Finland, which should be taken into account in the building code. Reinforcements may be required in existing buildings – there have already been a number of collapses of buildings due to snow loads in recent years.

Although the depths of soil frost might decrease in future, the uncertainties are so large that no changes to the present guidelines for frost insulation of pipelines and other structures should be made.

In land use planning, the areas vulnerable to floods or high sea levels should be mapped and building on those areas avoided.

6.2.12 Health

Increased intensity and frequency of extreme weather events may cause additional pressure in the health sector, particularly with the ageing of population. In 2020, one fifth of Finns will be over 65 years of age, while today their proportion is 15%. The mortality of elderly people has been very high in southern and central Europe during recent heat waves. In Finland, the extreme heat will remain much less intense, but the mortality is likely to increase here already at somewhat lower temperatures than further south.

Storms and intense small-scale wind phenomena (mini tornadoes) may cause accidental health hazards to individual people. The same is true of floods, but they may also induce large-scale health risks, particularly through contamination of water supply. This happened in some communities in Finland in summer 2004 but the actions of health authorities were effective enough to prevent diarrhoea and other epidemics.

Additional mortality from cardiovascular diseases can be statistically observed two days after the onset of an extremely cold spell; in the case of pulmonary diseases, the time delay is twelve days. With milder winters, these risks are likely to decrease in future.

The occurrences of many infectious diseases have distinct seasonal cycles in Finland. This is the case with e.g. the common flu, with a higher rate of occurrence in winter. The change of winter climate as such may not have any impacts on these "winter diseases". On the other hand, several summertime health risks are caused by animals, plants or other organisms whose occurrence is weather-dependent. There is some evidence of e.g. northward migration of the diseases caused by *Ixodes ricinus*, a tick that used to be common only in the south-western archipelago in Finland. In 2003, 753 cases of Lyme disease and 16 cases of encephalitis caused by this species were reported.

Allergic diseases are more and more common in Finland. If they are caused by the pollen of a certain plant, the extent of the area and habitat of this plant are obviously important. Warmer climate and a longer growing season might favour some of these harmful plants. The same is true of the occurrence of cyanobacteria, some of which contain toxic substances.

6.2.13 Tourism and recreation

Tourism employs about 120,000 people in Finland, mainly in small and medium-size enterprises. In 2003, the number of foreign visitors was 4.6 million, over 90% of them from Europe. Recreation in nature is an essential part of Finnish lifestyle; more half of the working-aged population pick berries and two thirds go walking or swimming.

Increased uncertainty of snow conditions has already been a problem for winter tourism and recreation, particularly in southern Finland. This has led to the construction of several underground facilities for cross-country skiing. Even in Lapland the important Christmas tourism has suffered from late arrival of snow cover. However, internationally the skiing resorts of northern Finland may benefit in future if snow conditions in central Europe decline as expected.

Short season is a major obstacle to the development of summer tourism in Finland. Scenarios of warmer and longer summers are thus welcomed by tourism operators and may affect their future plans. On the other hand, algal blooms may become a nuisance in warmer waters and lower the attraction of Finnish lakes and the Baltic Sea.

6.2.14 Insurance

Climate change is likely to increase the damages caused by extreme weather events also in Finland. Thus, insurance companies face higher uncertainties in their risk estimates, which may be reflected in the premiums and coverage of insurance systems. At present, the companies offer a good insurance coverage for forests, for instance against fire, storms, floods, heavy snow, insects or pathogens. On average, some 70% of annual compensations in forest insurance are paid for storm damage.

On the other hand, home and property insurance policies do not cover damages caused by heavy rain or floods at the moment. However, if the flood is considered exceptional (i.e. it has a return period of over 20 years) it is possible to get compensation from the government. In 2004, these compensations amounted to about EUR 7 million, most of which was due to the heavy rains in southern and central Finland in July-August. The government also subsidises agriculture for damages caused by adverse weather conditions if they exceed 30% of the value of a normal harvest.

6.2.15 Climate change in Finnish Lapland

In Finland, the regionally widest definition of the Arctic covers almost one third of the country, while the strictest definition limits the Arctic to the northernmost Lapland, where most of the 4,000 Sami people live. The total population of Finnish Lapland is around 200,000.

It is widely thought that the impacts of climate change would be more severe in the Arctic than elsewhere in the world. In Finnish Lapland, the observed climatic changes have been relatively small thus far, unlike in many regions in Canada and Siberia. Exceptional snow conditions have, however, occurred; record late arrival of snow in some years, but record high accumulations in late winter in others.

Reindeer husbandry is still important in Lapland, particularly in small communities. Over 5,300 people own reindeer, the annual meat production amounts to 2,000 tonnes. Some 200 small enterprises are active in reindeer tourism. Reindeer are also of great cultural value because many of their owners are Sami people.

According to the ACIA project, the impacts of climate change are expected to be mainly unfavourable on reindeer. If winters get milder and precipitation increases, snow may be thicker and icy layers may form inside the snow cover. This makes it difficult for reindeer to dig lichen, and their need for supplementary food increases.

In summer, higher temperatures will worsen the problems with mosquitoes and black flies. On the other hand, longer growing season may enhance biomass production on the natural feeding grounds of reindeer.

6.3 Adaptation measures

6.3.1 National measures

The need to draft a programme for adaptation to climate change was identified in Parliamentary responses to the National Climate Strategy submitted to Parliament in March 2001. Work on the National Strategy for Adaptation to Climate Change began towards the end of 2003, and was coordinated by the Ministry of Agriculture and Forestry, with contributions from various ministries and expert organisations. Several top Finnish researchers in the field of climate change and its impacts were involved in this work together with other experts and representatives from various sectors. The draft strategy was circulated widely for comment, and Finnish stakeholders and citizens were able to contribute through the Internet.

The Adaptation Strategy was published in January 2005 (Ministry of Agriculture and Forestry 2005). It is based on a set of scenarios for future climatic and economic conditions in Finland. The objective of the Adaptation Strategy is to reinforce and increase the capacity of society to adapt to climate change. Adaptation may involve minimising the adverse impacts of climate change, or taking advantage of its benefits. While the National Energy and Climate Strategy focuses on mitigation measures to be taken in the near future, the scope of the Adaptation Strategy extends as far as 2080.

The starting point for the implementation of the Strategy is that the detailed evaluation of the impacts of climate change and the definition of adaptation measures are integrated into the operations of different sectors and institutions; their planning, implementation and follow-up.

There are differences in the preconditions of sectors for defining the impacts of climate change and the associated adaptation measures. Some sectors, such as agriculture and food industry, forestry, water resources, transport and communications, and power production are already in immediate connection with climate and weather factors today, and their operation is adapted according to these factors. Differences between sectors also exist in the time span of planning and implementation. Even though the sectors' preconditions for assessing the impacts and defining the adaptation measures are different, climate change will impose new challenges to the whole process of administration. All sectors will be required to assess and develop the facilities of the appropriate branch of administration, intensify the use of research information, as well as strengthen co-ordination and co-operation between different branches of administration (sector authorities, regional authorities and local authorities), institutions and actors.

The general means available to authorities include administrative methods and planning, normative (legislative) and economic-technical methods. The development of these means for the adaptation to climate change can be carried out as part of several different tools, including environmental management systems, environmental impact assessment and risk management systems.

Inclusion of the adaptation as part of the operation of administration requires research and development of methods. The challenges include the fact that climate change, its impacts and adaptation measures will take place over a very long time period, the impact relations are very complex and significant uncertainties are still involved.

The methods for adaptation, both those by the public sector and those by the private sector, were preliminarily defined in the National Strategy for Adaptation to Climate Change. The findings in some important sectors are presented in Tables 6–6. Both anticipatory and reactive methods are given if both of them are possible in the sector involved. In addition, the needs for research and information are outlined, as well as the possibilities and requirements of the private sector to participate in the adaptation work.

Table 6–6 Summary of possible definitions of policy for adaptation to climate change in some important sectors in Finland according to the National Strategy for Adaptation to Climate Change (2005). Preliminary estimates of the timing of policies are also given: *immediate: 2005–2010, **short-term: 2010–2030, ***long-term: 2030–2080.

Energy:

		Anticipatory
Public	**Administration and planning**	• Inclusion of adaptation to climate change in the long-term planning and strategies of the energy sector. Progress will be gradual as applicable information is accumulated
	Research and information	• Research and development targeted at adaptation will be added to continue and supplement the research on climate change mitigation
	Economic-technical definitions of policy	• More detailed examination of the need, quality, dimensioning and possible realisation times for concrete adaptation measures • Using suitable means of preparation for an increased need for repairs in some sectors
	Normative definitions of policy	• Surveying the potential need to change standards, etc., as necessary
Private		• Adaptation surveys specific to each branch of energy • Systematically introducing adaptation to climate change as part of long-term planning and strategies in branch organisations and large enterprises of different energy branches

Transport and communications:

		Anticipatory	Reactive
Public	Administration and planning	• Inclusion of climate change in the transport sector's long-term planning* • Securing the functionality of telecommunications networks (wired networks) **	
	Research and information	• Surveying of flood sensitive areas* • Anticipatory systems and warning systems for extreme phenomena** • Assessment of the ice situation in the Baltic Sea*	
	Economic-technical definitions of policy	• Maintenance of the structures (road body, ditches, bridges and culverts) and condition of road network, particularly on smaller roads and gravel roads while floods and rains increase and ground frost diminishes** • Maintenance of the structures (railway beds) and condition of railways while floods and rains increase and ground frost diminishes** • Minimising the environmental hazards caused by antiskid treatments (alternatives to salt, planning of groundwater protection)**	• Taking more difficult traffic conditions into account in planning and schedules • Repair of storm damage to overhead cables • Increase of winter traffic in the Baltic Sea • Antiskid treatment of roads and airports • Repair of storm damage to the road and rail networks
	Normative definitions of policy	• New planning norms and guidelines for road and railway construction**/***	• Guidelines and definition of tolerances for the duration of disturbances
Private		• Maintenance of the structures and condition of the private road network while floods and rains increase and ground frost diminishes**	• Taking more difficult traffic conditions into account in planning the schedules and timing • Salting and antiskid treatment of roads

Industry:

		Anticipatory
Public	**Administration and planning**	• Inclusion of adaptation to climate change in the long-term planning and strategies of the energy sector. Progress will be gradual as applicable information is accumulated
	Research and information	• Sector-specific surveys of the information and research needs of adaptation and their focusing • More detailed investigation of the economic effects of adaptation specific to sector
	Economic-technical definitions of policy	• Sector-specific detailed examination of the need, quality, dimensioning and possible realisation times for concrete adaptation measures • Systematic survey of industries located in flood-sensitive areas and consideration of the required adaptation methods as necessary
	Normative definitions of policy	• Surveying the potential need to change standards, etc., as necessary
Private		• Sector-specific surveys of adaptation needs • Systematically introducing adaptation to climate change as a part of long-term planning and strategies in the branch organisations and large enterprises of different sectors

Agriculture:

		Anticipatory	Reactive
Public	**Administration and planning**	• Observation of production methods adaptable to climate change, production structure and locations in subsidy policy*** • Development of animal disease monitoring systems** • Development of plant disease and pest monitoring systems*	
	Research and information	• Development of new technologies and cultivation methods and providing information on them** • Conceptualisation of climate change and its risks*	
	Economic-technical definitions of policy	• Integration of changed climatic conditions and plant protection requirements into plant improvement programmes*	• Minimising the disadvantages of the potentially increasing use of pesticides**
	Economic-technical definitions of policy	• Assessment of the revisions to water protection guidelines**	
Private		• Introduction of new cultivation methods, cultivated crops and technology**	• Extending the farm animal grazing period*** • Increasing the control of pests and diseases**

Land use and communities:

		Anticipatory	Reactive
Public	**Administration and planning**	• The evaluation of the impact of climate change will be included in the long-term planning of regional and urban structures • Town planning processes will be associated with a requirement to carry out additional investigations on adaptation to climate change in particularly vulnerable areas (flood risk areas, observation of the microclimate, terrain and soil, conduction of rainwater and surface waters, construction in shore areas, potential increase in windiness, protective city block areas, avoidance of hollows)	
	Research and information	• Flood-sensitive areas and structures will be surveyed • Anticipatory systems and warning systems for extreme phenomena will be developed • Regional and local impacts and means of adaptation will be investigated	
	Economic-technical definitions of policy		• The conduction of rain and surface waters will be improved
	Normative definitions of policy	• The need to amend the Land Use and Building Act and Decree and municipal building codes will be investigated • Recommendations will be issued at different levels of planning as necessary	
Private			• The conduction of rain and surface waters will be improved

Health:

		Anticipatory	Reactive
Public	**Administration and planning**	• Securing the capacity of healthcare to correspond to changing climatic conditions* • Cooperation between climate researchers and health and social care* • Potential supplementing of the guide for special circumstances provided by the Ministry of Social Affairs and Health with regard to hot periods • Energy policy must aim to secure the distribution of electricity or its adequacy	
	Research and information	• Information about the dangers of the changing climate, such as heat waves* • Studies related to special circumstances, following them and organising reporting related to them • Information on the dangers of algal blooms* • Information on the increased risk of infectious diseases*	• Studies related to special circumstances and organising reporting related to them
	Economic-technical definitions of policy	• Development of urban planning with regard to the control of the urban heat island phenomenon* • Preparedness planning must pay attention to backup systems for the distribution and production of electricity	• Ensuring air conditioning and sufficient ventilation in retirement homes and hospitals, for example, by quality recommendations*
Private			• Increased air conditioning***

Biodiversity:

<table>
<tr><th colspan="2"></th><th>Anticipatory</th></tr>
<tr><td rowspan="3">Public</td><td>Administration and planning</td><td>• Reducing the stress phenomena caused by humans on nature by the control of the use of land*
• Evaluation, development and monitoring the extent of the conservation area network*
• Maintaining traditional diverse habitats*
• Changes in policy regarding the care and use of conservation areas as necessary*
• Appreciation of valuable habitats in the care and use of forests*
• Preservation of valuable traditional biotopes with the help of environmental subsidies for agriculture*
• Including an evaluation of the effects of climate change in the ongoing planning and development projects for the promotion of diversity*
• Introduction of an information system for conservation areas*</td></tr>
<tr><td>Research and information</td><td>• Increasing cooperation between the different parts of administration, as well as information and guidance*
• Advice for forest owners and training for forest professionals*
• Improving the monitoring, planning and information systems for biological diversity*
• Evaluation of the possibilities for ex situ protection with regard to climate change*
• Studies of threatening factors caused by climate change at the ecosystem level and species level
• Carrying out habitat-level general follow ups and supplementary species-level follow ups</td></tr>
<tr><td>Economic-technical definitions of policy</td><td>• Control and prevention of the spread of new species*
• Restoration and care of valuable habitats*
• Prevention of the extinction of species through zoos and planting*
• Reconstructing and restoring wetlands and swamps*</td></tr>
<tr><td>Private</td><td></td><td>• Reducing the burden on the environment and the atmosphere
• Preservation of valuable traditional biotopes*
• Appreciation of valuable habitats in the care and use of forests*</td></tr>
</table>

Water resources:

		Anticipatory	Reactive
Public	Administration and planning	• Planning of water management* • Surveying of risk targets and preparation of general plans for risk targets* • Acquisition of temporary flood control structures* • Emergency preparedness planning* • Land use planning to reduce flood risks and especially to avoid construction in flood areas* • Taking rain-induced floods into account in zoning and urban planning* • Flood forecasts • Planning of trenching and stormwater management	• Operational flood prevention • Cooperation between authorities
	Research and information	• Surveying the quality requirements for water at cattle farms and dairy farms* • Improvement in the predictability of floods (heavy rains): weather forecasts, weather radar, follow-up of soil dampness and snow/satellites and observation • Studying the impacts of rain-induced floods* • Surveying the need for temporary flood protection structures, their acquisition and the responsibilities associated with use* • Information about flood dangers	• Information in flood and drought situations • Instructions from the authorities to reduce flood damage • Restrictions on water use
	Economic-technical definitions of policy	• Raising of flood banks • Construction of reserve water intake plants* • Interconnection of the networks of water management utility companies* • Investments in projects that improve preparation for special situations and regional cooperation* • Expansion of water supply and sewer networks* • Supporting the construction of irrigation systems for agriculture*	• Compensation for damage caused by exceptional flooding of water systems • Use of temporary flood protection structures • Use of reserve systems at water management utility companies, disinfection • Transportation of water, water pickup points, bottling of water • Purchasing water from another water management utility company • Distribution of lower-quality water
	Normative definitions of policy	• Changes to regulation permits	• Execution of building regulations • Changes to regulation permits
Private		• Taking out insurance* • Construction of buildings farther away from flood areas* • Construction of irrigation systems* • Joining the network of a water management utility company / choosing the location for a well and maintaining its condition	• Protection of buildings against flood • Economising with water, recycling water, introduction of lower-quality water • Increasing the discharge capacity of dams

Forestry:

		Anticipatory	Reactive
Public	**Administration and planning**	• Inclusion of climate change aspects in the National Forest Programme* • Revision of forest management recommendations to correspond to climate change** • Protection of gene pools of forest trees**	
	Research and information	• Development of forest management adapting to climate change and mitigating it* • Development of a system for anticipating and monitoring*	
	Economic-technical definitions of policy	• Development of harvesting* • Tree improvement* • Control of pests and diseases*** • Maintenance of forest roads*	• Rapid repair of wind damage in order to prevent consequential damage** • Selection of the origin of artificial regeneration material**
	Normative definitions of policy	• Assessment of the needs for change in forest legislation in changing climatic conditions**/*** • Potential bans on wood imports from areas most badly contaminated by pests***	
Private		• Preparation of forest plans on the basis of new management recommendations**/***	• Rapid repair of wind damage in order to prevent consequential damage**

Table 6–7 Preliminary estimates of how global climate impacts will reflect on different sectors in Finland (Finland's National Strategy for Adaptation to Climate Change, 2005).

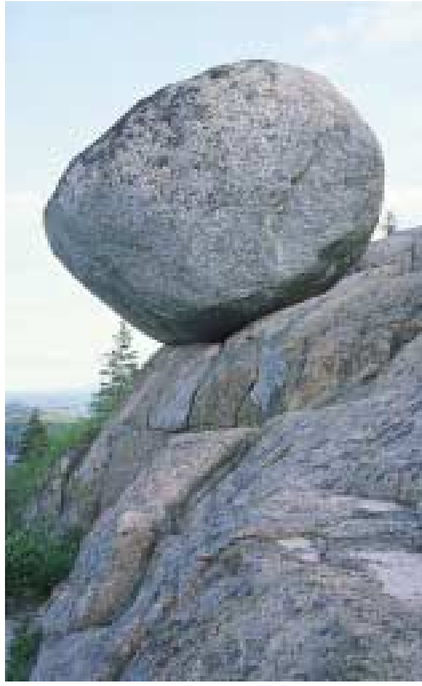
Sector	Connections
Agriculture and food production	• Uncertainty on the preservation of the level of production in present major production areas • Increased demand for Finnish food products • Uncertainty of the food supply of developing countries in changing climatic conditions
Forestry	• Diminishing of the world's forest reserves and its impacts on Finland's forest sector • Increase in forest reserves in the boreal belt and its impacts on Finland's forest secto
Water resources	• Exhaustion of water resources in different areas of the globe; effects on the opportunities of water exports from Finland, etc. • Increased risk of conflicts between countries in dry areas that are trying to utilise the same water resources, and the effects in Finland
Tourism	• Regional climate effects in the Mediterranean and the Alps, for example, may affect tourists' preferences in ways which will be reflected in Finnish tourism
Transport and communications	• Potential changes in the ice conditions of the North-East Passage will be reflected in Finland's sea traffic
Energy	• Rains in Norway and Sweden; possibility of electricity imports
Insurance	• Reinsurance

6.3.2 Global effects on adaptation in Finland

The need of the different sectors to adapt to changes taking place elsewhere is based on diverse connections. Agriculture, which is sensitive to climate, will probably be strongly regulated by the EU's agricultural policy in future. Tourism, however, is an industry in which the effects of climate change can be seen direct in the preferences and choices of consumers. The effects can be general or be reflected from one sector to another. For example, conflicts possibly developing in areas suffering from water shortage may be reflected in Finland as global security issues. Finland's Security and Defence Policy (2004) also discusses the issues pertaining to environmental security and states that further efforts will be taken to predict the impacts of climate change and to adapt to these impacts.

Only preliminary estimates can be presented for Finland's need to adapt to changes taking place in other parts of the globe (Table 6–7). The information will become focused with the progress of impact research, and adaptation issues will also receive attention in surveys.

6.4 Vulnerability assessment



Experiences from the application of risk analyses concerning the impacts of climate change are few in Finland for the time being. Methods and instructions have not been developed for the inclusion of the risks and uncertainties related to the adaptation into decision-making. Such instructions would enable different decision-makers to evaluate the risks of climate change in relation to other future risks.

The risks of the impacts of climate change can already be included in the risk assessments of industries, organisations and companies. However, implementation of the adaptation strategy requires that risk assessment methods applicable to the impacts of climate change must be developed and applied further. Moreover, assessments that co-ordinate different risks, such as climate, environment, economy, health and insurance operations, will be needed. These will require precise information about the expected impacts and uncertainties of climate change.

Weather observations create a foundation for planning several functions of society, assessing risks caused by weather and climate, and setting standards, such as safety standards applicable to construction. Statistical analysis of the occurrence rates of extreme values is one of the crucial tasks. For example, it can be estimated that rainfalls similar to those that correspond to the three-day rain accumulations that caused the flooding of the River Vantaa in the summer of 2004 will be repeated at one or more Finnish measurement stations at intervals of about three years. If, however, an individual rain station is examined, a similar rainfall will only be repeated after several centuries. What was exceptional with the heavy rains in summer 2004 was their extent: abundant rains reaching such a wide area occur in Finland less frequently than once every 15 years.

The Finnish Meteorological Institute's weather service system is responsible for issuing warnings associated with extreme weather phenomena. The Institute's climate service is responsible for other reporting related to climatically exceptional weather situations and it compiles statistical data on monthly temperature and rain conditions, for example.

The essential tasks of the Finnish Meteorological Institute's weather service include the production of weather and air quality forecasts, calculations and warnings related to weather, as well as informing interested parties about them. The Communications Market Act and the decree that entered into force on 15 October 2003 oblige the Finnish Meteorological Institute to provide warnings with an emergency notice or other official notice in case of a danger or threat to industry. The European Union regulates the supervision and reporting of air quality through directives.

In the aftermath of the December 2004 tsunami in Southeast Asia, a decision was made to establish a special unit which will launch warnings for the Finns in case of weather-related or other hazards abroad. The work of the unit is based on co-operation between the Finnish Meteorological Institute, the Finnish Institute for Marine Research and the Institute of Seismology of the University of Helsinki.

Case studies could be used to improve the readiness of many sectors to face the ongoing climate change. For example, precise meteorological and hydrological observation data exist on the 2004 flooding of the River Vantaa. Plenty of recent and documented information also exists on the effects of floods on different sectors of society. This means that researchers of climate change impacts are provided with a favourable research frame for testing the functionality of impact models and simultaneously evaluating the effects of various adaptation measures.

The National Strategy for Adaptation to Climate Change describes the scenarios of climate change, socio-economic development and natural systems. The impacts of climate change and adaptation to it have been assessed on the basis of existing information up until the year 2080. The estimates still include uncertainties. Some of the definitions of policies that have been presented in the strategy are still preliminary or they will be scheduled over a long time period. The most immediate measures, such as research, communications, revision of preparation and risk assessment systems, preparation for extreme weather phenomena and the inclusion of adaptation aspects in sector-specific planning and international co-operation are "win-win" measures. These have positive effects on the development of sectors and on sustainable development.

The sector-specific examinations of the adaptation strategy describe the characteristics and objectives of the sectors, including environmental objectives. The effects of climate change have been assessed from the point of view of the developmental and environmental aspects of each sector. The presented definitions of policies are in line with objectives and measures aimed at improving the state of the environment.

The positive or negative effects of climate change concern different groups of citizens. Based on present knowledge, the nature of northern Finland and its inhabitants will be particularly sensitive to the effects of climate change. Initiation of the adaptation strategy measures will allow more detailed determination of how the impacts of climate change concern different groups and what kind of adaptation measures can be used to promote equal social development. However, this will require the development of research and assessment methods.

Of all the risks involved in climate change in Finland, those caused by detrimental changes elsewhere in the world may, however, be the most serious ones. Soaring food prices, malnutrition and other health hazards could require immense international efforts with high costs to all wealthy economies.

LITERATURE

Carter, T., Fronzek, S. and Bärlund, I. 2004. FINSKEN: a framework for developing consistent global change scenarios for Finland in the 21st century. *Boreal Env. Res. 9:91-107.*

Finland's Security and Defence Policy. 2004. The Government's Report to the Parliament. Publications of the Prime Minister's Office 16/2004, 170 p.

Forsius, J., Kuivalainen P. and Mäkinen, P., 1996. Effects of climate change on the production and consumption of electricity in Finland. In: *SILMU (1996) The Finnish Research Programme on Climate Change. Final Report, (ed. by J. Roos), Edita. Helsinki, 484–491.*

Haapala, J., Meier, H. and Rinne, J. 2002. Numerical Investigations of Future Ice Conditions in the Baltic Sea. *AMBIO: A Journal of the Human Environment: Vol. 30, No. 4, pp. 237–244.*

ILMAVA Project. 2002. [Effect of Climate Change on Energy Resources in Finland. Final report on the Ilmava Project within the Climtech Programme] (In Finnish). Tammelin, B., Forsius, J., Jylhä, J., Järvinen, P., Koskela, J., Tuomenvirta, H., Turunen, M. A., Vehviläinen, B., Venäläinen, A. *Finnish Meteorological Institute, Helsinki.*

Johansson, M., Kahma, K., Boman, H. and Launiainen, J. 2004: Scenarios for sea level on the Finnish coast. *Boreal Env. Res. 9: 153–166.*

Jylhä, K., Tuomenvirta, H. and Ruosteenoja, K. 2004. Climate change projections for Finland during the 21st century. *Boreal Env. Res. 9:127–152.*

Kankaala P., Ojala A., Tulonen T., Haapamäki J. and Arvola L. 2000. Response of littoral vegetation on climate warming in the boreal zone; an experimental simulation. *Aquatic Ecology 34(4), pp. 433–444.*

Kaivo-oja, J., Luukkanen, J. and Wilenius, M. 2004: Defining alternative national-scale socio-economic and technological futures up to 2100: SRES scenarios for the case of Finland. *Boreal Env. Res. 9: 109–125.*

Martikainen, P., Regina, K, Syväsalo, E., Laurila, T., Lohila, A., Aurela, M., Silvola, J., Kettunen, R., Saarnio, S., Koponen, H., Jaakkola, T., Pärnä, A., Silvennoinen, H., Lehtonen, H., Peltola, J., Sinkkonen, M and Esala, M. 2002. Agricultural soils as a sink and source of greenhouse gases: A research consortium (AGROGAS). In 'Understanding the global system, The Finnish perspective'. FIGARE Report, ed. by J. Käyhkö and L. Talve, Turku.

Ministry of Agriculture and Forestry. 2005. Finland's National Strategy for Adaptation to Climate Change. 2005, Helsinki, 276 p.

Saarikko, Riitta. 1999. Climate change and crop potential in Finland: regional assessment of spring wheat. University of Helsinki, Dept. of Plant Production, Publ. no. 55.

Saarnio, S. et al. 2000. Response of *Sphagnum* mosses to increased CO_2 concentration and NH_4 NO_3 availability. Proceedings of the 11th International Peat Congress, Québec City, Canada, p. 1059.

Sælthun, N.R., Aittoniemi, A., Bergström, S., Einarsson, K., Jóhannesson, T., Lindström, G., Ohlsson, P.E., Thomsen, T., Vehviläinen, B. and Aamodt, K.O. 1998. Climate change impacts on runoff and hydropower production in the Nordic countries, *TemaNord 1998:552*, Nordic Council of Ministers, Copenhagen.

Tuomenvirta, H., Uusitalo, K., Vehviläinen, B. and Carter, T. 2000. Climate change, design precipitation and dam safety: estimate of changes in precipitation, its extremes and temperature in Finland up to 2100. *Reports of the Finnish Meteorological Institute 4/2000, 65 p.*

Tuomenvirta, H. 2004. Reliable estimation of climatic variations in *Finland. Finnish Meteorological Institute, Contributions 43*, 82 p.

Vehviläinen, B. 2001. Floods – research and management in Finland. A paper presented at a Nordic Seminar, Sundvolden, Norway, 24–25 April 2001, 15 p.



7 Financial resources and transfer of technology

7.1 Objectives of Finnish development co-operation

The general objectives of Finnish development co-operation are formulated in the Government Resolution on Development Policy, which was published adopted in 2004. The main target will be poverty reduction with the main emphasis on the least developed countries (LDC) in general and especially on long-term partner countries (Tanzania, Ethiopia, Mozambique, Kenya, Zambia, Nepal, Vietnam and Nicaragua).

The mitigation of environmental threats is also one of the main goals of Finland's development policy. Finland supports a wide range of projects and programmes which aim at combating global threats by preventing environmental degradation, and by giving assistance for sustainable use of natural resources. Finland also supports the inclusion of principles of environmentally sustainable development in the poverty reduction starategies of its partner countries.

By promoting the implementation of multilateral environmental environmental agreements in its development co-operation, Finland seeks to safeguard the state of the global environment. The most important agreements supported in the co-operation are the United Nations Framework Convention on Climate Change (UNFCCC), UN Convention on Biological dDiversity (UNCBD), UN Convention to Combat Desertification (UNCCD) and the activities of the UN Forum on Forests (UNFF). At the same time the Finnish development work embraces the promotion of social equality, democracy and human rights. Finland includes consideration for the environment as a cross-cutting theme in all its development co-operation. In the year 2004 Finland focused its financial development contributions in target countries from project-based funding to more programme-based funding via both bilateral and multilateral channels.

The official overseas development aid of Finland was 0.65% of the GNP in the year 1990, and 0.80% in 1991. It decreased dramatically due to the recession in 1993–1994 and has not recovered; in 2003 it was 0.35%.

7.2 Provision of financial resources through multilateral agencies

For the prevention and mitigation of global environmental problems in developing countries, Finland has contributed additional resources to the GEF in the past few years raising its total funding in the year 2004 to EUR 8.0 million. In 2003, the funding was EUR 7.4 million, in 2002 it was EUR 3.4 million.

Approximately 77% of the Finnish financial contribution to the GEF is counted as ODA. The GEF divides the funds differently by international environmental agreement: 40% of the funds are focused equally on UNFCCC and UNCBD projects, 10% are given to projects under the Montreal Protocol and the remaining approximately 10% are shared by the rest of international environmental agreements.

Finland has actively participated in the UN Conference on Environment and Development (UNCED) process and supported the implementation of Agenda 21 through e.g. the World Bank (Table 7–1).

Finland has also supported the Trust Fund for Environmentally and Socially Sustainable Development (TFESSD) in 2003 with EUR 1.3 million, from which 16% can be counted under UNFCCC in that year (EUR 0.21 million).

Finnish support to UNFCCC has been thematic in nature and listed under bilateral aid. This aid also comprises supporting developing countries' costs for official participation in UNFCCC meetings with EUR 265,000 in 2001–2003.

Table 7–1 Financial contributions to other multilateral institutions (ODA). Only part of the contribution is climate change related.

Disbursements	Contributions (millions of euros)			
	2000	**2001**	**2002**	**2003**
Multilateral institutions				
1. World Bank/IDA	14.9	34.2	33.1	31.4
2. African Development Bank and Fund	13.9	3.7	16.9	*
3. Asian Development Bank and Fund	3.7	–	7.1	5.3
4. Inter-American Development Bank	1.6	0.1	0.1	0.1
5. United Nations Development Programme	13.0	13.5	13.1	13.5
6. United Nations Environment Programme	2.9	2.9	2.9	2.9
7. UNFCCC**	–	–	0.5	–
8. Other of which				
– European Development Fund	5.3	–	3.0	32.6
– European Community	49.5	61.6	64.2	63.1
– Nordic Development Fund	4.7	4.7	9.6	9.0
– Montreal Protocol	1.1	1.1	1.1	1.1
– CGIAR	1.3	1.3	1.3	1.3
– WIDER	0.2	0.3	0.3	0.3
Total	**112.1**	**118.4**	**145.1**	**160.6**

* Contribution to the Asian Development Bank and Fund in 2003 was paid in 2002.
** Finnish support by multilateral channels to UNFCCC includes LDCF.

Table 7–2 **Total bilateral and multilateral ODA under UNFCCC in 2001–2003 (EUR million; PCF and CDM/JI not included).**

	2001	2002	2003
(UNFCCC relevant) bilateral	5.0	6.6	4.8
(UNFCCC relevant) multilateral	0.6	0.9	0.8
(UNFCCC focal area) GEF	0.8	1.0	2.3
UNFCCC new funds (LDCF)	–	0.5	–
Total	**6.4**	**9.0**	**7.9**

During the reporting period the contribution under the UNFCCC thematic funding has been increasing over the past few years (Table 7–2).

In a joint Political Declaration (Bonn 2001), Finland together with the EU and five other donor countries committed to providing as climate change funding for developing countries the sum of USD 410 million per year as of 2005. Finland's contribution to the commitment is USD 6.4 million per year.

7.3 Bilateral assistance to developing countries

Finland's development co-operation aims to prevent environmental problems in developing countries by, for example, supporting development of environmental legislation and management, transfer of technology aimed at environmental protection, sustainable use of natural resources and equitable division of the benefits obtainable from these resources. Finland also supports a wide range of programmes that target ecologically sustainable ways of making a living from the land, environmental research, training and education, and opportunities for citizens to participate in and prepare for the growing environmental requirements in trading.

In 2001–2003, Finland had altogether 13 projects directly under climate change related assistance. The contributions vary between regions and programmes (Table 7–3). Most of Finland's main target countries for development co-operation are in Africa, which can be seen in the financing of projects and programmes for climate change related issues.

Table 7–3 **Regional contributions of Finnish ODA related to the implementation of climate related bilateral projects and programmes in 2001–2003 (EUR million).**

	2001	2002	2003
Africa	2.56	2.81	1.93
Asia	1.71	1.17	0.86
Central America	0.29	1.83	1.44
South America	0.06	0.35	0.05
Middle-East	0.02	–	–
Research funding (unspecified area)	0.20	0.40	0.24
Other funding	0.15	0.77	0.24
Total (bilateral, UNFCCC focal area)	**4.99**	**6.64**	**4.77**

Figure 7–1 Structure of Finnish climate-related bilateral aid in 2001–2005.

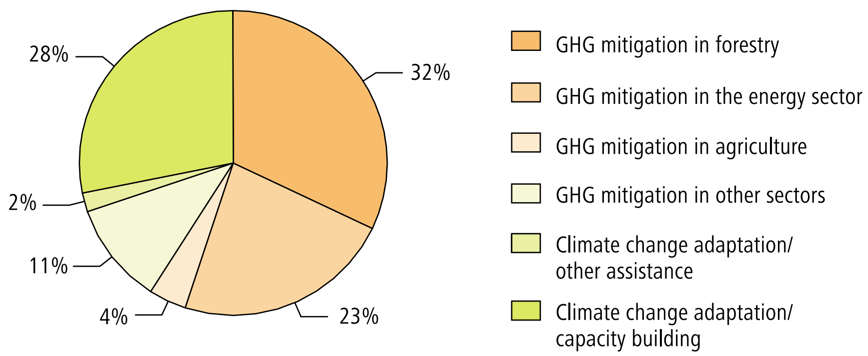


Figure 7–1 shows that mitigation-related projects in forestry account for the largest part of the aid. Support to projects relating to energy and climate change adaptation is also substantial.

In the support for adaptation capacities, the most important lines of action have been capacity building and vulnerability assessments in partner countries. Other funding channels in the Finnish ODA system are the above-mentioned multilateral funding as well as funding through NGOs.

7.3.1 Forestry co-operation

Forestry co-operation forms a significant part of Finnish development aid. Finland has supported sustainable forest management in various countries by developing the partner country's own national forest plans, sector policies and development strategies for forestry.

Community forestry is an important part in the promotion of sustainable forest management and has been assisted during the reporting period in Malawi, Mozambique, Namibia, Tanzania, Zambia, Guatemala, Honduras, Nicaragua, Vietnam and Laos. Community involvement in forest management is particularly important in the current conditions, where increasing numbers of government organisations, including forest administration, are facing budgetary restrictions and budgetary downsizing.

Community-based forest fire management is perhaps the most innovative part of Finnish ODA activities in relation to the mitigation the UNFCCC objectives. During the reporting period a programme for the control and management of forest and bush fires at the organisational and administrative levels has been supported in Namibia, Mozambique and Burkina Faso. The programmes have concentrated on the involvement of rural populations in the management of fire and on building the capacity of national forestry organisations to promote such activities.

7.3.2 Energy sector co-operation

Energy-related pollution is increasing rapidly in many parts of the developing world, and its prevention is becoming an important factor in Finnish development co-operation. In the long term it is important to introduce renewable energy resources gradually. Finland's involvement in this field has been directed to the use of biomass via enhancement of wood fuel production through sustainable forest management and community participation projects in e.g. Malawi, Tanzania, Zambia, Namibia and Mozambique. Finland has also supported solar and wind energy projects in Bolivia, Senegal and Afghanistan.

A partnership initiative in energy and environmental co-operation with Central American countries was announced by Finland at the Johannesburg World Summit on Sustainable Development (WSSD). Partnership initiatives are a new form of development co-operation. The idea is to seek financing from both the public and private sectors. The countries involved in the energy sector partnership initiative between Finland and Central America are Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama. The project promotes the use of renewable energy sources and clean technology in the partner countries. It comprises experimental activity in the wind, solar, small hydro-electric and bio-energy sectors, surveys and feasibility studies of energy resources, utilisation of the Kyoto Protocol's clean development mechanism, development of energy markets and financing models, and technology transfer and training. The aim is to slow down the climate change and to improve the availability of energy services to the most impoverished people in these partner countries. Finland finances this three-year project to the tune of EUR 3 million.

In China, Finland has also participated in district heating projects in urban areas by giving concessional credits for minimising emissions related to heat production. A concessional credit scheme has also been utilised to finance solar PV systems in remote areas in Vietnam.

7.3.3 Other climate change related co-operation

Finland has been participating in the protection of marine coastal areas in the Mediterranean area and in Africa, which are also counted as actions under the UNFCCC. A flood control project in the Yellow River in China is one of the preventative measures to mitigate factors related to the rising of the water level caused by the climate change.

In Nicaragua, Finland has been involved in budgetary support to the environmental sector for the decentralisation of the environmental administration and to reverse the degradation process of the Nicaraguan environment. In Africa, Finland has supported the IPALAC (International Program for Arid Land Crops), which improves the utilisation and research concerning crops and trees in arid and semi-arid areas.

7.4 Activities related to transfer of technology

Finland has specific programmes and financial arrangements for transferring environmentally sound technology to developing countries. A few examples of Finnish bilateral projects and programmes that are related to the transfer of technology are presented in Table 7–4.

Table 7–4 Description of selected projects or programmes that promoted practicable steps to facilitate and/or finance the transfer of, or access to, environmentally sound technologies.

Project / programme title:
Support to the meteorological services in Mozambique

Purpose:
Improved meteorological services in Mozambique

Recipient country	Sector	Total funding	Years in operation
Mozambique	Climate change / capacity building	€3,500,000	2002–2005

Description:
The flood catastrophe in Mozambique at the beginning of 2000 caused extensive damage to the country's meteorological services and infrastructure. Finland supported Mozambique's meteorological institute (INAM) in immediate flood reconstruction in the years 2000–2001 (Phase I). Finnish development support to rebuild the meteorological service facilities will benefit the early warning system for weather catastrophes in the whole southern African region.

Together with the EU, Finland started a collaboration partnership to support and develop the weather service system of Mozambique (Phase II) in 2002–2005. The total funding for this will be EUR 3.5 million. The project is being carried out by the weather service company Foreca Ltd and the development consulting group Scanagri. The aim is to carry out the project so that the local scientists, meteorologists and maintenance people can run the completed meteorological system after the project is finished.

Indicate factors which led to project's success:
Long-term plan for development aid and multi-donor community funding that lead to more efficient project planning and use of funds, training and local maintenance of the meteorological system.

Technology transferred:
Rebuilding and strengthening the meteorological observation system and improving telecommunication connections. Foreca Ltd trains local people to maintain the system. Meteorological radar was funded through the programme.

Impact on greenhouse gas emissions / sinks (optional):

Project / programme title:
Tanzania national forest programme implementation support project, Phase II, 2004–2005

Purpose:
National Forest Programme Implementation Support Project (NFP-ISP) Preparatory phase

Recipient country	Sector	Total funding	Years in operation
Tanzania	Forestry / mitigation	€365,000	2004–2005

Description:
A new forest policy, National Forest Programme (NFP), was approved by the Tanzanian cabinet in 1998. This two-year programme aims to ensure sustainable implementation of the policy in the forest sector. The implementing agency is the NFP Co-ordination Unit functioning under the Forestry and Beekeeping Division. The programme will continue afterwards as a SWAP (Sector Wide Approach) which aims for sectoral support in the forest sector in the development co-operation between Finland and Tanzania.

Indicate factors which led to project's success:
Long-term co-operation with the partner country in the forestry sector. Strong commitment by Finland in previous years forms a good basis for the implementation of the sustainable forestry.

Technology transferred:

Impact on greenhouse gas emissions / sinks (optional):

Project / programme title:
Development of the meteorological systems in the Caribbean Region

Purpose:
To promote sustainable economic development and to improve planning and operational decisions in all weather-related socio-economic sectors by providing advanced meteorological services.

Recipient country	Sector	Total funding	Years in operation
Caribbean region	Climate change adaptation / capacity building	€3,100,000	2001–2005

Description:
The SIDS Caribbean project strengthened the meteorological infrastructure in the Caribbean region. Guidelines for the development in the area were already set in the UN Global Conference in 1994 (Declaration of Barbados). The implementing parties to this project were the World Meteorological Organization and the Finnish Meteorological Institute. The objectives of this project in the Caribbean region was especially to improve the meteorological and hydrological services to give high-quality and adequate amounts of informational services for the public and authorities according to international standards and practices.

Special attention was given to the following areas:
- Improvement of communication systems (regional weather services and weather station services)
- Improvement of the meteorological station network (automatic weather services)
- Standardisation of the database and improvement of the sustainability of the regional network
- WMO training of local employees

Indicate factors which led to project's success:
Regional approach enabling all the Small Island Developing States in the Caribbean area to participate.

Technology transferred:
Telecommunications systems and equipment, observation network, regional calibration laboratory, database management system, data rescue equipment.

Impact on greenhouse gas emissions / sinks (optional):

Project / programme title:
Energy and environment partnership with Central America

Purpose:
To promote the use of renewable energy sources and sustainable development

Recipient country	Sector	Total funding	Years in operation
Central American countries	Energy / mitigation	€3,000,000	2003–2006

Description:
The partnership was launched at the Johannesburg Summit for Sustainable Development to promote the use of renewable energy sources and clean technologies in the Central American region, to combat climate change and to make energy services more accessible to the poor. The partnership goals are in conformity with the EU Energy Initiative, which is a new type of partnership model for multi-donor development co-operation to support sustainable development through utilisation of renewable energy resources. The public and private sectors participate in this programme which has increased the co-financing interest of international banks and funding institutions for the programme.

Altogether over 30 Finnish private sector representatives, universities, research institutes and donors participate in this programme. Approximately the same number of partners from Central America participate in this programme. Ministries of the Environment or Energy in the Central American region act as national focal points. The growing interest of international funding agencies as well as the EU and its member states clearly indicate the importance of this programme and its achievements.

Indicate factors which led to project's success:
Wide ranging participation of private sector, universities, donors and research institutes in the programme. A partnership regional co-ordination office is located in San Salvador in the building of Central American integration organisation (SG-SICA). Capacity building and training (including CDM), developing financing models, energy market development and energy resource surveys and studies are included in the programme.

Technology transferred:
Demonstration projects, such as installation of a solar system for the vaccination programme (PAI) in Honduras, a photovoltaic system for two Kuna communities in Panama (Fig. 7–2), solar electrification in Guatemala and a solar pumping system in El Salvador; use of sawdust, coffee residues and sugar cane bagasse as biomass suitable for energy co-generation in Belize, Costa Rica, El Salvador and Nicaragua; ecological stoves endowment in Honduras and Guatemala; feasibility studies and equipment for small hydroelectric power plants in Guatemala, El Salvador and Nicaragua.
Central American Carbon Finance Guide was published in 2004.

Impact on greenhouse gas emissions / sinks (optional):

Figure 7–2
An example of the photovoltaic systems installed in the Kuna Indian community of Ustupu in Panama. The community has a population of 4,000.
(Photo: Markku Nurmi)

Project / programme title:
Environmental support project in Nicaragua

Purpose:
Decentralisation of environmental administration (MARENA)

Recipient country	Sector	Total funding	Years in operation
Nicaragua	Climate change adaptation / Capacity building	€2,900,000	2004–2006

Description:
Institutional support from Finland and Denmark to Nicaragua for the decentralisation of environmental administration of the Ministry for the Environment and Natural Resources (MARENA). MARENA will lead the decentralised environmental administration and prioritise its field of work, and develope further donor co-ordination and accountability for future development of environmental administration, healthy environment, sustainable development and laws and strategies for the environmental sector.

The objectives of MARENA are to regulate, co-ordinate and promote sustainable management of natural resources and the environment by developing policies, strategies, laws and other environmental management instruments which lead to a healthy environment for the population and contribute to sustainable development. Part of this capacity building will also be aimed at supporting climate change-related issues.

Indicate factors which led to project's success:
Harmonisation of the Danish and Finnish assistance in this development programme, and strong and shared commitment of authorities in Finland, Denmark and Nicaragua based on the benefits of joint programming.

Technology transferred:

Impact on greenhouse gas emissions / sinks (optional):

Project / programme title:
The Egyptian Pollution Abatement Project (EPAP)

Purpose:
Curbing of industrial pollution

Recipient country	**Sector**	**Total funding**	**Years in operation**
Egypt	Environmental protection / capacity building	€5,300,000	1997–2004

Description:
The project aimed at setting up adequate mechanisms and resources to curb industrial pollution. The best use of the available World Bank and European Investment Bank pollution abatement investment funds were also sought. The project incorporated sub-components for industrial environmental auditing, industrial pollution abatement action plans, development of regional government organisations, awareness raising, NGO and media support, development of banking procedures and development of an environmental database.

Indicate factors which led to project's success:
Strengthening of administrative organisations and their procedures, elaboration of general and sector-specific inspection and self-monitoring manuals and mobilisation were possible via broad participation of different stakeholders, including environmental NGOs. Successful promotion of public awareness of industrial environmental issues through media and information campaigns, and development of pollution abatement information databases.

Technology transferred:

Impact on greenhouse gas emissions/sinks (optional):

7.5 Neighbouring regions

Finland has promoted and supported joint environmental programmes in its neighbouring regions since 1991. The focal areas have been the southern neighbours – Estonia, Latvia and Lithuania – and north-western Russia, particularly the St. Petersburg region, the Republic of Karelia and the Murmansk Region. In the 1991–2004 period, the Ministry of the Environment channelled EUR 144 million into environmental co-operation in the neighbouring areas. Out of this amount, EUR 103 million were used for investment projects and EUR 41 million for technical assistance projects.

During 2001–2004, the Ministry's total support was EUR 35 million, of which EUR 21.5 million were used for investment projects and EUR 13.5 million for technical assistance.

The primary aim of the co-operation has been to prevent transboundary air and water pollution. Relative to the costs involved, co-operation with the neighbouring regions is a very efficient way of protecting the Finnish environment.

The strategic objectives of the environmental co-operation have been as follows:

- Reduction and prevention of harmful transboundary pollutants entering Finland from neighbouring countries
- Promotion of nature protection, biodiversity and sustainable values of nature
- Promotion of sustainable development in regional planning, housing and building
- Promotion of implementation of the EU's environment acquis in the Baltic states
- Promotion of joint implementation projects under the UNFCCC.

Finland's new Strategy for Co-operation in the Neighbouring Areas was adopted in 2004. Most funds were reserved for the environment, economy, nuclear and radiation safety, social welfare and health care, and strengthening of the civil society. In the neighbouring areas in Russia, the co-operation aims to promote regional stability, support balanced economic and societal developments, develop the rule of law, and reform administration and legislation. Furthermore, the co-operation is intended to reduce environmental and nuclear safety risks, promote security, and improve social welfare and health care. The next Strategy for Co-operation in the Finnish Neighbouring Areas will be adopted in 2006.

As part of the co-operation in the neighbouring areas, multilateral financing is directed to projects especially through the World Bank Group, the European Bank for Reconstruction and Development (EBRD), the Nordic Investment Bank (NIB), the Nordic Environmental Financing Corporation (NEFCO), NDEP Support Fund (Northern Dimension Environmental Partnership) and within the framework of the credit mandate of the European Investment Bank (EIB). Channelling of support to projects via the financing institutions is possible also in other areas in Russia whenever it is appropriate for political or economic reasons. It is important to exercise influence through the administrative bodies of the relevant financing institutions to make sure that the institutions are active in areas and sectors that are significant from Finland's point of view, such as the environmental sector.

In future, co-operation in the neighbouring areas will generally be pursued in the form of programmes. This approach is based on multi-annual plans prepared by various ministries, and is designed to result in broad-based formulation of plans of action. Concrete projects will be implemented mainly within the framework of these programmes in order to avoid multiplication of separate projects and to create effective entities. Programmes that span several years facilitate project planning and assessment of financing needs. A sense of continuity helps the partners commit themselves to the projects and contributes to the developmental impact of the activity. Priority is given to projects that accumulate and produce results that the partners can "reproduce" and "export" beyond the neighbouring areas.

The Baltic states' accession to the European Union in May 2004 transformed the Finnish-Baltic co-operation into normal co-operation between EU member states. However, all projects based on earlier commitments will be completed. In addition, support for technical assistance projects may still continue for at least a few years. Furthermore, support for some exceptional investment projects related to cross-border risks (e.g. oil combating) or jointly financed projects in Russia might be considered.

Some common interests were indicated in discussions between Finnish and Baltic environmental authorities:

- The Baltic Sea and the Gulf of Finland, including oil transport
- Environmental co-operation between the EU and Russia, the Northern Dimension
- Implementation of the EU's environmental legislation
- Utilisation of the EU's financing instruments, including the cohesion and structural funds, Interreg, LIFE, agricultural funds
- Development of the EU's internal strategies and environmental programmes, including the 6th environmental action programme, the strategy for sustainable development, and the EU's research programmes
- Promoting multilateral issues of mutual interest.

The Finnish Ministry of the Environment has three main targets for its future co-operation with the Baltic countries: 1) development of favourable conditions for investments in order to reduce discharges to water, air emissions and waste generation, and to enhance maritime safety; 2) institutional strengthening and co-operation between authorities; and 3) sustainable development in different sectors of society.

The situation and development in the new neighbouring countries of the European Union, especially Ukraine and Belarus, also reflect on Finland's adjacent areas. Our new strategy also includes co-operation with these countries, in projects evaluated case by case.

7.6 Use of CDM/JI mechanisms

The use of the CDM/JI mechanisms was excluded from Finland's National Climate Strategy due to the uncertainties concerning the rules at the time when the Strategy was adopted in Summer 2001. Already in June 1997, the Ministry of Trade and Industry had, however, appointed a Working Group on Kyoto Mechanisms to examine the possibilities, criteria and preconditions for the use of the mechanisms from Finland's point of view. In its report, published in March 1999, the working group concluded that sig-

Table 7–5 CDM and JI projects included in the Finnish pilot programme.

6 CDM project ideas (changes are likely)	Status (March 2005)
5 MW biomass energy, El Salvador	Draft PDD* completed
Biogas recovery and utilisation (1.2 MW), Costa Rica	Draft PDD completed
9 MW mini hydro project, India	Validation ongoing
2.2 MW bundle of small biomass gasifier plants, India	Validation ongoing
4 small hydro projects, 9 MW, Honduras	One project in operation and registered as a CDM project (Rio Blanco), validation ongoing for three projects
2 MW mini hydro project, Zambia	Draft PDD completed
4 JI projects	
2.5 MW biomass project, Tamsalu, Estonia	In operation
2.5 MW biomass project, Kadrina, Estonia	In operation
8 MW biomass project, Paide, Estonia	In operation
18.4 MW wind farm, Pakri, Estonia	In operation

*PDD = Project Design Document

nificant potential for GHG emission reductions exists in economies in transition and in developing countries. The working group recommended that Finland should be prepared for the rapid adoption of the mechanisms by setting up a special pilot programme.

The Finnish CDM/JI Pilot Programme was launched in 1999 in order to develop Finland's capacity to apply the project-based mechanisms. The Pilot Programme operates under the Ministry for Foreign Affairs and is supervised by an inter-ministerial Steering Committee. The Finnish Environment Institute (SYKE) has been acting as a consultant to the Programme since autumn 2000.

The Pilot Programme has four main objectives:

- To gather experiences on Joint Implementation (JI) and Clean Development Mechanism (CDM)
- To implement pilot projects and develop a diversified project portfolio
- To purchase cost-effective greenhouse gas emission reductions on behalf of Finland, resulting from eligible and feasible CDM and JI pilot projects
- To build administrative capacity and develop national guidelines and procedures for the selection and implementation of CDM and JI projects.

The activities during the pilot phase are divided into three parts: (i) bilateral CDM and JI project activities (approximately EUR 9 million), (ii) investment in the Prototype Carbon Fund, PCF, of the Word Bank (USD 10 million) and (iii) investment in the Baltic Sea Region Energy Co-operation Testing Ground Facility, TGF, (EUR 1.75 million). The TGF will purchase emission reductions from JI projects in the Baltic Sea Region. Investors will receive a pro rata share of the emission reductions generated by the projects both from PCF and TGF.

The Ministry of the Environment of Finland has signed Memoranda of Understanding (MoU) regarding JI co-operation with Estonia, Latvia, Lithuania, Poland, Hungary and Ukraine. Finland and Estonia have also signed a framework agreement on JI co-operation. Concerning CDM co-operation, the Ministry for Foreign Affairs of Finland has signed MoUs with El Salvador, Costa Rica and Nicaragua. CDM co-operation is also included in the general environmental MoU signed with China.

The Pilot Programme has received over 130 CDM and JI bilateral project proposals. CDM project ideas were mainly identified through an international small-scale CDM Tender in spring 2003. Currently, the Pilot Programme has six bilateral CDM project ideas and four JI projects ongoing at different stages. All the projects are small. The expected total amounts of delivered emission reductions vary between 10–500 Gg CO_2 eq. per project.

The CDM project ideas are located in Costa Rica, El Salvador, Honduras, India, and Zambia; all JI projects are located in Estonia (Table 7–5). The latter situation is due to the fact that only the Estonian Government had the administrative capacity and practical willingness to develop JI at the time when these projects were chosen in the neighbourhood areas of Finland. There were efforts to launch projects also in other potential neighbouring JI host countries. All the JI projects currently follow the more complex JI second track type of approach. The aim is, however, to move to the simpler JI first track as soon as Finland and Estonia fulfil all the requirements of the JI first track.

Project types include biomass energy, small hydro, biogas recovery and utilisation, and wind power. Changes are still expected to the current CDM project portfolio, and new CDM project ideas may still be developed within the Pilot Programme framework.

In general, the development of JI and CDM projects has been more complex and time consuming than expected. Especially delays in developing international CDM rules, processes and administration have hampered CDM development and prevented implementation of some project ideas. Capacity building is clearly needed both in host and investing countries. Learning-by-doing is, however, a successful approach for creating and developing capacity for the use of project-based mechanisms. Transaction costs are rather high in small projects. Costs can be reduced through capacity-building and straightforward implementation of CDM rules.

Although many challenges and uncertainties still remain, the implementation of several projects shows that application of the project-based Kyoto mechanisms is both possible and feasible. The division of activities between bilateral projects and investments in funds can also be viewed as a successful approach in the Finnish CDM/JI Pilot Programme. The funds offer a more straightforward and somewhat less risky approach to acquiring emission reductions with the expense of less capacity building benefits in the investing country.

The Pilot Programme will be evaluated in 2006. Finland's target is to get emissions reductions of about 2.0 Tg by the CDM/JI Pilot Programme in the Kyoto commitment period.

Figure 7–3 In 2005, the Rio Blanco Small Hydroelectric Project in Honduras was registered as the first Finnish Clean Development Mechanism project by the CDM Executive Board. Water flows to the turbines through an underground intake pipe; thus environmental changes in the river channel have been minimised. The waterfalls upstream of the powerplant will remain at their natural state. (Photos: Markku Nurmi).



8 *Research and systematic observation*

8.1 General policy

Research on climate change started relatively early in Finland. During the early and mid-1990s, the activities were focused on impact research, and mainly limited to the field of natural sciences. Finland completed already in 1996 the first national assessment on climate change and its impacts. Another important branch of research is the development of existing and new adaptation and miti-gation methods and technologies. The focus in the research has moved towards the latter branch and this trend will continue in the coming years.

The National Energy and Climate Strategy states that more research is needed in order to understand the causes, mechanisms and impacts of climate change. The need to focus on adaptation was emphasized in the Parliament's deliberations of the strategy.

The level of research activity into climate change impacts and adaptation in different sectors in Finland was analysed in 2003 (Table 8–1). The primary focus in the climate change research has been on traditionally strong areas, including palaeoclimatic reconstruction, historical climatology, glaciology, sea

Table 8–1 Recent level of research activity into climate change impacts and adaptation in Finland and approximate time horizons to consider in planning and implementing adaptive strategies (Carter and Kankaanpää 2003).

	Level of research activity		
Sector	**Impacts**	**Adaptation**	**Adaptation lead-time (years)**
Soils	Moderate	Very low	5–20
Agriculture	High	Low	1–20
Forestry	High	Low	10–100
Fisheries	Moderate	Very low	5–20
Energy	Moderate	Low	10–50
Construction	Very low	Very low	5–50
Tourism/Recreation	Very low	Very low	5–20
Transport	Moderate	Low	5–50
Insurance	Very low	Very low	1–10
Community planning/Settlements	Very low	Very low	10–100
Nature conservation/Biodiversity	Moderate	Very low	10–100
Water	High	Low	10–100
Coastal zones	Low	Very low	10–100
Human health	Very low	Very low	1–20

ice modelling, hydrological modelling and, more recently, climate modelling, and research into the carbon cycle and energy systems. Some notable gaps in knowledge about the potential impacts of climate change were considered apparent for human health, construction, insurance, tourism and recreation, and community planning. Even more striking was the relatively poor treatment of adaptation across all sectors. However, considerable progress has been already made in adaptation research since this assessment.

8.2 Research

8.2.1 Climate process and climate system studies

The Finnish Meteorological Institute (FMI) has a research programme, Climate and Global Change, with a staff of around 40 scientists. As to climate process and climate systems studies, the research emphasis of the programme is on

- Observed climate of Finland and of the boreal zone
- Climate services (supply of climate data, analysis of extreme events, media relations)
- Greenhouse gases (measuring GHG concentrations and fluxes and interpretation of measurements with modelling tools, Pallas GAW station in Lapland)
- Aerosols and climate (measuring aerosol properties, modelling aerosol dynamics, Pallas GAW station)

The Finnish Meteorological Institute has also done extensive work in the homogenisation of observed station data in order to detect the real climatic or natural signal of the change in the observed variables, particularly surface air temperature and precipitation (Tuomenvirta 2004). Data are also converted to maps to study the areal differences of the change as well as the physical causes for these changes. Boreal effects have received much attention.

The Department of Physical Sciences at the University of Helsinki has over 20 years' tradition in aerosol related atmospheric research. Currently, some 35 scientists are engaged in this area. The main research subjects are aerosol dynamics, formation and growth of atmospheric aerosol particles and cloud droplets, atmospheric chemistry, urban aerosols, and forest-atmosphere interactions. In addition to the theoretical work, the Department has a well equipped aerosol laboratory and two field stations (SMEAR I and SMEAR II), where e.g. aerosol dynamics, atmospheric chemistry, micrometeorology, gas exchange between forest and atmosphere, soil chemistry and forest growth are measured continuously (Fig. 8–1). The Department also hosts the international headquarters of the ILEAPS (Integrated Land Ecosystem – Atmosphere Processes Study) Programme, in connection with the Finnish Meteorological Institute.

Finnish research institutes have extensive activities in paleoclimatology. This is partly based on good natural archives: the lakes are rich in layered sediments, and in them age-old tree trunks near the northern tree line have been preserved. At the Environmental Change Research Unit at the University of Helsinki, the central research theme is the development and application of hydrobiological, paleoecological and computational techniques to provide historical perspectives to ecological and environmental change. This research

Figure 8–1
The observation tower at Hyytiälä Forestry Field Station of the University of Helsinki. The installation, SMEAR (Station for Measuring Forest Ecosystem-Atmosphere Relations) gives continuous information on interactions between trees and atmosphere, air quality and aerosols.

group presently comprise more than 15 people; the group is involved in e.g. four EU projects. The main focus is on arctic lakes.

At the University of Helsinki, the Institute of Geology has specialised in dendrochronological research, whereas the Institute of Geography focuses on biological indicators in varved lake sediments. The latter is an important research topic also at the universities of Joensuu and Jyväskylä. The Finnish Geological Survey (GTK) also studies varved sediments, with an emphasis on their physical properties.

8.2.2 Climatic modelling and prediction

The Finnish Meteorological Institute coordinates the Finnish climate system modelling effort in the COSMOS Earth System Model consortium, led by the Max-Planck Institute for Meteorology, Germany. The main modelling challenges in spring 2005 were to implement a stochastic treatment of the sub-grid-scale cloud structures to ECHAM5 atmospheric GCM and to interface it with the radiative transfer code, to contribute to the ECHAM5 aerosol model (HAM).

The FMI has prepared several projections on climate change since the early 1990s. These projections have been widely used for assessing the likely consequences of climate change for ecosystems, economic activities, energy production, and forestry and human health. The projections are also valuable for policy makers and the general public. The projections include e.g. those used in the FINSKEN project (see Section 6.1.2).

The FMI and the Finnish Environment Institute (SYKE) participated in the PRUDENCE programme in 2001–2004. This programme, "Prediction of Regional scenarios and Uncertainties for Defining EuropeaN Climate change risks and Effects", provided high-resolution climate change scenarios for Europe for 2071–2100 using dynamical downscaling methods. These scenarios are used to explore changes in the frequency and magnitude of extreme weather events.

Together with the Finnish Institute of Marine Research, the FMI is developing better forecasts of winds, waves and ice conditions for sea areas using coupled atmospheric and marine models. The coupling technique is based on the ECAWOM model. The FIMR-FMI coupled model consists of the atmospheric model HIRLAM and the wave model WAM.

The Division of Atmospheric Sciences at the Department of Physical Sciences, University of Helsinki, has participated in analysing the regional climate change simulations conducted by the Swedish Rossby Centre, as well as in the analysis of global climate model results from the Coupled Model Intercomparison Project. The current foci of research include greenhouse gas induced changes in climatic extremes and probabilistic interpretation of climate change projections.

8.2.3 Research on the impacts of climate change

8.2.3.1 Major research programmes

The impacts of climate change are studied at several universities and sectoral research institutes. A considerable part of this research receives external funding from the Academy of Finland, the Finnish National Fund for Research and Development (SITRA), the National Technology Agency (TEKES), various foundations and the European Union.

Two extensive research programmes, coordinated by the Academy of Finland, SILMU and FIGARE, studied both the impacts, adaptation and mitigation of climate change. They will be described here, because their main focus was on the impacts of climate change.

SILMU

An interdisciplinary effort called the Finnish Research Programme on Climate Change (SILMU) was initiated in 1990 to coordinate the majority of all climate change research in Finland. The key research areas in the programme were the climate changes anticipated in Finland, estimation of the effects of changing climate on ecosystems, and the development of adaptation and prevention strategies.

The programme lasted six years, and the annual budget was equivalent to EUR 2–3 million. Altogether, the programme comprised over 60 research projects and involved some 200 researchers. The fields of research had been grouped into four sub-groups: atmosphere, water bodies, terrestrial ecosystems and human actions.

Many research projects under SILMU were included in international research programmes on climate change, such as the World Climate Change Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP).

FIGARE

In 1999, the Academy of Finland launched FIGARE, the Finnish Global Change Research Programme. The programme's main objectives were to:

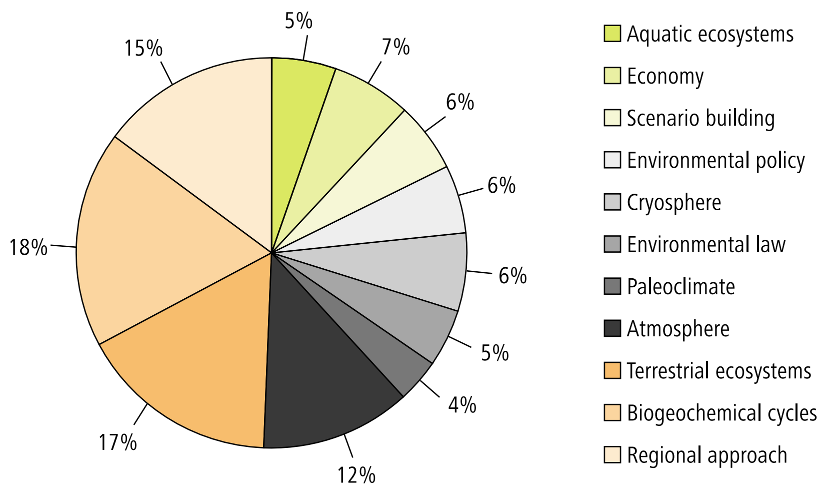
- Analyse the process of global change and its underlying causes and impacts at different temporal and regional levels
- Analyse and predict the environmental and socio-economic impacts of global change using methods such as scenario analysis
- Try and find social, economic and technological solutions that could help to intervene in the process of global change or adapt to the changes
- Train researchers and experts in the field.

FIGARE was conducted over a three-year period in 1999–2002. The programme was coordinated by the Academy of Finland, which also provided 63% of the total funding of EUR 6.7 million. Additional funding was available from the National Technology Agency TEKES, the Ministry of the Environment, the Ministry for Foreign Affairs, the Ministry of Agriculture and Forestry and the Ministry of Transport and Communications.

The programme was evaluated by a team of international experts in spring 2003 (Jäger et al. 2003). Considering the modest amount of funding and the short duration, the team was impressed by the general standard of the programme. The team considered that more attention should have been paid to inter and intra-project collaboration, e.g. through joint workshops. Dissemination of results could also have been an integral part of the projects.

The programme consisted of 36 research projects in 18 clusters or consortia Fig. (8–2). Altogether, the programme involved 227 researchers in around fifteen universities or research institutions. Several hundreds of scientific publications, including some twenty doctoral dissertations were prepared.

Figure 8–2 Although the FIGARE programme aimed at an integrative approach, the projects can be classified into specific fields of research according to their main interest area. The adjacent diagram shows one plausible classification into eleven thematic groups.



The Finnish Biodiversity Research Programme (FIBRE, 2001–2003) and the Research Programme on Sustainable Use of Natural Resources (SUNARE, 2001–2004) also contained climate-related topics. The Academy of Finland was responsible for both programmes.

8.2.3.2 Sectoral research on impacts

Agriculture

In recent years the research emphasis has been on the greenhouse gas balances of agricultural soils, but indirectly this kind of research also gives information on the agricultural impacts of climate change. The emission factors of soils were studied e.g. in the FIGARE programme in a project coordinated by Agrifood Research Finland (MTT). Actual measurements of emissions from different soil types under varying management practices were made both in southern and northern Finland.

The land area data of organic soils have been improved and a time series for the changes since 1990 has been developed by MTT. This organisation is carrying out a study on the reserves of organic carbon in agricultural soils in Finland as a joint effort with the Finnish Museum of Natural History and the Scottish Crop Research Institute. The study is scheduled for the years 2003–2007. On the research farm of MTT, changes in organic carbon contents of soil are studied in different crop rotations (pasture vs. cereal crops in monoculture). The impact of no-till as compared to molboard ploughing will also be studied.

Finnish researchers have also participated in several international programmes, which have aimed at determining the impact of future climatic change and associated stresses on the growth, yield and quality of different agricultural products across Europe.

Forests

The results of the National Forest Inventories as such have also served the climate change research and national greenhouse gas inventories. Specific studies have focused on assessing carbon pools and fluxes. Experimental work on the impacts of different forest management practices on forest carbon stocks and fluxes have also been performed.

In 2000, the Finnish Forest Research Institute (METLA) started an extensive research programme ”Pools and fluxes of carbon in Finnish forests and their socio-economic implications”. This programme consists of three projects:

1. Forest carbon sinks and the economic costs of the Kyoto Protocol

The objective of this study is to integrate carbon sinks into global economic models and to analyse how the various definitions of carbon sinks and the credited proportions of them affect the costs of the Kyoto Protocol in various countries. The reliability and comparability of the carbon sink estimates of various countries will also be studied.

2. Modelling forest carbon cycles

This study aims at developing dynamic and mechanistic carbon cycling models that will work at varying spatial and temporal scales. The impact of various forest management scenarios on carbon pools and fluxes is simulated in connection with climatic change in order to predict their socio-economic and political implications.

3. Pools and fluxes of carbon on mineral soils and peatlands
The aim of the study is to determine the carbon pools and fluxes of forests on mineral soils and peatlands in Finland. Of particular interest is the significance of fine roots in carbon cycling in forest soils.

This METLA project is scheduled for the years 2000–2005. In Addition, METLA has several other ongoing projects related to climate change, e.g.

- Modelling and extrapolation of peatland greenhouse gas fluxes (2002–2005)
- Greenhouse gas (CH_4 and N_2O) release in wetland buffer ecosystems after nutrient release from forestry practices (2003–2005)
- Forest carbon balance (2004–2005).

In 2000, the University of Joensuu established a Centre of Excellence for Forest Ecology and Management (CEFEM). This Centre aims at enhancing scientific research on the functional and structural dynamics of the boreal forest ecosystem with management implications. One of the key topics of the Centre is to study the acclimation of forest trees in elevating temperature and atmospheric carbon. These studies are based on long-term field experiments and model simulations. A special emphasis is put on introducing the impacts of climate change into the long-term dynamics of the boreal forest ecosystem with the implications on the sustainable management of forest resources.

The CEFEM and the University of Helsinki participate in the ACCROTELM (Abrupt Climate Changes Recorded over the European Land Mass) research programme, supported by the European Commission, together with nine other research institutions in EU countries. The programme will generate continuous records of hydrological/temperature changes from mire sites in transects across Europe during the last 4500 years. The programme is scheduled for 2003–2006.

Finnish forest researchers are using complex, multifaceted models to study the effects of climate change. They found at an early stage that it is not sufficient to use models where the consequences of the changing climate are aggregated into a few variables representing the effects of temperature, precipitation, and hydrological and nutrient cycles on the long-term dynamics of the forest ecosystem. Instead, it is necessary to use ecophysiological models, which include a detailed description of the within-stand light regime and where also the effect of thinning on radiative transfer has been taken into account.

Another step forward has been an analysis of the modifications needed in forest management under changing climate conditions. These modifications aim at optimising the timber yield and carbon sequestration on a sustainable basis in terms of its socio-economic implications. These analyses are carried out using the national forest inventory data as a basis of the modelling work. Forest researchers have been also in close co-operation with atmospheric scientists and Finland has had a visible role in global, European and Nordic CO_2 flux tower networks (Fluxnet, Carboeurope, NECC).

Finnish forestry researchers are also involved in climate-related projects abroad, e.g. in the Philippines, Laos, Nepal, Central America and in some countries in Africa.

Peatlands
As outlined above, a considerable part of the forestry research into climate issues has concentrated on peatlands. In general, the impacts of climate change and the role of peat in Finnish greenhouse gas balances have been extensively studied; the key topics have been the following:

- Long-term average accumulation of carbon in natural peatland
- Effects of forest drainage on the stores of carbon in peat and tree stands
- Life cycle analysis of peat harvesting
- Effects of elevated atmospheric CO_2 on peatlands.

An extensive research programme "Greenhouse impacts of the use of peat and peatlands in Finland", is scheduled for the years 2002–2005. The scientific aim of the programme is to develop models for the greenhouse gas dynamics of different land use forms of peatlands, relevant for peat utilisation and the national greenhouse gas inventory work. The programme consists of eight subprojects:

- Ecosystem and regional scale models on peatland gas exchange
- Quality control of measurements
- Net ecosystem exchange of carbon dioxide in forests
- Greenhouse gas balance of natural mires
- Greenhouse gas balances in drained peatland forests
- Greenhouse gas balances of afforested fields and cutaway peatlands
- Greenhouse gas emissions from cultivated and abandoned organic agricultural soils
- Greenhouse gas balances of restored cutaway peatlands.

The total funding of the programme is around EUR 1.5 million; some 45% come from the Ministry of Trade and Industry, 45% from the Ministry of Agriculture and Forestry and 10% from the Ministry of the Environment. Some projects have additional funding from corresponding research institutions.

Finland has also participated in the BERI (Bog Ecosystem Research Initiative) of the European Union. The objectives of this programme were to study the effects of elevated CO_2 and N deposition a) on the net exchange of carbon dioxide and methane between bogs and the atmosphere, and b) on the plant biodiversity of bog communities. Similar technology and methodologies were applied at five bogs in different parts of Europe, one of the sites being located in Finland.

The peat industry has also made extensive research, including investigation of peat quality and quantity as well as matters connected with the environment. One coherent area of interest consists of preparing a bog for production, the production itself, storage, optimisation of transportation, and the use of peat in power and heating plants.

Inland waters and marine areas

Impact research in this sector has been intensive. One of the four subprogrammes of SILMU concentrated on the aquatic impacts of climate change. The goal was to achieve integrated knowledge about the impacts of possible changes on the hydrology and ecology of Finnish lake and sea ecosystems.

In FIGARE, this sector was also in focus. Finnish lakes as a source of greenhouse gases were studied in the CARBO Project by the Geological Survey of Finland and the Finnish Environment Institute; a study of the total amount of carbon stored in the lake sediments in Finland was also made. As to the quality of inland waters, studies on the future changes of nitrogen and phosphorus leaching were also performed. One FIGARE project analysed solar UV-B actions on aquatic ecosystems.

The climate change impacts on runoff and hydropower were analysed in a Nordic coproject "Climate, Water and Energy" (CWE), funded by the Nordic Council of Ministers and the participating organisations. The Finnish Environment Institute (SYKE) and the Finnish Meteorological Institute participated in this programme, together with power companies. SYKE and FMI have also had wider co-operation in studying the impacts of climate change on design precipitation, design floods and dam safety. This multi-stage programme has been running since the late 1990s, and will be finalised in 2005.

The Finnish Institute of Marine Research (FIMR) has been involved in several international coprojects concerning the Baltic, North Atlantic and Polar seas. In the Baltic Sea, the research has focused on ice conditions and water level variations, in the other marine areas long-term physical changes and their causes have been analysed. For example, the EU-funded ASOF Project has concentrated on the heat and moisture exchange between the North Atlantic and the Arctic Sea, and the AICSEX project on the observation and modelling of the Arctic sea ice conditions.

The Geophysical department of the University of Helsinki and the FIMR have used a dynamic-thermodynamic sea ice model for estimating future ice condition in the Baltic Sea in collaboration with the Rossby Center. The model results show that the climate warming will have a considerable effect on the extent, thickness and duration of ice in the Baltic Sea.

Finland has also participated in BALTEX (the Baltic Sea Experiment), an extensive research programme in the meteorology and hydrology of the Baltic Sea and its entire drainage area. Since the onset of the programme in 1994, it has involved about 50 institutions from 14 countries. Science plan has been established for BALTEX Phase II for the years 2003–2012.

Within the FINSKEN Programme, sea level scenarios were developed (Johansson et al. 2004). They include scenarios for both mean and maximum sea levels. The former is important for, among other things, shipping, water exchange in the bays and development of coastal wetlands. The latter scenarios are used to evaluate risks for buildings, harbours, roads and bridges. In addition, scenarios were presented for the variability of sea level.

The SYKE Research Programme for the Protection of the Baltic Sea aims to elucidate the effects of anthropogenic changes on the ecosystem of the Baltic Sea. The research concentrates on investigating and modelling the structure and function of the ecosystem, the interaction between bottom sediments and the water phase, water quality changes and marine coastal biodiversity. SYKE is also studying the long-term effects and risks of both air pollution and climate change on terrestrial and aquatic ecosystems. In addition, fluxes of greenhouse gases and carbon storages are estimated and pollution control measures assessed.

Transport

The Ministry of Transport and Communications has participated actively in different national research programmes (such as SILMU, FIGARE and CLIMTECH) by co-financing studies that are concern the transport sector. Moreover, the Ministry has launched or has been otherwise actively involved in various sector-specific research programmes that are listed in Section 4.5.

The Finnish Meteorological Institute and the Finnish Institute of Marine Research are agencies of the administrative sector of the Ministry of Transport and Communications. Both these institutes have active roles in the research on climate change impacts and adaptation. They have studied e.g. the impact of predicted climate change on ice cover in the Baltic Sea and the impact of climate change on road conditions in winter.

Arctic research

The Arctic is a priority area for studying the effects of global change, because of the magnitude of expected climate changes and the fragility of the environment. The Arctic also has a major influence on the global systems of climate, ocean circulation and other environmental phenomena.

The Northern Dimension, the initiative submitted by Finland to the European Union to strengthen the position of the EU in northern Europe, has increased awareness of the Arctic and other issues related to northern regions. Finland's Arctic Research Strategy (1998) has four priority areas: natural resources, global change, man and communities, and infrastructure. As to the global change, the strategic goals of the research are to analyse the processes and factors underlying such change and to draw conclusions from these analyses, to develop research and technical capabilities for monitoring the change, to predict the effects of the change on Arctic ecosystems and communities and to devise measures to prevent global change or help us adapt to it.

Finland participated the Arctic Climate Impact Assessment (ACIA), which was a four-year scientific study of the Arctic conducted by an international team of 300 scientists. In addition to the eight member states of the Arctic Council, six indigenous people's organisations participated in the assessment, which was published in November 2004.

The Arctic Centre at Rovaniemi, a separate institute affiliated to the University of Lapland, participates in national and international research projects on arctic environmental policy, northern environmental institutes and law making, and natural resources of the Arctic and their sustained use. The topics also include climate change aspects, which were dealt with in e.g. two extensive, EU-funded research programmes, BASIS (the Barents Sea Impact Study) and TUNDRA (Tundra Degradation in the Russian Arctic). The Centre is host to the Global Change Programme Office (IASC/GCPO) of the Secretariat of the International Arctic Science Committee.

The Thule Institute in Oulu operates as an independent national institute for northern and Arctic research. Global change in the north is a major component in the Institute's research activities. The Thule Institute also hosted the secretariat of the Nordic Arctic Research Programme (NARP), initiated by the Nordic Council of Ministers. The annual budget of the programme was around one million euros for its five years' duration from 1999 to 2003.

The Arctic Research Centre of the Finnish Meteorological Institute at Sodankylä does research on themes related to the upper air, the boundary layer, atmosphere-biosphere interaction, and UV impact. In upper air research the Centre functions as an auxiliary station in the global Network of Detection of Stratospheric Change. As to climate change issues, its current projects include e.g. SAONAS (Measurements of stratospheric aerosols and cloud particles), SCUVS (Study of chemical composition of stratosphere) and PVC (Study of climate change effects on the polar vortex).

Arctic snow, sea-ice and glaciers in a changing climate were studied in FIGARE. Another FIGARE project focused on ecosystem feedbacks to global warming; the main objective in this project is to understand the functioning of ecosystems at the Arctic treeline under present conditions and to find out how these ecosystems might react to expected warming. A third project concentrated on physiological and ecological stress responses and recovery of wild subarctic plants.

Within Arctic paleolimnology, there are several recently finished or ongoing research projects:

- Holocene climatic variability in the Fennoscandian Arctic inferred from lake sediments and glaciers
- Climate history as recorded by ecologically sensitive Arctic and Alpine lakes in Europe during the last 10,000 years
- Pollution and rapid climatic changes in the Arctic as recorded by lake sedimentary archives
- Northern lakes as key witnesses for global change – an integrated study
- Multiproxy approach to estimate changes in UV exposure in Arctic lakes.

Other sectors

As outlined in Table 8–1, the impact studies in other sectors have been moderate, low or very low.

The effects of climate change on fish and fisheries have been studied by the Finnish Game and Fisheries Research Institute. This institute has also done some research into the climatic impacts on reindeer and the game resources in Finland. As to biodiversity and nature conservation, the focus has been in the effects from climate change on endangered species and biotypes. These studies have been made at several universities and research institutes.

Research in the energy sector has concerned hydropower in particular. In the Nordic research programme Climate and Energy (CE) all renewable energy resources, including hydropower, wind power, bio-fuels and solar energy will be studied with. The goal is to create an objective basis for improved decisions concerning climate change and energy issues within the Nordic region. The programme is scheduled for 2003–2006 and is funded by Nordic Energy Research (EUR 1.2 million), the Nordic energy sector (EUR 0.4 million) and participating institutions (EUR 0.4 million). Contacts will also be created with the Baltic countries and Russia. The Finnish participants include FMI, SYKE, University of Joensuu and power companies.

The effects of climatic warming on heating energy requirements have been studied by e.g. the Finnish Meteorological Institute and various power companies. The Technical Research Centre of Finland (VTT) made an extensive study of the impacts of climate change on build-up environments, buildings and construction.

Impacts of heat waves and other climatic extremes on health have mainly been evaluated on the basis of international research. The direct interest in Finland has been in certain climate-sensitive diseases like those caused by ticks. As to tourism and recreation, some preliminary studies have been made by e.g. the Finnish Tourist Board (MEK), which works under the Ministry of Trade and Industry for the general promotion of tourism to Finland.

8.2.4 Socio-economic analysis

No systematic evaluations have been made of the overall impacts of climate change on Finnish economy. Some analyses have been performed in different sectors, like forestry. In addition to sectoral research institutes, these studies have been made by the Research Institute of the Finnish Economy (ETLA), the Government Institute for Economic Research (VATT), the Helsinki School of Economics and the Technical Research Center of Finland (VTT).

Under FIGARE, there were the following socio-economic research projects:

- Global policies and Finland: environment, energy markets and the forestry sector
- Global problems, knowledge, institutions and policies
- Climate change and decision-making
- Conditioning global and local climate, biodiversity and development policies.

The effects of the Kyoto agreement and the Kyoto mechanisms have been studied in more detail than the overall economic impacts of climate change. In fact, the first FIGARE project mentioned above concentrated on the Kyoto issues. The international framework in that project included the number of countries participating in emission reduction, the extent and design of international emission trading, the size of carbon sinks, the role of international trade in electricity, the role of international trade agreements and, finally, the working of the world oil market.

Socio-economic scenarios were developed for Finland within the FINSKEN programme. (Kaivo-oja, Luukkanen and Wilenius 2004). These include scenarios of population and economic development, as well as technological and social foresight studies. One of the major challenges is to make explicit the correlations and interactions between, among other things, economic activity, demographic structure, technological change, energy use and greenhouse gas emissions.

In connection with the preparation of the National Energy and Climate Strategy, a number of socio-economic studies were made on e.g. the electricity market, emissions trading, energy taxation and energy subsidies.

8.2.5 Research and development on adaptation and mitigation

As pointed out in Table 8–1, the current level of understanding of climate change adaptation and adaptive capacity is insufficient in Finland. Few studies of the impacts of future climate change have considered adaptation, and those that did rarely offered more than a shopping list of possible adaptation options.

However, since the Third National Communication, the situation has improved considerably. The Finnish Environment Institute (SYKE) prepared a preliminary report on adaptation to climate change in Finland in 2003 (Carter and Kankaanpää 2003). As a continuation to this work, the environment cluster started the FINADAPT programme, coordinated by SYKE. The programme has been financed by the Ministry of the Environment (EUR 0.3 million); approximately the same amount will come from other sources, including host institutes. The programme is scheduled for the years 2004–2005.

The primary objective of FINADAPT is to estimate the adaptability of Finnish society and environment to the impacts of climate change. The methods will include a combination of literature review, expert judgement, modelling and scenario analysis, stakeholder dialogue and survey responses.

FINADAPT is expected to produce a priority list of recommendations for future research into climate change adaptation, which is likely to emphasise:

- Involvement of multiple sectors and stakeholders
- Inclusion of both autonomous and planned adaptation
- Focus on the timing of adaptation measures
- Adaptation to mean climate change vs. extreme events
- Focus on "no regrets" adaptation measures
- Economic assessments of impacts and adaptation
- Relationships between adaptation and mitigation
- New technologies required for adaptation
- Consideration of methods of evaluating adaptation strategies
- Examination of the process of adaptation.

These priorities, along with others emerging from parallel EU, Nordic and national projects, are likely to be central to the development of a new national research programme, as recommended in the National Climate Change Adaptation Strategy. The strategy also states that the research must produce practical information about the possible adaptation measures. The requirement for a high scientific standard ensures that adaptation will be based on as reliable information as possible, and the requirement for practicality ensures that the information can be utilised in practice. Furthermore, it must be ensured that science and practice are in mutual interaction. Research supporting adaptation to climate change must observe some aspects associated with research methods and contents:

- Cross-sectorality (including the relation of climate change to other change factors)
- Comparability of research results from different sectors
- International research cooperation
- Multidisciplinarity (the integration of research on the impacts of climate change and adaptation measures with other environmental research and with social and technological research)

- Information requirements for decision-making and practical measures
- Common real-time climate information to suit the needs of research and practical operations (developing a climate databank and distributing information for research and the planning of adaptation actions)
- Uncertainties (climate change scenarios, impact assessments, the effectiveness of adaptation measures)
- Connection with climate change mitigation (co-ordination of impact and adaptation research and research aimed at mitigation)
- Development of research, planning and assessment methods (cost-benefit, cost efficiency, risk and multicriteria analyses, development of public participation)
- Economic impact assessments (optimisation of mitigation and adaptation, uncertainty estimates).

As to the mitigation technologies, a major step forward was the CLIMTECH Programme in 1999–2003. Under this programme, technologies that can be applied to control greenhouse gas emissions and climate change were investigated. The programme included both the control and reduction of emissions within Finland as well as the use of Finnish technology to limit emissions elsewhere. The time scale for the technologies studied extends beyond the first commitment period of the Kyoto Protocol to about 2030.

Under CLIMTECH, the control of climate change was being analysed against the background of the overall picture. Forecasts were made on the requirements and possibilities for controlling emissions and these were weighed against their economic consequences. The programme helped to identify the most important development fields. Additionally, the implementation and commercialisation of Finnish technology was supported.

CLIMTECH was run as a framework programme. VTT Energy was responsible for the implementation of the programme, a steering group guided and supervised the work. The costs of the programme totalled about EUR 5 million, of which almost EUR 4 million were provided by the National Technology Agency TEKES.

CLIMTECH consisted of 27 projects in six subject fields:

- Renewable energy sources and distributed energy production (5)
- Energy efficiency and industry (6)
- Non-CO_2 greenhouse gases (2)
- Capture and utilisation of CO_2 (2)
- Models and systems (9)
- Commercialisation (3).

Eight companies and seven research institutes carried out research work in the CLIMTECH projects. Additionally, several companies participated in the financing and/or the executive group working of the research projects.

TEKES has started a new technology programme known as ClimBus – Business Opportunities in Mitigating Climate Change. The budget for this five-year programme totals EUR 70 million, of which the share of TEKES is roughly half. Through the programme, TEKES finances the development of technology and services, and produces new competence and strong international networks among various actors. The programme will cover the years 2004–2008.

The aim of the programme is to enhance Finnish business and to create new enterprises and business operations for the global market of climate technology and services. Finnish enterprises are expected to gain their share of the growing markets and to develop their know-how and business operations. ClimBus concentrates on technology sectors, where Finland already has solid expertise. These sectors include technology and services associated with the production and application of bioenergy and with efficient use of energy.

In addition, the programme focuses on the development of services in the mitigation of climate change, for instance, as concerns emissions trading and the monitoring of emissions. The programme also collates data on changes that climate policy brings to the operating environment, and analyses the consequent impacts on markets and on needs to develop technology.

Research on adaptation and mitigation is also done outside these major research programmes in various institutes and enterprises. For example, Agrifood Research Finland has the following ongoing projects:

- Mitigation of greenhouse gas emissions from agriculture and adaptation to the climatic change (2001–2007)
- Carbon reserves in agricultural soils and their response to management (2004–2007)
- Production and use of biogas, supply of additional material on farms and use of the digestion residual in plant nutrition, related hygiene issues and greenhouse gas emissions (2004–2006).

The recent or ongoing projects of the Technical Research Centre of Finland (VTT) include the following projects:

- Greenhouse impact of peat fuel chain
- Effect of climate change on electricity network business
- Built environment and transport nets
- The long term challenges, risks and opportunities of the climate regime
- Biomass-based climate change mitigation through renewable energy
- Urban form, transportation and greenhouse gas emissions
- Effects of the climate change on the built-up environment in Finland
- Scenario analysis of emission reduction possibilities their impact on the structure of energy production and industry
- Implications of climate policy on global energy system and demand of technologies.

8.3 Systematic observations

As to the systematic observations in general, the Finnish Meteorological Institute is responsible for atmospheric observing systems. The Finnish Institute of Marine Research carries out observations in the marine areas, while the Finnish Environment Institute conducts climate-related observations of inland waters and terrestrial phenomena. The Finnish Meteorological Institute provides much of the support to developing countries to establish and maintain observing systems.

Finland follows the internationally agreed principle that the meteorological observational information is free of charge for scientific and educational purposes, the marginal cost involved with the delivery only being charged. The potential commercial use of the data that have been released creates a barrier to unrestricted availability of the data as long as it is not generally agreed how the recovery of the infrastructure costs of the data originators is secured.

8.3.1 Atmospheric climate observing systems

Meteorological observations have been made at several stations in Finland for more than a hundred years. In March 2005, observations were made at three meteorological observatory stations, 37 synoptic stations, 35 climatological stations, 286 precipitation stations and 140 automatic stations.

Long climatological time series form a necessary basis not only for the climatological research itself but also for estimates on the impacts of climate change. Finnish climate observations have been included in the international NkDS and ECD datasets, which are Nordic and European collections of reliable long-term climatic observations for climate change research.

Under the Global Climate Observing System (GCOS) programme, Jokioinen, Jyväskylä, and Sodankylä stations are included in the GCOS Surface Network (GSN) and the GCOS Upper-Air Network (GUAN). – Finland's national report on the GCOS is under preparation and will be submitted in 2006.

The Finnish Meteorological Institute maintains the Climatological Database of the following components:

- Station Metadata Register with history
- Record values of the station
- Daily values (including total atmospheric ozone since 1994, ultraviolet irradiance since 1994)
- Synop data
- Hourly values for solar radiation and sunshine hours
- Rawinsonde data
- Normal values
- Automatic weather station data since 1996
- Automatic synop data since 1998
- Mast Data since 1986.

All these data are quality-checked and archived in a relational database at the Finnish Meteorological Institute.

The EUMETNET was established to promote European cooperation in the development of a meteorological observation network and the basic weather services. The FMI hosts the programme, which has been established to improve the observation technology for severe weather conditions.

Finland's membership in the European Meteorological Satellite Organisation (EUMETSAT) allows it to receive real-time weather satellite images and the possibility to participate in several research programmes of EUMETSAT. The Finnish Meteorological Institute hosts the ozone research programme and participates in the satellite climate data programme.

Finland also participates in the Global Atmosphere Watch (GAW) programme of the World Meteorological Organisation (WMO). The objective of the GAW is to observe greenhouse gas concentrations and long-range transport of pollutants in the atmosphere (Fig. 8–3).

Figure 8–3.
The Pallas station in Lapland is the northernmost GAW station in continental Europe. It offers unique possibilities for carrying out measurements on atmosphere-biosphere exchange and background air composition.
(Photo: Juha Hatakka)

The Finnish Meteorological Institute has eight Doppler radars for the weather service. The University of Helsinki has a weather radar for research purposes, and Vaisala Corporation is developing a prototype for the next generation of radars. The cost of a single weather radar system is approximately EUR 2 million, and the service life about 15 years. The availability of radar information from the radar network of the FMI is the best in the world.

The Air Quality Database of the FMI includes pollutants conventionally associated with regional air pollution, which are measured continuously in Finland at 20 background stations. Atmospheric pollutant measurements were carried out in the following international programmes:

- AMAP (Arctic Monitoring and Assessment Programme), co-ordinated by the Arctic Council
- EMEP (Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Pollutants in Europe) co-ordinated by the UC/ECE
- HELCOM (Helsinki Commission, Baltic Marine Environment Protection Commission, earlier the EGAP programme), which monitors the load of airborne pollutants to the Baltic Sea
- INTEGRATED MONITORING: an international programme co-ordinated by the ECE.

The Finnish Environment Institute is the inventory agency for air pollutant emissions and compiles the reports to the UNECE CLRTAP and according to the EU directives on air pollution. Air pollutants include emissions of sulphur (as SO_2), nitrogen oxides (as NO_X), carbon monoxide

(CO), ammonia (NH_3), particulate matter (TSP, PM_{10} and $PM_{2.5}$), volatile organic hydrocarbons (NMVOC), heavy metals and persistent organic pollutants (POP). The air emission data system (IPTJ) at SYKE contains information on the emissions, their sources and on the spatial coverage of emissions over Finland. The system meets the requirements set in the guidelines of the international conventions UNFCCC and UNECE CLRTAP.

8.3.2 Ocean climate observing systems

The Finnish Institute of Marine Research (FIMR) maintains networks of water level and water temperature observations in the marine areas of Finland. The FIMR has also developed the Baltic Sea Database, which provides real-time information on the state of the Baltic Sea for the general public, media and authorities.

The FIMR has recently participated in the development of operational sea ice monitoring by satellites, integrated use of new microwave satellite data for sea ice observations and improvement of measurement technologies for marine near-surface fluxes. All three studies were EU projects. The EURONODIM programme in 1998–2000 created a European network for oceanographic data and information management.

8.3.3 Terrestrial climate observing systems

The Finnish Environment Institute (SYKE) is a national centre for environmental information. The most important environmental data systems are the following:

1. Environmental Information System (HERTTA), which consists of the following subsystems:

- Hydrology and Water Resources Management Data system (HYDRO)
- Groundwater Database (POVET)
- State of Finland's Surface Waters (PIVET)
- Lake Register
- Information System for Monitoring Land Use Planning
- Phytoplankton Database
- Air Emission Data system Databank
- Environmental Properties of Chemicals
- Database of Harmful Algal Blooms
- Database of Threatened Species.

Most of these data systems can be utilised in research related to climate change. Of particular interest is HYDRO, because it contains a number of time series dating back to the 1800s. The series on the freezing and breakup dates of Finnish lakes and rivers are among the longest in the world.

2. The Compliance Monitoring Data System (VAHTI), which contains data on pollution loading, water and air pollution control, waste management and noise abatement. VAHTI also has information on how installations comply with environmental regulations; in 2003 the system contained information on 31,000 clients. VAHTI may be used in future as a data source for the emissions trading system.

3. *Geographical Information System*. It consists of over 50 nationwide GIS databases. SYKE utilises satellite data to study e.g. snow conditions and surface water temperatures.

Flood forecasting at the Finnish Environment Institute is based on the Watershed Simulation and Forecasting System (WSFS). Its main component is a hydrological model representing the circulation of water in a catchment. WSFS covers 100% of Finland and is used for forecasting over 85% of the total area of the country. The forecasts are made daily for 300 water level and discharge observation points. The WSFS is used for a number of purposes, including studies on climate change.

In 1998, the European Environment Agency issued instructions for building an observation network for monitoring the quality and quantity of water in EU member states. Together, the national networks form EUROWATERNET, which provides reliable and comparable data on the state of waters all over Europe. In Finland, the new monitoring system was implemented at the beginning of 2000. There are 195 observation points for rivers, 253 for lakes and 74 hydrological sampling stations.

The Finnish Meteorological Institute is also involved in terrestrial climate observations by measuring soil temperatures at the Jokioinen Observatory and at the Arctic Research Centre at Sodankylä.

8.3.4 Support for developing countries

In the 1990s, Finland's total contribution to co-operation projects concerning meteorological technology transfer and education/training was about EUR 16 million. Projects were carried out in some thirty countries all over the world. The Finnish Meteorological Institute has had the main responsibility in this work; other Finnish institutions and companies have participated in some of the programmes.

After the floods in Mozambique in February–May 2000, the Finnish Government decided to start a reconstruction programme of the Mozambican Meteorological Service (INAM). The programme, Post-Emergency Reconstruction Programme in the field of Meteorology, has gone on in Mozambique since 2002 and still continues. In 2002–2005, the allocation of Finland was EUR 3.5 million (see also Table 7–5).

In the Caribbean region, a project "Preparedness to Climate variability and Global Change in Small Island Developing States, Caribbean Region" has been carried out by the FMI in co-operation with the national meteorological institutions. The total budget of this project was around EUR 3 million in 2001–2005 (see Table 7–5 for details). Finland also supported a preparatory phase for a Pilot Project for the Development of an Automated Weather Service Production System for the Caribbean Area with an amount of EUR 0.35 million in 2004–2005.

Co-operation between the meteorological institutes of China and Finland has continued in the fields of atmospheric chemistry, climate change and meteorological services. Another co-operation project was started in 2005 between the FMI and TERI (Energy and Resources Institute of India); it will also focus on the composition of the atmosphere and on climate change issues.

The national meteorological institutes of Finland and Argentina started a joint ozone research programme already in 1987, including total ozone measurements in Marambio, Argentina and Sodankylä, Finland. In 1999 this scientific co-operation was extended to include also UV radiation research. During 2003, FMI and Servicio Meteorológico Nacional started measurements with two new aerosol research instruments.

The Finnish Environment Institute (SYKE) has also been involved in the enhancement of systematic observations in developing countries. Since 2000, SYKE has worked with an extensive project for the development of environmental monitoring in the Republic of Kyrgyzstan. A recent major project in Cambodia has focused on the protection of water resources and the sustainable use of natural resources in order to safeguard local livelihoods in the Mekong River Basin. SYKE's international projects are financed by the Finnish Ministry for Foreign Affairs, EU programmes and funds, the World Bank, the European Bank of Reconstruction and Development and the Asian Development Bank.

LITERATURE

Carter, T.R. and Kankaanpää, S. 2003. A preliminary examination of adaptation to climate change in Finland. The Finnish Environment 640, Finnish Environment Institute, 66 pp.

Jäger, J., Cramer, W., Hordijk, L., Sarukhan, J. and Dyck, E. 2003. Finnish Global Change Research Programme (FIGARE) – Evaluation Report. Publications of the Academy of Finland 7/03, 34 p.

Johansson, M., Kahma, K., Boman, H. and Launiainen, J. 2004: Scenarios for sea level on the Finnish coast. Boreal Env. Res. 9: 153–166.

Kaivo-oja, J., Luukkanen, J. and Wilenius, M. 2004: Defining alternative national-scale socio-economic and technological futures up to 2100: SRES scenarios for the case of Finland. Boreal Env. Res. 9: 109–125.

Tuomenvirta, H. 2004. Reliable estimation of climatic variations in Finland. Finnish Meteorological Institute, Contributions 43, 82 p.



9 *Education, training and public awareness*

9.1 *Climate change issues in Finland's educational system*

Climate change issues form a part of environmental education in Finland. In official educational strategies, climate change is often dealt with together with other threats to sustainable development.

In the National Core Curriculum for Basic Education (2004), the general objectives of the education on sustainable development for students are outlined as follows:

- come to understand the prerequisites for human well-being, the necessity of environmental protection, and the relationship between the two
- learn to observe changes taking place in the environment and human well-being, to clarify these changes` causes and consequences, and to act for the good of the living environment and the enhancement of well-being
- learn to evaluate the impacts of their consumption and daily practices, and will adopt the courses of action required for sustainable development
- learn to promote well-being in their own communities and to understand the threats to, and potential for, well-being at a global level
- come to understand that, through their choices, individuals construct both their own futures and our common future; the pupils will learn to act constructively for a sustainable future

Young people should learn to examine the challenges to sustainable development from several points of view, e.g. exploring the effects of human activity on the environment and changes that have occurred; analysing global environmental hazards and their causes as well as means to correct the course of the development; assessing the cycles of substances and energy in the environment and production systems and learning how to save energy and raw materials. Examples of successful practices will be incorporated into instruction and the school's everyday life.

The importance of environmental education at different stages in life is also highlighted, from children attending day-care to senior citizens. As to climate change issues, the youngest age groups can only be indirectly involved, i.e. through the training and increased awareness of their parents and carers. In some other sectors, e.g. in waste handling, environmental education can be started much earlier.

In basic education, all pupils get an insight into climate change and its causes and consequences. Participation in measurements and other practical exercises is of vital importance. At upper secondary schools, a more detailed view of climatic issues is given. The general principle is that climatic issues are integrated into the teaching of all subjects, not only e.g. physics and biology. The matriculation examination has often contained questions related to climate change. In vocational education, e.g. air quality themes are discussed.

The National Core Curriculum for Upper Secondary Schools (2003) also highlights a number of sustainability and climate-related issues:

- familiarity with the key factors of the ecological, economic, social and cultural dimensions of sustainable development
- knowledge on how to measure, assess and analyse changes occurring in both the natural environment and the cultural and social environments
- ability and willingness to act for sustainable development in their own everyday life and as students, consumers and active citizens
- ability to co-operate for a better future at local, national and international levels.

Climate change education is enhanced by local, national and global projects at schools. The topic of a local project may at its simplest be "The climatic impact of our school". Nationwide projects may involve e.g. theme days, campaigns or competitions. The international GLOBE Programme was initiated at Finnish schools in 1995; after ten years, some 125 schools are still active. Teachers have generated innovative applications of GLOBE to improve their working conditions and created small effective networks between colleagues from different schools in Finland and abroad.

Climate issues have also been dealt with in the Environment and School Initiative (ENSI) of the OECD, in UNESCO's Baltic Sea Project, and in the Baltic 21 E Programme. The goal of the ENSI is to support educational developments that promote environmental understanding through research and the exchange of experiences internationally. The teaching of climate change has been one of the major topics in the "Knowledge Forum" of ENSI on the Internet.

At universities, the teaching related to climate change is closely tied to the research in this field, as described in Section 8.2. Climate issues are also dealt with in connection with multidisciplinary topics of environmental education, which are available for students in the programmes for class-room teachers as well as subject teachers. However, only a fraction of teachers outside natural sciences have adequate pedagogical background in the issues of sustainable development and climate change.

The Finnish National Commission on Sustainable Development has established a Sub-committee on Education for Sustainable Development for the period 2003–2007. Its main task is to prepare a new national strategy to promote sustainable development in the education system.

The Finnish national strategy for the UN Decade of Education for Sustainable Development (DESD 2005-2014) is being prepared. The strategy will be based on the UNECE Strategy for ESD and the Baltic 21E Programme. The latter one was adopted in 2002 and has been implemented in Finland on an experimental basis.

9.2 Increasing public awareness

9.2.1 Government's activities

A leading principle of the Government's activities in climate policy is to inform the public about all activities and decisions in an open, transparent way. A broad-based Climate Forum led by the Ministry of the Environment has the special task of promoting awareness on climate change issues. The Forum has some 60 members representing different ministries, industrial and environmental NGOs, research institutes and labour unions. The meetings are an opportunity for information sharing and exchange of views. The Climate Forum also organises public seminars, which deal with e.g. topics of coming climate negotiations. These seminars are well attended and also usually attract media interest.

Several ministries have disseminated public information relevant to combating the climate change and adjusting to it. This activity has taken place both as campaigns and on a continuous basis. The information provided is based on the sector-specific work in each ministry. The ministries have environmental websites with up-to-date information about a variety of issues related to climate change. For example, the summaries of the IPCC TAR working groups and the ACIA programme were translated into Finnish and made available via the Internet. On the other hand, it is a common situation that ministry personnel do not have the time and the opportunity to respond to all information needs of either the media or individual citizens.

The co-operation between different ministries was enhanced in 2002, when a special publicity programme, the Climate Change Communications Programme, designed to increase awareness of issues related to climate change in Finland was started. The need for such a programme was expressed in the National Climate Strategy 2001. The programme consists of various publicity campaigns designed to inform the public about the likely impacts of climate change, and what must be done to curb climate change. Campaigns are aimed at various groups and organisations, including energy companies, waste management firms, local authority officials, teachers, and entrepreneurs in the agriculture and forestry sectors.

Up to the end of 2004, the Climate Change Communications Programme put forward 132 project proposals, of which 30 were approved. The funding resources granted to them have totalled EUR 0.73 million. The projects have enabled the latest knowledge provided by researchers and other experts to be shared with the various participants. Projects between different participants and collaboration between different projects have improved the dissemination of information and encouraged new ways of working.

The Climate Change Communications Programme has produced information packs and events targeted mainly at professionals, particularly those in the field of information and public relations, in various sectors. In addition to material on climate change, communication methods and development of communication skills are a prominent part of the programme.

Two funding rounds will be organised in 2005, the focus being on how best to reach ordinary consumers. During 2005, the consumer campaigns of other countries and the experiences gained from them will also be reviewed. The Climate Change Communications Programme will continue at least until the end of 2006. In future years the programme's own information channels will extend to run parallel with project operations.

The programme is co-ordinated by the Ministry of Trade and Industry and run by Motiva Oy. Other participating organisations are the Ministry of the Environment, the Ministry of Transport and Communications, the Ministry of Agriculture and Forestry and the National Board of Education. The steering group consists of climate change experts and communications experts from the participating ministries.

The Ministry of Transport and Communications and the Ministry of Trade and Industry are funding two campaigns aiming at awareness-raising and change in transport behaviour. First of all, in 2005 a two-year-campaign "Malttia teille/Be patient on the road" was launched with the aim to provide enhanced ecodriving training for 1,000 professional heavy duty vehicle drivers and for 1,500 passenger car drivers. Second, another campaign covering the years 2005–2007 was launched on promoting mobility management at the local and regional levels. Both of these campaigns are conducted by Motiva in collaboration with some other partners.

Climate Change Communications Programme; projects 2002–2004

General communication and information

Enjoy the weather – your choices affect the climate
The project produced information bulletins on the effect of everyday choices on climate change. Climate Marthas provided advice on possible lifestyle changes. **The Martha Organization** / *www.marttaliitto.fi*

Citizen, natural environment and climate change
The project produced a leaflet on the effects of climate change on the Finnish natural environment. The leaflet also makes suggestions on how everyone can help slow down the change through their own actions. **WWF Finland** / *www.wwf.fi*

Yard talk – climate change and households
The project employs many different methods to impart information on the effects of households on climate change. The target groups are housing service managers, service companies and households. Discussion forum Energia-Esteri www.energiaesteri.fi. **The VVO Group and ASRA ry** / *www.vvo.fi*

Clean air – is it?
The project produced a 30-minute information programme on climate change for the deaf using Finnish sign language. **The Finnish Association of the Deaf** / *jari.heiskanen@kl-deaf.fi*

Radio programmes on climate change
The project produced 12 radio documentaries on climate change. **Uudenmaan ympäristönsuojelupiiri (Uusimaa environmental protection group)** / *Silja Sarkkinen*

Science in aid of environmental and human well-being
The project produced a five-part TV series on climate change, which was shown within the YLE Prisma science programme. **Rec Button Oy** / *Eija Lehmuskallio*

The Venus Theory
The project produced a documentary film, *The Venus Theory*, about climate change as a phenomenon, its effects and associated risks. **Talent House** / *Pasi Toiviainen*

www.ilmasto.org
The project developed a website *www.ilmasto*.org, which was assembled by public organisations to report on climate change from various perspectives. **Friends of the Earth Finland** / *toimitus@ilmasto.org*

<u>**Education and research**</u>

Material to mull over the climate debate
The project created an information package to improve the public's ability to understand and critically analyse the debate on climate change. The material was tested at upper secondary schools. **Finnish Environment Institute SYKE** / *jari.lyytimaki@ymparisto.fi*

Ilmari – climate information for schools
The project helps environmental organisations i) to train climate messengers who visit comprehensive and upper secondary schools, ii) to organise information events, and iii) to encourage young people to participate in climate projects. In 2004–2005, almost 200 school visits were made. The material is assembled at *www.ilmasto.org*. **Youth Academy and youth environmental organisations** / *kirsi.airaksinen@nuortenakatemia.fi*

Climate chill-out time!
The project collected together teaching material on climate change, produced educational material, exercises and tips for teachers, and trained comprehensive school and upper secondary school teachers. **Suomen Ympäristökasvatuksen Seura ry (Finnish association for environmental education)** / *www.sykse.net*

Climate change – challenge for research and education
The project organised a seminar for the purpose of disseminating information between different fields of research, improving co-operation between researchers, and stimulating public debate. **Finnish Air Pollution Prevention Society** / *www.netlife.fi/isy*

Change of air
The project created the Change of Air Internet School, which imparts information on the effects of climate change on the everyday lives of people, businesses and the national economy. The project also included training for teachers. **The Economic Information Office** / *www.tat.fi*

Climate change in South-West Finland
The project collects the climate actions and plans into a body of study material, to be published on the YLE Green Path website. A series of lectures on climate change were organised for students. **Efektia Oy, Energy Agency of South-West Finland, Turku Polytechnic and YLE Forum** / *henna.hauta-heikkila@efektia.fi*

Is our climate warming up?
The project organised an exhibition with this title at the Heureka Science Centre. The exhibition reviewed recent developments in modern climate research and opportunities for making an impact available to people, particularly young people. After the exhibition, the schematic models were also transferred to the Change of Air Internet School. **The Finnish Science Centre (Heureka)**, *www.heureka.fi*

Local authorities and other regional agents

Climatic effects of scattered settlement
The project produced leaflet material for local authority representatives and construction professionals on the effects of scattered populations on climate change. **The Association of Finnish Local and Regional Authorities** / *www.kunnat.net, www.kuntaliitto.fi*

Information on climate change for local authorities
The project assembled an advisory network, with the remit of activating local authority representatives and employees through provision of information and expert services on climate change. **The Association of Finnish Local and Regional Authorities** / *www.kunnat.net, www.kuntaliitto.fi*

Climate information in Turku
The project provided information on climate change and its mitigation by collecting material and organising information workshops for employees, officials and decision-makers of the City of Turku. **Energy Agency of South-West Finland** / *liisa.harjula@vsenergiatoimisto.fi*

From theory to practice in Kuopio
The aim of the project was to promote the implementation of Kuopio climate strategy through advice, education and information. The target group covered everyone from individual city residents to entrepreneurs and decision-makers. **Environmental Centre of the City of Kuopio** / *www.kuopio.fi*

Energy and waste sector

Energy and the climate
The project produces educational material and provides training on the effects of energy production and energy consumption on climate change for the customer service personnel of energy companies. **The Association of Finnish Energy Industries** / *pekka.tiusanen@energia.fi*

Climate issues and waste advisory services
The project organised seminars and educational events and produced material on climate change and waste e.g. through story telling. The target group included waste advisers and other personnel involved in information services in the sector. **Finnish Solid Waste Association** / *www.jly.fi/ekoteho*

Effluent treatment and the climate
The project aimed to create an information pack to include the climatic effects of biogas production from effluent decomposition, and the principal methods of exploiting biogases in energy production. **Technology Centre Hermia Ltd, Sentre – Kestävien energiaratkaisujen keskus (Centre for sustainable energy solutions)** / *jussi.orhanen@sentre.fi*

Figure 9–1 Is our climate warming up? Children can find it out themselves at the Heureka Science Centre. (Photo: Climate Change Communications Programme)

Public events waste management
The project provides information on the organisation of waste management at public events, and the effect of waste sorting on climate change. The target group consists of event organisers, as well as the general public. **Garbage Gang** / *www.roskajoukko.com*

Other activity sectors

Regional traffic forums
The project organised events and happenings schools, workplaces and residents' associations in Jyväskylä. The purpose was to seek solutions for the promotion of public transport and light transport, and for the reduction of private motoring. **Suunnitteluverkko a4 / (Planning network a4), City of Jyväskylä, Central Finland Regional Environment Centre** / *www.jyvaskyla.fi/liikenne/alf/*

Climate change – challenge in construction
The aim of the project was activation of construction professionals, particularly subcontractors, to seek information on climate issues. **The Finnish Association of Building Owners and Construction Clients** / *www.rakli.fi*

Climate change and forestry
The project produced a brochure and information pack for forestry professionals and forest owners. **Forestry Development Centre Tapio** / *www.tapio.fi*

Service sector action for climate
The aim of the project was to involve small businesses in the Tampere region, such as shoe, bicycle and machinery repair shops, in the prevention of climate change. **Ekokumppanit Oy, Moreenia** / *suvi.holm@tt.tampere.fi*

Seminars for forestry professionals
The project organised six seminars intended for forestry professionals in different parts of Finland. **North Karelia Polytechnic, Forestry Development Centre Tapio** / *kari.kuokkanen@ncp.fi*

Options for sustainable transport
The project collected information on sustainable transport and alternatives to private motoring, as well as links to other web services, e.g. public transport route guides. The target groups were young adults of the Helsinki region and anyone interested in available transport options. **WSP LT Consultants Ltd** / *maija.stenvall@wspgroup.fi*

The farmer and climate change
The project produced a leaflet and educational material on emissions caused by agriculture and means of reducing them. The target group consisted of farmers, and teachers and advisers in the agricultural sector. **MTT Agrifood Research Finland** / *www.mtt.fi*

Additional information on the programme and projects:
www. ilmastonmuutos.info

9.2.2 Other activities

Motiva has a number of activities which increase public awareness in climate issues. It produces and distributes information about energy saving and renewable energy technologies for households, enterprises and communities. Its means of information dissemination include www-service, brochures, guides and publications, seminars and workshops, fairs and exhibitions. Motiva also supports other organisations in the production of information material and introduction of new action models.

Motiva launched the Annual Energy Awareness Week in 1996. Close on 600 companies took part in the week in 2003. The companies promote energy efficiency by sponsoring the primary schools taking part in the week; over 30,000 pupils participated in 2003.

Climate issues are also included in the information distributed by FINERGY, the Finnish Energy Industries Federation. They give advice about household energy saving through Adato, which is the energy branch's publishing, training and information company. Consumers can e.g. calculate their electricity consumption and its distribution by a simple ElectricityDoctor program.

The municipal sector works in Finland in different ways to reduce greenhouse gas emissions and to increase public awareness of climate change issues. The responsibility of municipalities in energy production, traffic, land use planning and waste management is significant in Finland. By arranging surveys or opinion polls the municipalities are able to plan their actions which aim at e.g. reducing greenhouse gas emissions in an appropriate way, and find effective methods to proceed.

Municipalities can reduce their emissions in a number of ways. Among these, saving of energy, increasing the share of renewable energy sources, in-

Figure 9–2 Snowmen against Global Warming in front of the Finnish Parliament. (Photo: Friends of the Earth Finland).

tensification of energy production, and efficient waste management are the easiest to introduce. Other ways include public procurements, promotion of new technology in small area and distance heating, energy audits, and energy services provided to real estate companies by heating contractors.

The Association of Finnish Local and Regional Authorities (AFLRA) – a co-operation and interest body of the municipalities – is running a special climate campaign together with 48 local authorities, who together account for almost half of the population of Finland. Many local authorities conduct basic analytical work contributing to calculations of greenhouse gas emissions while also drafting their own programmes to help curb emissions.

The services of the Finnish Meteorological Institute (FMI) are divided into government-funded basic services and commercial services. An essential element of the former is the production of high-quality general information on the past, present and future state of the atmosphere. Public interest in climate and weather has increased in recent years, and the web pages of the FMI are also very popular (23 million visits in 2003). The library of the FMI has by far the largest collection of climate-related publications and magazines in the country.

The Finnish National IPCC Committee, chaired by a representative from the FMI, organises public seminars. Themes for the seminars come from the work of the IPCC. The Committee also had the TAR summaries for policy makers translated into Finnish. These texts are available through the web pages of several relevant institutions.

Several environmental NGOs have been active and innovative in raising public awareness. They maintain extensive websites on climate, greenhouse gases and related topics. They have also arranged seminars, photo exhibitions and campaigns. As an example, Friends of the Earth Finland held a demonstration of "Snowmen against Global Warming" in 17 municipalities in February 2005 (Fig. 9–2).

9.3 *Climate change in the Finnish media*

Climate change issues have been extensively dealt with in the Finnish media since the early 1990s. The coverage was partly stimulated by SILMU, whose administrators and scientists provided information for television programmes and for a number of newspaper articles. A period of mild winters from the late 1980s until the late 1990s strengthened the public interest in climate change issues.

After the Kyoto Protocol and the subsequent burden sharing by the EU were agreed upon, the climate discussion in Finnish newspapers was analysed by Luukkanen and others (2000). The discussion consisted of two phases: (i) the commitment to the zero-reduction objective, and (ii) the means for reaching the target. The first phase was quite polarised: one group considered the zero-reduction target to be too tight for Finland, the other group considered it as the minimum requirement. The former group consisted of representatives of several ministries, energy companies and energy-intensive industries, the latter included representatives from the Ministry of the Environment, the Green Party and environmental NGOs.

The discussion about the means for reaching the target was divided into two discourses. Competitiveness of industry was the central concern in one discourse, while the other discourse saw renewable energy sources and structural change as a possible means.

The discussion and political debate on the construction of a new nuclear power plant was very lively in Finland in the late 1990s. It also served as a major factor increasing the interest of the media and public awareness on climate issues. The Climate Strategy of 2001 also inspired debate and discussion. When the Finnish Parliament finally approved the construction of the nuclear power plant, after a close voting in June 2002, the situation became more settled in Finland.

The initiative to launch the EU-wide emission trading system started a next wave of public debate in 2002, and the coverage of climate issues remained high in Finnish media. The newspapers have discussed these issues in numerous articles in recent years. The articles tend to cluster at the times of intense weather events like heavy rains and storms, or when new scientific results are presented. The publication of the ACIA assessment in November 2004 inspired a lively scientific discussion. The enforcement of the Kyoto Protocol in February 2005 also peaked the media interest.

The Climate Change Communications Programme (CCCP) analysed 1,264 articles, published in Finnish newspapers on climate change issues in January–September 2004. Some 45% of the articles dealt with climate research, 13% were columns and opinions, 13% discussed climate politics, 11% emissions and emissions trading. CCCP and other campaigns were the topics of 16% of the articles. Two per cent of the articles were written contributions of those with a sceptical attitude to the significance of human role in climate change.

The scientific knowledge on climate change has also been made widely available to the citizens. After the five years of the SILMU programme, a book spanning across the programme's activities and results was published in Finnish (Kuusisto et al. 1996). The results of the CLIMTECH and FIGARE programmes were also made available for the general public

Figure 9–3 Climate change issues have also aroused the interest of some entrepreneurs; the 'Kasvihuoneilmiö' *(Greenhouse Effect)* is a large roadside shop and service station halfway between Helsinki and Turku.

(Savolainen et al. 2003, Kuusisto and Käyhkö 2004). The Finnish television has frequently shown documentary programmes and arranged debates on climate issues.

Several cultural events and exhibitions related to climate change have also been arranged in Finland. The Heureka Science Centre had an impressive exhibition on this theme already in 1996; afterwards it appeared at other venues in Finland. WWF Finland arranged an international photo exhibition "Images Beyond the NAKED EYE" in Helsinki in 2000, demonstrating different aspects of climate change from the viewpoints of man and nature. In 2002, the Arctic Centre had an exhibition '*Glaciers – Frozen Assets*' in Lapland, presenting various aspects of ice research and climate change at high latitudes. In 2004, the Arctic Centre organised an event '*The Snow Show 2004*' , where international artists and architects paired up to design experimental works of snow and ice. The artists included e.g. Yoko Ono, Anish Kapoor and Zaha Hadid.

9.4 People's views and attitudes

Several surveys have been made to find out what people in Finland think about climate change issues. For the Science Barometer 2004 of the Finnish Society for Scientific Information, 2,500 people aged 18–70 were interviewed. Although the survey covered the science as a whole, questions relating to climate change were also presented. The great majority (84%) agreed with the statement "*Climate change is a real and serious threat and political decision-makers need to take effective action against it*". Disagreement with the statement did not rise above 10% in any of the population groups.

Only 25% of the people thought science might be able to find the means to arrest or slow down climate change, nearly half (45%) were sceptical. On the other hand, the people who believed that science can prevent environmental pollution or even improve the condition of the environment (45%) outnumbered those who did not share this opinion (32%).

The capacity of the respondents to take in scientific knowledge in principle was significantly high. This was demonstrated by the opinion held by 73% of the respondents that "*The media should offer more information on science than it does now*". This demand was strong also in the previous survey in 2001, and it seems to be broadly agreed with throughout society.

A survey focusing on climate issues was made in December 2004. It was carried out by Taloustutkimus Oy, and commissioned by the Ministry of Trade and Industry. About a thousand people were interviewed, aged 15–79.

This survey, *Citizens' views of the climate change*, indicates that the Finns know the global effects of the climate change quite well and are worried about them. Heavy rains, floods and storms were considered as a very serious threat by 50% of the respondents, while 36% considered them fairly serious. The next most alarming consequences were increased poverty in developing countries, damages by insects and pathogens, and serious droughts.

Many people expressed their willingness to act in order to mitigate the climate change; only few respondents (4%) believed that they themselves could not contribute in any way. Of the individual issues, sorting and recycling of waste were the most interesting ones, as 88% of the respondents were very or quite ready to participate in these actions. Energy conservation (85%), composting of organic waste (80%), reduction of consumption and waste (80%) and the use of renewable energy sources in heating (74%) were also considered to be among suitable methods for mitigating the climate change. Buying eco or 'ringed seal' electricity and reducing motoring were the least interesting alternatives.

In most cases women were more willing to take action than men. The readiness also varied according to age. For instance, sorting and recycling of waste do not interest the 15–24-year-olds as much as they do more aged citizens who, again are, unlike the young, not willing to make use of the new ways of life provided by technology, such as telework.

Besides the readiness to take action, the study also charted the respondents' views of the effects of the climate change with regard to their own lives. The loss of 'good, old winters' was mentioned most often, by 24% of people. Almost half of the respondents did not mention any effect.

One more poll, conducted by TNS Gallup Oy on behalf of the Finnish Energy Industries Federation (Finergy) in 2004, showed that 46% of Finns supported using nuclear energy, while 25% had a negative opinion of it and 29% were neutral. The gap between the supporters and opponents was wider than in any previous poll during twenty-two years. The support was above the average among men (63%), farmers (55%), the highly educated (54%), office workers (50%) and people aged over fifty (50%).

9.5 Participation in international activities

As already discussed, Finland has participated in several climate-related international efforts, such as the GLOBE Programme and the Cities for Climate Protection Campaign of the ICLEI. Some Finnish projects in developing countries have also aimed at increasing public awareness of climate change issues. Likewise, most Finnish forestry projects in developing countries try to promote sustainable forest management practices through higher public awareness.

The Climate Change Communications Programme has had some contacts in Europe. Some of the projects of the programme have been presented in international conferences, and there has been some co-operation with the corresponding Swedish campaign.

Finland was active in the preparation of the ACIA assessment, and will also participate in the International Polar Year 2007–2008, which will be a good opportunity to increase awareness of climate change and its impacts at high latitudes.

LITERATURE

Kuusisto, E., Kauppi, L. and Heikinheimo, P. 1996. Ilmastonmuutos ja Suomi (Climate change and Finland). Helsinki University Press, 265 p.

Kuusisto, E. and Käyhkö, J. 2004. Globaalimuutos (*Global Change*). Otava, Helsinki, 170 p. (*in Finnish*)

Luukkanen, J., Kaisti, H., Perimäki, A., Tirkkonen, J., Vehmas, J. and Karppi, I. 2000. Kohti hyväksyttävää ilmastostrategiaa. (Summary: Acceptable climate policy. Analysis of actor views of possibilities and alternatives of Finnish climate policy). *Suomen ympäristö 474*, Helsinki.

National Board of Education. 2004. National Core Curriculum for Basic Education. Edita, Helsinki, 320 p.

Savolainen, I, Ohlström, M. and Kärkkäinen, A. 2003. Ilmasto - Haaste teknologialle. Näkemyksiä ja tuloksia Climtech-ohjelmasta (Climate – a challenge to technology. Views and results of the CLIMTECH Programme). Edita, Helsinki, 208 p. (*in Finnish*)

Abbreviations

ACEA	European Automobile Manufacturers Association
ACIA	Arctic Climate Impact Assessment
AFLRA	Association of Finnish Local and Regional Authorities
AMAP	Arctic Monitoring and Assessment Programme
BALTEX	Baltic Sea Experiment
BASIS	Barents Sea Impact Study
BAT	Best Available Techniques
CAA	Civil Aviation Administration
CCP	Cities for Climate Protection
CDM	Clean Development Mechanism
CGIAR	Consultative Group on International Agricultural Research
CHIP	Changing Climate and Impact on Potato Yield and Quality
CHP	Combined Heat and Power Production
CIS	Commonwealth of Independent States
CLIMTECH	Technology and Climate Change Programme
COP	Conference of Parties
CRF	Common Reporting Format
DREMFIA	Dynamic Regional Sector Model of Finnish Agriculture
EC	European Community
ECCP	European Climate Change Programme
EFI	European Forest Institute
EFTA	European Free Trade Association
EMAS	Eco-management and Audit Scheme
EMU	European Monetary Union
ETLA	Research Institute of the Finnish Economy
ETSAP	Energy Technology Systems Analysis Programme
EU	European Union
EUMETSAT	European Meteorological Satellite Organisation
FFCS	Finnish Forest Certification System
FIBRE	Finnish Biodiversity Research Programme
FIGARE	Finnish Global Change Research Programme
FIMR	Finnish Institute of Marine Research
FMI	Finnish Meteorological Institute
FINSKEN	Developing Consistent Climate Scenarions for Finland
GAW	Global Atmospheric Watch
GCM	Global Circulation Model
GCOS	Global Climate Observing System
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GTAP	Global Trade Analysis Project
HELCOM	Helsinki Commission
HFCs	Hydrofluorocarbons
IASC	International Arctic Science Committee
ICAO	International Civil Aviation Organisation
ICLEI	International Council for Local Environmental Initiatives
IEA	International Energy Agency
IGBP	International Geosphere-Biosphere Programme
IPALAC	International Program for Arid Land Crops
IPCC	Intergovernmental Panel on Climate Change
IMO	International Maritime Organisation
IUCN	World Conservation Union

JAMA	Japanese Automobile Manufacturers Association
JI	Joint Implementation
KAMA	Korean Automobile Manufacturers Association
LDC	Least Developed Countries
LULUCF	Land Use, Land-Use Change and Forestry
METLA	Finnish Forest Research Institute
MINTC	Ministry of Transport and Communications
MoU	Memorandum of Understanding
MTI	Ministry of Trade and Industry
MTT	Agrifood Research Finland
NACD	North Atlantic Climatological Data Set
NARP	Nordic Arctic Research Programme
NCS	National Climate Strategy
NDF	Nordic Development Fund
NEMO	Advanced Energy Systems and Technologies
NFI	National Forest Inventory
NFP	National Forest Programme
NGO	Non-Government Organisation
NMVOC	Non-Methane Volatile Organic Compounds
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
OTC	Over The Counter
PCF	Prototype Carbon Fund
PEFC	Pan-European Forest Certification
PFCs	Perfluorocarbons
PISA	Programme for International Student Assessment
QA	Quality Assurance
QC	Quality Control
R&D	Research and Development
SBI	Subsidiary Body for Implementation
SBSTA	Subsidiary Body for Scientific and Technological Advice
SILMU	Finnish Research Programme on Climate Change
SITRA	Finnish National Fund for Research and Development
SUNARE	Research Programme on Sustainable Use of Natural Resources
SWECLIM	Swedish Regional Climate Modelling Programme
SYKE	Finnish Environment Institute
TAR	Third Assessment Report (of IPCC)
TEKES	National Technology Agency
TFESSD	Trust Fund for Environmentally and Socially Sustainable Development
TGF	Testing Ground Facility (of the Baltic Sea Region Energy Co-operation)
TPES	Total Primary Energy Supply
TUNDRA	Tundra Degradation in the Russian Arctic
UNCBD	United Nations Convention on Biological dDiversity
UNCCD	United Nations Convention to Combat Desertification
UNCED	United Nations Conference on Environment and Development
UNFCCC	United Nations Framework Convention on Climate Change
UNFF	United Nations Forum on Forests
VATT	Government Institute for Economic Research
VTT	Technical Research Centre of Finland
WCRP	World Climate Change Programme
WMO	World Meteorological Organisation
WSSD	World Summit on Sustainable Development
WWF	World Wildlife Fund

Units and conversion factors

Conversion Factors between Energy Units

	toe	MWh	GJ	Gcal
toe	1	11.63	41.868	10
MWh	0.086	1	3.6	0.86
GJ	0.02388	0.2778	1	0.2388
Gcal	0.1	1.163	4.1868	1

Example: 1 toe = 11.63 Mwh

Prefix

k	= kilo	$=10^3$	=1 000
M	= mega	$=10^6$	=1 000 000
G	= giga	$=10^9$	=1 000 000 000
T	= tera	$=10^{12}$	=1 000 000 000 000
P	= peta	$=10^{15}$	=1 000 000 000 000 000

Key category analysis for base year (1990) and latest inventory year (2003) according to Tier 2 method.

IPCC Source Categories	Direct GHG	Key Category in 1990	Criteria	Key Category in 2003	Criteria
1.A. Fuel Combustion					
Liquid fuels	CO_2	YES	L	YES	L, T
Solid fuels	CO_2	YES	L	YES	L, T2
Gaseous fuels	CO_2	NO		NO	
Other fuels	CO_2	YES	L	YES	L, T2
1.A 1. Energy Industries					
Liquid fuels	CH_4	NO		NO	
	N_2O	NO		NO	
Solid fuels	CH_4	NO		NO	
	N_2O	NO		NO	
Gaseous fuels	CH_4	NO		NO	
	N_2O	NO		NO	
Biomass	CH_4	NO		NO	
	N_2O	NO		NO	
Other fuels	CH_4	NO		NO	
	N_2O	NO		YES	L2
1.A 2. Manufacturing Industries and Construction					
Liquid fuels	CH_4	NO		NO	
	N_2O	NO		NO	
Solid fuels	CH_4	NO		NO	
	N_2O	NO		NO	
Gaseous fuels	CH_4	NO		NO	
	N_2O	NO		NO	
Biomass	CH_4	NO		NO	
	N_2O	NO		NO	
Other fuels	CH_4	NO		NO	
	N_2O	NO		NO	
1.A 3. Transport					
a. Civil Aviation	CH_4	NO		NO	
	N_2O	NO		NO	
b. Road Transportation					
Gasoline	CH_4	NO		NO	
Cars with Catalytic Converters	N_2O	NO		YES	L, T
Cars without Catalytic Converters	N_2O	NO		YES	T2
Diesel	CH_4	NO		NO	
	N_2O	NO		NO	
Natural gas	CH_4	NO		NO	
	N_2O	NO		NO	

IPCC Source Categories	Direct GHG	Key Category in 1990	Criteria	Key Category in 2003	Criteria
c. Railways	CH_4	NO		NO	
	N_2O	NO		NO	
d. Navigation					
Residual Oil & Gas/Diesel Oil	CH_4	NO		NO	
	N_2O	NO		NO	
Gasoline	CH_4	NO		NO	
	N_2O	NO		NO	
e. Other Transportation					
Liquid fuels	CH_4	NO		NO	
Gasoline	N_2O	NO		NO	
Diesel	N_2O	NO		NO	
1.A 4. Other Sectors					
Liquid fuels	CH_4	NO		NO	
	N_2O	NO		NO	
Solid fuels	CH_4	NO		NO	
	N_2O	NO		NO	
Gaseous fuels	CH_4	NO		NO	
	N_2O	NO		NO	
Biomass	CH_4	YES	L	YES	L
	N_2O	NO		NO	
Other fuels	CH_4	NO		NO	
	N^2O	NO		NO	
1.A 5 Other					
Liquid fuels	CH_4	NO		NO	
	N_2O	NO		NO	
Gaseous fuels	CH_4	NO		NO	
	N_2O	NO		NO	
1.B. Fugitive Emissions from Fuels					
1.B 1 Solid Fuels					
Peat production areas	CO_2	YES	L	YES	L, T
Peat production areas	CH_4	NO		NO	
1.B 2. Oil and Natural Gas					
Flaring	CO_2	NO		NO	
Oil refining	CH_4	NO		NO	
Gas transmission	CH_4	NO		NO	
Gas distribution	CH_4	NO		NO	
2. Industrial Processes					
2.A 1. Cement Production	CO_2	NO		NO	
2.A 2. Lime Production	CO_2	NO		NO	
2.A 3 Limestone and Dolomite Use	CO_2	NO		NO	
2.A 4 Soda Ash Use	CO_2	NO		NO	
2.B 2 Nitric Acid Production	N_2O	YES	L	YES	L, T
2.B 5 Other: Ethylene	CH_4	NO		NO	

IPCC Source Categories	Direct GHG	Key Category in 1990	Criteria	Key Category in 2003	Criteria
2.B 5 Other: Hydrogen Production	CO_2	NO		NO	
2.C Iron and Steel production	CH_4	NO		NO	
2.F 1. Refrigeration and Air Conditioning Equipment	HFCs, PFCs	NO		YES	T2
2.F 2 Foam Blowing	HFCs	NO		NO	
2.F 4 Aerosols	HFCs	NO		NO	
2.F 7 Electrical Equipment	SF6	NO		NO	
2.F Other (grouped data)	HFCs PFCs SF6	NO		NO	
3. Total Solvent and Other Product Use	N_2O	NO		NO	
4. Agriculture					
4.A. Enteric fermentation	CH_4	YES	L	YES	L, T
4.B. Manure management	CH_4	NO		NO	
4.B. Manure management	N_2O	YES	L	YES	L2, T
4.D. Agricultural soils: direct emissions, animal production and sludge spreading	N_2O	YES	L	YES	L, T
4.D. Agricultural soils: indirect emissions	N_2O	YES	L	YES	L, T
5. LULUCF					
5.A 1. Forest Land remaining Forest Land					
carbon stock change in living biomass	CO_2	YES	L1	YES	L1, T1
5.B 1. Cropland Remaining Cropland					
net carbon stock change in soils: mineral	CO_2	YES	L1	YES	L1, T1
net carbon stock change in soils: organic	CO_2	YES	L1	YES	L1, T1
5.C 1. Grassland Remaining Grassland					
net carbon stock change in soils: mineral	CO_2	YES	L1	YES	L1, T1
net carbon stock change in soils: organic	CO_2	NO		NO	
5 (I) Direct N_2O Emissions from N Fertilization	N_2O	NO		NO	
5 (IV) Carbon Emissions from Agricultural Lime Application	CO_2	NO		NO	
5 (V) Biomass Burning					
Forest Land	CO_2	NO		NO	
	CH_4	NO		NO	
	N_2O	NO		NO	
6. Waste					
6.A. Solid Waste Disposal on Land	CH_4	YES	L	YES	L, T

IPCC Source Categories	Direct GHG	Key Category in 1990	Criteria	Key Category in 2003	Criteria
6.B 1 Industrial Wastewater	CH_4	NO		NO	
6.B 2 Domestic and Commercial Wastewater					
sparsely populated areas	CH_4	NO		NO	
densely populated areas	CH_4	NO		NO	
sparsely populated areas	N_2O	NO		NO	
densely populated areas	N_2O	YES	L2	YES	T2
6.B 3. N input from Fish Farming	N_2O	NO		NO	
6.B 3. N input from industrial wastewater	N_2O	NO		NO	
7. Other - non-energy use of fuels	CO_2	YES	L2	YES	L

1L=level, T=trend, 1=only with LULUCF, 2=only without LULUCF.

Summary tables of 2003 emissions

The CRF tables contain minor inconsistencies compared to the figures given elsewhere in the report due to shortcomings in the used software (CRF Reporter version 2.17)

(Sheet 1 of 3)

Submission 2006 v1.1
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES		Net CO_2 emissions/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		**55 404.32**	**236.60**	**22.69**	**1 320.18**	**733.06**	**17.82**	**14.86**	**0.01**	**0.00**	**235.84**	**580.80**	**145.02**	**107.85**
1. Energy		**69 676.64**	**21.71**	**3.76**							**235.74**	**577.55**	**104.08**	**97.18**
A. Fuel Combustion	Reference Approach [2]	69 033.83												
	Sectoral Approach [2]	69 554.64	18.78	3.76							235.74	577.55	87.74	97.18
1. Energy Industries		36 266.78	1.29	1.15							61.68	26.55	NO	56.45
2. Manufacturing Industries and Construction		12 037.55	0.59	0.51							59.08	53.18	4.11	26.16
3. Transport		13 102.66	2.79	1.71							85.38	368.89	48.24	2.10
4. Other Sectors		5 983.78	13.94	0.35							24.88	119.95	34.95	7.45
5. Other		2 163.86	0.16	0.05							4.72	8.98	0.44	5.02
B. Fugitive Emissions from Fuels		122.00	2.93	0.00							NA,NO	NA,NO	16.34	NA,NO
1. Solid Fuels		NO	NO	NO							NO	NO	NO	NO
2. Oil and Natural Gas		122.00	2.93	0.00							NA,NO	NA,NO	16.34	NA,NO
2. Industrial Processes		**3 543.52**	**0.70**	**4.58**	**1 320.18**	**733.06**	**17.82**	**14.86**	**0.01**	**0.00**	**IE,NO**	**IE,NO**	**11.51**	**10.67**
A. Mineral Products		1 179.13	NO	NO							NO	NO	1.06	IE,NO
B. Chemical Industry		160.05	0.25	4.58	NA	NO	NA	NO	NO	NO	IE,NO	NO	3.97	2.62
C. Metal Production		2 187.87	0.45	NO				NO		C,NO	IE,NO	IE,NO	1.20	4.83
D. Other Production [3]		16.47									IE	IE	5.29	3.22
E. Production of Halocarbons and SF_6						NA,NO		NA,NO		NO				
F. Consumption of Halocarbons and SF_6					1 320.18	733.06	17.82	14.86	0.01	0.00				
G. Other					NO	NO	NO	NO	NO	NO				

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

Note: All footnotes for this table are given at the end of the table on sheet 3.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 2 of 3)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/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)			
3. Solvent and Other Product Use	63.81		0.13							NO	NO	29.00	NO
4. Agriculture		88.81	12.51							**NA,NE**	**NA,NE**	**NA,NE,NO**	**NE**
A. Enteric Fermentation		76.67											
B. Manure Management		12.15	1.78									NA,NE	
C. Rice Cultivation		NO										NO	
D. Agricultural Soils[4]		NE	10.73									NE	
E. Prescribed Burning of Savannas		NE	NE							NE	NE	NE	
F. Field Burning of Agricultural Residues		NE	NE							NE	NE	NE	
G. Other		NE	NE							NE	NE	NE	NE
5. Land Use, Land-Use Change and Forestry	[5] **-17 879.64**	**0.68**	**0.07**							**0.09**	**3.24**		
A. Forest Land	[5] -25 699.93	0.37	0.04							0.09	3.24		
B. Cropland	[5] 4 172.32	NE	NE							NE	NE		
C. Grassland	[5] 3 010.79	NE,NO	NE,NO							NE	NE		
D. Wetlands	[5] 637.18	0.31	0.03							IE	IE		
E. Settlements	[5] IE,NA,NE	NA,NE	NA,NE							NA	NA		
F. Other Land	[5] IE,NA,NE	IE,NA	IE,NA							NA	NA		
G. Other	[5] NE	NE	NE							NE	NE		
6. Waste	IE,NO	124.70	0.52							**IE,NA,NO**	**IE,NA,NO**	**0.43**	**IE,NO**
A. Solid Waste Disposal on Land	[6] NE	116.07								NA,NO	NA,NO	0.16	
B. Waste-water Handling		6.04	0.35							NO	NO	0.27	
C. Waste Incineration	[6] NE	NE	NE							IE	IE	IE	IE
D. Other	NE	2.59	0.17							NO	NO	NE,NO	NO
7. Other *(please specify)* [7]	**NO**	NO	1.13	NO	NO	NO	NO	NO	NO	**NO**	**NO**	**NO**	**NO**
Other non-specified	NO	NO	1.13	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Note: All footnotes for this table are given at the end of the table on sheet 3.

SUMMARY 1.A SUMMARY REPORT FOR NATIONAL GREENHOUSE GAS INVENTORIES (IPCC TABLE 7A)
(Sheet 3 of 3)

Inventory 2003
Submission 2006 v1.1
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Net CO_2 emissions/removals	CH_4	N_2O	HFCs		PFCs		SF_6		NO_x	CO	NMVOC	SO_2
				P	A	P	A	P	A				
	(Gg)			CO_2 equivalent (Gg)						(Gg)			
Memo Items: [8]													
International Bunkers	**3 108.12**	**0.19**	**0.10**							**50.14**	**4.78**	**1.39**	**21.79**
Aviation	1 076.82	0.03	0.05							2.97	2.05	0.25	0.28
Marine	2 031.30	0.16	0.05							47.17	2.73	1.14	21.51
Multilateral Operations	**NO**	**NO**	**NO**							**NO**	**NO**	**NO**	**NO**
CO_2 Emissions from Biomass	**31 518.07**												

(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 the documentation box to Table 1.A.(c).

(3) Other Production includes Pulp and Paper and Food and Drink Production.

(4) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(5) For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(6) CO_2 from source categories Solid Waste Disposal on Land and Waste Incineration should only be included if it stems from non-biogenic or inorganic waste streams. Only emissions from Waste Incineration Without Energy Recovery are to be reported in the Waste sector, whereas emissions from Incineration With Energy Recovery are to be reported in the Energy sector.

(7) If reporting any country-specific source category under sector "7. Other", detailed explanations should be provided in Chapter 9: Other (CRF sector 7) of the NIR

(8) Countries are asked to report emissions from international aviation and marine bunkers and multilateral operations, as well as CO_2 emissions from biomass, under Memo Items. These emissions should not be included

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

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO_2 [(1)]	CH_4	N_2O	HFCs [(2)]	PFCs [(2)]	SF_6 [(2)]	Total
	CO_2 equivalent (Gg)						
Total (Net Emissions) [(1)]	**55 404.32**	**4 968.67**	**7 035.33**	**733.06**	**14.86**	**62.26**	**68 218.51**
1. Energy	**69 676.64**	**455.89**	**1 166.23**				**71 298.75**
A. Fuel Combustion (Sectoral Approach)	69 554.64	394.29	1 165.63				71 114.56
1. Energy Industries	36 266.78	27.14	356.13				36 650.06
2. Manufacturing Industries and Construction	12 037.55	12.39	158.45				12 208.39
3. Transport	13 102.66	58.66	529.58				13 690.90
4. Other Sectors	5 983.78	292.67	107.00				6 383.46
5. Other	2 163.86	3.42	14.47				2 181.75
B. Fugitive Emissions from Fuels	122.00	61.59	0.60				184.19
1. Solid Fuels	NO	NO	NO				NO
2. Oil and Natural Gas	122.00	61.59	0.60				184.19
2. Industrial Processes	**3 543.52**	**14.66**	**1 420.21**	**733.06**	**14.86**	**62.26**	**5 788.57**
A. Mineral Products	1 179.13	NO	NO				1 179.13
B. Chemical Industry	160.05	5.21	1 420.21	NA,NO	NA,NO	NO	1 585.47
C. Metal Production	2 187.87	9.45	NO	NA,NO	NA,NO	C,NO	2 197.32
D. Other Production	16.47						16.47
E. Production of Halocarbons and SF_6				NA,NO	NA,NO	NO	NA,NO
F. Consumption of Halocarbons and SF_6 [(2)]				733.06	14.86	62.26	810.18
G. Other				NO	NO	NO	NO
3. Solvent and Other Product Use	**63.81**		**40.30**				**104.11**
4. Agriculture		**1 865.04**	**3 877.23**				**5 742.27**
A. Enteric Fermentation		1 609.98					1 609.98
B. Manure Management		255.06	552.43				807.49
C. Rice Cultivation		NO					NO
D. Agricultural Soils[(3)]		NE	3 324.80				3 324.80
E. Prescribed Burning of Savannas		NE	NE				NE
F. Field Burning of Agricultural Residues		NE	NE				NE
G. Other		NE	NE				NE
5. Land Use, Land-Use Change and Forestry[(1)]	**-17 879.64**	**14.35**	**20.29**				**-17 845.00**
A. Forest Land	-25 699.93	7.79	12.06				-25 680.09
B. Cropland	4 172.32	NE	NE				4 172.32
C. Grassland	3 010.79	NE,NO	NE,NO				3 010.79
D. Wetlands	637.18	6.56	8.23				651.98
E. Settlements	IE,NA,NE	NA,NE	NA,NE				IE,NA,NE
F. Other Land	IE,NA,NE	IE,NA	IE,NA				IE,NA,NE
G. Other		NE	NE				NE
6. Waste	**IE,NO**	**2 618.75**	**160.14**				**2 778.89**
A. Solid Waste Disposal on Land	NE	2 437.49					2 437.49
B. Waste-water Handling		126.86	107.32				234.17
C. Waste Incineration	NE	NE	NE				IE
D. Other	NE	54.40	52.83				107.23
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**350.92**	**NO**	**NO**	**NO**	**350.92**

Memo Items: [(4)]							
International Bunkers	3 108.12	3.92	30.97				3 143.01
Aviation	1 076.82	0.58	14.14				1 091.53
Marine	2 031.30	3.35	16.83				2 051.48
Multilateral Operations	**NO**	**NO**	**NO**				**NO**
CO_2 Emissions from Biomass	**31 518.07**						**31 518.07**

Total CO2 Equivalent Emissions without Land Use, Land-Use Change and Forestry[(5)]	86 098.15
Total CO2 Equivalent Emissions with Land Use, Land-Use Change and Forestry[(5)]	68 218.51

(1) For CO_2 from Land Use, Land-use Change and Forestry the net emissions/removals are to be reported. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(2) Actual emissions should be included in the national totals. If no actual emissions were reported, potential emissions should be included.

(3) Parties which previously reported CO_2 from soils in the Agriculture sector should note this in the NIR.

(4) See footnote 8 to table Summary 1.A.

(5) These totals will differ from the totals reported in table 10, sheet 5 if Parties report non-CO_2 emissions from LULUCF.

TABLE 10 EMISSIONS TRENDS (CO_2)

(Sheet 1 of 5)

(Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990) (Gg)	1991 (Gg)	1992 (Gg)	1993 (Gg)	1994 (Gg)	1995 (Gg)	1996 (Gg)	1997 (Gg)	1998 (Gg)	1999 (Gg)
1. Energy	**53 533.04**	**52 640.91**	**51 778.68**	**53 643.28**	**58 889.72**	**55 483.41**	**60 696.00**	**59 678.71**	**56 238.66**	**55 478.90**
A. Fuel Combustion (Sectoral Approach)	53 307.15	52 426.15	51 554.07	53 370.94	58 719.14	55 306.08	60 536.60	59 474.59	56 091.36	55 346.53
1. Energy Industries	19 226.09	18 993.59	18 761.08	21 336.33	26 241.60	24 113.34	29 312.64	27 212.11	23 885.49	23 315.19
2. Manufacturing Industries and Construction	13 136.34	12 696.05	12 250.56	12 359.68	12 528.62	11 894.81	11 700.64	12 159.55	11 990.47	11 803.93
3. Transport	12 548.60	12 174.83	12 101.86	11 657.06	12 029.55	11 841.35	11 782.16	12 374.55	12 507.43	12 694.80
4. Other Sectors	7 061.02	7 106.58	7 033.74	6 569.32	6 227.56	5 773.43	5 885.84	5 909.39	6 005.68	5 922.71
5. Other	1 335.09	1 455.09	1 406.82	1 448.54	1 691.81	1 683.14	1 855.31	1 818.99	1 702.28	1 609.90
B. Fugitive Emissions from Fuels	225.89	214.76	224.62	272.35	170.58	177.34	159.40	204.12	147.31	132.37
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	225.89	214.76	224.62	272.35	170.58	177.34	159.40	204.12	147.31	132.37
2. Industrial Processes	**3 467.86**	**3 197.54**	**2 949.47**	**2 719.31**	**2 999.99**	**2 852.62**	**2 729.97**	**3 269.97**	**3 218.02**	**3 291.44**
A. Mineral Products	1 308.52	1 122.97	1 009.11	911.27	959.48	924.87	958.83	976.73	986.75	1 071.41
B. Chemical Industry	133.70	147.34	111.00	95.64	136.14	117.19	133.40	135.13	124.27	121.92
C. Metal Production	2 009.15	1 912.13	1 814.80	1 697.11	1 888.54	1 795.07	1 623.14	2 142.52	2 091.76	2 083.07
D. Other Production	16.50	15.09	14.56	15.30	15.83	15.50	14.59	15.59	15.24	15.05
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other										
3. Solvent and Other Product Use	115.72	107.03	95.04	87.45	83.49	77.99	73.59	71.83	72.49	70.84
4. Agriculture										
A. Enteric Fermentation										
B. Manure Management										
C. Rice Cultivation										
D. Agricultural Soils										
E. Prescribed Burning of Savannas										
F. Field Burning of Agricultural Residues										
G. Other										
5. Land Use, Land-Use Change and Forestry (2)	**-21 439.86**	**-36 168.24**	**-30 029.71**	**-27 618.46**	**-17 155.37**	**-15 407.83**	**-22 925.89**	**-16 885.54**	**-16 187.95**	**-17 015.33**
A. Forest Land	-27 793.46	-41 764.79	-35 676.18	-33 931.64	-24 297.27	-24 058.26	-31 323.23	-25 274.33	-24 735.27	-25 892.55
B. Cropland	7 416.30	5 613.25	5 437.50	5 428.01	5 239.57	6 901.38	7 129.44	6 707.35	6 130.18	5 800.32
C. Grassland	-1 647.96	-610.03	-409.33	257.09	1 254.22	1 093.85	600.14	1 002.96	1 739.75	2 393.65
D. Wetlands	585.26	593.34	618.31	628.07	648.11	655.21	667.75	678.47	677.40	683.25
E. Settlements	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE
F. Other Land	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**
A. Solid Waste Disposal on Land	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
B. Waste-water Handling										
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
7. Other ***(as specified in Summary 1.A)***	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
Other non-specified	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Total CO2 emissions including net CO2 from LULUCF (3)	**35 676.75**	**19 777.23**	**24 793.48**	**28 831.58**	**44 817.84**	**43 006.20**	**40 573.66**	**46 134.97**	**43 341.22**	**41 825.86**
Total CO2 emissions excluding net CO2 from LULUCF (3)	**57 116.61**	**55 945.47**	**54 823.19**	**56 450.05**	**61 973.21**	**58 414.02**	**63 499.55**	**63 020.50**	**59 529.18**	**58 841.18**
Memo Items:										
International Bunkers	**2 826.24**	**2 630.95**	**2 971.34**	**2 454.10**	**2 118.97**	**1 911.14**	**2 109.33**	**2 248.35**	**2 632.43**	**2 817.67**
Aviation	984.34	917.02	810.63	761.79	801.99	867.40	927.85	964.73	988.44	1 057.97
Marine	1 841.90	1 713.93	2 160.71	1 692.31	1 316.98	1 043.74	1 181.48	1 283.62	1 643.99	1 759.70
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass	19 276.54	18 979.10	18 679.49	22 140.94	22 967.27	22 923.34	23 574.45	26 529.14	27 161.95	29 725.02

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSIONS TRENDS (CO_2)
(Sheet 1 of 5)
(Part 2 of 2)

Inventory 2003
Submission 2006 v1.1
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	%
1. Energy	**54 247.08**	**59 336.19**	**61 792.61**	**69 676.64**	**30.16**
A. Fuel Combustion (Sectoral Approach)	54 116.38	59 213.68	61 665.89	69 554.64	30.48
1. Energy Industries	21 881.19	27 095.61	29 396.77	36 266.78	88.63
2. Manufacturing Industries and Construction	12 096.93	11 584.20	11 565.75	12 037.55	-8.36
3. Transport	12 596.26	12 710.95	12 909.08	13 102.66	4.42
4. Other Sectors	5 640.65	5 914.31	6 005.46	5 983.78	-15.26
5. Other	1 901.35	1 908.62	1 788.83	2 163.86	62.08
B. Fugitive Emissions from Fuels	130.70	122.51	126.72	122.00	-45.99
1. Solid Fuels	NO	NO	NO	NO	0.00
2. Oil and Natural Gas	130.70	122.51	126.72	122.00	-45.99
2. Industrial Processes	**3 409.76**	**3 333.54**	**3 145.56**	**3 543.52**	**2.18**
A. Mineral Products	1 123.55	1 136.05	1 130.65	1 179.13	-9.89
B. Chemical Industry	133.53	129.01	143.44	160.05	19.71
C. Metal Production	2 137.01	2 052.85	1 856.11	2 187.87	8.90
D. Other Production	15.66	15.62	15.35	16.47	-0.13
E. Production of Halocarbons and SF_6					
F. Consumption of Halocarbons and SF_6					
G. Other					0.00
3. Solvent and Other Product Use	70.29	69.04	66.46	63.81	-44.86
4. Agriculture					
A. Enteric Fermentation					
B. Manure Management					
C. Rice Cultivation					
D. Agricultural Soils					
E. Prescribed Burning of Savannas					
F. Field Burning of Agricultural Residues					
G. Other					
5. Land Use, Land-Use Change and Forestry (2)	**-16 324.68**	**-19 062.18**	**-18 902.38**	**-17 879.64**	**-16.61**
A. Forest Land	-25 256.87	-28 081.65	-26 919.67	-25 699.93	-7.53
B. Cropland	5 283.91	5 091.40	4 624.48	4 172.32	-43.74
C. Grassland	2 970.75	3 228.93	2 701.33	3 010.79	-282.70
D. Wetlands	677.53	699.15	691.48	637.18	8.87
E. Settlements	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	0.00
F. Other Land	IE,NA,NE	IE,NA,NE	IE,NA,NE	IE,NA,NE	0.00
G. Other	NE	NE	NE	NE	0.00
6. Waste	**IE,NO**	**IE,NO**	**IE,NO**	**IE,NO**	**0.00**
A. Solid Waste Disposal on Land	NE	NE	NE	NE	0.00
B. Waste-water Handling					
C. Waste Incineration	NE	NE	NE	NE	0.00
D. Other	NE	NE	NE	NE	0.00
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**0.00**
Other non-specified	NO	NO	NO	NO	0.00
Total CO2 emissions including net CO2 from LULUCF (3)	**41 402.45**	**43 676.59**	**46 102.24**	**55 404.32**	**55.30**
Total CO2 emissions excluding net CO2 from LULUCF (3)	**57 727.13**	**62 738.77**	**65 004.63**	**73 283.96**	**28.31**
Memo Items:					
International Bunkers	**3 056.13**	**2 868.68**	**3 085.79**	**3 108.12**	**9.97**
Aviation	1 028.20	1 054.02	1 042.01	1 076.82	9.39
Marine	2 027.93	1 814.67	2 043.78	2 031.30	10.28
Multilateral Operations	NO	NO	NO	NO	0.00
CO_2 Emissions from Biomass	29 708.85	28 909.96	31 092.66	31 518.07	63.50

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSIONS TRENDS (CH_4)
(Sheet 2 of 5)
(Part 1 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Total CH_4 emissions	**305.19**	**304.12**	**303.08**	**303.48**	**301.42**	**294.65**	**291.37**	**287.92**	**278.47**	**272.37**
1. Energy	19.10	20.38	20.97	21.64	22.08	22.02	22.63	22.09	22.15	21.10
A. Fuel Combustion (Sectoral Approach)	18.57	18.40	18.30	18.19	18.26	18.22	18.70	18.68	18.67	18.29
1. Energy Industries	0.40	0.41	0.41	0.45	0.56	0.57	0.65	0.67	0.70	0.73
2. Manufacturing Industries and Construction	0.61	0.55	0.54	0.59	0.61	0.62	0.57	0.63	0.59	0.61
3. Transport	4.77	4.52	4.38	4.20	4.03	3.91	3.74	3.61	3.47	3.35
4. Other Sectors	12.66	12.80	12.87	12.84	12.94	13.00	13.60	13.63	13.79	13.48
5. Other	0.12	0.12	0.11	0.11	0.12	0.12	0.14	0.14	0.13	0.12
B. Fugitive Emissions from Fuels	0.53	1.98	2.67	3.45	3.82	3.80	3.93	3.41	3.47	2.81
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	0.53	1.98	2.67	3.45	3.82	3.80	3.93	3.41	3.47	2.81
2. Industrial Processes	**0.43**	**0.46**	**0.47**	**0.63**	**0.64**	**0.69**	**0.69**	**0.62**	**0.71**	**0.71**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	0.19	0.22	0.22	0.20	0.18	0.23	0.23	0.18	0.25	0.26
C. Metal Production	0.24	0.24	0.25	0.44	0.46	0.46	0.46	0.44	0.46	0.45
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other										
3. Solvent and Other Product Use										
4. Agriculture	**102.33**	**98.32**	**95.44**	**95.44**	**95.90**	**92.12**	**92.62**	**94.24**	**92.29**	**90.93**
A. Enteric Fermentation	91.35	87.88	85.10	84.89	85.00	80.38	80.76	81.74	79.92	78.73
B. Manure Management	10.98	10.43	10.34	10.55	10.89	11.74	11.86	12.50	12.37	12.21
C. Rice Cultivation	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Agricultural Soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E. Prescribed Burning of Savannas	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Field Burning of Agricultural Residues	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
5. Land Use, Land-Use Change and Forestry	**1.06**	**0.60**	**0.85**	**0.50**	**0.76**	**0.67**	**0.57**	**0.73**	**0.47**	**0.68**
A. Forest Land	0.77	0.30	0.54	0.19	0.44	0.35	0.24	0.40	0.14	0.35
B. Cropland	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
D. Wetlands	0.29	0.30	0.31	0.31	0.32	0.32	0.32	0.33	0.33	0.33
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F. Other Land	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**182.27**	**184.36**	**185.36**	**185.27**	**182.04**	**179.15**	**174.86**	**170.24**	**162.85**	**158.94**
A. Solid Waste Disposal on Land	173.93	176.33	177.19	176.86	173.68	170.45	166.13	161.58	154.25	150.41
B. Waste-water Handling	7.31	6.89	6.87	7.02	6.88	7.00	6.82	6.73	6.56	6.37
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Other	1.03	1.15	1.29	1.39	1.49	1.70	1.91	1.92	2.04	2.16
7. Other *(as specified in Summary 1.A)*	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Memo Items:										
International Bunkers	0.19	0.17	0.19	0.15	0.13	0.11	0.12	0.13	0.14	0.15
Aviation	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03
Marine	0.17	0.15	0.17	0.13	0.11	0.09	0.10	0.11	0.12	0.12
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSIONS TRENDS (CH_4)

Inventory 2003

(Sheet 2 of 5)

Submission 2006 v1.1

(Part 2 of 2)

FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	%
Total CH_4 emissions	**261.74**	**256.10**	**246.32**	**236.60**	**-22.47**
1. Energy	20.37	21.55	21.37	21.71	13.67
A. Fuel Combustion (Sectoral Approach)	17.75	18.32	18.65	18.78	1.13
1. Energy Industries	0.69	0.86	1.05	1.29	220.29
2. Manufacturing Industries and Construction	0.64	0.57	0.59	0.59	-3.64
3. Transport	3.15	3.02	2.93	2.79	-41.39
4. Other Sectors	13.11	13.73	13.95	13.94	10.06
5. Other	0.15	0.14	0.13	0.16	33.89
B. Fugitive Emissions from Fuels	2.62	3.23	2.72	2.93	451.42
1. Solid Fuels	NO	NO	NO	NO	0.00
2. Oil and Natural Gas	2.62	3.23	2.72	2.93	451.42
2. Industrial Processes	**0.71**	**0.71**	**0.68**	**0.70**	**61.93**
A. Mineral Products	NO	NO	NO	NO	0.00
B. Chemical Industry	0.26	0.26	0.23	0.25	32.23
C. Metal Production	0.46	0.45	0.46	0.45	84.80
D. Other Production					
E. Production of Halocarbons and SF_6					
F. Consumption of Halocarbons and SF_6					
G. Other					0.00
3. Solvent and Other Product Use					
4. Agriculture	**90.94**	**89.24**	**90.04**	**88.81**	**-13.21**
A. Enteric Fermentation	78.59	77.53	77.96	76.67	-16.08
B. Manure Management	12.35	11.71	12.08	12.15	10.63
C. Rice Cultivation	NO	NO	NO	NO	0.00
D. Agricultural Soils	NE	NE	NE	NE	0.00
E. Prescribed Burning of Savannas	NE	NE	NE	NE	0.00
F. Field Burning of Agricultural Residues	NE	NE	NE	NE	0.00
G. Other	NE	NE	NE	NE	0.00
5. Land Use, Land-Use Change and Forestry	**0.48**	**0.81**	**0.82**	**0.68**	**-35.64**
A. Forest Land	0.15	0.49	0.49	0.37	-51.65
B. Cropland	NE	NE	NE	NE	0.00
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	0.00
D. Wetlands	0.33	0.33	0.34	0.31	6.03
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	0.00
F. Other Land	IE,NA	IE,NA	IE,NA	IE,NA	0.00
G. Other	NE	NE	NE	NE	0.00
6. Waste	**149.23**	**143.79**	**133.40**	**124.70**	**-31.58**
A. Solid Waste Disposal on Land	140.72	135.25	124.71	116.07	-33.27
B. Waste-water Handling	6.24	6.16	6.20	6.04	-17.37
C. Waste Incineration	NE	NE	NE	NE	0.00
D. Other	2.28	2.38	2.49	2.59	152.39
7. Other ***(as specified in Summary 1.A)***	**NO**	**NO**	**NO**	**NO**	**0.00**
	NO	NO	NO	NO	0.00
Memo Items:					
International Bunkers	0.17	0.15	0.17	0.19	-3.21
Aviation	0.03	0.03	0.03	0.03	10.44
Marine	0.14	0.13	0.14	0.16	-5.23
Multilateral Operations	NO	NO	NO	NO	0.00
CO_2 Emissions from Biomass					

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSIONS TRENDS (N_2O)

(Sheet 3 of 5)

(Part 1 of 2)

Inventory 2003

Submission 2006 v1.1

FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Total N_2O emissions	**25.57**	**23.64**	**21.84**	**22.21**	**22.60**	**23.27**	**23.13**	**23.06**	**22.51**	**22.14**
1. Energy	**1.96**	**1.96**	**2.02**	**2.18**	**2.34**	**2.41**	**2.61**	**2.77**	**2.85**	**2.93**
A. Fuel Combustion (Sectoral Approach)	1.95	1.96	2.02	2.18	2.34	2.41	2.60	2.77	2.85	2.93
1. Energy Industries	0.41	0.45	0.49	0.55	0.65	0.66	0.77	0.78	0.77	0.73
2. Manufacturing Industries and Construction	0.61	0.49	0.45	0.50	0.51	0.49	0.49	0.53	0.51	0.52
3. Transport	0.56	0.63	0.70	0.76	0.82	0.90	0.97	1.09	1.19	1.30
4. Other Sectors	0.35	0.36	0.35	0.34	0.33	0.32	0.34	0.34	0.34	0.34
5. Other	0.02	0.03	0.03	0.03	0.04	0.03	0.04	0.04	0.03	0.03
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
1. Solid Fuels	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2. Oil and Natural Gas	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
2. Industrial Processes	**5.34**	**4.64**	**4.20**	**4.39**	**4.63**	**4.72**	**4.72**	**4.66**	**4.44**	**4.34**
A. Mineral Products	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
B. Chemical Industry	5.34	4.64	4.20	4.39	4.63	4.72	4.72	4.66	4.44	4.34
C. Metal Production	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
D. Other Production										
E. Production of Halocarbons and SF_6										
F. Consumption of Halocarbons and SF_6										
G. Other										
3. Solvent and Other Product Use	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
4. Agriculture	**16.00**	**14.84**	**13.49**	**13.55**	**13.50**	**14.11**	**13.75**	**13.61**	**13.29**	**12.95**
A. Enteric Fermentation										
B. Manure Management	2.15	1.97	1.86	1.83	1.83	1.83	1.87	1.96	1.92	1.86
C. Rice Cultivation										
D. Agricultural Soils	13.85	12.88	11.64	11.72	11.66	12.28	11.88	11.65	11.36	11.09
E. Prescribed Burning of Savannas	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
F. Field Burning of Agricultural Residues	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
5. Land Use, Land-Use Change and Forestry	**0.12**	**0.09**	**0.06**	**0.04**	**0.07**	**0.05**	**0.05**	**0.07**	**0.06**	**0.07**
A. Forest Land	0.09	0.07	0.03	0.01	0.04	0.02	0.03	0.04	0.03	0.05
B. Cropland	NE	IE,NE	NE	NE	NE	NE	NE	NE	NE	NE
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO
D. Wetlands	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F. Other Land	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA	IE,NA
G. Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
6. Waste	**0.53**	**0.52**	**0.51**	**0.50**	**0.51**	**0.52**	**0.53**	**0.52**	**0.51**	**0.50**
A. Solid Waste Disposal on Land										
B. Waste-water Handling	0.46	0.44	0.43	0.41	0.41	0.41	0.40	0.40	0.38	0.36
C. Waste Incineration	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D. Other	0.07	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.13	0.14
7. Other *(as specified in Summary 1.A)*	**1.43**	**1.39**	**1.35**	**1.35**	**1.36**	**1.25**	**1.27**	**1.24**	**1.16**	**1.14**
	1.43	1.39	1.35	1.35	1.36	1.25	1.27	1.24	1.16	1.14
Memo Items:										
International Bunkers	**0.09**	**0.08**	**0.09**	**0.08**	**0.07**	**0.06**	**0.07**	**0.07**	**0.09**	**0.09**
Aviation	0.04	0.04	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04
Marine	0.05	0.05	0.06	0.04	0.03	0.03	0.03	0.03	0.04	0.05
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass										

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSIONS TRENDS (N_2O)
(Sheet 3 of 5)
(Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	%
Total N_2O emissions	**22.25**	**22.02**	**22.34**	**22.69**	**-11.26**
1. Energy	**2.97**	**3.26**	**3.56**	**3.76**	**92.18**
A. Fuel Combustion (Sectoral Approach)	2.97	3.25	3.56	3.76	92.46
1. Energy Industries	0.67	0.89	1.08	1.15	182.99
2. Manufacturing Industries and Construction	0.53	0.50	0.50	0.51	-16.45
3. Transport	1.39	1.49	1.60	1.71	204.55
4. Other Sectors	0.32	0.34	0.35	0.35	-1.65
5. Other	0.04	0.04	0.04	0.05	93.16
B. Fugitive Emissions from Fuels	0.00	0.00	0.00	0.00	-48.94
1. Solid Fuels	NO	NO	NO	NO	0.00
2. Oil and Natural Gas	0.00	0.00	0.00	0.00	-48.94
2. Industrial Processes	**4.40**	**4.14**	**4.31**	**4.58**	**-14.22**
A. Mineral Products	NO	NO	NO	NO	0.00
B. Chemical Industry	4.40	4.14	4.31	4.58	-14.22
C. Metal Production	NO	NO	NO	NO	0.00
D. Other Production					
E. Production of Halocarbons and SF_6					
F. Consumption of Halocarbons and SF_6					
G. Other					0.00
3. Solvent and Other Product Use	0.20	0.16	0.14	0.13	-35.00
4. Agriculture	**13.03**	**12.79**	**12.67**	**12.51**	**-21.82**
A. Enteric Fermentation					
B. Manure Management	1.80	1.76	1.78	1.78	-17.07
C. Rice Cultivation					
D. Agricultural Soils	11.23	11.04	10.89	10.73	-22.56
E. Prescribed Burning of Savannas	NE	NE	NE	NE	0.00
F. Field Burning of Agricultural Residues	NE	NE	NE	NE	0.00
G. Other	NE	NE	NE	NE	0.00
5. Land Use, Land-Use Change and Forestry	**0.07**	**0.07**	**0.07**	**0.07**	**-43.98**
A. Forest Land	0.04	0.04	0.04	0.04	-57.63
B. Cropland	NE	NE	NE	NE	0.00
C. Grassland	NE,NO	NE,NO	NE,NO	NE,NO	0.00
D. Wetlands	0.03	0.03	0.03	0.03	6.05
E. Settlements	NA,NE	NA,NE	NA,NE	NA,NE	0.00
F. Other Land	IE,NA	IE,NA	IE,NA	IE,NA	0.00
G. Other	NE	NE	NE	NE	0.00
6. Waste	**0.51**	**0.52**	**0.51**	**0.52**	**-2.48**
A. Solid Waste Disposal on Land					
B. Waste-water Handling	0.36	0.36	0.34	0.35	-25.36
C. Waste Incineration	NE	NE	NE	NE	0.00
D. Other	0.15	0.16	0.16	0.17	158.58
7. Other *(as specified in Summary 1.A)*	**1.07**	**1.08**	**1.08**	**1.13**	**-20.89**
	1.07	1.08	1.08	1.13	-20.89
Memo Items:					
International Bunkers	**0.10**	**0.09**	**0.10**	**0.10**	**12.63**
Aviation	0.04	0.04	0.04	0.05	10.41
Marine	0.05	0.05	0.05	0.05	14.56
Multilateral Operations	NO	NO	NO	NO	0.00
CO_2 Emissions from Biomass					

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS (HFCs, PFCs and SF_6)
(Sheet 4 of 5)
(Part 1 of 2)

Inventory 2003
Submission 2006 v1.1
FINLAND

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)	(Gg)
Emissions of HFCs[(4)] - (Gg CO2 equivalent)	**0.01**	**0.04**	**0.10**	**0.09**	**6.52**	**29.32**	**77.29**	**167.64**	**245.19**	**316.19**
HFC-23	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	0.00	C,NA,NO	0.00
HFC-32	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.00	0.00	0.01
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-125	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.00	0.01	0.02	0.03
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-134a	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.01	0.04	0.09	0.09	0.13
HFC-152a	0.00	0.00	0.00	0.00	0.00	0.02	0.04	0.04	0.03	0.03
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-143a	NA,NO	NA,NO	NA,NO	NA,NO	0.00	0.00	0.00	0.01	0.02	0.01
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Unspecified mix of listed HFCs[(5)] - (Gg CO2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO	NA,NE,NO
Emissions of PFCs[(4)] - (Gg CO2 equivalent)	**C,NA,NO**	**C,NA,NO**	**C,NA,NO**	**C,NA,NO**	**C,NA,NO**	**C,NA,NO**	**C,NA,NO**	**C,NA,NO**	**1.80**	**30.10**
CF_4	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO
C_2F_6	C,NA,NO	C,NA,NO	NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO
C_3F_8	NA,NO	C,NA,NO	NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	0.00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
$c\text{-}C_4F_8$	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
C_6F_{14}	C,NA,NO	NA,NO	C,NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed PFCs[(5)] - (Gg CO2 equivalent)	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Emissions of SF6[(4)] - (Gg CO2 equivalent)	**86.52**	**59.27**	**28.68**	**27.46**	**27.26**	**57.52**	**37.50**	**41.56**	**27.92**	**34.99**
SF_6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS (HFCs, PFCs and SF_6)

(Sheet 4 of 5)
(Part 2 of 2)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003	Change from base to latest reported year
	(Gg)	(Gg)	(Gg)	(Gg)	%
Emissions of HFCs[(4)] - (Gg CO2 equivalent)	**501.60**	**581.97**	**396.46**	**733.06**	**5 817 868.73**
HFC-23	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	0.00
HFC-32	0.00	0.01	NA,NO	0.01	100.00
HFC-41	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-43-10mee	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-125	0.03	0.05	0.03	0.06	100.00
HFC-134	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-134a	0.24	0.20	0.13	0.16	100.00
HFC-152a	0.02	0.00	0.00	0.00	2 854.44
HFC-143	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-143a	0.02	0.04	0.04	0.06	100.00
HFC-227ea	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-236fa	NA,NO	NA,NO	NA,NO	NA,NO	0.00
HFC-245ca	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed HFCs[(5)] - (Gg CO2 equivalent)	NA,NE,NO	NA,NO	NA,NO	148.25	100.00
Emissions of PFCs[(4)] - (Gg CO2 equivalent)	**22.18**	**19.74**	**12.60**	**14.86**	**100.00**
CF_4	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	0.00
C_2F_6	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	0.00
C_3F_8	0.00	0.00	0.00	0.00	100.00
C_4F_{10}	NA,NO	NA,NO	NA,NO	NA,NO	0.00
$c\text{-}C_4F_8$	NA,NO	NA,NO	NA,NO	C,NA,NO	0.00
C_5F_{12}	NA,NO	NA,NO	NA,NO	NA,NO	0.00
C_6F_{14}	NA,NO	NA,NO	NA,NO	NA,NO	0.00
Unspecified mix of listed PFCs[(5)] - (Gg CO2 equivalent)	NA,NO	NA,NO	NA,NO	1.06	100.00
Emissions of SF6[(4)] - (Gg CO2 equivalent)	**31.86**	**35.85**	**33.46**	**62.26**	**-28.04**
SF_6	0.00	0.00	0.00	0.00	-28.04

Note: All footnotes for this table are given at the end of the table on sheet 5.

TABLE 10 EMISSION TRENDS (SUMMARY)
(Sheet 5 of 5)
(Part 1 of 2)

Inventory 2003
Submission 2006 v1.1
FINLAND

GREENHOUSE GAS EMISSIONS	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)
CO2 emissions including net CO2 from LULUCF(3)	35 676.75	19 777.23	24 793.48	28 831.58	44 817.84	43 006.20	40 573.66	46 134.97	43 341.22	41 825.86
CO2 emissions excluding net CO2 from LULUCF(3)	57 116.61	55 945.47	54 823.19	56 450.05	61 973.21	58 414.02	63 499.55	63 020.50	59 529.18	58 841.18
CH_4	6 409.02	6 386.52	6 364.67	6 373.11	6 329.77	6 187.65	6 118.67	6 046.32	5 847.84	5 719.80
N_2O	7 928.02	7 327.88	6 770.01	6 885.50	7 006.11	7 212.71	7 171.62	7 150.12	6 976.79	6 864.44
HFCs	0.01	0.04	0.10	0.09	6.52	29.32	77.29	167.64	245.19	316.19
PFCs	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	C,NA,NO	1.80	30.10
SF_6	86.52	59.27	28.68	27.46	27.26	57.52	37.50	41.56	27.92	34.99
Total (including net CO2 from LULUCF(3)	**50 100.32**	**33 550.95**	**37 956.95**	**42 117.74**	**58 187.50**	**56 493.39**	**53 978.73**	**59 540.62**	**56 440.76**	**54 791.37**
Total (excluding net CO2 from LULUCF)(3), (6)	**71 540.19**	**69 719.19**	**67 986.65**	**69 736.21**	**75 342.87**	**71 901.22**	**76 904.63**	**76 426.16**	**72 628.71**	**71 806.70**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	Base year (1990)	1991	1992	1993	1994	1995	1996	1997	1998	1999
	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)
1. Energy	54 540.94	53 676.67	52 845.45	54 774.35	60 080.34	56 693.83	61 978.92	61 002.36	57 586.57	56 831.03
2. Industrial Processes	5 219.15	4 704.57	4 290.78	4 120.40	4 482.10	4 416.70	4 322.57	4 935.71	4 883.73	5 034.34
3. Solvent and Other Product Use	177.72	169.03	157.04	149.45	145.49	139.99	135.59	133.83	134.49	132.84
4. Agriculture	7 108.44	6 666.36	6 187.42	6 203.42	6 197.48	6 308.85	6 208.86	6 196.74	6 057.42	5 925.11
5. Land Use, Land-Use Change and Forestry(7)	-21 381.36	-36 126.95	-29 994.08	-27 595.98	-17 118.49	-15 377.99	-22 897.19	-16 848.24	-16 160.56	-16 977.97
6. Waste	3 991.82	4 031.88	4 051.79	4 046.80	3 980.43	3 924.70	3 834.95	3 736.89	3 578.20	3 494.06
7. Other	443.61	429.39	418.54	419.31	420.15	387.32	395.04	383.33	360.91	351.96
Total (including LULUCF)(7)	**50 100.32**	**33 550.95**	**37 956.95**	**42 117.74**	**58 187.50**	**56 493.39**	**53 978.73**	**59 540.62**	**56 440.76**	**54 791.37**

GREENHOUSE GAS EMISSIONS	2000	2001	2002	2003
	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)
CO2 emissions including net CO2 from LULUCF[3]	41 402.45	43 676.59	46 102.24	55 404.32
CO2 emissions excluding net CO2 from LULUCF[3]	57 727.13	62 738.77	65 004.63	73 283.96
CH_4	5 496.45	5 378.20	5 172.70	4 968.67
N_2O	6 897.78	6 825.29	6 925.41	7 035.33
HFCs	501.60	581.97	396.46	733.06
PFCs	22.18	19.74	12.60	14.86
SF_6	31.86	35.85	33.46	62.26
Total (including net CO2 from LULUCF)[3]	**54 352.31**	**56 517.63**	**58 642.87**	**68 218.51**
Total (excluding net CO2 from LULUCF)[3], [6]	**70 676.99**	**75 579.82**	**77 545.26**	**86 098.15**

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	2000	2001	2002	2003
	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)	CO2 equivalent (Gg)
1. Energy	55 595.09	60 797.91	63 344.34	71 298.75
2. Industrial Processes	5 343.86	5 270.57	4 939.64	5 788.57
3. Solvent and Other Product Use	132.29	118.64	109.86	104.11
4. Agriculture	5 949.12	5 840.25	5 819.18	5 742.27
5. Land Use, Land-Use Change and Forestry[7]	-16 292.27	-19 024.54	-18 863.54	-17 845.00
6. Waste	3 292.26	3 180.05	2 958.72	2 778.89
7. Other	331.96	334.77	334.67	350.92
Total (including LULUCF)[7]	**54 352.31**	**56 517.63**	**58 642.87**	**68 218.51**

(1) The column "Base year" should be filled in only by those Parties with economies in transition that use a base year different from 1990 in accordance with the relevant decisions of the COP. For these Parties, this different base year is used to calculate the percentage change in the final column of this table.

(2) Fill in net emissions/removals as reported in table Summary 1.A. For the purposes of reporting, the signs for removals are always negative (-) and for emissions positive (+).

(3) The information in these rows is requested to facilitate comparison of data, because Parties differ in the way they report CO_2 emissions and removals from LULUCF.

(4) Enter actual emissions estimates. If only potential emissions estimates are available, these should be reported in this table and an indication for this be provided in the documentation box. Only in these rows are the emissions expressed as CO_2 equivalent emissions.

(5) In accordance with the UNFCCC reporting guidelines, HFC and PFC emissions should be reported for each relevant chemical. However, if it is not possible to report values for each chemical (i.e. mixtures, confidential data, lack of disaggregation), this row could be used for reporting aggregate figures for HFCs and PFCs, respectively. Note that the unit used for this row is Gg of CO_2 equivalent and that appropriate notation keys should be entered in the cells for the individual chemicals.

(6) These totals will differ from the totals reported in table Summary 2 if Parties report non-CO_2 emissions from LULUCF.

(7) Includes net CO_2, CH_4 and N_2O from LULUCF.

Documentation box:
• Parties should provide detailed explanations on emissions trends in Chapter 2: Trends in Greenhouse Gas Emissions and, as appropriate, in the corresponding Chapters 3 - 9 of the NIR. Use this documentation box to
• Use the documentation box to provide explanations if potential emissions are reported.

Acknowledgements

During the preparation of the Fourth National Communication of Finland the goal was to ensure an open process by offering the opportunity for different stakeholders and other parties to contribute to the discussion about the contents of the National Communication.

Information on the preparation of the National Communication of Finland was provided on the website established for comments to the Communication. The website gave details about the status of the National Communication as the Finnish Government's official report to the UN Climate Secretariat and about the timetable of the reporting. The website also informed about the possibility to give comments on the contents of the National Communication and instructed how to submit comments to the editorial board of the National Communication.

Information about the commenting was sent by email to the relevant ministries, research institutes, enterprises and citizen's organisations (to a total of over 80 organisations and to 270 email addresses). Comments were received from 16 organisations, mainly from ministries and research institutes, such as the Ministry of Agriculture and Forestry and the University of Helsinki, the Division of Atmospheric Sciences. Once approved by the editorial board, account was taken of all the relevant comments in compiling the National Communication.

The Editorial Board gratefully acknowledges the contribution of the commentors for their efforts and suggested modifications to improve the National Communication. It also wishes to express its gratitude to the many data providers from the ministries, research and other institutes and organisations.

List of the organisations informed about the commenting:

Academy of Finland
Agrifood Research Finland
Central Organisation of Finnish Trade Unions
Central Union of Agricultural Producers and Forest Owners
Civil Aviation Administration
Confederation of Finnish Industries
Energy Market Authority
Evangelical Lutheran Church of Finland
Federation of Finnish Commerce
Federation of Finnish Enterprises
Finnish Association for Nature Conversation
Finnish Centre for Health Promotion
Finnish Centre for Pensions
Finnish Energy Industries
Finnish Environment Institute
Finnish Federation for Communications and Teleinformatics
Finnish Forest Industries Federation
Finnish Forest Research Institute
Finnish Institute of Marine Research
Finnish Meteorological Institute
Finnish National Board of Education
Finnish Oil and Gas Federation
Finnish Road Administration
Finnish Transport and Logistics
Finnish UN Association
Friends of the Earth Finland
Geological Survey of Finland
Government Institute for Economic Research
Greenpeace Nordic
Helsinki School of Economics
Helsinki University of Technology
Lappeenranta University of Technology
Nature League
Metsähallitus
Ministry for Foreing Affairs
Ministry of Agriculture and Forestry
Ministry of Defence
Ministry of Education
Ministry of Finance
Ministry of Justice
Ministry of Labour
Ministry of Social Affairs and Health
Ministry of the Environment
Ministry of the Interior
Ministry of Trade and Industry
Ministry of Transport and Communications
Motiva Oy
National Land Survey of Finland
National Public Health Institute
National Research and Development Centre for Welfare and Health
National Technology Agency of Finland

Orthodox Church Finland
Labour Institute for Economic Research
Prime Minister's Office
Radiation and Nuclear Safety Authority
Service Centre for Development Cooperation
Statistics Finland
Technology Industries in Finland
The Association of Automobile Importers in Finland
The Association of Finnish Local and Regional Authorities
The Central Union of Swedish-speaking Agricultural Producers in Finland
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The Finnish Consumer's Association
The Finnish Metalworkers Union
The Finnish National Commission on Sustainable Development
The Finnish National Fund for Research and Development
The Finnish Tax Administration
The Green League
The Research Institute of the Finnish Economy
The Saami Parliament
The Union of Health and Social Care Professionals
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University of Oulu
University of Rovaniemi
University of Tampere
University of Turku
VTT (Technical Research Centre of Finland)
WWF Finland
Ålands landskapsregering

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FI–00023 GOVERNMENT, FINLAND

951–731–360–8 (volume)
951–731–361–6 (pdf)

Printed by:
Hämeen Kirjapaino Oy, Tampere